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UNIVERSITY OF CALIFORNIA SANTA CRUZ

CULT AND COPPER: INTRA-ACTIONS FROM THE BRONZE AGE TO A-LIFE

A dissertation submitted in partial satisfaction
of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

FILM & DIGITAL MEDIA

by

Casondra M. Sobieralski

June 2022

The Dissertation of Casondra M. Sobieralski
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Vice Provost and Dean of Graduate Studies

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Casondra M. Sobieralski

2022

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Abstract: “Cult and Copper: Intra-Actions from the Bronze Age to A-Life”
Casondra M. Sobieralski

Some media archaeologist look to the Victorian Era as the starting point for the Digital Era because the nineteen century telegraph laid the conceptual groundwork for the internet and solved electrification. However, Victorian innovations relied on the conductivity of copper, and the Bronze Age is when humans first mastered wide-scale copper production. In the Bronze Age Levant, two closely related love and sexuality goddesses were associated with this production: Hathor (from Egypt) and Astarte (from Canaan). Thus this research project positions the Bronze Age period as the early dawn of the Digital Era, and it mytho-poetically re-casts these feminine deities as “proto-cybergoddesses” because of their role, as per ancient belief systems, in digital media technology history. This exploration of copper as an agential actor in the history of networked information systems (telegraph, telephone, internet) relies on methodologies from media archaeology, elemental media, posthumanism, agential realism, and Archaeology.

This story then serves as a case study for a Virtual Reality cyber-archaeology game. Cyberarchaeology trends encourage the creation of multi-sensory projects that leverage the affordances of multi-media and strive to create embodied experiences. Few projects dare, however, to speculate about intangible heritage. As an exception, this game is the result of textual research in Archaeology, cyber-archaeology, and Human Computer Interaction; international archaeology museum research; documentary field work at archaeology sites in Israel and Cyprus; interviews with archaeologists and curators; collaborative design ideation using improvisational theater techniques; and a collaboration with Serious Games

engineering graduate students to realize a playable prototype. In “Cult and Copper,” players use their own breath, via a simulated breath interface, to control a smelting fire and ensure a successful copper smelt. Early smelting methods, which employed blowpipes to heat smelting furnaces, required deep and sustained breathing techniques. Thus this cyberarchaeology game probes, what if altered states manipulated by breath were one of the reasons shamanism and smelting were linked? The game facilitates an experiential awareness of smelting’s physiological effects via breath, encourages players to ask questions about intangible heritage aspects of copper smelting, and motivates further scholarly investigation.

Acknowledgements

Many thanks to a long list of contributors to this collaborative project including the Serious Games Program at University of California, Santa Cruz: Timna Studios (Amber Sargeant, Wenbo Xie, Yichen Yao, and Yuanzhou Wu), Steven Goodale, Dr. Magy Seif El-Nasr, and Dr. Edward Melcer. Thank you also to Bronze Age Productions participants including Walter Fasnacht of Zurich University/Almyras Excavation in Cyprus; Dr. Daniela DeAngeli of University of Bath; UC Berkeley Anthropology Professor Emeritus Ruth Tringham; Despoina Sampatakou of University of York; game designer Dr. Anamaria Ciucanu; former Jim Henson Muppet artist Luise Shafritz; performer/gamer Kathryn Kane, and others; Heather Kelley from the Carnegie Mellon University Entertainment Technology department for her Hathor frame drum recordings and advice; Dr. Stephen Martin and Dr. Saied Haidarian for their narrative voice performances; and Andrew Sobieralski for his engineering research on low-cost, DIY, open source code spirometers to guide our breath interface development. I also express much gratitude to Dr. Erez Ben-Yosef from Tel Aviv University for welcoming me to observe his 2017 excavation in Timna, for inspiring my imagination, for pointing me to research resources, and for patiently enduring years of related email questions. Thank you to Dr. Adina Paytan for jump-starting this project by including me on her 2017 research trip to Israel via the International Research Experience for Students in Coastal Zone Research (IRES) program. IRES is a National Science Foundation (NSF) funded program. Other funding for this project came from SSRC-Mellon Foundation, the UC Santa Cruz Film & Digital Media department, and Florence French. And of course, thank you to my ever-insightful, helpful, and patient advisors at UC Santa Cruz, Dr. Susana Ruiz, Dr.

Elaine Sullivan, and Dr. Anna Friz. A separate, special thank you goes to Dr. Stephen Martin for all of his grounding, support, and encouragement through this endeavor, especially as I conducted it through a trying global pandemic. You have been my shining light, my dear friend, since our 2017 adventures on the IRES team.

This research project is dedicated to my STEM-focused niece Skyler, teenage robotics competitions goddess. It is also dedicated to my nephew Griffen, who loves history, archaeology, and video games.

Immersion in the World of Cult and Copper: Introduction

This Digital Media critical practice project brings overdue awareness to an unsung ancient tale. The story divulged herein takes place in the Bronze Age Levant, when and where goddesses of love and sexuality were also goddesses associated with copper. Through a media archaeology lens, I celebrate copper's role as a medium and as an agential actor in the history of networked information systems up to and including the internet. That history, I argue, dawns with the development of wide-scale copper production in the Bronze Age. During that era in Syro-Palestine and in Cyprus, copper procurement and production was protected, in the ancient worldview, by two closely related love and sexuality goddesses: Hathor (from Egypt) and Astarte (from Canaan). Thus I mytho-poetically re-cast these deities as "proto-cyber-goddesses."

My refreshed mythology is a historical nod to cyberfeminists' artistic and scholarly works of the 1990s, but with a contemporary acknowledgement that some of the ideals they expressed were met while some are still left unrealized. Cyberfeminists wrote "manifestas"[1] describing a world in which computer technology served as the bridge across the gender divide; they saw an opportunity for the gender ambiguity of cyberspace to liberate women from having their minds prejudged because they embodied female forms. They championed cyber realms as new alternative spaces, free from patriarchal barriers, for their voices to be heard, their art to be seen, their

[1] "Manifesta" is a deliberately feminized version of the word manifesto. Third Wave feminists Jennifer Baumgardner and Amy Richards popularized the term with their book by the same name. See: Jennifer Baumgardner and Amy Richards, *Manifesta: Young Women, Feminism, and the Future* (New York: Farrar, Straus and Giroux, 2000).

businesses to thrive (including with more flexibility for entrepreneuring mothers to work from home), and their activism to become global.[2] Cyberfeminists such as philosopher Sadie Plant played with feminine mythic metaphors, such as linking the world wide web to the Greek spider goddess Arachne, and likening VR caves to womb-like spaces.[3] She played linguistically with connecting digital networking concepts to practices traditionally associated with women.[4] Though one might critique some of her ideas as being essentialist today, she saw systems-oriented thinking as a natural extension of the important social networking and multitasking that women have always done.[5] Not all cyberfeminists, however (Plant being a notable exception[6]), heeded the material aspects of media technology production, such as environmental impacts and labor practices/processes. This work updates earlier cyberfeminist work by making themes of materiality central.

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[2] For more on cyberfeminism see: Lamis Alshejni, "Unveiling the Arab Woman's Voice Through the Internet," in *Women@Internet: Creating New Cultures in Cyberspace,* ed. Wendy Harcourt (London/NY: Zed Books, 1999), 214-218; Sarah Diamond, "Taylor's Way," in *Processed Lives: Gender and Technology in Everyday Life*, ed. Jennifer Terry and Melodie Calvert (London/NY: Routledge, 1997); Farideh Farhi, "Information Technologies and Identity in Iran," in *Women@Internet: Creating New Cultures in Cyberspace,* ed. Wendy Harcourt (London/NY: Zed Books, 1999), 206-213; Sohail Inayatullah and Ivana Milojevic, "Exclusion and Communication in the Information Era: From Silences to Global Conversations," in *Women@Internet: Creating New Cultures in Cyberspace,* ed. Wendy Harcourt (London/NY: Zed Books, 1999), 76-88; Sadie Plant, *Zeros + Ones: Digital Women + the New Technoculture* (London: Fourth Estate, 1997).
Also see my own prior work, "Cyberfeminism, Third World Women, and the Greening of the Computer Industry," 2004, https://pelefire.com/casondra/pages/essays/text/cyberfem.pdf.
[3] Sadie Plant, *Zeros + Ones: Digital Women + the New Technoculture* (London: Fourth Estate, 1997), 65-72, 178-180.
[4] Plant coined the term cyberfeminism in 1994. She was the director of the Cybernetic Culture Research Unit at the University of Warwick in Britain. See: Mia Consalvo, "Cyberfeminism," Encyclopedia of New Media (Thousand Oaks, CA: SAGE, 2002), 9-10. Last edited April 4, 2012. https://study.sagepub.com/sites/default/files/Ch17_Cyberfeminism.pdf
[5] Leslie Regan Shade, *Gender and Community in the Construction of the Internet* (NY: Peter Lang Publishing, 2002), 62.
[6] Sadie Plant, *Zeros + Ones: Digital Women + the New Technoculture* (London: Fourth Estate, 1997), 48-50, 76-81, 244.

I then used this historical story of copper's relationship to fecundity goddesses as a case study to design a meditative, Virtual Reality cyber-archaeology game. Driven by deep and sustained breathing, the game affords the player a simulated sense of what it could have been like to be an ancient smelter using blowpipe technology to heat a crucible. In so doing, this piece creates an embodied sense of the intangible heritage practices surrounding copper production. The VR piece also reveals esoteric reasons that Bronze Age copper production seems to have been tied to shamanism and goddesses cults.

This project uses media archaeology–a subset of Media Studies–and the social science discipline of Archaeology to think through cyber-archaeology design processes. As an introductory definition, the term media archaeology refers to a collection of fluid and evolving methodologies for considering alternative or unexcavated media histories.[7] Media archaeologists deconstruct beyond the semiotics of what is written, broadcast, or otherwise conveyed to analyze the material aspects of media. To Jussi Parkikka, for example, this includes holistically examining the production of those materials and elucidating the environmental consequences of that production. The material aspects of digital media, specifically, can include computers, their components, the natural resources from which those components are composed, and the material conditions of the labor that produced the electronics.[8] Cyber-archaeology is a term that describes practices that employ digital technologies for the purpose of representing the ancient past. About thirty years ago (1990s), digital heritage projects began embracing evolving computer

[7] For more detail, as articulated in chapter 1 of this work, see: Shannon Christine Mattern, *Code + Clay ... Data + Dirt: Five Thousand Years of Urban Media* (Minneapolis: University of Minnesota Press, 2017), xv-xvi.
[8] Jussi Parikka, *A Geology of Media* (Minneapolis: University of Minnesota Press, 2016), 1-3.

graphics techniques to create 3D models of monuments and artifacts.[9] Contemporary cyber-archaeology endeavors to expand approaches to digital heritage. Whereas early digital archaeology projects tended to focus on static "things," new trends in the field seek to establish interpretation, meaning, and context by using more fluid digital affordances that are now available. Such affordances allow for multi-sensory, participatory, and embodied approaches to storytelling.[10]

Through an interdisciplinary approach, this project makes contributions to both media archaeology discourse and cyber-archaeology design. Methods I used towards this aim included textual research, museum research of artifacts, documentary field research at archaeology sites, consultations with museum curators and field archaeologists, and Zoom-based lessons in Bronze Age smelting techniques with an experimental archaeologist based in Switzerland.[11] To sort, order, and sift this research such that I could synthesize it into a game, I invented a method of collaborative design ideation using Zoom to lead improvisational theater techniques with an international "troupe" of archaeologists, performers, and game

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[9] As one example that I was involved with directly, see: Kevin Cain with Casondra Sobieralski and Philippe Martinez, "Reconstructing a Colossus of Ramesses II from Laser Scan Data," in *ACM SIGGRAPH 2003 Sketches and Applications*, ed. ACM SIGGRAPH 2003 (New York, NY: Association for Computing Machinery, 2003), https://dl.acm.org/doi/10.1145/965400.965514.

[10] See: Mauritzio Forte, "Cyber Archaeology: 3D Sensing and Digital Embodiment," in *Digital Methods and Remote Sensing in Archaeology: Archaeology in the Age of Sensing*, ed. Maurizio Forte and Stefano Campana (Cham: Springer International Publishing, 2016), 276-277, 282, 287; Eva Pietroni, "From Remote to Embodied Sensing: New Perspectives for Virtual Museums and Archaeological Landscape Communication." in *Digital Methods and Remote Sensing in Archaeology: Archaeology in the Age of Sensing*, ed. Maurizio Forte and Stefano Campana (Cham: Springer International Publishing, 2016), 438-439; Jeffrey Stuart, *"Challenging Heritage Visualisation: Beauty, Aura and Democratisation," Open Archaeology 1, no. 1 (n.d.):* 144–145, https://doaj.org/article/b6a0e825a9a744a79ed72c7d64d2abb5; and Alice Watterson, "Beyond Digital Dwelling: Re-Thinking Interpretive Visualisation in Archaeology." *Open Archaeology 1, no. 1 (n.d.): 119-121,* https://doaj.org/article/184fd6853fcf45e8917f96b705280730.

[11] For two years the covid-19 pandemic unfortunately precluded working together in Europe, despite having secured funding to do so.

designers. That design research allowed me to compose polished design documents that communicated my vision to engineering graduate students. Through collaboration, we merged my historical research and narrative design with their technical prowess to realize a playable prototype of the "Cult and Copper" Virtual Reality game.

Often media archaeologists look to the Victorian Era as the genesis of the Digital Era. Tom Standage, for example, outlines how the nineteenth century telegraph and telephone laid the conceptual and infrastructural groundwork for the internet.[12] Parikka writes that copper has been core to technical media since the nineteenth century.[13] Copper wires allowed for signal transmission via the telegraph and telephone, and they were also crucial for the Victorian innovation of electrification, without which digital tools would not exist. Paul DeMarinis draws connections among telecommunications networks–including the Victorian telegraph–and digital culture in relation to the transmission of signal, noise, and code.[14] Frances Dyson argues that "New Media" are not really new, and that prior technologies inform the information age. She points to the Victorians' use of techno-spiritualist expressions to describe transmission technologies, and notes that such expressions carried through time to describe digital media experiences, particularly within Virtual Reality.[15] However, I argue that Victorian innovations that relied on the conductive

[12] Tom Standage, *The Victorian Internet: The Remarkable Story of the Telegraph and the Nineteenth Century's On-Line Pioneers* (New York, NY: Berkley Books, 1999), 7-14, 206-207.
[13] Jussi Parikka, *A Geology of Media* (Minneapolis: University of Minnesota Press, 2016), 33.
[14] Paul DeMarinis, "Erased Dots and Rotten Dashes, or How to Wire Your Head for Preservation," in *Media Archaeology: Approaches, Applications, and Implications,* ed. Erkki Huhtamo and Jussi Parikka (Berkeley: University of California Press, 2011), 211-238.
[15] Frances Dyson, *Sounding New Media: Immersion and Embodiment in the Arts and Culture* (Berkeley: University of California Press, 2009), 7-11.

and transductive properties of copper have a deeper history yet, and unearthing cultic aspects of that history yields broader perspectives about digital media's history. Victorians, afterall, would not have been able to employ copper in their technological achievements without the Bronze Age innovators and laborers–and even before them the Chalcolithic (Stone Bronze Age) thinkers and workers–who figured out how to craft copper metal from rocks in the first place. The blending of theory and praxis that is embraced in some contemporary approaches to Media Studies is clearly age-old.

In antiquity, the dangerous, precarious, and uncertain endeavor of copper production was steeped in magic and mysticism. Naturally within this world view, copper production relied on divine intervention. In the Levant that intervention was associated with two closely related goddesses: the Egyptian Hathor and the Canaanite Ba'alat, later called Astarte. These goddesses made their way from Egypt-occupied Syro-Palestine to Cyprus when the center of copper production migrated north to the island from the southern Negev. When the Greeks settled in Cyprus, they renamed Astarte, the Near Eastern copper goddess worshipped there, Aphrodite. In positioning Hathor and Astarte as the foremothers of networked culture and computers, I am melting down an established history that suggests that the Digital Age is rooted in modernity and in technical innovations credited mostly to men. Instead I forge a new feminized techno-mythology that links past and present using copper as the through-line. I examine how women in the Bronze Age and in the preceding Chalcolithic era might have contributed to these earliest days of industry and to digital technology history as well.

After investigating my Bronze Age story as a case study, I applied design questions to the creation of a cyber-archaeology media project that explored the relationship between cult and copper in the Levant. For example, how can one design interactions within a virtual world to convey concepts of relationality between human and non-human actors? How can elements such as fire become actors with agency? My overarching design challenge was how to improve upon conventional interaction design for virtual heritage/cyber-archaeology because in the existing historical VR pieces that I played, interactive elements were not meaningfully integrated into the story. Interactive affordances missed opportunities to convey historical context and meaning by failing to demonstrate how past peoples might have interacted with their tools, their environments, or each other. This lack of relevance between story and interaction mechanisms broke my sense of immersion in narrative pasts. In this cult and copper VR game, interaction via breathing actually creates the story and harkens the time period.

Breath became central to this design concept because Walter Fasnacht, an experimental archaeologist from University of Zurich who was guiding part of my research on ancient smelting, suggested to me that the early relationship between smelting and shamanism might have had something to do, in part, with hallucinatory states related to breath.[16] Fasnacht explained that prior to the invention of bellows for pumping air into furnaces, smelters used blowpipes. A smelt using blowpipes required a group of about four to six smelters to engage in deep, sustained breathing

[16] Toxic smelting fumes and oxygen deprivation can also create hallucinatory states if novice smelters sit too close to the smelting crucible. Obviously, though, these variables are not safe to experiment with in a museum experience.

for about two hours.[17] The potential relationship between breath and shamanism made sense to me in relation to meditative practices such as pranayama (breath focused) yoga, Holotropic breathwork, and even Lamaze breathing techniques for birthing.[18] Further, designing around the concept of breath increases another type of immersion that other game theorists do not typically address. That immersion is what game designer and yogini Carrie Heeter calls interoception. Interoception implies a sensory awareness of bodily systems (like breath), the environment that the body occupies, and the interplay between the two. Interoception, she says, focuses on the present moment and is synonymous with embodied presence. Since virtual worlds, like internal worlds, are experienced by the body, Heeter sees the potential of both meditative arts and Virtual Reality to enhance interoception.[19] Thus I decided to create a virtual experience that allowed participants to explore and question, through an experiential embodied approach, this speculation about the role of breath as related to the intangible heritage surrounding cult and copper.

I created a design document for a non-competitive, experiential Virtual Reality experience, or game, intended for visitors in a museum setting. Then to realize the vision, I established a collaboration with graduate students from the University of California, Santa Cruz Serious Games program, a subset of the Engineering department. The Serious Games students built a playable prototype from my design

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[17] Conversation with Walter Fasnacht, Experimental Archaeologist at University of Zurich, Switzerland. Interviews via Zoom, December 23, 2020 and April 16, 2021.

[18] For general explanations on these various forms of breathwork, see: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3415184/ & https://www.yogajournal.com/practice/beginners/how-to/pranayama (pranayama), http://www.holotropic.com/holotropic-breathwork/about-holotropic-breathwork/ (Holotropic), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3209750/ (Lamaze)

[19] Carrie Heeter, "A Meditation on Meditation and Embodied Presence," *Presence: Teleoperators & Virtual Environments* 25, no.2 (November 2016): 175-183, DOI: 10.1162/PRES_a_00256.

documents and from media assets that I compiled from my 2017, 2018, and 2019 fieldwork and museum research in Israel and Cyprus. The VR game specifically focuses on the relationship between copper smelting and shamanism and employs a simulated breath interface to drive the action.[20] The game objective is to ensure a successful copper smelt using a breathing technique derived from pranayama yoga to heat and maintain a furnace via blowpipes.

This interdisciplinary treatise includes three chapters. The aim of chapter one, "Copper, Media, and Materiality," is to expand the temporal frame around digital culture by arguing that its roots lie in the Bronze Age, not just in the Victorian Era. It establishes how media materialism, posthumanism, and cybernetic theory–ideas which some contemporary media archaeology theorists embrace–can offer perspectives through which to define copper as a material medium. Each of these theoretical discourses considers the material conditions of technologies; such considerations are applicable whether those technologies allow for copper production or digital computation. Each thought system challenges binaries between "nature" and cultural practices including labor and innovation. Posthumanism in particular deconstructs binaries between organism and machine. Archaeology, then, by definition studies materiality via remains of the past. Archaeology necessarily considers tools/technologies, environments, and cultural practices relationally to

[20] Char Davies utilized a breath interface in her VR art piece "Osmose" in 1995. However, Davies utilized breath for navigation through space, and balancing within space, as an alternative to an interface such as a joystick. By mirroring the techniques of scuba diving, the participant breathed in to float upward and breathed out to descend. In contrast, "Cult and Copper" is about finding stillness and settling into the body through breath. Both pieces, however, use bodily awareness to heighten a sense of immersion. See: http://www.immersence.com/osmose/

suggest interpretations of how past peoples lived. Thus chapter one considers how some specific thought systems used within Media Studies and approaches to Archaeology can inform one another. Through these complementary methods I establish an interpretation of how copper, by changing social structures and social practices, functioned as an agential medium in the Bronze Age. Chapter one then takes an imaginative turn to speculate about the role of copper in a future that includes quantum computing. In this future, quantum computing hastens the drive towards emergence and artificial life, both of which have digital media applications, particularly in gaming. Copper's speculative relationship to this flourishing of artificial life, or "a-life," mythically ties copper back to the love/sexuality goddesses who were originally associated with the fecundity of the earth, including copper ore, plus copper production.

Chapter one is a direct response to Jussi Parikka's *A Geology of Media.* I take inspiration from Parikka's "deep media archaeology" idea that geological elements, including minerals that are extracted from the Earth and used to construct electronic components, are themselves media.[21] Copper is one such mineral, and I build on Parikka to include the Bronze Age in the discussion of copper's role in media technology history. This chapter also is in dialogue with the work of media archaeologist Shannon Mattern, who looks at ancient cities as networks. Mattern argues that media archaeology discourse skews towards the masculinist by ignoring contributions of women or the feminine; it also focuses on machines to the exclusion

[21] Jussi Parikka, *A Geology of Media* (Minneapolis: University of Minnesota Press, 2016), 3-4.

of people interacting with those tools and toys.[22] This research project as a whole seeks to rebalance such masculinization. Following Mattern's approach, my story of copper and Levantine goddesses seeks to bridge media archaeology and Archaeology by going deeper in time. Second, in shining a light on the role of copper goddesses as part of techno-social history, I am adding a "feminized" dimension to media archaeology discourse.[23]

Chapter 2, "Copper and the Goddess," takes a deep dive into a very specific aspect of the history of copper in the Bronze Age Levant: the relationship between goddess cults and copper. It examines the role of the Egyptian goddess Hathor in the mining camp of Timna (located in modern Israel), the importance of Astarte in Canaan, and how the two similar goddesses intertwined. When the Phoenicians from northern Canaan established copper production facilities in Cyprus, they took Astarte with them and built temples to her next to their copper workshops. Representations of Hathor and Astarte often continued to appear in the same ritual places on the island.

The respective tourism industries of both Timna and Cyprus promote particular narratives about goddesses and copper production. The Cypriot Ministry of Tourism even recommends an Aphrodite itinerary for travelers to follow which includes goddess temples, "goddess" related artifact troves at copper production sites, and a stop at the mythical birthplace of Aphrodite.[24] However, contemporary archeologists challenge these popular culture versions of ancient history. While these stories as

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[22] Shannon Christine Mattern, *Code + Clay ... Data + Dirt: Five Thousand Years of Urban Media* (Minneapolis: University of Minnesota Press, 2017), xv.
[23] Ibid., xv.
[24] https://www.visitcyprus.com/files/cultural_routes/Aphrodites_Cultural_Route_brochure_EN.pdf

presented at Timna and throughout Cypriot archaeology sites are fun and satisfying to the imagination, they tend to be grossly oversimplified. In some cases they are even in conflict with new archaeological interpretations. Thus chapter two looks at the narratives promoted by the tourism industry and then engages with critical deconstructions of those narratives. Challenges and updates to popular Timna narratives come from archaeologists including Uzi Avner and Erez Ben-Yosef. In Cyprus, archaeologists Bernard Knapp, Rebecca Bolger, and Daisy Knox inform deeper, more theoretical approaches to deciphering representations of the feminine–including when such representations might or might not indicate goddesses–and to considering the role that copper played in the social history of antiquity. Along with expanding media archaeology discourse, research for this chapter served to help me understand intersecting Bronze Age histories. Stepping into these ancient worlds informed me as a worldbuilder and designer so that I could select and represent a slice of those histories for an immersive cyber-archaeology game.

Chapter 3, "Expressing History Through Intra-Action: Contributions to cyber-archaeology through the "Cult and Copper" Virtual Reality Game," describes my process and methodology for creating the designs for the VR game "Cult and Copper." The chapter opens by briefly describing how I approached my historical research process for worldbuilding (the fruits of which are detailed in chapter 2), and then defines how I position myself in relation to existing cyber-archaeology discourse. This discourse–informed by creative and scholarly thinkers Eva Pietroni, Tara Jane Copplestone, Christopher Johanson, Diane Favro, Alice Watterson, Mauritzio Forte, Jeffrey Stuart, Erik Champion–includes perspectives on how to effectively employ the affordances of multimedia to create multi-sensory digital

archaeology experiences. Many of these scholars value creative process over completed models because the process of creating a model requires thinking through doing; through process new knowledge is created. Chapter three also explores perspectives regarding how to balance empirical knowledge with interpretation/imagination in creating virtual archaeology experiences. How does a designer make clear to an audience what is known fact and what is speculative interpretation? This question becomes especially challenging when attempting to represent intangible heritage as my "Cult and Copper" VR project does.

Chapter 3 outlines my original contribution to cyber-archaeology practices by introducing immersion theories from game studies and other arts disciplines. For this intangible heritage project, immersion means that the participant feels fully surrounded and supported by the imaginary VR world in three hundred and sixty degrees; even the sky holds importance. The participant feels fully present in her body, in the moment, and in the VR environment to the point that she feels she is a participating smelter in the Bronze Age Negev Desert. She is free from distractions of the outer world and free from internal mind chatter. This definition of immersion is informed by Forte from cyber-archaeology and Janet Murray from Game Design and Narrative Studies, both of whom stress the importance of bodily engagement as Heeter does.[25] It is informed by literary scholar Marie-Laure Ryan, who writes about spatial immersion (response to setting) and emotional immersion (resulting from

[25] Mauritzio Forte, "Cyber Archaeology: 3D Sensing and Digital Embodiment," in *Digital Methods and Remote Sensing in Archaeology: Archaeology in the Age of Sensing*, ed. Maurizio Forte and Stefano Campana (Cham: Springer International Publishing, 2016), 283; Janet H. Murray, *Hamlet on the Holodeck: The Future of Narrative in Cyberspace* [Updated edition] (Cambridge: The MIT Press, 2017), 155-156.

connection to characters).[26] To Ryan, immersion is successful when a media participant feels she has become a character within the book, film, game, or other medium in question.[27] Mark J.P. Wolf, then, offers a road map to creating successful cognitive immersion, suggesting that symbolic signifiers of time, place, and culture–such as artifacts, myths, and rituals–create a sense of being in a consistent, coherent world.[28] The fusion of these and other approaches to immersion noted in chapter three creates a sense of not just being in a given space, but being there at a particular point in time, as Champion urges digital heritage projects to do.[29]

This chapter argues that interaction design is also part of creating a successful sense of immersion, including the interoceptive sense of presence as immersion that Heeter describes. Thus this project also recognizes cues from Human Computer Interaction (HCI) designers Lucy Suchman and Joshua McVeigh-Schultz to stress the importance for redefining interaction design as "intra-action" design. HCI designers borrow the term and theory of "intra-action" from feminist physicist-philosopher Karen Barad. Barad defines intra-actions–part of her agential realism framework–as representing causal relationships among apparatuses of physical production (such as social/cultural practices and tools) and phenomena. Instead of creating flow charts of how independent entities (subjects) act upon other entities (objects), intra-action highlights dynamic, fluid webs of relationality and dismantles

[26] Marie-Laure Ryan, *Narrative as Virtual Reality 2: Revisiting Immersion and Interactivity in Literature and Electronic Media* (Baltimore: Johns Hopkins University Press, 2015), 214-215.
[27] Ibid., 85-86.
[28] Mark J. P. Wolf, *Building Imaginary Worlds: The Theory and History of Subcreation* (New York: Routledge, 2013), 154-155.
[29] Erik Champion, *Critical Gaming: Interactive History and Virtual Heritage* (Surrey, England: Ashgate Publishing Limited, 2015), 101-103.

the superior position of the human agent.[30] This approach allows for animism to become a design metaphor. What non-human elements of an archaeology story can have agency that entangles with human agency?

Chapter 3 then elucidates my process and methodology for creating the "Cult and Copper" VR game, and how I narrowed my decision to situate the game in a virtual Timna, or a space evocative of this place. I had a tantalizing array of research information from several Levantine sites that either definitively evidence or strongly suggest the connection of Bronze Age goddess cults with copper production: Timna in modern Israel plus Palaepaphos, Kition, and Enkomi in Cyprus. In the midst of a global pandemic that barred researchers from fieldwork and in-person collaborations, I became the director and producer of "Bronze Age Productions." This series of Zoom-based improvisational theater games served as a means of collaborative ideation that helped me to narrow a game setting and to performatively think through some of the many possibilities for intra-actions among human and non-human characters within a Bronze Age copper production framework.

Using Bronze Age Productions as a design research method allowed me to create a focused design document, rooted in extensive historical research. These documents guided a collaboration with graduate students in the Serious Games program at University of California, Santa Cruz. The game became the culmination of a theory-praxis approach to realizing a cyber-archaeology project that started with archaeological content research, then focused on design research and collaboration, moved to worldbuilding and interface design, and then advanced to collaborative prototyping. Chapter 3 concludes by reflecting upon results of the collaborative

[30] Karen Michelle Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham N.C.: Duke University Press, 2007), 139.

process. It outlines successes and challenges along the path, notes what parts of my design document were left unrealized in the playable prototype, and suggests where I would take the game next with substantial funding.

Taken as a whole, chapters one, two, three, and the resulting Virtual Reality cyber-archaeology game establish that media technology history is not just a linear progression of tools. Rather, media history is layered, and those layers collapse into one another such that within media tools the past exists concurrently with the present. The internet and other digital media apparatus that we use today contain the materials, environmental forces, knowledge, beliefs, and human labor of prior centuries and even prior millenia. Future media technology will also contain seeds of that past and shoots of this present. Further, the materiality of media is about far more than just those tools as "things." Rather, it is also about the dynamic and sometimes circular evolution of processes and collaborative efforts that enable those tools. Media archaeology must recognize what was important to the people–past, present, and future–who shape and are shaped by those processes. Media archaeology must also acknowledge that there are no sharp lines dividing users of tools, the tools themselves, and the environmental resources/conditions that allow for both users and apparatus to exist. Media history is more a tapestry of interconnected actions and agents than a timeline. The collaborative VR component of this research project stakes a claim that an experiential approach to exploring the ancient intangible heritage relationship among cult, copper, and techno-craft processes is an effective way to bring a sensory, embodied awareness to these intellectual concepts.

Before launching into the journey of cult, copper, and cyber-archaeology design, clarification of how some contentious terms are used throughout this text should be

useful. The Levant is a geographical region describing the lands of the Eastern Mediterranean Sea. There is no standard definition of the Levant, as some sources included Egypt and most, but not all, include Cyprus. The modern countries of Syria, Lebanon, Israel, and Palestine are all part of the Levant. Of course, some sources do not recognize Palestine as a modern political entity, and some countries in the Middle East are resistant to recognizing Israel as a modern state. For the purposes of this work, the Levant shall mean the modern countries/territories of Cyprus, Syria, Lebanon, Palestine, Israel and Jordan. I refer to Egypt as an independent culture that occupied the Levant during part of the Bronze Age. That said, the borders of these contemporary place names do not neatly match ancient place names. Thus in referring to the ancient Levantine mainland (as opposed to the separated island of Cyprus), I use the ancient term Syro-Palestine. The state of Israel did not exist until 1948, so the archaeological literature and museum texts use the term Syro-Palestine, or the names of specific ancient cities therein, to identify locations of ancient artifacts, for example. In referring to places located in contemporary space, I use contemporary names. An ancient copper mining site in the Negev desert is now a contemporary tourist attraction, Timna, run by the modern state of Israel as a national park within the 1948 borders of Israel. Thus I refer to Timna as being in modern Israel. Likewise, the word Canannite can have multiple definitions. In this text, it is used to identify people from the land of Canaan, which means the southern Levantine mainland. This term embraces several different tribes and ethnicities. I use the term Phoenician to indicate a group from the northern edge of Canaan. At one time they were centered in what is today Lebanon, but they also built ports and temples in what is today northern Israel. Phoenicians were known for their seafaring

abilities, thus they also settled colonies in Cyprus, taking their technologies–and their goddess–with them. I use the term Semitic to describe the many tribes of people who inhabited the Levant and shared a common language tree. I use the term within the text to distinguish these peoples from the ancient Egyptians. Many of these geographic and ethnic terms are highly debated and politicized. I recognize these debates, but they are largely beyond the scope of this work. Thus my usage of these terms is guided by the way the British Museum, secular museums in Israel, and museums in Cyprus use them because these are places where I conducted my research.

In terms of temporal frameworks, the "Chalcolithic Era" and the "Bronze Age" are interpretive terms (like "the Renaissance"), and they occur at different times in different locations. I offer specific dates/date ranges for artifacts, social and technological trends throughout the text where dates are useful. As a general framework to ground my reader in time, the Chalcolithic Era (Copper-Stone Age) comes after Neolithic times (the Stone Ages). One can consider the Chalcolithic Era as spanning from about 4500 BCE to 3300 BCE in Syro-Palestine and a bit later–about 4000 to 3000 BCE–in Cyprus. One can estimate that the Bronze Age covered approximately 3300 BCE until 1050 BCE in Israel and about 3000 BCE until 1050 BCE in Cyprus. Cyprus archaeologists subdivide each of these periods because changes in stylistic and technological markers on the island were often quite distinct between the Early, Middle, and Late Bronze Ages. I explain these subdivisions where that is helpful to understanding significant cultural shifts, but for the purposes of this text I generally seek to focus on broader concepts. The Bronze Age precedes the Iron Age, which is the story setting for the Old Testament, then Classical Greece

and Rome. So in the West, the Bronze Age is the prequel to Biblical and Classical times.

Because the Levant is indeed an area of so much political tension and conflict, a land of conflicting narratives and hotly contested borders, I maintain a highly idealistic vision with this project. Implicitly, a challenge to patriarchal means of mapping lies within this tale that uses goddesses as avatars through a historical journey. In both Cyprus and within/around Israel, contemporary borders are born of militarized aerial maps. Such remote military maps represent a "God's eye" view which implies hierarchy and being subject-*ed* to authority, says Caren Kaplan. Military maps strip land of its human presence and its deep history, including the ancient intangible heritage shared by people now engaged in conflicts.[31] Naive as it might be, my hope is that using media archaeology to map the mingling and migrations of ancient goddesses as "proto-cybergoddesses" can bring a new awareness to my ancestral people. These goddesses, so important to media technology history, were adored throughout the Levant, before contemporary colonial borders existed. Thus my hope is that Hathor and Astarte can demonstrate that we with Levantine roots share an unsung history that gave rise to an interconnected, networked globe. Military maps objectively divide, but copper goddesses are an underrecognized part of the history of a communications revolution that has compressed space-time, allowing an interconnected world to share subjective experiences in an instant. In addition to the textual articulation of this research, perhaps the associated VR game can encourage players to slow down

[31] Caren Kaplan said of aerial maps, "Within the omniscient grasp of the totalizing view, innumerable elements may be lost to sense and thus to human history." See Caren Kaplan, *Aerial Aftermaths: Wartime from Above*. (Durham: Duke University Press, 2018), 204.

and gain an embodied awareness of this mythological and technology history heritage that is shared by Levantine peoples. If this VR game is ever installed at a museum or archaeology site in the Middle East, it is my ideal that this embodied awareness can challenge abstract political concepts of identity that create discord over unity. Implicit in this project is a feminist motivation towards offering a new olive branch strategy in lands frought with violence. Along with being a goddess of love, sexuality, and copper, Hathor was also a goddess of music and dance. By tracing how she danced with Astarte all over the copper-rich Levant, may Hathor historically inform us as to how to find the right rhythm to dissolve militaristic lines in the sand.

CHAPTER 1: Copper, Media, and Materiality

"A medium must not mean but be." -- John Durham Peters[32]

Imagine it is dusk in the Negev desert, about 3300 BCE. The temperature is cooling to 109 degrees Fahrenheit (about 43 Celsius). The setting sun is casting a coral glow, hazy with dust, on the towering rust colored rock formations that surround you in a 360-degree panorama. Both the formations in the distance and the earth beneath you are rich with copper. You can feel the pulse of the landscape as you and four other smelters sit around a smelting fire pit, about two feet wide, fifteen inches high, and ringed with stone. Each of you takes long, deep breaths and exhales through a long blowpipe tipped with a clay nozzle. A woman playing a slow, steady, resonant frame drum guides your breathing rhythm. The rocky hills hypnotically reverberate the drum beat. Nestled in the flames is a small ceramic saucer surrounded by charcoal and acacia sticks. The saucer protects small nuggets of malachite, a copper carbonate ore with a greenish hue. You point your nozzle towards the base of the base layer of charcoal to create the most intense heat. Maintaining a fire temperature of about 2200 degrees Fahrenheit (1200 Celsius) is necessary to smelt pure copper out of this ore. A breeze aids your efforts to stoke the fire with air. The flames communicate to you as the copper starts to melt. It is easier to see their messages as night moves in. Green flames flickering like charmed snakes mean that the copper is turning molten. Hints of blue are also an auspicious sign, signifying that burning charcoal is bonding with the carbon in the ore, producing carbon dioxide gas and metal. As the copper melts, ruby red slag

[32] John Durham Peters, *The Marvelous Clouds: Toward a Philosophy of Elemental Media* (Chicago, London: University of Chicago Press, 2015), 14.

(iron oxide) forms and rises to the top of the saucer. The copper sinks to the bottom. With wooden tongs you pick up the saucer to pour off the slag, a safe distance from skin. The slag runs in rivulets like snakes through the sand. Copper remains in the dish, coagulated into irregularly shaped pink-yellow clumps.[33] The copper is "born" of the furnace, under a constellation of stars representing a goddess of fertility and renewal, her arm reaching out in the shape of another undulating snake. An ibex, symbol of the copper smelter as shaman, watches over the group from a hilltop in the distance.[34] Here in the early Bronze Age desert lie the material, technical, and anthropological pre-dawn of the Digital Age.

The primary aim of this chapter is to expand media archaeology discourse by arguing that the historical roots of digital culture–particularly the roots of digital networked information systems–include the Bronze Age. Some media histories cite the Victorian Era as the historical period that provided the foundation for digital networks because the Victorian telegraph provided the conceptual and infrastructural basis for the telephone and then eventually the internet.[35] For example, British

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[33] Information on the smelting process is compiled from experimental archaeology experiments detailed in: Paul T. Craddock, *Early Metal Mining and Production (*London: Archetype Publications Ltd., 2010), 129-348. The added detail about drumming is not historically verifiable; though plausible, it is the product of imagination.

[34] For information on shamanic symbols associated with copper smelting, as suggested by Negev star lore (ibexes, snakes, birds), see: George F. Steiner, "The Goddess and the Copper Snake: Metallurgy, Star-lore and Ritual in the Rock Art of the Southern Levant," *Expression Quarterly Journal of Atelier Editions in Cooperation with UISSP-CISNEP (International Scientific Commission on the Intellectual and Spiritual Expressions of Non-Literate Peoples)*, no. 12 (June, 2016): 73-95. Ibexes, snakes, and birds also appear on Chalcolithic pottery from the Negev, as exhibited in "*Mind and Matter: The World of the First Copper Masters,"* curated by Dr. Michael Sebbane. Eretz Israel Museum, Chaim Levanon St 2, Tel Aviv-Yafo, Israel. Show viewed on September 2, 2019. https://www.eretzmuseum.org.il/e/398/

[35] In discussing the internet, it is important to clarify that the internet and the world wide web are not the same thing. The internet is a physical infrastructure that relies on cables. The web is the ever-changing collection of information and/or media that travels through those cables. The web also includes services that allow for the transfer of that information/media.

science and technology journalist Tom Standage details the history of the telegraph in his book "The Victorian Internet." Standage explains that the [digital] internet draws from the nineteenth century telegraph's use of interconnected networks to allow communication over vast distances. He notes that "internet" by definition actually means "interconnected networks."[36] The Victorian Era is also when experimenters such as Hans Christian Oersted, William Sturgeon, and Samuel F. B. Morse began to decode how to work with the electrical currents that eventually came to power modern technologies.[37] Computer processors and monitors, internet routers, and cell phones of course all came to rely on this electrification. It was, additionally, a Victorian–mathematician Ada Lovelace–who first saw the potential of computers to do more than calculate; Lovelace deduced that computers could use rule-based systems to manipulate symbols, and thus she is commonly considered to be the first programmer.[38] This idea of symbolic operations is still necessary for using computers as communication tools.

Copper is the material that allowed for the success of the telegraph and telephone. Copper was essential to the electrification of Victorian analog technologies, and is still used to power digital technologies, because of its conductive properties. Copper was fundamental to early internet cables, and it is still an important component of more contemporary fiber optic cables.[39] Thus without

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[36] Tom Standage, *The Victorian Internet: The Remarkable Story of the Telegraph and the Nineteenth Century's On-Line Pioneers* (New York, N.Y.: Berkley Books, 1999), 206-207.
[37] Ibid., 7-14.
[38] "Ada Lovelace," Computer History Museum, last modified 2021, https://www.computerhistory.org/babbage/adalovelace/.
[39] Though fiber optic cables use light impulses to code information–which enables much faster data transfer than the old copper coaxial wires–often a thin tube of copper around the optical fibers helps to power the cable. See: United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) and The International Cable Protection

copper, the technological advances of the Victorian Era, and then the technologies that grew from those innovations, would likely not have come to be. Different geographical locations learned to work with copper at different times; this study focuses on copper production during the Bronze Age in the Levant, i.e. the Eastern Mediterranean. In antiquity, Timna–in the southern Negev desert (modern Israel) was known for copper production. The center of Levantine copper production and export shifted northward to the island of Cyprus, which is named for copper (*Kupros* in Greek).[40] In the Levant, two popular goddesses were associated with love, sexuality, and copper: Hathor and Astarte (who was later named Aphrodite by the Greek settlers of Cyprus). Thus from a media archaeology perspective, this thesis seeks to seat these goddesses in the history of digital technologies, and to explain what the esoteric connection likely was between fecundity, birthing, and copper production in the Bronze Age world view.[41]

In order to reframe the Bronze Age through a media archaeology lens, this chapter will explain what media archaeology is, and according to whom. Media archaeology generally reacts against the idea that studies of digital media can ignore such media's own past influences. Rather than fetishizing the newest media trends, media archaeologists point out "hitherto unnoticed continuities and ruptures" among generations of media. I.e. they tend to argue that the evolution of media is not

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Committee Ltd. (ICPC), *Submarine Cables and the Oceans – Connecting the World,* L. Carter, D. Burnett, S. Drew, G. Marle, L. Hagadorn, D. Bartlett-McNeil, and N. Irvine. UNEP-WCMC Biodiversity Series No. 31. ICPC/UNEP/UNEP-WCMC, United Kingdom: UNEP-WCMC, 2009, (accessed September, 13, 2020), 18, https://www.unep-wcmc.org/system/dataset_file_fields/files/000/000/118/original/ICPC_UNEP_Cables.pdf?1398680911.

[40] https://www.metmuseum.org/toah/hd/cyco/hd_cyco.htm

[41] Chapter two is specifically all about these goddesses and their relationship to copper, but chapter one introduces them.

necessarily linear.[42] Scholars of media archaeology typically also highlight the materiality of media. Drawing from German media theory[43] and related discourses, media archaeologists argue that media are more than semiotics and the interpretation of content; they additionally recognize the importance of media's material components, which can include hardware, software, and electrical circuits.[44]

Using the work of media archaeologist Jussi Parrika, communications scholar John Durham Peters, art historian and sound studies scholar Douglas Kahn, and philosopher-physicist Karen Barad, I create a posthumanist framework–i.e. one that breaks binaries between human and non-human agencies–to explore the agency of copper, how copper as a material functions as a medium itself, and how copper plus human agency have entangled. It especially focuses on some important ways in which these entangled agencies functioned to shape culture in the Bronze Age and in the preceding Chalcolithic (Stone-Copper) Era that gave rise to the Bronze Age. The social science discipline of Archaeology necessarily studies the way people and their tools/technologies shape one another. It makes sense, then, that Archaeology and media archaeology can inform one another in examining the role of copper, and this chapter highlights examples of how they can do so. Finally this chapter speculates about the role of copper in shaping a future in which quantum computing hastens the development of emergence and artificial life, or "a-life." If life in the

[42] Erikki Hutamo and Jussi Parika, "Introduction–An Archaeology of Media Archaeology," in *Media Archaeology: Approaches, Applications, and Implications,* eds. Erikki Hutamo and Jussi Parikka (Berkeley & Los Angeles: University of California Press, 2011), 1-3.
[43] Friedrich Kittler is one German media theorist often cited. For further reading, see: Friedrich Kittler, *Dissonance Networks 1800/1900*, trans. Michael Metteer with Chris Cullens (Stanford: Stanford University Press, 1990).
[44] Jussi Parikka, *A Geology of Media* (Minneapolis: University of Minnesota Press, 2016), 1-3.

twenty-first century is conceptualized as being packets of informational code, how does that circle back to ancient ideas linking copper to a sexuality goddess?

Figures 1 and 2: Inside submarine cables. On the left are underwater telegraph cables from the early 1900s. The inner copper conductor transmitted messages. Gutta percha insulated the copper; iron wires protected the bundle. On the right are samples of coaxial telephone era cables. A conductive inner copper sleeve is strengthened with steel wires. Polyethylene dielectric and an outer conductor surround those elements. Black polyethylene surrounds the bundle. Photos by Lonnie Hagadorn, used here with permission from the United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) and The International Cable Protection Committee Ltd. (ICPC) report, page 17.

What Is Media Archaeology?

Media archaeology, media materialism, "elemental" media, and posthumanist agential realism are all useful frameworks with which to demonstrate how copper as a material is a medium with agencies. Copper acts agentially both in relation to other media and in relation to people; i.e., rather than being an inert "object," copper can sometimes perform as a dynamic actant that influences and is influenced by other actants. Shannon Mattern describes media archaeology as a set of conceptual and

methodological tools for examining media's materiality and nonlinear histories.[45] Typically, says Mattern, the idea of "archaeology" serves as a metaphor for "digging" into historical resources such as archives of old machines. In regard to materiality, Mattern explains that "media archaeology turns our attention away from traditional hermeneutics—i.e, textual interpretations of what's on the page or screen—and toward the page and screen themselves: toward the hardware of media…"[46] In regard to media's nonlinear histories, Siegfried Zielinski's approach to media archaeology provides examples. Zielinski examines historical "fractures" and "turning points" that challenge firmly established media history narratives; he rejects the notion that media advances along a trajectory from "primitive" to "complex" apparatuses.[47] Rather, Zielinski states:

> Magical, scientific, and technical praxis do not follow in chronological sequence for anarchaeology; on the contrary, they combine at particular moments in time, collide with each other, provoke one another, and in this way, maintain tension and movement within developing processes.[48]

To support his argument, Zielinski excavated a cast of historical characters. These include a seventeen century Jesuit priest (Athanasius Kircher) who worked with early "multimedia" projection systems using mirrors, glass cylinders and sound effects;[49] a Neo-Platonist (Giovan Battista della Porta) who applied his interest in classical Hermeticism, medieval alchemy, sympathetic magic, and natural philosophy to the creation of "transformative" optical phenomena that could reveal that which was not

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[45] Shannon Christine Mattern, *Code + Clay ... Data + Dirt: Five Thousand Years of Urban Media* (Minneapolis: University of Minnesota Press, 2017), xv-xvi.
[46] Ibid., xvi.
[47] Siegfried Zielinski, "Deep Time of the Media–Toward an Archaeology of Hearing and Seeing by Technical Means (Cambridge: MIT Press, 2006), 7.
[48] Ibid., 258.
[49] Ibid., 101-158.

visible to the naked eye;[50] and a seventeenth century musician, doctor and natural philosopher (Robert Fudd) who employed Pythagorean principles of metaphysical harmony [a sort of Classical mathematical "code"] to build instruments.[51]

Mattern objectively recognizes that media archaeology's lack of one specific methodology or goal opens it to criticism for its vagueness. However, she notes, media archaeology's fluid and evolving objectives are also why the sub-discipline is celebrated as an opportunity for methodological diversity."[52] In considering the varied approaches of media archaeology theorists, Mattern points out that an intense focus on materiality can become problematic when scholarship centralizes technological "things" without also considering the humans who shape and are shaped by those technologies. She critiques that in so doing, media archaeologists risk erasing people and environments that are part of the complete interaction loop of any specific medium. To date, she says, media archaeology texts also tend to ignore the contributions of women or recognition of the feminine.[53] She cites Zielinski as a rare example of a media archaeologist who delves deeper than the Victorian Era to highlight contributions of the Renaissance and Classical Greece; but she points out that he still only looks at the techno-scientific contributions of men.

Mattern points to Jussi Parikka as another media archaeologist who addresses "deep time" because of his focus on geologic time; he draws awareness to the elemental and earth components of media objects.[54] My primary argument aligns with and extends the scholarship of Jussi Parikka. Parikka contends that the

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[50] Ibid., 57-100.
[51] Ibid., 102-106.
[52] Shannon Christine Mattern, *Code + Clay ... Data + Dirt: Five Thousand Years of Urban Media* (Minneapolis: University of Minnesota Press, 2017), xv-xvi.
[53] Ibid., xv-xvi.
[54] Ibid., xvi.

material aspects of media act upon humans in conjunction with the semiotics and meaning of media. He explains that these materialities tell stories about gender, embodiment, labor, modes of production, and global logistics. Most inspiring to my exploration of copper's agential role in ancient history, however, is Parikka's thesis that "there is such a thing as *geology of media*; a different sort of temporal and spatial materialism of media culture than the one that focuses solely on machines or even networks of technologies as nonhuman agencies." Parikka lends creative insight into the relationship between media and the geophysical environment. He states that media materialism needs to consider what components of the earth–such as minerals–enable technologies.[55] Parikka leads his reader to recognize that "media materiality is very metallic" in that tin, cobalt, palladium, silver, gold, and aluminum, in addition to copper, all are used in the technical components of media.[56]

Parikka exposes the geology and geophysics of media for reasons of environmental urgency; this is a primary objective of his book *The Geology of Media*. He demonstrates the adverse impacts that extracting minerals for the creation and powering of media technologies has upon the Earth. He also touches upon the environmental impact of the e-waste resulting from discarded electronics, as heavy metals within them seep into the ground/water and become toxic pollutants.[57] On these environmental points I am in full accord.[58] From a media archaeology point of view, however, I expand upon Parikka's project whereby he states: "Metals and

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[55] Jussi Parikka, *A Geology of Media* (Minneapolis: University of Minnesota Press, 2016), 3-4.
[56] Ibid., 33.
[57] Ibid., 34-35, 47-52.
[58] See my 2004 research project, "Cyberfeminism, Third World Women, and the Greening of the Computer Industry that was inspired by Danwen Xing's Whitney Museum of Art documentary photography exhibit about e-waste in China: http://www.pelefire.com/casondra/pages/essays/text/cyberfem.pdf

minerals were tightly linked to the emergence of modern engineering, science, and technical media. For instance, copper has been a crucial material of technical media since the nineteenth century."[59] While it is true that copper has indeed been an important metal in modern electrical and digital media technologies, my project fills in a historical gap between geological time and modernity to explore a much earlier beginning to the industrial processes which Parikka critiques. This ancient history is full of feminized myth and magic.

In ancient times copper was of such central importance as a media material and as a medium itself that eras were named for the metal: the Chalcolithic Era (which means Stone-Copper Age) and the Bronze Age (whereby bronze is made of mostly copper mixed with a small percentage of other metals such as tin). My research of ancient Syro-Palestine and Cyprus demonstrates that as far back as Chalcolithic times, copper served as an agent of communications via ritual items that told culturally-specific stories of cult deities and tales of who held power. Copper was an actor that prompted changes in social structures, migrations, and trade patterns. Copper production and trade facilitated networks of information exchange regarding technology transfers, religion, styles and fashions. Copper's role in media and as a medium is not just a modern phenomenon.

I find inspiration in Mattern's work, as well as in Parikka's, because Mattern is enticed by the potential ways in which the social science discipline of Archaeology can inform methods for media archaeology. For example, she recognizes that archaeologists have questioned their *own* agency, human agency, the agency of creatures, environments, and objects. They have also "debated who owns the past

[59] Jussi Parikka, *A Geology of Media* (Minneapolis: University of Minnesota Press, 2016), 33.

and who does, or should, have the right to shape cultural memory." Archaeologists grapple with the ethics of how their work is potentially commercialized by the heritage industry, how it is romanticized and politicized. [The Levant, for instance, is a region where Archaeology can be intensely politicized because who controls the narrative of the past controls perception of who lays claim to Middle Eastern territories in the present.] Mattern applauds that archaeologists are critical and self-reflexive in a way that media archaeologists can learn from. This includes addressing gendered meanings and interpretive biases. Mattern believes that Archaeology, through its cross-cultural lenses, "has the potential to expand Media Studies' understanding of what constitutes media, of what materials and systems serve communicative functions."[60] Questions emerging from my own research include: What can copper communicate about histories? Can figurines of copper goddesses communicate something about power in relation to gender in the Bronze Age? Can the Bronze Age remind Silicon Valley technology companies that natural resource depletion and wealth inequalities can be material consequences of new technologies? Mattern would likely say yes to the latter because she is interested in how contemporary archaeological methods engage with non-linear, non-successive evolutions and entangled temporalities; Archaeology no longer looks at time as being stratified, she says.[61] Archaeologist Christopher Witmore affirms, "The present is always a rich aggregate mix of multiple times which are not linear in association." Past eras bubble up into later ones via material traces and by performative re-

[60] Shannon Christine Mattern, *Code + Clay ... Data + Dirt: Five Thousand Years of Urban Media* (Minneapolis: University of Minnesota Press, 2017), xxi-xxiv.
[61] Ibid., xxvii-xxviii.

enactments.[62] Zelinski demonstrates similar thinking with media archaeology, asserting: "In the internet, all earlier media exist side by side." Further, he suggests, those earlier media simultaneously still exist independently of networked machines.[63] These media exist just as Witmore describes archaeological time–folded and entangled, not bound between temporal frames.[64] Mattern also posits that "a civilization's prevailing media formats cultivate its habits of mind, its economy, its modes of governance, and its culture."[65] As examples, in Victorian times, the copper telegraph enabled a compression of space and time that became associated with British colonialism. The telegraphic networking of the British Empire allowed for greater centralization of commerce, and therefore power, from London.[66] In the contemporary United States, we use the internet for online commerce; industries that require internet savvy technologists have created an economic class of workers; and networked social media mold habits of mind that shape elections. Copper as the prevailing media format of the Bronze Age Levant, I shall demonstrate, also affirms Mattern's assertions.

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[62] Christopher Whitmore, "Vision, Media, Noise, and the Percolation of Time: Symmetrical Approaches to the Mediation of the Material World," *Journal of Material Culture* 1, no. 3 (2006): 280-281, https://doi.org/10.1177/1359183506068806.

[63] Siegfried Zielinski, "Deep Time of the Media–Toward an Archaeology of Hearing and Seeing by Technical Means (Cambridge: MIT Press, 2006), 31.

[64] Christopher Whitmore, "Vision, Media, Noise, and the Percolation of Time: Symmetrical Approaches to the Mediation of the Material World," *Journal of Material Culture* 1, no. 3 (2006): 280-281, https://doi.org/10.1177/1359183506068806.

[65] Ibid., 87.

[66] Bedouin tribes in Libya, however, had a different relationship to their environment and to space-time than did the Ottomans and British who colonized their land. Trouble heated when the Ottomans and British imposed telegraph lines, a fixed marker of imperialism, upon the Bedouin's otherwise fluid space. The infrastructure had "an insidious impact in the spatial practices of everyday life" for the Bedouin. The Bedouin rebelled against this space-dominance by sabotaging the telegraph infrastructure. See: Mostafa Minawi, *The Ottoman Scramble for Africa: Empire and Diplomacy in the Sahara and the Hijaz* (Stanford: Stanford University Press, 2016), 131.

Copper as a Medium

Media archaeology draws from new materialism, which Parikka summarizes as a "vibrant methodology" for understanding agencies of the nonhuman within their particular material circumstances.[67] Kevin Fisher, an archaeologist of Bronze Age Cyprus, explains how archaeology, too, questions the recursive relationships between people and their actions [rituals, habits, craft skills], place [the built environment, landscape, climate], and I would add artifacts. Fisher describes these relational influences as "interanimations."[68] Parikka attributes the historical legacy of materialism to Marx's political thought and theory, whereby Marx investigated the relationship between material and social processes. Parikka also credits media materialists, i.e. media scholars who demonstrate that technology, functioning as an active agent, determines the beingness of things in the world (ontology) and how things are known in the world (epistemology).[69] Media materialists echo some of Bruno Latour's Actor Network Theory (ANT). Latour, a sociologist, used ANT to map non-hierarchical relationships among material agents (human and non-human) and their actions. ANT looks at humans and objects as agents that influence one another via a flattened, non-hierarchical network.[70] Latour says that interactions are constantly shifting, not fixed.[71] In his model, objects can mediate actions, or recede into the background.[72]

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[67] Jussi Parikka, *A Geology of Media* (Minneapolis: University of Minnesota Press, 2016), 103.
[68] Kevin D. Fisher, "Investigating Monumental Social Space in Late Bronze Age Cyprus, an Integrative Approach," in *Spatial Analysis and Social Spaces: Interdisciplinary Approaches to the Interpretation of Prehistoric and Historic Built Environments*, ed. Eleftheria Paliou, Undine Lieberwirth, and Silvia Polla (Berlin/Boston: De Gruyter, 2014), 30.
[69] Jussi Parikka, *A Geology of Media* (Minneapolis: University of Minnesota Press, 2016), 1.
[70] Bruno Latour, *Reassembling the Social: an Introduction to Actor-Network-Theory* (Oxford: Oxford University Press, 2005), 70-71, 142.
[71] Ibid., 68.

Considering the idea of nonhuman agencies paved the way for posthumanist thought. Karen Barad, a feminist quantum physicist-philosopher in the tradition of Neils Bohr, deciphers how these patterns of agencies literally occur at a subatomic level of quantum entanglements; they are not just abstract "maps" of agencies as metaphors. Further, these interrelated agencies are not merely bi-directional as one might interpret them to be in ANT; instead they are in a constantly shifting, fluid, ontological performance. To Barad, "things" do not preexist; rather their becoming is the result of entangled, mutual, interdependent agencies. Matter, they explains, is the result of dynamic, relational, productive processes, i.e. "intra-actions."[73] Intra-action is the keystone of an epistemological-ontological-ethical framework which they calls "agential realism".[74] This framework, they says, "provides an understanding of the role of human *and* nonhuman, material *and* discursive, natural *and* cultural factors in scientific and other social-material practices [such as archaeology or design], thereby moving such considerations beyond the well-worn debates that pit constructivism against realism, agency against structure, and idealism against materialism."[75] Barad's posthuman agential realism dissolves anthropocentric binaries between human and non-human, nature and culture, and instead frames materialism in terms of "naturalcultural" practices.[76]

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[72] Ibid., 79.
[73] Karen Michelle Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham N.C.: Duke University Press, 2007), 33, 150.
[74] Agential realism is discussed in more detail in chapter 3 in relation to interaction design and interface design concepts.
[75] Ibid., 26.
[76] Ibid., 226. However, Barad takes the term "naturalcultural" from Haraway: "I want to convince my readers that inhabitants of technoculture became who we are in the symbiogenetic tissues of naturecultures, in story and in fact." [Donna Haraway, *The Companion Species Manifesto: Dogs, People, and Significant Otherness* (Chicago: Prickly Paradigm Press, 2003), 12.] Haraway challenged binaries between nature and culture decades earlier in her famous *Cyborg Manifesto*, first published in 1985: "In the traditions of

This foundational understanding of Barad's specific contribution to posthumanism, then, helps to contextualize the work of media theorist John Durham Peters, who celebrates "elemental media." A term that represents an emerging interdisciplinary concept drawing from Media Studies, environmental humanities, and other discourses, elemental media creates an elegant framework for thinking about the agency of copper as a medium. Peters argues that the intellectual idea of media as a means of conveying messages–in the manner of newspapers, radio, internet–is relatively recent. Seemingly echoing the ideas of Neo-Platonic magicians and alchemists of the Renaissance, Peters explains that once upon a time "media" referred to the natural elements—again earth [whereby "earth" can refer to the ground itself or to materials extracted from the ground], water, fire, and air.[77] Elemental media can also include natural phenomena, such as auroras or radio waves, that can function as "information" or carry aesthetic value. Parikka, too, writes, "The earth is a part of media both as resource and as transmission."[78] Here Parikka is referencing the geological components of electronic media and the signals/semiotics that are conveyed through their use; he is also referencing the sky/atmosphere as a medium for signal transmission, and the transmission of

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"Western" science and politics–the tradition of the appropriation of nature as resource for the productions of culture, the tradition of reproduction of the self from the reflections of the other–the relation between organism and machine has always been a border war. The stakes in the border war have been the territories of production, reproduction, and imagination." Haraway says the cyborgs rework the nature-culture binary, and she argues for "*pleasure* in the confusion of boundaries and *responsibility* in their construction." [Donna Haraway, "A Cyborg Manifesto: Science, Technology, and Socialist Feminism in the Late 20th Century," in *New Media Reader*, ed. by Noah Wardrip-Fruin (Cambridge: MIT Press, 2003), 516-517.]

[77] John Durham Peters, *The Marvelous Clouds: Toward a Philosophy of Elemental Media* (Chicago, London: University of Chicago Press, 2015), 2-3.

[78] Jussi Parikka, *A Geology of Media* (Minneapolis: University of Minnesota Press, 2016), 30.

sonified vibrations released by earthquakes.[79] Thus the idea of elemental media expands more recent definitions of media to again include materials and phenomena from within nature that carry signals and/or information.[80] Peters' ideas of elemental media certainly hedge towards posthumanism by decentering the anthropocentric viewpoint in the definition of media.

The notion of elemental media is useful in decoding media archaeology, I would argue, because expanding the definition of media allows for new interpretations of media histories. Both elemental media and media archaeology are based on the understanding that media are not only about symbols and semiotics used to convey intended intellectual meanings; Peters advocates for considering both immateriality and materiality of media in balanced relationship to one another.[81] Whereas media archaeology looks at innovations of the past, however, elemental media looks beyond signifying machines to ontologically recognize elements of nature, past or present, as media. Media can occur outside of human design, such that fog or fire, as examples, can be media. Herein, of course, the element of focus is copper. However, other phenomena such as electromagnetism act upon copper. The elements of fire and air are integral to conditions of copper production via the smelting process. Smelting is surrounded by a rich anthropology as described ahead, an entanglement of human and non-human conditions.

Sounding much like Barad, Peters argues that media are a synthesis between naturally occurring elements/events and culture. He says that the entanglement of

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[79] Ibid., 9-13.
[80] Elemental media theories could also apply to Levantine copper goddesses. Chapter two details how figurines representing these goddesses–crafted from clay and copper extracted directly from the earth–were part of the transmission of ideologies.
[81] John Durham Peters, *The Marvelous Clouds: Toward a Philosophy of Elemental Media* (Chicago, London: University of Chicago Press, 2015), 12.

the natural with the cultural allows, then, for media to be understood as "infrastructures of data and control."[82] As examples, I suggest that this could include control of nature, economy, and power through copper mining; attempted control of popular thought via propaganda printed on former trees or broadcast through air; control of privacy, rights, and privileges through data collection enabled by fossil fuels powering data transfer. Peters summarizes the philosophy of elemental media poetically:

> Nature's lesson is that meaning does not require a subject. The concept of elemental media is more than an interdisciplinary gesture; it is also a bid in a long philosophical, religious, and political debate about the nature and location of meaning. Media can be rich in semiotic stuff without being the sole property of humans.[83]

How, then, can copper specifically represent posthumanist agency as a material in modern times? Douglas Kahn points to ways in which copper wires demonstrate agency without humans purposefully activating the material. Kahn notes that nineteenth century copper telegraph lines made the earth's energetic environments more apparent. Because they were long metallic conductors [like lightning rods], telegraph cables:

> ... attracted surrounding energies from each other and from the environment. When lines ran close enough to each other, their electromagnetic fields interacted and through induction "leaked" information to one another, and some of that was musical. Via its copper cables, the telegraph system functioned as a detector of natural phenomenon, a transmitter of "noise," not just signal.[84]

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[82] Ibid., 2-3.
[83] Ibid., 308.
[84] Douglas Kahn, *Earth Sound, Earth Signal: Energies and Earth Magnitude in the Arts* (Berkeley: University of California Press, 2013), 68.

Effects of solar flares/auroras and thunderstorms were evident via telegraph lines, too. Telegraph lines, then phone lines, could register thunderstorms three-hundred to four-hundred miles away, and sparks from a storm could unfortunately even sizzle a telegrapher.[85] Kahn recounts stories of indigenous people listening to telegraph lines in Australia, Western US, South America. A Native American man named Long Day spoke of "spirit voices" over the wires.[86] Through the proliferation of the telegraph, copper became intra-active with the earth itself, as well as with people inhabiting the earth. The telegraph connected not just by written messages, but by earth signals.

The telephone was not originally intended for carrying the human voice.[87] Rather, as Kahn explains, telegraph and telephone lines interacted with electromagnetic fields by picking up naturally occurring electromagnetic waves. People listened to the "undulatory" currents of the telegraph, which were good for voice and music; if a telephone device was attached to a telegraph line, people heard sounds before anyone started talking or performing. These sounds could be naturally occurring electromagnetic fields that induced a current in the wire. In other words, the wire acted as an antenna. Telephone lines also acted as a *transducer*, a device that facilitates the movement from one energy state to another. The early telephone

[85] Ibid., 63-67.
[86] Ibid., 49.
[87] In 1875/1876, after the telegraph was well established, the "speaking telephone" resulted from a ladder race between Alexander Graham Bell and Elisha Gray. Bell did not really "invent" the telephone as is popularly believed; rather he made a modification to the "harmonic telegraph" that enabled the human voice to travel along a wire. See: Tom Standage, *The Victorian Internet: The Remarkable Story of the Telegraph and the Nineteenth Century's On-Line Pioneers* (New York, N.Y.: Berkley Books, 1999), 195-198.

served both as a scientific instrument for perceiving environmental energy and as an aesthetic device for experiencing the sounds of nature.[88]

In concert with Peters' recounting of a time when earth, water, fire and air were considered media, Kahn adds specificity in regard to signal transmission:

> Mentioning nature and communications in the same breath would have been easier during the nineteenth century, when the earth was regularly put in-circuit with communications technologies…Telegraph and telephone signals were returned through the earth, and a ground meant the ground under people's feet; information was underground information.[89]

Thus elemental media includes unintended or messy signals ("noise") that result from physical phenomena, such as earth's electromagnetism, as part of media, too.

Kahn's examples demonstrate how copper has also performed intra-actively with other non-human agents–agents in nature–whether or not a human is part of the system; but copper also exists within humans. Copper is a soft metal, so for industrial uses it is usually alloyed with another metal such as silver or tin for more strength.[90] In its pure form, though, copper is part of communications networks within our bodies. Along with being essential to brain development, heart function, and immunity, copper plays a role in making neurotransmitters. These are chemical messengers that allow nerves to communicate with one another via electrical impulses. Along with networking our computers, copper helps to form the connective tissue in the skin, collagen.[91] Considered from a posthuman perspective, copper just

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[88] Douglas Kahn, *Earth Sound, Earth Signal: Energies and Earth Magnitude in the Arts* (Berkeley: University of California Press, 2013), 26.
[89] Ibid., 2.
[90] "Copper Alloys: Introduction," Copper Development Association, 2018, https://copperalliance.org.uk/knowledge-base/education/education-resources/copper-alloys-introduction/.
[91] "Copper is Essential for Health and Nutrition," Copper Development Association, 2018, https://copperalliance.org.uk/benefits-copper/health/.

as a material already breaks the binary dividing line between inner and outer communications and networking systems.

Such examples demonstrate that copper holds a seemingly "animistic" quality in that it can exist and act with or without an evident operator. Copper also has a long history of intra-acting with persons of specialized technical skill—from ancient smelters-as-shamans to computer coders as a class. Peters says that media are entangled ensembles of natural elements and human craft.[92] This particular type of intra-action is also part of copper's role as media. Where copper does intra-act with people externally, such intra-actions have created enormous societal, and even environmental, shifts.

In the twenty-first century, we are living in an era when copper is intra-acting with our daily lives via electronic devices and internet cables that deliver information through the web, social media, and video conferencing. The deep roots of these networks, and some of the social changes they prompted, lie in a prehistory when humans first mastered the craft of turning copper ore into metal at a household use scale in the Chalcolithic (Stone-Copper) Era. One could compare this to how Silicon Valley started out with DIY tinkerers soldering their own circuit boards. Then just as homebrew computing evolved into a predominant industry, the Bronze Age intensified copper production on a wide scale such that copper production became a primary industry in the ancient Levant.[93]

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[92] John Durham Peters, *The Marvelous Clouds: Toward a Philosophy of Elemental Media* (Chicago, London: University of Chicago Press, 2015), 3.
[93] Arthur Bernard Knapp, *The Archaeology of Cyprus: From Earliest Prehistory through the Bronze Age* (Cambridge: Cambridge University Press, 2013), 246-260.

A Posthumanist Perspective on Copper as Medium and Intra-Active Agent in the Bronze Age Levant

Barad's concepts of agential realism and intra-action allow for storytelling about copper from a perspective that decenters the hierarchical position of the human and even gives voice to the elements of elemental media. Further, one can apply Barad's approach to thinking of entangled agents as creators of space-time towards new ways of imagining stories that link antiquity and contemporaneity via punctuated temporalities. In this investigation, those punctures are various iterations of networked information systems, stitched through time, that were enabled by copper. The journey begins in the Arabah Valley, a desert region that spans what is today southern Israel and Jordan.

In discussing ancient technology and punctuated change, archaeometallurgist Erez Ben-Yosef and his co-authors aptly assert:

> Archaeology is uniquely situated through its deep-time perspective to holistically and diachronically examine ancient human, social, and technological evolution. Changes in technology provide unique opportunities for qualitatively measuring the refashioning of material culture through time to monitor underlying social change.[94]

Technologies are more than tools; they are evidence of social processes and complex relationships between land, geology, and cultural practices. In order to elucidate how copper and related technologies agentially sparked cultural shifts in the Bronze Age, it is useful to establish how copper first became an actor during the Chalcolithic era. The Chalcolithic, or Stone-Copper Age, marked the transition between the Stone Age and the Bronze Age. In both ancient Syro-Palestine and in

[94] Erez Ben-Yosef, , B Liss, O.A. Yagel, O Tirosh, M Najjar, and T.E. Levy, "Ancient Technology and Punctuated Change: Detecting the Emergence of the Edomite Kingdom in the Southern Levant," *Plos One* 14, no. 9 (2019): e0221967, 1, https://doi-org.oca.ucsc.edu/10.1371/journal.pone.0221967.

Cyprus, the roots for the relationships among copper, power, and cult seem to start there. Speaking broadly and generally, the shift from the Neolithic period (Stone Age) to the Chalcolithic Era brought about more complex societies and religion, with copper playing a significant role–though not an exclusive role–in facilitating this. Agricultural developments and associated commercial trade, for example, also come into play; but herein I examine the role of metallurgy and associated technologies.

Zielinski adheres to the idea that in looking at the deep time of media, one can deduce how technological developments lead to paradigm shifts, and how those shifts can "support and accelerate economic, political, or desired ideological processes."[95] The work of archaeologist Tom Levy is helpful in elucidating how copper technologies created economic, political, and ideological shifts starting in Chalcolithic Syro-Palestine (circa 4500 BCE to 3300 BCE in this region). Levy suggests that the interrelationships among environment, population increase, and changes in technology–most notably copper metallurgy–provided the basis for society becoming increasingly complex.[96] The relative egalitarian structure of Neolithic society shifted towards a more hierarchical structure. This is materially evidenced in part by the wealth-–including copper and gold artifacts–found in some Chalcolithic graves. Levy cites at least one grave, in Nahal Qanah [located in what is now the Palestinian territory of the West Bank], that appears to be that of an individual chief.[97]

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[95] Siegfried Zielinski, "Deep Time of the Media–Toward an Archaeology of Hearing and Seeing by Technical Means (Cambridge: MIT Press, 2006), 37.
[96] Tomas E. Levy, "Cult, Metallurgy and Rank Societies, Chalcolithic Period (ca.4500-3500 BCE)," in *The Archeology of Society in the Holy Land,* ed. Thomas E. Levy (London: Continuum, 2003), 226.
[97] Ibid., 235-236.

Levy outlines three "interrelated variables", all relying on craft specialization, that seem to have promoted a Chalcolithic shift in social structures. This shift gave rise to elite classes and stabilized a new social order. Levy defines the variables as risk management, resource competition, and gift-giving. Copper metalworking in particular strengthened elite groups through a system of gift-giving. Bestowing gifts to elites who controlled natural resources, for example, could ensure access to those resources. Levy notes that by retaining control of the means of production of those prestige gifts—in this case metalworking—and by restricting who had access to the skills and knowledge for producing said gifts, elites could further increase the value of what become specialized items. Metalworking became a "highly guarded activity."[98]

The secrecy of metalworking is part of where its cultic aspect likely comes into play. The relationship between cult and copper in the southern part of Syro-Palestine became more complex during the Chalcolithic era. The earliest known public sanctuaries, with standing stones representing deities, appeared in the Chalcolithic Era.[99] While much about the intangible cultural heritage of this time is unknown, archaeologists look to the Chalcolithic Ghassulians–who were metalworkers–to speculate about spiritual life in the Syro-Palestinian region. Ghassulians inhabited an area in the Negev desert northeast of the Dead Sea in the latter half of the fifth millennium BCE.[100] Archaeologists deduce that their copper

[98] Ibid., 238-241.
[99] Ibid, 235-236.
[100] Milena Gošić, and Isaac Gilead, "Unveiling Hidden Rituals: Ghassulian Metallurgy of the Southern Levant in Light of the Ethnographical Record," in *Copper and Trade Routes of the South-Eastern Mediterranean,* ed. Karolina Rosińska-Balik Agnieszka Ochał-Czarnowicz Marcin Czarnowicz Joanna Dębowska-Ludwin, Bar International Series 2753 (Oxford: Archaeopress, 2015), 25.

artifacts, along with their tools and technologies for creating those artifacts, were linked to ritual. This deduction is based on the artifacts' form, their lack of use-wear patterns, and their contexts: they are found in production sites and in burials, but not in domestic settings. Since there is no record of Ghassulian ritual practice, an array of researchers, including Milena Gošić and Isaac Gilead, look to ethnographic evidence from Africa and to mythology from Greece and Sumeria to piece together models for the relationship among metalworking, ritual, and magic.[101] For example, in Iron Age sub-Saharan Africa, sacred, secret rituals were required before metalworkers were initiated with knowledge of their craft. Gošić and Gilead believe that initiation rites were very probably also performed by Ghassulian coppersmiths.[102]

Figure 3: Chalcolithic copper artifacts, presumed to be ritual items, from the Nahal Mishmar Cave Treasure on exhibit at the Eretz-Israel Museum.
Photo by Casondra Sobieralski, Tel Aviv, 2019.

[101] Ibid., 29-30.
[102] Ibid., 32.

The key takeaway from Chalcolithic Palestine relative to this chapter, however, is that this period marks the time span when copper began to perform intra-actively with humans. Copper provoked social behaviors including cultic practices and new customs that ensured a more complex, more hierarchical economic order. Given the material evidence that archaeologists have–and do not have–to date, one can articulate notable similarities and differences between how copper acted as an agent in ancient Palestine and in ancient Cyprus. In both locations, copper was an important catalyst towards a more stratified social structure. However, whereas little is known about the role of women in Chalcolithic Palestine, Chalcolithic Cypriot culture offers a lot of clues if not conclusions. In Cyprus, women in the third millennium BCE likely played a role that led to the very earliest copper-enabled technologies.

In Cyprus, the Chalcolithic period spanned from about 4000 BCE to 2500 BCE. Early Chalcolithic society overall was agriculturally oriented, with a largely egalitarian social structure organized at the household and village level.[103] Interesting cultural shifts started to occur in the Middle Chalcolithic period in particular. Some of these shifts were driven by copper, though archaeologist Bernard Knapp notes that production across all sectors of material culture intensified. The Middle Chalcolithic on the island is known for an abundance of figurines carved from picrolite (a type of stone found near copper deposits), new and often gendered symbolic and ideological conventions, the earliest (though still limited) occurrence of cold-

[103] Arthur Bernard Knapp, *The Archaeology of Cyprus: From Earliest Prehistory through the Bronze Age* (Cambridge: Cambridge University Press, 2013), 241-242.

hammered copper objects, and an increasing complexity of social organization.[104] For the first time in Cyprus, high status burials occur, providing clues about increasing socioeconomic complexity, and maybe ideological shifts. The earliest known artifacts made from copper ore, and picrolite figurines associated with copper finds, appear in graves in the Souskiou area include (along with faience beads, shell beads, pottery). Tombs start to show more focus on individual households rather than on communities.[105] By the Late Chalcolithic, copper presents its emergence as a cultural agent via solid evidence of small-scale indigenous metalworking; copper ore and possible smelting crucibles emerged in the area of Kissonerga, along with copper tools and copper jewelry.[106]

While copper production through the Middle Chalcolithic was still nascent, picrolite pendant production was prolific, and a relationship between the two exists: the locations of picrolite sources overlap with the locations of copper ore. They might have been collected together, and/or experimentation with picrolite might have paved the way for experimentation with copper, Knapp explains. Picrolite cruciform figurines are a hallmark of the Middle Chalcolithic era. The vast majority of these figurines with outstretched arms are females, and some are depicted in the process of giving birth. Archaeologists thus deduce that these figurines were associated with childbirth, birthing rituals, and/or ceremonies promoting fertility. (To date no evidence indicates that they were goddesses.)[107] Because the stone figurines were

[104] Ibid., 195.
[105] Ibid., 214-227.
[106] Ibid., 230.
[107] For more on picrolite figurines and their possible ritual uses, also see: Diane Bolger, *Gender in Ancient Cyprus: Narratives of Social Change on a Mediterranean Island*, Gender and Archaeology Series, V. 6. (Walnut Creek, CA: AltaMira Press, 2003), 93-110. Looking to

so tied with femininity, Knapp suggests that women might have been the ones to procure the picrolite and make the pendants. Further, according to Knapp, Chalcolithic Cypriots seem to have prioritized picrolite over copper to connote status. This is indicated by the exquisiteness of the stone, the individualization of picrolite figurines, and their context; many were found in burials of women and children (rarely in the graves of men).[108] So how does one interpret these copper-related puzzle pieces in regard to gender?

Figure 4: These picrolite cruciform figurines were so common in Chalcolithic Cyprus that today they represent Cyprus on Euro coins. Photo by Daniela DeAngeli, 2020, used with permission.

With the cautionary caveat that much is still unknown about cultural practices surrounding picrolite figurines, I offer the following thought for consideration and speculation: if women were actually the ones collecting Chalcolithic picrolite, and if picrolite procurement and production paved the way for copper procurement and production, then these real women, not just their mythic goddesses, played a hitherto completely unrecognized role in the very earliest dawn of digital technologies that relied on copper for their electronic components–such as copper wires, early computer chips, and motherboards. These ancient women potentially played a role

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Bolger, chapter two of this exposition describes how, through ritual uses, picrolite figurines functioned as prehistoric media.

[108] Arthur Bernard Knapp, *The Archaeology of Cyprus: From Earliest Prehistory through the Bronze Age* (Cambridge: Cambridge University Press, 2013), 232-239.

in the communications technology history that relied on copper for the precursors of copper internet cables, i.e. telegraph and telephone cables. Thus the picrolite associated with leading the path to copper experimentation, and the likely-female makers of picrolite artifacts, all become intra-active agents in the punctuated history of digital technologies.

The Late Chalcolithic period in Cyprus was a pivot point into the Bronze Age. The intensification of copper mining and production (along with agricultural production) set in motion the increased centralization of power. Picrolite production (and presumably the status of those who procured and crafted it) declined. The most dynamic shift to happen, I would argue, is that Cyprus starts to become more international. Materials and designs, such as those used for and on pottery, reveal connections with Anatolia and with the eastern Aegean.[109] Increasingly fluid exchange with other lands, driven largely by copper trade, eventually became a hallmark of Bronze Age, particularly Late Bronze Age, Cyprus.

During the Bronze Age, copper production (and the intensification of agriculture) deepened the trajectory towards greater social complexity and increased hierarchy. Further, while the Chalcolithic provides the first clues about the connections among copper, copper production technologies, and cultic practice, the Bronze Age broadcasts this relationship as religions became more formalized. Chapter two focuses specifically on these relationships and how feminine deities are central to copper-cult constructs, but here I offer a general overview defining the role of copper in Bronze Age techno-social changes.

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[109] Arthur Bernard Knapp, *The Archaeology of Cyprus: From Earliest Prehistory through the Bronze Age* (Cambridge: Cambridge University Press, 2013), 246-260.

A Bronze Age Case Study in Ancient Palestine: Copper Mining in Timna

The intra-active role of copper in Bronze Age Palestine included copper being a driver for increased cultural exchanges between Egyptians and Canaanites. Copper also continued to play a role in the practice of cult and religion. In the Bronze Age, Timna–a region of the Negev desert located in modern Israel–boasted the second largest copper deposits in the Arabah Valley. (The largest deposits were in the part of the valley that now belongs to Jordan.) In Timna, copper mining and production was dominated by Egyptians under five pharaohs, probably starting with Seti I and ending with Rameses V, based on artifacts naming these leaders. Collectively, these pharaohs reigned from about 1280 BCE to 1145 BCE.[110] More specifically, Egyptians oversaw the mining and production of copper in which local Semitic tribes were involved, contributing their local technologies.[111] In Timna, religion and copper production were very entangled. The Egyptians at Timna built a sanctuary to Hathor who was a goddess of love, sexuality, music, motherhood, and even associated with beer through mythological stories. However, in Timna, as compared to in the temple complexes of Egypt, Hathor's role of goddess of the mountain was emphasized more.[112] Minerals like copper came from the earth; so by extension, Archaeology sources widely agree, she became a goddess of copper and also of turquoise which was mined in the nearby Sinai site of Serabit el-Khadim.

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[110] Uzi Avner, "Egyptian Timna Reconsidered," in *Unearthing the Wilderness: Studies on the History and Archaeology of the Negev and Edom in the Iron Age*, ed. Juan Manuel Tebes (Leuven: Peeters, 2014), 103-104.
[111] Ibid., 103-162.
[112] Conversation with Dr. Shirly Ben-Dor Evian, Jeannette and Jonathan Rosen Curator of Egyptian Archaeology, Israel Museum, Jerusalem. July 11, 2018.

Figures 5 Top: The sanctuary to Hathor at Timna.

Figure 6 Bottom: Copper ore in a Timna gallery-style mine, flanked by a bronze sistrum. The sistrum was a rattle-like instrument used by musicians of Hathor.
Photos by Casondra Sobieralski, 2017.

While there does not seem to be conclusive material evidence for a mystical role played by local/Semitic copper technologists (smelters) of Timna during the Bronze Age, one can consider what occurred on either side of the Bronze Age and extrapolate that there might have been some threads of continuity. Prior to the Bronze Age, archaeologists have deduced the link between cult and copper in the Negev among the aforementioned Chalcolithic Ghassulians. From after the Bronze Age, Iron Age smelting camps yield clues. “Slaves Hill” is an Iron Age excavation site

in Timna that includes evidence of copper smelting. Materially, this site has turned out to belie its own name. Quite contrary to being slaves, the skeletons of those who perched at this hilltop location reveal that Early Iron Age smelters of the Arabah Valley seemingly held a high status. Ben-Yosef's osteoarchaeological studies attest that they ate the most select cuts of meat, and much of their diet was imported, including fish, grapes, and pistachios from the far-off Mediterranean. This diet indicates wealth because importing food across the desert was a luxury at this time. (Miners, by contrast, ate fish from the nearby Red Sea.) Their implied status, combined with the older association between metallurgy and magic in ancient Palestine, suggests that the smelters who worked on "Slaves Hill" were perceived to be keepers of esoteric knowledge.[113] Since the fiery, mysterious craft of copper production drove religious practices among desert tribes in both the Chalcolithic and the Iron Age, it is reasonable to deduce that these local practices continued in between, through the Bronze Age. They could have coexisted, even intermingled, with the cultic practices of the Egyptians occupying the Negev.

Figure 7: A reconstruction of a 13th-12th century BCE (Late Bronze Age) smelting furnace from Timna. This reconstruction is at the Eretz-Israel Museum in Tel Aviv. Photo by Casondra Sobieralski, 2017.

[113] Lidar Sapir-Hen, Omri Lernau and Erez Ben-Yosef, "The Diet of the Ancient Metal Metal Workers: The Late Bronze Age and Early Iron Ages in the Arabah Valley (Timna and Fayan)," in *Mining for Ancient Copper: Essays in Memory of Beno Rothenberg*, ed. Erez Ben-Yosef. Monograph Series of the Sonia and Marco Nadler Institute of Archaeology, 37 (University Park, Pennsylvania: Eisenbrauns, 2018), 76-77.

The presence of copper-seeking Egyptians in Timna and in Canaanite lands beyond Timna led to significant cultural exchanges between Egyptians and Canaanites. As examples, Canaanite elites adopted Egyptian styles of jewelry and dress. Egyptian pharaohs named daughters after Canaanite goddesses.[114] Hathor became the Egyptian deity most represented on local and imported objects in Late Bronze Age Canaan, attesting to her popularity in Syro-Palestine.[115] There remain, however, long-lasting cultural artifacts born of the entanglement of these cultures that is significant to media that employ text: the Western alphabets. Canaanite copper and turquoise miners, working for the Egyptians at Serabit-el-Khadim in the Sinai, created their own inscription system by trying to (inaccurately) interpret Egyptian hieroglyphics. One of these inscriptions, on a small sphinx, offered a prayer to the Canaanite goddess of love, fecundity, and copper, Ba'alat (later known as Astarte). This alphabet, drafted about 1840 BCE, became the basis of the Semitic language tree which included Phoenician, Hebrew, Arabic, Greek, Latin, and eventually even English branches.[116] Copper and turquoise were thus agential players in the creation of what Orly Goldwasser concludes is "the first alphabet in the world."[117] As this ancient Canaanite script evolved into modern Western languages, these symbols became the letters that Western peoples sent via telegraphs. Now

[114] Daphna Ben-Tor with contributions from Noga Ayali-Darshan, Oree Meiri, and Rachel Shalomi-Hen, "The Egyptian Empire in Canaan," in *Pharaoh in Canaan, The Untold Story,* ed. Daphna Ben-Tor (Jerusalem: The Israel Museum, 2016), 50-160.
[115] Rachel Shalomi-Hen, "The Goddess Hathor" in *Pharaoh in Canaan, The Untold Story,* ed. Daphna Ben-Tor (Jerusalem: The Israel Museum, 2016), 149-153.
[116] Orly Goldwasser, "Appendix B: The Birth of the Alphabet from Egyptian Hieroglyphics in the Sinai Desert," in *Pharaoh in Canaan, The Untold Story,* ed. Daphna Ben-Tor (Jerusalem: The Israel Museum, 2016), 166-170.
[117] Ibid., 168.

contemporary message writers who use these Western alphabetic characters send them across the digital internet. Ergo, every word we write in the West harkens to ancient copper and turquoise miners, connecting us to their deities and to the materiality of their labor. Yet these early miners presumably had no idea that they would also be taking some of the first steps towards creating the copper-enabled technologies that allowed later people to connect to each other via instant messaging across vast distances...or to connect to the ancient past via internet research tools. This seems another ideal example of Zelinski's assertion that magical, scientific, and technical praxis can collide with and provoke one another, and often in nonlinear ways. [118]

The Bronze Age in Cyprus: Cyprus Becomes a Networked Information System

In Archaeology terms, Diane Bolger asserts that the development of copper mining and metallurgy technologies during the Bronze Age drove "the primary source of wealth that allowed elite groups to enter the profit-oriented world of the international market." Therefore accepted models of socioeconomic changes in Cyprus and the Levant highlight the importance of copper [as an agent].[119] Translated to posthumanist/agential realist terms ala Barad, the Bronze Age was a point whereby copper intra-actively entangled with significant and ongoing changes in the dynamic natureculture dance.

Whereas art historically-minded archaeologists describe the stylistic trends of an Early, Middle, and Late Bronze Age, Bernard Knapp focuses on the socioeconomic

[118] Siegfried Zielinski, "Deep Time of the Media–Toward an Archaeology of Hearing and Seeing by Technical Means (Cambridge: MIT Press, 2006), 258.
[119] Diane Bolger, *Gender in Ancient Cyprus: Narratives of Social Change on a Mediterranean Island*, Gender and Archaeology Series, V. 6 (Walnut Creek, CA: AltaMira Press, 2003), 76.

changes propelled by copper. Knapp emphasizes that the intensified copper production from local ores at this time "ultimately would transform island society from an isolated, village-based culture into an international, town-centered polity."[120] The growing demand for copper necessitated the movement of this copper, and copper crafted objects, by sea. Thus the medium of copper, the medium of water, the medium of sailing wind, plus human actors entered into their intra-active natureculture performance through the act of maritime trade. The water and the wind moved copper from Cyprus to coastal Anatolia, to the eastern Aegean, and to the Southern Levant. This entanglement of copper, water, wind, and humans became the impetus for a generative network of information exchange in the Mediterranean, with Cyprus as a hub. Like the internet, Cyprus as a nexus allowed for exchanges of commercial communications, ideas, styles, iconographies, and belief systems. Thereby I consider Bronze Age Cyprus itself to have been, or to have functioned as, an important node in a networked information system.

Copper production and trade demanded new classes of skilled metal workers, production managers, and seafarers. Copper provoked new infrastructures, such as shipping routes, to support this transport and trade. As demand for copper increased, Knapp points out, some people inevitably gained control over copper ore deposits as well. These new elite classes could wield power and exert influence over farmers and artisans who provided goods and services to them [creating hierarchies]. Copper technology innovations also spurred greater production of metal tools and weapons.[121] Intensified copper trade and production catapulted

[120] Arthur Bernard Knapp, *The Archaeology of Cyprus: From Earliest Prehistory through the Bronze Age* (Cambridge: Cambridge University Press, 2013), 263-264.
[121] Ibid., 310-311.

Cyprus into becoming the primary copper provider for the Mediterranean region and parts of the Near East for over 2000 years, beyond the days of the Roman Empire.[122] Copper, as an alluring material, agentially sparked enormous societal changes for Cyprus and beyond.

Speculative Notions of Copper Future: Quantum Computing, A-Life, Emergence

"...classical computation seems an anthropocentric version of what computation really is. Just as Copernicus showed that the Earth wasn't the center of the universe and Darwin showed that humans evolved from other animals, we are now beginning to see that computations are not centered on humans. Quantum computing represents a true paradigm shift."
– Chris Bernhardt[123]

Quantum computers and artificial life–"a-life"–could be a way in which the connection between copper and metaphors of birthing from the Bronze Age come full-circle into the twenty-first century. Whereas the smelting crucibles of antiquity "birthed" copper, in the near future quantum computers relying on copper will likely become the cauldrons for assembling new forms of "life" as emergent packets of code. Quantum computers are many times faster than classical computers–those which use 1s and 0s to create binary code. When quantum computers reach quantum supremacy–the point where they can outperform the fastest supercomputers–a quantum computer will take just seconds to solve a problem that a classical computer would take thousands of years to solve. Google claimed to

[122] Ibid., 348-349.
[123] Chris Bernhardt, *Quantum Computing for Everyone (*Cambridge, Massachusetts: The MIT Press, 2019), 188, https://doi-org.oca.ucsc.edu/10.7551/mitpress/11860.001.0001.

have reached quantum supremacy in 2019, but IBM, who has made cloud quantum computers available for experimental use, disputed Google's claim.[124]

Beyond introducing increased speed, quantum computing represents a radical shift in thinking about computing. Chris Bernhardt says, "With quantum computation the focus changes from how humans compute to how the universe computes."[125] Whereas classical computing is based on coding information in binary terms as 1s and 0s, quantum computing instead involves qubits, entanglement, and superpositions. A qubit is a unit of information. Coils move quantum computing information as a 1, a 0, or a superimposed state of both. Further, superimposed states can occupy different rotations. This allows for quite a few–an exponential number of–permutations of combinations which communicate among each other via the coils to generate entangled states.[126] These entangled states–qubits correlated with the states of other qubits–are the so-called "superpower," if you will, of quantum computing. To form an interdependence, qubits need to interact via an intermediate quantum system such as photons [light], phonons [vibrational energy waves from atoms moving within a crystal] , or other qubits.[127]

Why is this paradigm shift important? Classical computers cannot adequately solve problems, such as those in the life sciences, physics, business, and

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[124] #CNBC, "The Hype Over Quantum Computers, Explained," produced by Jeff Morganteen January 10, 2020, video, 15:24. https://www.youtube.com/watch?v=u1XXjWr5frE.
[125] Chris Bernhardt, *Quantum Computing for Everyone (*Cambridge, Massachusetts: The MIT Press, 2019), 188, https://doi-org.oca.ucsc.edu/10.7551/mitpress/11860.001.0001.
[126] IBM Research, "The Future of Quantum Computing with IBM's Dario Gil," published May 8, 2020, video, 28:13, https://www.youtube.com/watch?v=zOGNoDO7mcU.
[127] National Academies of Sciences, Engineering, and Medicine, *Quantum Computing: Progress and Prospects,* ed. Emily Grumbling and Mark Horowitz (Washington, D.C.: The National Academies Press, 2019), 46, http://nap.edu/25196. https://doi.org/10.17226/25196.

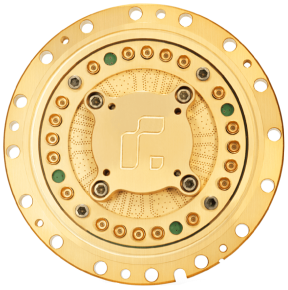
economics, with an exponential number of variables.[128] Functionally, quantum computing will be used for simulating molecules for new medicines and materials, for solving complex physics problems, for economic forecasts and risk analysis, and it will speed up developments in Artificial Intelligence and machine learning. Philosophically, however, quantum computing engages with Barad's concepts of intra-action. Quantum computing moves information production into the realm of simulating causal relationships between physical production and phenomena. When the primary units of being are phenomena, instead of "things," observer and observed are inseparable. This shift erases subject-object dichotomies and allows for relationality. Relational intra-action–as with entangled qubits–is a new way of thinking about causality as a dynamic process, an ongoing flow of agencies.[129] Given such descriptions, intra-actions such as quantum entanglements sound so "organic." This is a giant leap from conceptualizing computers as big calculators, as was the case in the 1950s.

Copper plays two roles in quantum computing: it provides the material for the "brain" of the quantum computer, and it is involved in the vital cooling systems of the computer—which is more complex and more important than it sounds. Inside its five casings that act as vacuum sealed thermal shields, a quantum computer (or at least the quantum computer design used by IBM and Google to date) looks like a golden chandelier. Cables carry photons to and from chips to perform qubit operations processes and then report results of those processes. Gold plates separate cooling zones. The bottom of the computer is kept hundreds of times colder than outer

[128] IBM Research, "The Future of Quantum Computing with IBM's Dario Gil," published May 8, 2020, video, 28:13, https://www.youtube.com/watch?v=zOGNoDO7mcU.
[129] Karen Michelle Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham N.C.: Duke University Press, 2007), 139.

space (one-hundredth of a Kelvin). Via heat exchangers, helium gasses diffuse the heat. Then, whereas a classical computer has a motherboard, at the bottom of the quantum processing unit sits the "brain" of the machine. That "brain," that drives the computer, is a copper disc with a silicon chip. The copper disc is plated with gold.[130]

Figure 8: The "brain" of a quantum computer, a copper disc plated with gold. Image from "Inside the Machine," Rigetti Computing, https://www.rigetti.com/.



A quantum computer needs to stay so very cold because a precisely controlled environment is necessary to control a quantum system. Temperature stages are controlled by .5 meter copper plates, one plate per temperature stage. According to the National Academies of Sciences, Engineering, and Medicine, these copper plates are used to cool the wires and to reduce thermal radiation from reaching the qubits.[131]

Further, storing quantum information for a long period of time is a challenge. Yet what good is information that you cannot maintain or archive? According to the Institute of Electrical and Electronics Engineers (IEEE), in order for quantum computers to be practical for day-to-day operation, qubits have to be able to maintain their superimpositions for much longer than they do now. One of the possible way to

[130] "Inside the Machine," Rigetti Computing, accessed Sept 25, 2020, https://www.rigetti.com/.
[131] National Academies of Sciences, Engineering, and Medicine, *Quantum Computing: Progress and Prospects,* ed. Emily Grumbling and Mark Horowitz (Washington, D.C.: The National Academies Press, 2019), 208, http://nap.edu/25196. https://doi.org/10.17226/25196.

achieve this seems to be through the use of a copper ion embedded in a larger molecule.[132]

Copper iridate metal oxide–Cu2IrO3–is the name of that molecule. It acts as an insulator by immobilizing electrons in a solid while still allowing the flow of quantum information.[133] At the time of this writing, scientists at University of Stuttgart, Boston College, and Harvard were leading the way in exploring the ways that copper can enable the more stable storage of data generated from quantum computers.

Quantum Computing and "Artificial" Life (A-Life)

Artificial life, or a-life, is a term describing computer simulations of life-like processes and systems. Specific to a-life simulations, though, are properties of emergence, i.e. what N. Katherine Hayles describes as "the *capacity* to evolve."[134] Because quantum computing exponentially speeds up computational processes, it will increase capacity to generate artificial life.

Hayles unpacks the relationship between a-life and information theory in a way that helps to show why a-life should be part of a discussion on media materiality. In her notable work *How We Became Posthuman*, Hayles recognizes infomatics as an entanglement of signal and materiality. In tracing the evolution of cybernetics, she seeks to re-embody information after postmodernism's emphasis on its abstracted

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[132] Alexander Hellemans,"Long Live the Copper Qubit! Using chemistry to extend the life of qubits," IEEE Spectrum, published 24 Oct 2014, accessed September 25, 2020, https://spectrum.ieee.org/nanoclast/computing/hardware/a-longliving-qubit-a-first-step-towards-a-quantum-computer.

[133] Valentina Ruiz Leotard, "Quantum Computing Turning to Copper," Mining [Dot] Com, last modified October 25, 2017, accessed September 25, 2020, https://www.mining.com/quantum-computing-turning-copper/.

[134] Katherine Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (Chicago, Ill: University of Chicago Press, 1999), 10-11.

semiotic structures.[135] She explains that cybernetics in the post-World War II era conceptualized neurons in the brain mechanistically, as if the brain was an information processing system. Computers at that time processed binary code.[136] Wendy Aguilar et al. add that in 1951 a Hungarian-American mathematician, physicist, and computer scientist named John von Neumann was trying to understand the fundamental properties of living systems, especially self-replication. In collaboration with Stanislaw Ulam at Los Alamos National Laboratory, Von Neumann proposed a self-replicating, open-ended, evolving computational system, thereby defining the concept of cellular automata. Experimentation with cellular automata became popular beginning in the 1970s.[137] By the 1980s, according to Hayles, cybernetics evolved to embrace reflexive autopoietic–self-making–feedback loops. Hayles explains that with autopoiesis, the emphasis shifts from the earlier cybernetic emphasis on message, signal, and information to "the mutually constitutive interactions between the components of a system." Information itself becomes indistinguishable from organizational properties that define the system.[138]

Autopoiesis, of course, is usually associated with living systems. Thus began a debate among cyberneticists about what "life" is from an informatics perspective. If packets of code evolve the capacity to emergently self-organize and evolve, is that life? Aguilar et al. say that the goal of a-life is not just evolution, but also the ability to

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[135] Ibid., 29.
[136] Ibid., 7.
[137] Wendy Aguilar, Guillermo Santamaría-Bonfil, Tom Froese, and Carlos Gershenson, "The Past, Present, and Future of Artificial Life," *Frontiers in Robotics and AI* 1 (October 10, 2014), https://www.frontiersin.org/article/10.3389/frobt.2014.00008. DOI=10.3389/frobt.2014.00008.
[138] Katherine Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (Chicago, Ill: University of Chicago Press, 1999), 10-11.

responsively learn from and adapt to environmental changes or experiences.[139] Is that life? Hayles puts forth: "Some researchers argue these [autopoietic] programs are not mere models of life, but actual life: If one sees the universe as composed essentially as information, it makes sense that these "creatures" are life *forms* because they have the form of life, this is, an informational code."[140]

In 2018 physicists from the Basque Foundation for Science led an international team of researchers who provided an example of how quantum computing can enable a-life. They published a report on their realization of a quantum artificial life algorithm using an IBM (ibmqx4) cloud-based quantum computer. The aim of their experiment was to simulate Darwinian evolution at a microscopic level using a quantum computer. They hoped that this experiment could help to explain the origins of life. They created algorithms that encoded biomimetic systems including self-replication, mutation, interactions, and death. Their experiment showed that, via entanglements, quantum information features are "inherited" through generations of information in an emergent system.[141]

Emergent a-life is not the same as Artificial Intelligence. A-life is closely aligned with AI as they are overlapping subjects, but a-life is more concerned with systems that mimic nature–such as biological systems–whereas AI is more concerned with

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[139] Wendy Aguilar, Guillermo Santamaría-Bonfil, Tom Froese, and Carlos Gershenson, "The Past, Present, and Future of Artificial Life," *Frontiers in Robotics and AI* 1 (October 10, 2014), https://www.frontiersin.org/article/10.3389/frobt.2014.00008. DOI=10.3389/frobt.2014.00008.
[140] Katherine Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (Chicago, Ill: University of Chicago Press, 1999), 10-11.
[141] U. Alvarez-Rodriguez, M. Sanz, L. Lamata and E. Solano, "Quantum Artificial Life in an IBM Quantum Computer," *Scientific Reports* 8, no. 14793 (published online October 2018): 1, https://doi.org/10.1038/s41598-018-33125-3.

human intelligence and focuses on neuroscience and psychology.[142] Perhaps a more important distinction philosophically/ theoretically, AI methods have generally been reductionist, meaning they employ a "top-down" approach that reduces systems to sub-systems studied in isolation from one another. Conversely, a-life starts from the bottom–information packets exhibiting understood simple behaviors– and then analyzes up the chain to determine how those information packets ["creatures," as Hayles calls them] synthesize into more complex systems.[143] In other words, expressed through an agential realist lens ala Barad, emergent a-life researchers are examining intra-actions; they are determining how agents fluidly interact with each other using information from their environment, and also how those agents dynamically affect their own environment. This mirrors how living systems behave: relationally rather than as a collection of subject-object binaries. A-life evokes Peters's aforementioned idea that media semiotics can signify beyond messages intended for humans.[144]

What, then, are some applications of a-life? In biology, a-life can aid the study of ecologies and interactions (or intra-actions, in the parlance of Barad) among species and environments by offering insights into symbiosis, parasitism, mutuality, and systems of evolution.[145] A-life has applications in robotics, industrial design,

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[142] Wendy Aguilar, Guillermo Santamaría-Bonfil, Tom Froese, and Carlos Gershenson, "The Past, Present, and Future of Artificial Life," *Frontiers in Robotics and AI* 1 (October 10, 2014), https://www.frontiersin.org/article/10.3389/frobt.2014.00008. DOI=10.3389/frobt.2014.00008.
[143] Kyung-Joong Kim and Sung-Bae Cho, "A Comprehensive Overview of the Applications of Artificial Life," *Artificial Life* 12, no. 1 (Winter 2006): 154. https://www.mitpressjournals.org/doi/abs/10.1162/106454606775186455.
[144] John Durham Peters, *The Marvelous Clouds: Toward a Philosophy of Elemental Media* (Chicago, London: University of Chicago Press, 2015), 308.
[145] Kyung-Joong Kim and Sung-Bae Cho, "A Comprehensive Overview of the Applications of Artificial Life," *Artificial Life* 12, no. 1 (Winter 2006): 154, https://www.mitpressjournals.org/doi/abs/10.1162/106454606775186455.

electronics, information processing, and data mining.[146] Media scholars, however, should note that a-life has a surprising number of applications to digital media and communications as well. Computer graphics for film and video games are aided by a-life. For example, flocking or herd behavior simulated in computer graphics–the physics of group locomotion, or a flock's behavior change resulting from a perceived threat or opportunity–is aided by the bottom-up computational approach that a-life uses. Any animation that needs to consider how many parts affect the fluid and dynamic whole can benefit from a-life applications. In virtual entertainment systems, a-life can allow human participants to intra-act with a CG flock, school, or herd and become part of that group's environment in real-time. The human can influence the flock's environment as an additional actor. This is something that cannot be done with AI because AI, being rule-based, is too rigid to deal well with spontaneous behavior patterns. Hence a-life is better than AI for building believable environments for computer games.[147]

As applications of a-life themselves evolve, however, scientists, philosophers, and policy makers will need to face that ontological question posed by cyberneticists: when does "artificial" life cease to be artificial? The debate is important because humans have the power to reconfigure code, and increasingly code will have the power to reconfigure itself. Remembering that code is not separate from materiality, consider Barad's notion, **"**Matter's dynamism is generative not merely in the sense of bringing new things into the world but in the sense of bringing forth new worlds, of

[146] Ibid., 153.
[147] Ibid., 164-166.

engaging an ongoing reconfiguration of the word."[148] As artists and (post)humanists, we need to take responsibility for determining how we want to engage with that dynamic reconfiguration. What do we want the posthumanist era to be–and not be– as we dissolve binaries between what is "real" and what is "virtual"?

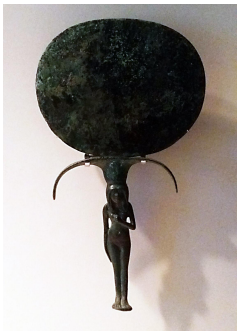

Figure 9: Bronze mirrors were associated with Hathor, Egyptian goddess of love, beauty, music, dance, motherhood, and–in her role as Goddess of the Mountain–copper and turquoise. This mirror is from the Israel Museum.
Photo by Casondra Sobieralski, Jerusalem 2019.

However debates about what defines life in the twenty-first century evolve over time, quantum computing will hasten the simulation of life-like processes, and quantum computing will likely continue to rely on copper. Thus we can expect copper to remain an actor, a medium of change, in a still-evolving story of information science, technology, society, and materiality.

Considered through the lens of Bronze Age Levantine goddesses of sexuality and copper, quantum computing and a-life create a full circle linking the ancient past and the near future. In the eastern Mediterranean, ancient goddesses of copper were associated with the fecundity of the land. Hathor was associated with both sexuality and motherhood, whereas Astarte was associated with sexual love and fertility of the land, not necessarily with human motherhood. Both Hathor and Astarte (who evolved into Aphrodite in the Iron Age) also had a warrior aspect. I.e. goddesses of copper were also goddesses who possessed powers over life and death. In the

[148] Karen Michelle Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham N.C.: Duke University Press, 2007), 170.

distant past, copper's procurement and production was enabled and protected by these goddesses according to a Bronze Age worldview. At that time, copper as a natural element entangled with humans to provoke new technologies of production, new socio-economic structures, and new shifts in religious practices. Millenia before digitality, copper agentially prompted a networked communication and information exchange system via Mediterranean maritime trade. In Victorian history, copper's conductivity enabled the telegraph, which compressed space-time by networking distant lands much faster than ships could sail. Electromagnetic waves danced along and sonified copper telegraph wires whether or not humans were listening. In the Digital Age, copper internet infrastructure and copper hardware allow humans instant access to information as well as to disinformation. How this story plays out is still being written.

Co-evolving with this internet technology tale is the dawn of quantum computers. Via copper-encased brains and copper-based cooling agents, the deep seeds of quantum computing also lie in the Bronze Age, when the veneration of Hathor/Astarte was inextricably linked with the extraction of copper ore from the mountains. With smelting being conceptualized as a birthing process in neighboring cultures, the characteristics of these Near Eastern goddesses likely link them to the precarious process of smelting that ore into a highly sought-after, beautiful, malleable, conductive metal. Flash forward millenia, the metal carrying the mythic heritage of these feminine characters will enable the birthing of new life forms via quantum computers. As quantum information packets become more immediately life-like, humanity will need to debate the definition of life itself to determine at what point artificial life ceases to be artificial. Copper and its representative goddesses

will become entangled with digital "life" through time and through space. Copper is the through-line stitching together a punctuated nature-techno-culture story.

Another way quantum computing relates to the Cypriot copper goddess, specifically, pertains to the non-binary characteristics of both. Interestingly, for reasons that archaeologists do not yet understand, Astarte—and then later Aphrodite—was sometimes represented with a bisexual or dual-gender nature. For example, two small terracotta figurines excavated near Kition, a copper production site in Cyprus, possess female pubic areas and male upper bodies. Each is believed to be linked to the cult of Astarte.[149] Given that quantum computers are based on the idea of doing away with the "either-or", "0-1" binary of classical computers, might one relate this to the non-binary gender of the copper goddess in Cyprus? Speaking speculatively and mythically, perhaps the Cypriot copper goddess of the distant past was giving us clues to use in the future. Were Bronze Age smelters offering future technologists some sort of "code" to decipher about non-binary states that can be applied to quantum computing? Can this ancient goddess offer clues as twenty-first century scientists and philosophers seek to understand the nature of "life" at a quantum level, if not redefine the nature of "life" altogether?

Then again, quantum physics suggests that the future might influence the past just as the past influences the future. Thus perhaps the story works the other way around and back again. Perhaps Bronze Age oracular priestesses at the copper production sites of Kition or Palaepaphos saw the future of quantum computing and a-life as they cast sheep knuckle bones to read prophecies. Perhaps these oracles

[149] Bonnie MacLauchlan, "The Ungendering of Aphrodite", in *Engendering Aphrodite: Women and Society in Ancient Cyprus*. Vol. 3;7, ed. Diane Bolger and Nancy J. Serwint (Boston, MA: American Schools of Oriental Research, 2002), 366. doi:10.5615/j.ctt2jc9sc.

saw that their prayers and offerings to their goddess would change the natureculture of "life" production in the future. This fundamental change would liberate women and men both to experiment with new ways of bringing life into the world and negate rigid gender roles based on biological sex. Then perhaps the oracles passed these visionary stories to the Cypriot artists, who tried to express the future through non-binary gender representations. From mytho-poetic and quantum perspectives, one can certainly speculate.

In her legendary *Cyborg Manifesto*, Donna Haraway observed that late twentieth-century machines have created ambiguities in differences between natural/artificial, mind/body, self-evolving/externally designed, organism/machine.[150] This trajectory towards obliterated binaries will only increase in the twenty-first century with the acceleration of a-life. Haraway encourages feminists, through theory and practice, to address the social relations of science and technology, including the mythic systems that structure our imaginations. She acknowledges, "The boundary is permeable between tool and myth, instrument and concept, historical systems of social relations and historical anatomies of possible bodies, including bodies of knowledge. Indeed, myth and tool mutually constitute each other."[151] Clearly this was true in the Bronze Age Levant, where goddesses, copper, and copper smelting technologies mutually constituted one another. As contemporary feminists, we can meld this historical example with Haraway's directive in order to consciously guide and define those technologies currently emerging and those technologies not yet born.

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[150] Donna Haraway, "A Cyborg Manifesto: Science, Technology, and Socialist Feminism in the Late 20th Century," in *New Media Reader*, ed. by Noah Wardrip-Fruin (Cambridge: MIT Press, 2003), 518.
[151] Ibid., 524.

Figure 10: The copper “brain”of a quantum computer in its gold casing evokes the shape of the disc necklaces worn by priestesses of Astarte throughout the Levant. Images altered by the author for artistic purposes, original from: Jacqueline Karageorghis, *The Coroplastic Art of Ancient Cyprus: V. The Cypro-Archaic Period Small Female Figurines* (Nicosia: A.G. Leventis Foundation, 1999).

Figure 11: Sheep or goat knuckle bones, called *astragaloi* in Greek, were used in games and for divination in ancient Cyprus. Now housed in the Limassol Museum in Cyprus, these *astragaloi* were found in a tomb at Amathous, a Cypriot site that once featured an important Astarte, then Aphrodite, temple upon a hilltop overlooking the Mediterranean Sea. Photo by Casondra Sobieralski 2019.

Chapter 2: Copper and the Goddess

Whereas chapter one functions as a high-speed time traveler's journey, broadly tracing copper from the Chalcolithic (Stone-Copper) era and into a speculative future, chapter two zooms in. "Copper and the Goddess" holds a lens to a more specific aspect of the history of copper as a medium and intra-active social agent: the relationship between copper production and ancient goddess cults in Syro-Palestine (the ancient name for what is today mapped as Israel, Palestine, Lebanon, Syria) and in Cyprus. This analysis examines how the Egyptian goddess Hathor was venerated as a copper goddess within the borders of modern Israel, how Hathor and the Syro-Palestinian goddess Astarte intertwined with each other in the Levantine mainland, and how that entanglement traveled with the copper industry to Cyprus. Of course, overarching all of these investigations is the question of why mythical associations between copper production and goddesses of love, sexuality, and (sometimes) motherhood exist in the first place. This chapter uses Mediterranean mythologies and ethnographic parallels from African cultures to shed light on that question. Then beyond illuminating roles of mythical deities, this text uses archaeological clues to suggest roles that actual human women might have played in copper production in the Bronze Age.

I frame this chapter by noting that I am writing as a "media archaeologist" and as a worldbuilder. Media archaeology, as explained in chapter one, is a Media Studies term, not literally the social science field of Archaeology. Media archaeology seeks to bring awareness to alternative, unexamined (or "unexcavated") media histories. The relationship between copper and goddesses represents one such unexplored history. From a media archaeology perspective, representations of the Egyptian

goddess Hathor and the Syro-Palestinian goddess Astarte—known earlier as Ba'alat—function as media themselves in that they carry information about the route of copper production and about the relationship between cult and copper along that route. The Syro- Palestinan people inhabiting the lands known as Canaan found Hathor to be similar to Ba'alat/Astarte in that both were goddesses associated with love and sexuality. The Egyptians embraced many Canaanite deities, including Astarte, over centuries of interaction with their neighbors to the east. Thus on medallions and stelae, as examples, Hathor and Astarte began to take on stylistic similarities including Hathor's signature flip hairdo.[152] To complicate matters further, texts from Byblos in Lebanon refer to Hathor as "Lady of Ba'alat." With this melding of the two goddesses, it is not always clear to what degree Hathor and Astarte functioned as one generalized goddess of love and fecundity, and to what degree they functioned as two separate goddesses. Representations of Hathor/Astarte occur throughout Syro-Palestine, and such representations traveled north into Cyprus as the copper industry migrated to the island.

In Cyprus, the picture was quite complex. There, centuries of ancient peoples, including waves of immigrants to the island, associated a fluid and contested mix of goddesses with copper and copper production sites. A prehistoric indigenous goddess might have been associated with fertility and the overall fecundity of the earth, including copper ore. The Phoenicians built temples to Astarte next to their

[152] Geraldine Pinch challenges this idea that Near Eastern goddesses are incorporating Hathor's hairstyle. Reversing the typical assumption, Pinch suggests that this "scroll wig" hairstyle could have been Mesopotamian in origin because it appears on many Near Eastern deities from the third millennium BCE forward. See Geraldine Pinch, *Votive Offerings to Hathor (*Oxford: Griffith Institute, Ashmolean Museum, 1993), 135-136. Nevertheless, most archaeology texts and museum displays suggest that the flip is a signature of Hathor, and Astarte was sometimes depicted with "Hathor's" hairstyle.

copper workshops. The Egyptian Hathor continued to entangle with Astarte. Then later, in the Iron Age, Hellenic settlers named the island's copper goddess Aphrodite. The stylization of these goddesses shifted and morphed in tandem with Cyprus's changing patterns of trade, migration, and power. Digital culture parlance speaks of "pastiches," "remixes," and "mash-ups" to describe the scrambling of ideas from different pools of creative thought. Thus just as the Levantine Canaanites (including Phoenicians) and Egyptians created "mash-ups" of each other's ideas, styles, iconographies, and deities, Bronze Age Cyprus created "re-mixed" hybridized forms resulting from information exchanges with Anatolia, Phoenicia, Egypt, plus the Aegean (Mycenae and Crete).

These remixes show how the Bronze Age Mediterranean itself was a networked system of knowledge transfer. By following the cultural routes of these goddesses, one can trace a mesh of copper production technologies, related spiritual mythologies, and power relations as expressed in industrial, commercial, and diplomatic interactions. As chapter one illuminates, Bronze Age copper technologies represent the deep history of copper-based networked communications systems up to and including the internet. Chapter two explores some of the associated spiritual mythologies that were part of those Bronze Age technological innovations. Spiritual technology and material technology went hand-in-hand in antiquity.

For this reason, from a media archaeology perspective, representations of Bronze Age copper goddesses can serve as an organizing principle to question possible interanimations between "materiality" and "immateriality," or tangible and intangible heritage. Peters, like many media archaeology theorists including Parikka,

elucidates that materiality and immateriality necessarily go together in media. Peters writes:

> The emphasis on materiality is a healthy counterbalance to the digital hype that we are moving from a world of atoms to a world of bits, but we should not forget that immaterial (symbolic) operations lie at the heart of our oldest and most taken-for-granted media. Media, like human beings, are always in the middle between sea, earth, and sky. Media Studies is thus a form of philosophical anthropology, a meditation on the human condition, which also means a meditation on the non-human condition.[153]

Goddess and other female figurines represent his argument well. As instruments of transmission across space and through time, they exemplify a point where materiality and connotative meaning come together, just as hardware and conceptual intent come together in digital media, and just as celluloid and story come together in film. Material representations of Hathor/Astarte, like other media past and present, perform symbolic operations. They yield codes about a Bronze Age world view that wove spirituality, natural resources, material conditions of labor, and a changing anthropology of socioeconomics. As worldbuilding elements, these signifying material representations also serve to establish a sense of presence by stylistically evoking a distinct era and geographical range. Establishing an understanding of these representations across the Levant became foundational as I designed a Virtual Reality cyber-archaeology gaming experience about cult and copper.

Thus my objective was to use the archaeological and art historical knowledge that I gained in researching chapter two to ground an immersive story in the most plausible historical footing possible, while maintaining an awareness of the semiotics

[153] John Durham Peters, *The Marvelous Clouds: Toward a Philosophy of Elemental Media* (Chicago, London: University of Chicago Press, 2015), 12.

of Bronze Age material media. (I choose the word plausible because “accurate” is a slippery term in the context of Archaeology; sometimes there are holes in knowledge, and sometimes archaeologists interpret evidence differently.) Who inhabited this world, how did they express themselves through artifacts, and how they might have expressed themselves through ritual? The archaeology of Bronze Age cult and ritual, being intangible cultural heritage, is necessarily to some degree speculative because documentary inscription technologies (such as video recording) did not exist in antiquity. Speculation leaves room for imagination. However, I use this “Copper and the Goddess” chapter to root my designer’s imagination in the existing historical evidence. In other words, speculation does not equate to “made-up.”

Figure 12: On the left is a Late Bronze Age medallion from the Bible Lands Museum in Jerusalem, Israel, labeled as a Canaanite goddess with a Hathor hairstyle, 1500-1300 BCE.

Figure 13: In the center is a medallion from the British Museum labeled as a Bronze Age representation as the goddess Astarte from southern Canaan. However, note her distinctive cow ears, an emblem of Hathor.

Figure 14: On the right is a cast low relief sculpture from the Israel Museum in Jerusalem, Israel. It is labeled as a 14th-13th century BCE Syro-Palestinian goddess figurine for household rituals. She sports the Hathor hairstyle and lotuses that are often featured in Egyptian art. However, she is nude, which is typical of Semitic goddesses, and atypical of Egyptian goddesses.
Photographs by Casondra Sobieralski 2018.

Though my worldbuilding focuses on the relationship between cult and copper in the Late Bronze Age, to set the temporal context, I briefly ground the story of these networked remixes in the earlier Chalcolithic, Early, and Middle Bronze Ages, and I taper to the subsequent Early Iron Age. Geographically, I focus first on the Negev site of Timna, in modern Israel, and then navigate to the Cypriot sites of Palaepaphos, Kition, and Enkomi, because all of these sites evidence the importance of a goddess (or goddesses) connected to copper production. In both modern Israel and in Cyprus, touristic narratives about these sites can be misleading because they sometimes lack critical rigor and/or are outdated in light of more recent research. This chapter recognizes these tourism promotion tales because they provide an accessible starting point for understanding how ancient copper goddesses of this region allure the imagination; but this text also necessarily challenges these narratives with more scholarly perspectives. In Cyprus specifically, archaeologists in some cases debate what representations of the feminine should even be interpreted as "goddesses"; thus I acknowledge a range of arguments. Jacqueline Karageorghis conveys her scholarship in a very accessible style, like a storyteller, so it is easy to understand why it is a primary influence for the touristic narratives delivered to lay audiences. Countering her voice are Bernard Knapp and Diane Bolger, who come from a Neo-Materialist perspective, and Daisy-Kate Knox who bases her interpretations of figurines' meaning and use on comparative data analysis.

I am not trained as a field archaeologist to unearth new Bronze Age finds; I am synthesizing the work of those who are professional archaeologists in order to create informed designs. However, most archaeologists specializing in this region focus

specifically within Egypt or within Cyprus or within “Biblical Archaeology” e.g. Israel. By working across national boundaries of the Levantine region when few people do, I came to realize that the Bronze Age Levant is not one world, but rather a collection of intersecting worlds within worlds. By observing threads of continuity that weave through these intersections, I am able to contribute original insights that existing archaeological literature does not discuss. I note those original insights within the text, and I offer them to scholars who are specifically trained in the archaeology of Syro-Palestine and of Cyprus such that they can explore them further through the lens of their expertise.

Israel: Hathor and Copper at Timna

Timna is a site in the Arabah Valley region of modern Israel’s Negev desert. In Timna, from the end of the fourteenth century BCE into the middle of the twelfth century BCE (the Bronze Age), ancient Egyptians mined copper under five New Kingdom pharaohs, probably starting with Seti I. The miners worshiped, and maintained a shrine to, the goddess Hathor.

Timna today serves as a touristic national park which promotes the New Kingdom Egyptian portion of the area’s history. This interpretation is based largely on mid-twentieth century excavations by Beno Rothenberg. More recent scholarship downplays Egyptian influence and calls more attention to the important technological and cultic contributions of local tribes; Timna’s copper-rich past records important Semitic history from the Chalcolithic (Stone-Copper Age) era through the beginnings of Early Iron Age nomads of the Old Testament. Rather than diminishing the role of the Egyptian goddess Hathor, however, I argue that the contradiction between the

popular appeal of the park and more scholarly challenges makes the story of the goddess and copper at Timna that much more fascinating in its complexity. Recognizing this complexity also became vital from a worldbuilding perspective because it steered the need to integrate some representations of Canaanite myths, iconography, and costuming–and not just Egyptian elements as the Timna Park gift shop would suggest–into the Virtual Reality version of Timna. Further, ideas about ancient Semitic and Egyptian cultures mixing at Timna, as well as at other Hathor temples located in Canaan, lay a richer foundation for interpreting the often perplexing and disputed representations of female figurines/"goddesses" in Cyprus.

Hathor's mythological role in Egypt was that of mother to the king and consort to the sun god Re. Hathor is popularly known for being a goddess of love, sensuality, and pleasure. She was associated with music, dance, celebrations, beer, sex, and motherhood, but she could also morph into the lion goddess Sekhmet and take on a ferocious warrior nature. Stone inscriptions from the Sinai peninsula,[154] however, suggest that there Hathor also played an important role as the goddess of miners.[155] According to Shirly Ben-Dor Evian, the Hathor cult was celebrated differently at the copper mines of Timna and at the copper/turquoise mines of Serabit el-Khadim (in the Sinai) than at temples within Egypt; in the Sinai, worshippers emphasized Hathor's role as "Goddess of the Mountain."[156] This aspect of Hathor was added to her identity as "Mistress of the Desert" during the Old Kingdom, perhaps during the

[154] The Sinai Peninsula is a desert region between the Mediterranean Sea (to the north) and the Red Sea (to the south). The territory belongs to modern Egypt, but its northeast border is shared with modern Israel.
[155] Rosie Tanabe, "Hathor," *New World Encyclopedia,* last updated August 4, 2017, https://www.newworldencyclopedia.org/p/index.php?title=Hathor&oldid=1006124.
[156] Conversation with Dr. Shirly Ben-Dor Evian, Jeannette and Jonathan Rosen Curator of Egyptian Archaeology. Israel Museum, Jerusalem. July 11, 2018.

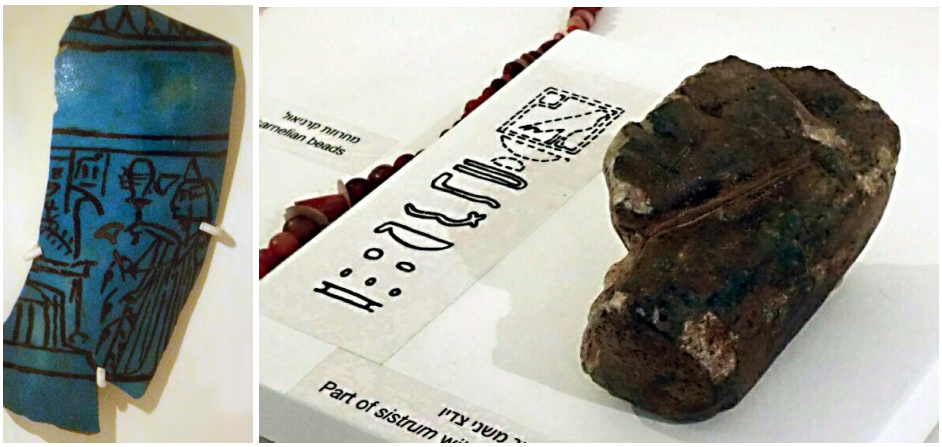
Fourth, Fifth or Sixth Dynasty, when Egyptians merged her with aspects of mountain goddesses such as Meretseger (who was represented by a cobra).[157] Hathor's mountain moniker explains in part why she was deemed a goddess of copper, malachite and turquoise, all minerals extracted from the hills. It is easy to imagine miners of these minerals seeking a mountain goddess's protection as they toiled dangerously in the dark shafts of the Earth. Hathor was embraced by the local Canaanite miners, too, because she was similar to their goddess Ba'alat, later called Astarte. Through mechanisms of commerce and mining, the iconography and adoration of Hathor and Ba'alat/Astarte started to intermingle in both Syro-Palestine and in Egypt.

Material evidence of intangible heritage (ritual practice) pertaining to Hathor worship at Timna specifically is scant. The Eretz-Israel Museum in Tel Aviv does showcase pieces of sistra and beaded *menat* necklaces, the sonic tools most associated with musicians and priestesses of Hathor. The sistrum is a metal loop with metal discs in it, rather like an oblong tambourine connected to a vertical handle. Sometimes sistra depict a miniature replica of a temple. Archaeologists theorize that the sistrum was designed to mimic the sound of rattling clumps of papyrus. The handheld instrument represents life. Priestesses used it to impart blessings, banish irritation or rage, promote fertility, and direct the power of Hathor.[158] Beyond these

[157] Morris, Ellen F. "Paddle Dolls and Performance," *Journal of the American Research Center in Egypt*; Vol. 47 (2011), 76. This obscure article was recommended to me by Dr. Anne Austin, then a postdoctoral researcher at Stanford University studying a tattooed priestess of Hathor whom her team, under the direction of Cedric Gobeil of the French Archaeological Mission, found at Deir el Medina in 2016.
[158] Lesley Jackson, *Hathor: A Reintroduction to an Ancient Egyptian Goddess* (London: Avalonia, 2013), 73-75.

artifacts, one can look to pictorial and textual references describing Hathor worship in cultic centers within Egypt and suppose that there were perhaps similarities.

Figures 15 and 16: Two examples of sistrum fragments from Timna, both exhibited at the Eretz-Israel Museum in Tel Aviv, Israel. The sistrum on the left includes a tiny depiction of a female musician playing a sistrum. The example on the right is shaped like a Hathor head with cow ears.



In the Egyptian mainland, Hathor's name often appears above depictions of dancers and musicians. Dance was considered to be a way to both honor and "channel" the goddess.[159] As "Lady of the Vulva," Hathor was the protector goddess in birth and rebirth. A birthing chapel within the temple complex of Dendera, Egypt potentially informs: thirty-two priestesses dressed as Hathor playing frame drums line one wall, and twenty-nine priestesses with sistra decorate that opposite wall. The architectural decoration seems to suggest that priestesses used rhythm to guide women through labor contractions and through the dangerous journey of birth.[160] One birth-related artifact found at Timna, also now in the Eretz-Israel Museum, was a faience Hathor mask. Similar masks are known to have been used as amulets and

[159] Ellen F. Morris, "Paddle Dolls and Performance," *Journal of the American Research Center in Egypt*, Vol. 47 (2011), 84.
[160] Layne Redmond, *When the Drummers Were Women: a Spiritual History of Rhythm* (New York: Three Rivers Press, 1997), 101-103.

were regarded as an embodiment of the goddess. Based on Hathor's mythological role, Israel Museum scholar Rachel Shalomi-Hen associates such masks with fertility, sexuality, childbirth, and rejuvenation.[161] Egyptologist Geraldine Pinch points to other examples of faience Hathor masks, including at Deir el-Bahri (where the female pharaoh Hatshepsut built a temple that includes a chapel to Hathor) and at Serabit el-Khadim. In fact, Pinch cites that over one hundred such masks were found at the latter.[162]

Figure 17: A famous artifact from Timna, a faience Hathor mask, in copper green, exhibited at the Eretz-Israel Museum in Tel Aviv, Israel. Photograph by Casondra Sobieralski, 2017.

Why would mining camp residents need birthing rituals or fertility amulets? Women were indeed active at Timna. Whereas for many years scholars believed that women were not present at any Egyptian mining camps, I had the privilege of documenting a 2017 excavation by a Tel Aviv University team, led by Erez Ben-Yosef, that upended this prior thinking; the team unearthed an undeniably female skeleton containing a fetal skeleton in her pelvis. On a subsequent excavation, the team found several more such female skeletons. Each was three-to-four months

[161] Rachel Shalomi-Hen, "The Goddess Hathor" in *Pharaoh in Canaan, The Untold Story,* ed. Daphna Ben-Tor (Jerusalem: The Israel Museum, 2016), 153.
[162] Geraldine Pinch, *Votive Offerings to Hathor (*Oxford: Griffith Institute, Ashmolean Museum, 1993), 142.

pregnant at her time of death. While the roles of these ancient women are unknown, Ben-Yosef hypothesizes that they might have been associated with the Hathor sanctuary, perhaps as musicians or priestesses, because of their proximity to the shrine and because of the presence of Egyptian beads found near the skeletons.[163] While this is an exciting interpretation, could they have played any number of roles, or multiple roles, at the site? Could those roles have included taking part in some aspect of copper production? Might women have fit into the smallest mine shafts better than men? Might they have been involved in some aspect of carrying, sorting, or smelting ore? Might they have been prostitutes or consorts to male miners, and might there have been a ritual element to this? (Whether "sacred prostitution" existed in the Near East as a literal practice or just as a symbolic idea of union is debated in scholarly texts.) Why did all the women die at approximately the same point of gestation, about the point at which a pregnancy "bump" starts to show? Could this indicate a sacrificial process of some sort? The answer might never be determined, but women as copper workers could have still been buried near the Hathor sanctuary just as women carrying out sanctuary functions could have been. Thus for now, all possibilities as to the roles of these women should remain open.

The Hathor Shrine at Timna: Site of Competing Narratives and Cultural Integration

Long ago the copper mines at Timna were attributed to the time of the Biblical King Solomon, but excavations by Rothenberg in the 1960s changed that interpretation. Rothenberg initially presumed that the mine shafts, smelting camps, and smelting furnaces that he unearthed suggested copper production by local

[163] Conversation with Professor Erez Ben Yosef in Tel Aviv, July 14, 2018. I was also there on site for the first find in July 2017.

desert tribes who predated the time of Solomon. Then in 1969 Rothenberg excavated a shrine that he (incorrectly) presumed Egyptians built. He reached this conclusion because the area around the shrine, known today as the "Hathor Temple," yielded about 11,000 artifacts, many of which were Egyptian. Some of those artifacts were inscribed, naming pharaohs Seti I through Rameses V (who reigned from about 1280 BCE to 1145 BCE). Biblical accounts of King Solomon, if indeed he was an actual historical figure, place him in the tenth century BCE. For Rothenberg, the Egyptian artifacts therefore served as evidence that activity at Timna did in fact predate Solomon. In the 1970s, Rothenberg engaged in further study of the Timna mining camps with a German mining museum. He focused on the Egyptian traces in Timna, and thus Timna became known for being an example of "Egyptian" New Kingdom copper mining and smelting technologies.[164]

Photos of Timna Park in the Negev Desert, Israel.
Figure 18 Left: The landscape in which the Hathor sanctuary was situated. Its remains lie at the base of the rock pillars on the left-hand side of the image.

Figure 19 Right: What still exists of the Hathor sanctuary itself.
Photographs by Casondra Sobieralski, 2017.

[164] Uzi Avner, "Egyptian Timna Reconsidered," in *Unearthing the Wilderness: Studies on the History and Archaeology of the Negev and Edom in the Iron Age*, ed. Juan Manuel Tebes (Leuven: Peeters, 2014), 104.

Deepening his Egypt-centered narrative, Rothenberg (probably incorrectly) deduced from his excavations that the "Hathor Temple," built against the side of a cliff, represented three phases of construction. Evidence of "Phase I" included the head of a Hathor statue (once displayed in a vertical niche) and two square pillars with relief carvings of Hathor's face. Rothenberg believed this first phase to be initiated by Seti I. "Phase Two," thought Rothenberg, included a reconstruction of the sanctuary with an enlarged courtyard and the addition of three stone basins. He believed that this phase was conducted under Pharaoh Rameses II or III, and that Egyptians abandoned Timna around the time of Rameses V's reign. His "Phase III" included the erection of a line of massebah, vertical stones representing deities, on the west side of the temple. He thought "Midianites" (a group of nomads from the Arabian desert just south of Timna, along the eastern edge of the Red Sea's Gulf of Aqaba) were responsible for this phase, and that they continued copper production in the valley.[165] Again, this is the story sold in the gift shop: Egyptians mined at Timna, and then Midianites, with cooperation between them during an overlap period.

However, contemporary archaeologists including Uzi Avner (formerly of the Israel Antiquities Authority) and Ben-Yosef challenge many of Rothenberg's interpretations. In terms of mining technologies, both have concluded that Timna mining and smelting technologies used during the time between Seti I and Rameses V probably were actually developed by local tribes, as Rothenberg first thought, and not by Egyptians.[166] Egyptians, as occupiers of Canaan, seem to have managed the

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[165] Ibid., 105. Also noted on page 105, Rothenberg believed that the Egyptians returned to Timna for a brief time about 250 years later.

[166] See broadly, Uzi Avner, "Egyptian Timna Reconsidered," and Erez Ben-Yosef, B Liss, OA Yagel, O Tirosh, M Najjar, and TE Levy, "Ancient Technology and Punctuated Change: Detecting the Emergence of the Edomite Kingdom in the Southern Levant," *Plos One* 14, no. 9 (2019), https://doi-org.oca.ucsc.edu/10.1371/journal.pone.0221967.

operations; but at that point in history, Egyptians probably were not developing the technologies. Rather, copper production at Timna was probably a collaborative effort. An inscribed stela from above the Hathor sanctuary supports this hypothesis. The stela depicts an image of a man identified as Ramsesempere handing offering jars to Hathor. Though this man is styled as being Egyptian, Avner explains that nine stelae found in Egypt reveal that his given name is Benazen (Ben-Adon), and he was a Canaanite, educated in Egypt, who worked under the pharaohs Merneptah and Rameses III. His high status combined with his knowledge of the local Semitic language and customs afforded him the proficiency to negotiate agreements between the desert tribes and the pharaohs.[167] Before more recent scholarship challenging (or revising) Rothenberg, however, the tourism industry had already branded Timna as an Egyptian site. Perhaps marketing local contributions does not sound as exotic and alluring to those who are local.

Avner also complicates Rothenberg's outdated narrative about the "Hathor Temple." First, Avner clarifies that the Timna site should not be called a "temple," rather it is an open-air sanctuary. In Egypt, he points out, New Kingdom temples usually required guests to pass through three or four courtyards before reaching the isolated naos where the deity statue was housed. Only high-ranking priests, with the exception of the pharaoh who visited on special occasions, could enter to serve the god/dess. Conversely, at Timna the naos protecting Hathor was visible to all and easily approached. This was the sort of chapel built for commoners when they were not allowed in the temples, he says. Further, in regard to the architectural design of

[167] Uzi Avner, "Egyptian Timna Reconsidered," in *Unearthing the Wilderness: Studies on the History and Archaeology of the Negev and Edom in the Iron Age*, ed. Juan Manuel Tebes (Leuven: Peeters, 2014), 140.

the Timna sanctuary, he suggests that “The Egyptian mind could not have borne such disharmony.”[168] [169]

Figure 20 Left: An ancient gallery style mine shaft at Timna Park, Israel.

Figure 21 Right: A plaster replica, located in Timna Park, of the stela depicting “Ramsesempere” handing offering jars to Hathor. The Canaanite human is a bit taller than the Egyptian goddess if you do not account for her crown. Is this a loose interpretation of hieratic scale, or an intentional rejection of it? If the latter, does this represent the Egyptians’ diplomatic deference to the Canaanites as the residents of land? Did Canaanites carve this, and do so in a manner to assert their ownership of the land under Egyptian occupation? Who created this piece?
Photographed by Casondra Sobieralski, Timna Park, Israel, 2017.

Avner also challenges Rothenberg in suggesting that the “Hathor Temple” probably represented eight phases, not just three. Avner argues that the massebah and cultic basins are actually from the early phases of the site (not the later phases

[168] Uzi Avner, “Egyptian Timna Reconsidered,” in *Unearthing the Wilderness: Studies on the History and Archaeology of the Negev and Edom in the Iron Age*, ed. Juan Manuel Tebes (Leuven: Peeters, 2014), 122-124.
[169] Aesthetic judgments aside, however, Egyptologist Emily Teeter has persuasively argued against a widely held assumption that ordinary devotees did not have access to Egyptian temples. Yes, they were barred from entering the inner section of temples, but they could access courtyards, exterior chapels, and some interior spaces to commune with their deities. She cites the Temple of Amun, the shrine of Seti II and the Hypostyle Hall (both in the Temple of Amun at Karnak) and the first court of Luxor temple as places that all include inscriptions designating particular areas for popular worship. See: Emily Teeter, *Religion and Ritual in Ancient Egypt* (Cambridge: Cambridge University Press, 2011), 50-53, 77-78.

as Rothenberg interpreted) and signify that the sanctuary originally served as a local cult shrine. Massebah are a common custom in the Near East. [Such standing stone representations of deities also represent "the goddess" in Cyprus.] Basins were used for animal sacrifice; animal rites were part of Semitic tradition, but such rites were not practiced in Egyptian temples.[170] Ergo, in his analysis, Avner concludes that the Egyptian naos was added to an existing local shrine, and that Hathor was "not the owner of the house but a guest." Avner further supports his assertion by explaining, "...from the point of view of the gods in the masseboth and in the chapel, Hathor stands to the left of the local gods," indicating the less senior position in the hierarchy of Egyptian artistic rules. The Egyptians would have sought the protection of the local gods as well as their own, and Hathor would have been welcome among the local tribes because she was similar to their beloved Ba'alat.[171]

The Double Helix of Hathor and Ba'alat/Astarte

If Avner's theory that Hathor was a "guest" among local gods is accurate, it does not weaken the importance of Hathor's presence; rather, over time and space it seems to strengthen it, such that Hathor goes wherever the Semitic goddess goes, including Cyprus, as if they are a double helix. Untangling this relationship between Hathor and a Semitic goddess throughout the region is one of the most exciting findings of my research spanning multiple locations because most scholars of

[170] Uzi Avner, "Egyptian Timna Reconsidered," in *Unearthing the Wilderness: Studies on the History and Archaeology of the Negev and Edom in the Iron Age*, ed. Juan Manuel Tebes (Leuven: Peeters, 2014), 116-122. Also here, Avner argues that the Egyptians did not build their naos, with the Hathor-headed white sandstone pillars, until Phase 3. The stratum associated with Phase 6 yielded the highest number of [Egyptian style] artifacts during Rothenberg's time. Avner believes that the shrine's late phases–perhaps Phase 7 (based on Near Eastern masonry style), and certainly Phase 8 (when an enclosed space with a higher wall than before was added outside the courtyard)–occurred long after the Egyptians left.
[171] Ibid., 124-125.

Egyptology, ancient Israel, and Cyprus "stay in their lanes," so to speak, in terms of modern-day national boundaries. By crossing those boundaries—as Hathor veneration itself did—I gained an unusual bird's eye view to try to connect dots.

The complicated and fascinating relationship between the Egyptians and the Canaanites over centuries is the subject of countless scholarly works. Egyptians occupied Canaan for about four hundred years, but a group of Canaanites known as the Hyksos also occupied part of Egypt for a time following the Egyptian Middle Kingdom; the New Kingdom started when the Egyptians wrestled power from the Hyksos rulers. Egyptian temple relief scenes show the taking of Canaanite prisoners, yet Egyptian pharaohs prayed to the Semitic goddesses Anat and Astarte for success in battle, and even named daughters after them. Canaanites themselves embraced Egyptian styles and at least one Egyptian deity—Hathor—because her attributes were similar to their own goddess Ba'alat, later called Astarte. Sometimes Egypt's relations were better with one part of Canaan than another, just as relationships among Canaanite tribes were not static. Despite their complex relationship, however, Canaan and Egypt deeply influenced each other bi-directionally.

Serabit el-Khadim is another mining site in the Sinai that demonstrates a mix of Semitic and Egyptian cult elements, and this mix aids in deciphering the relationship between Hathor and Ba'alat/Astarte.[172] This site is especially known for turquoise mining, but the Egyptians oversaw copper mining there from the Old Kingdom

[172] Unfortunately I could not safely do field work at Serabit el-Khadim because it is in territory that had a strong ISIL presence in 2017.

through the Middle Kingdom and New Kingdom.[173] They erected a full-fledged temple (not a simple shrine) to Hathor in the Middle Kingdom. At least some of the miners there, however, were Semitic. A much-celebrated artifact at Serabit el-Khadim shows the identification between the Hathor and the Canaanite goddess: inhabitants of the mining camp left a small sphinx as a votive offering in the Hathor temple, and the sphinx bears an inscription to Ba'alat.[174]

The co-existence of these two similar goddesses at mining and commerce sites was not just spiritual, however; it appears to have been political, a form of diplomacy. The northern Canaanite temple of Ba'alat in Byblos—now within Lebanon—demonstrates this well. The Hathor-Ba'alat/Astarte connection there traces back even farther than in the Sinai; Hathor was deemed the "Lady of Byblos" in the Old Kingdom. Her name and her title as such appear in Byblos in the Egyptian Fourth Dynasty and become more prominent in the Sixth Dynasty.[175] Conversely in the Middle Kingdom and the New Kingdom, as exemplified in the Amarna letters, it was the custom for the king of Byblos to start messages to the Egyptian pharaoh by wishing him protection from Ba'alat.[176] Cultic objects at Byblos mimic Egyptian style and/or are from Egypt. Most notably, circular alabaster and calcite tables sent from Egypt to Byblos appear to be ceremonial donations which identify "Hathor, Lady of Byblos."[177] While acknowledging that it is difficult to decode the full meaning of a

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[173] Uzi Avner, "Egyptian Timna Reconsidered," in *Unearthing the Wilderness: Studies on the History and Archaeology of the Negev and Edom in the Iron Age*, ed. Juan Manuel Tebes (Leuven: Peeters, 2014), 137.
[174] Rachel Shalomi-Hen, "The Goddess Hathor" in *Pharaoh in Canaan, The Untold Story,* ed. Daphna Ben-Tor (Jerusalem: The Israel Museum, 2016), 149.
[175] Andrés Diego Espinel, "The Role of the Temple of Ba'alat Gebal As Intermediary between Egypt and Byblos during the Old Kingdom," *Studien Zur Alta gyptischen Kultur* 30 (2002): 118.
[176] Ibid., 116.
[177] Ibid., 108-109.

temple that houses a deity common to two states, Espinel suggests that these gifts were not offered solely for divine protection far from home. Rather, they must have also been a means by which the Egyptian court sought to obtain political and economic benefits from the authorities in Byblos. Egyptians would want to be in good favor of these authorities because Byblos was one of the most important commerce centers in the Near Eastern network.[178] Thus the conceptual linking of Hathor and Ba'alat appears to have been a symbolic transmission of diplomatic intentions through material exchanges.

Informed by the context of Serabit el-Khadim and Byblos, Avner's idea of Hathor in Timna being a "guest" among the local Semitic gods shows clear precedents. I follow the interpretations of scholar Shalomi-Hen in my worldbuilder's interpretation of the endlessly intriguing Hathor-Ba'alat (Astarte) connection in Canaan. Shalomi-Hen says that Hathor was clearly the Egyptian deity most represented on local and imported objects in Late Bronze Age Canaan, attesting to her popularity. However, Hathor's role in southern Canaan remains unclear. Scholars are not sure to what degree Hathor was venerated as an Egyptian goddess versus to what degree she was assimilated into the local goddess. What scholars do know is that Hathor was associated with the natural resources of the Levant [copper, malachite which is a type of copper ore, and turquoise]. This association with the land might explain why Hathor's symbolism was widespread in Canaan, and why her iconography mixed with that of a local Canaanite goddess.[179]

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[178] Ibid., 113-114.
[179] Rachel Shalomi-Hen, "The Goddess Hathor" in *Pharaoh in Canaan, The Untold Story,* ed. Daphna Ben-Tor (Jerusalem: The Israel Museum, 2016), 149-153.

Who, then, was the actual copper goddess: Hathor, Astarte, or both? Or did the distinction between them become so blurred that it did not matter at the folk-level of religious practice among copper miners, smelters, and/or exporters? Was there a distinction in how those different groups related to cult and copper?

Unpacking the Relationship Between the Goddess and Copper Production in Syro-Palestine

Reasons for connections between cult and copper in the Levant, and specifically cult and a goddess, seem to be multivalent. As noted in defining Hathor, the starting point is that she, as "Goddess of the Mountain," was associated with minerals extracted from the Earth. However, I was not satisfied with this simple answer being the *complete* answer, as Egyptian belief systems are typically quite complex and layered. So I dug deeper. I started by asking Ben-Yosef, a Tel Aviv University archaeometallurgist. His answers led me to research at an alchemy library in San Jose, California, and that research led me to start investigating ethnographic traditions in Africa. Through all of these layers of research, a consistent thread emerged: copper production, particularly smelting, must be contextualized in terms of magic, alchemy, and shamanism. Avner notes that in Hebrew, the words "smith" and "create" use the same root word ["קנה"] and therefore being a smith is actually synonymous with being a magician, "creating a new substance, a metal from rock."[180]

Ben-Yosef explained that ancient metallurgy seems to have been steeped in mysticism. The smelting process in particular was powerful, fiery, and not

[180] Uzi Avner, "Egyptian Timna Reconsidered," in *Unearthing the Wilderness: Studies on the History and Archaeology of the Negev and Edom in the Iron Age*, ed. Juan Manuel Tebes (Leuven: Peeters, 2014), 144.

scientifically understood by ancients. Smelters in the Arabah Valley, as revealed by Ben-Yosef's own osteoarchaeological studies of Early Iron Age smelters in Timna, seemingly held a high status.[181] This could suggest that they were perceived as keepers of esoteric knowledge. The smelting process itself, said Ben-Yosef, was understood as being a sexual union with the goddess.[182]

Further research into authors including Mircea Eliade (a historian known for being a leading twentieth century interpreter of religious experience) verified that in many parts of the world, "smelting represents a sacred sexual union, a sacred marriage (cf. the mixture of 'male' and 'female' ores), and this union takes place in the furnaces."[183] In Graeco-Roman Egypt, for example, ancients believed that copper was born of the womb-like cauldron of the smelting furnace.[184] These ideas probably have older roots.

Little material evidence of intangible cultural heritage practices, such as cultic practices, exists from the Chalcolithic or Bronze ages. Thus one means of speculating what spiritual beliefs surrounding copper might have been is to look at ethnographic evidence of smelting rituals and practices from Iron Age Africa and Greece. Sandra Blakely writes that in both areas, cultures used analogies of birthing, and both referenced ancestors and fertility of the earth, in relation to

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[181] Erez Ben-Yosef, Dafna Langgut, and Lidar Sapir-Hen, "Beyond Smelting: New Insights on Iron Age (10th C. Bce) Metalworkers Community from Excavations at a Gatehouse and Associated Livestock Pens in Timna, Israel," *Journal of Archaeological Science: Reports* 11 (2017): 411-26. doi:10.1016/j.jasrep.2016.12.010.
[182] Conversation with Professor Erez Ben Yosef in Tel Aviv, July 14, 2018.
[183] Mircea Eliade, *The Forge and the Crucible*, 2nd ed. (Chicago: University of Chicago Press, 1978), 60, also see 212-213.
[184] Jack Lindsay, *The Origins of Alchemy in Graeco-Roman Egypt* (New York: Barnes and Noble, Inc., 1970), 290-291.

smelting. Both linked smelting to magic and medicine.[185] Evidence of intangible heritage surrounding iron smelting is more certain in Africa, however, because traditional metallurgy techniques and associated rituals were practiced on the continent right up through the early twentieth century CE.

Filmmaking technology existed by the late 1800s, enabling early filmmakers to provide evidence that many cultures throughout Africa conceptualized smelting as a birthing process. Two sites in Zimbabwe provided ethnographic examples of nineteenth century furnaces decorated with clay depictions of women giving birth. Blakely says that the central metaphor in the iron smelt was the idea that the iron bloom was a fetus.[186] The furnace became the smelter's "wife", pregnant by the labor of the smelters, each of whom was the furnace's "husband." If any of these male smelters had sexual relations with a human woman during a smelt, including his human wife, it was considered adultery. Adultery, the smelters believe, could cause the furnace to become infertile or miscarry.[187] The Fipa people (Tanzania, Zambia) sang to the furnace as a bride. Through music, they sought to articulate the transformation of metal and fire into reproduction. They also believed that a fecund smelt transferred to the fertility of the land. Slag from the furnace became fertility medicine [presumably to the earth].[188]

Whereas Blakely traces commonalities to write generally about iron smelting as birthing in Africa, Africa historians Eugenia Herbert and Candice Gaucher created a documentary case study of one tribe's traditions. *Blooms of Bengali* (1986) focuses

[185] Sandra Blakely, *Myth, Ritual, and Metallurgy in Ancient Greece and Recent Africa* (Cambridge: Cambridge University Press, 2006), 2.
[186] Ibid., 66-68.
[187] Ibid., 106.
[188] Ibid., 119-123.

on the gendered aspects of traditional smelting among the Bassari people of Togo. After producing iron for about five hundred years, the Bassari ceased in the 1920s when industrialized practices in Europe outpaced the productivity of traditional methods. However, in 1914, German ethnographers captured film footage of the old processes in Bengali. Utilizing this old footage plus the experiential memories of tribal elders, the Bassari created a reenactment of a traditional smelt so that the historians could record the intangible cultural heritage before knowledge of it disappeared.

The Bassari traditionally believed that smelting depended on a combination of technical skill and the assistance of spiritual forces. A smelt required designated rituals, including sexual taboos. Women of childbearing age who had been sexually active or were menstruating were not allowed near the furnace prior to or during a smelt. A menstrual period represents failure to conceive that month, the Bassari told the documenting historians; since a smelt was seen as a gestation, bleeding women could cause a smelt to fail. Thus to be safe, post-menopausal women led a pre-smelt ritual of sharing beer made of millet. They poured a bit of beer on the ground as an offering to the ancestors, acknowledging their presence and their assistance. [Interestingly, beer is associated with Hathor where Hathor is worshiped, but where this Bassari beer ritual originated is beyond the scope of the film.] The perimeter of the furnace was marked with medicinal herbs. The furnace took shape from the ground up over five days, and as it grew taller, the Bassari referred to its human

parts: stomach, chest, head, nose, mouth. The furnace gradually transformed into a woman. The master smelter became a father.[189]

Tribesmen decorated the furnace with ash, adding leaves to represent abundance and fertility. "Safe" (i.e. not recently sexually active or bleeding) women offered food to the "mouth" of the furnace. Men chanted (translated to English by the filmmakers), "Give birth to good iron, give birth to good furnace iron." Bassari iron smelts lasted about forty-five hours [far longer than copper smelts], and during a smelt, smelters were forbidden sexual relations with humans. As Blakely also articulated, this would be adultery against the furnace. The Bassari believed that such indiscretion would cause a difficult labor or even "birth defects." Smelters listened for the iron bloom to drop within the furnace, an indication that the smelt was nearly complete. With the drop, smelting assistants were released from abstinence. However, the master smelter could only break his sexual abstention after the bloom was successfully extracted from the furnace. After the bloom was extracted, any woman could also come near the furnace; she was no longer a perceived risk.[190]

While Bassari women were excluded from the smelt itself, it is important to recognize their other labor contributions to metallurgy. Along with leading preparatory offerings, women traditionally supplied the charcoal that kept the furnace fire burning. As more smelting led to increased deforestation, women's labor increased because they had to seek and transport wood from farther sources. Women also engaged in mining, along with children. Children's small sizes made

[189] Carlyn Saltman, Eugenia W. Herbert, and Candice Gaucher, *The Blooms of Banjeli: Technology and Gender in African Ironmaking* (Watertown, MA: Documentary Educational Resources (DER), 1986), Documentary Film.
[190] Ibid.

them an asset in tight shafts. Mines could collapse, making this dangerous work.[191] So while the Bassari people traditionally saw smelting as a union of feminine and masculine forces, with the smelter overseeing the womb of the furnace, traditional metallurgy methods required the interdependent labor of both male and female humans.

How much Levantine customs and African customs mirrored or influenced one another is, again, speculative. In the Levant itself though, prior to Hathor's worship at Timna, what little material evidence does exist of cultic practice related to copper production comes from the Ghassulian people. Theirs was a Chalcolithic culture. For the latter half of the fifth millennium BCE, they were situated from the northern Negev (near the Dead Sea) through the Jordan Valley. Gošić and Gilead describe the Ghassulians as having the best documented Chalcolithic culture in the Southern Levant, and they were also the only Chalcolithic metalworkers that contemporary scholars have identified in the Timna or Golan areas.[192] Gošić and Gilead observed that Ghassulian tools are too thin/long to have been functional, and they lack wear patterns from use. These "tools" were also found in production sites and burials rather than in domestic use contexts. Therefore, they deduce, "It is our contention that all of the Ghassulian copper artifacts were symbolically charged, as was the technology itself."[193]

To bolster their hypotheses about Ghassulian connections between cult and copper, Gošić and Gilead sifted linkages between metallurgy and mythology in

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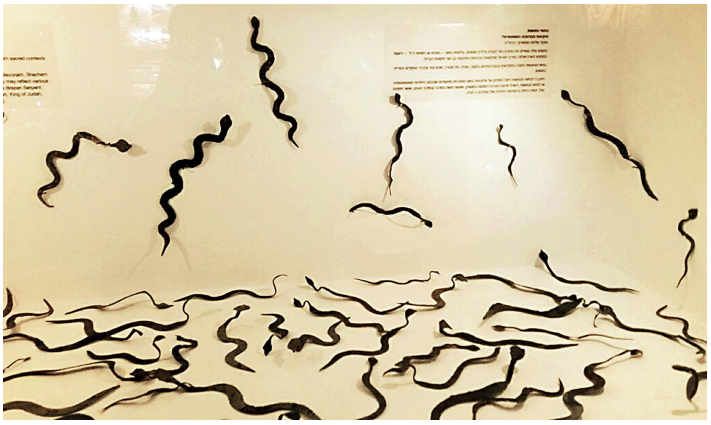
[191] Ibid.
[192] Milena Gošić and Isaac Gilead, "Unveiling Hidden Rituals: Ghassulian Metallurgy of the Southern Levant in Light of the Ethnographical Record," *Bar International Series* 2753 (2015): 25.
[193] Ibid., 29.

Greece and in Mesopotamia, where Ishtar—likely a precursor of Astarte—was related to metallurgy. Additionally they, like me, looked to African ethnography for clues. They found that in the Congo, smiths are considered to have magical powers and prescribe medicines. These smiths ascribed special powers to their hammers and bellows. In Ghana, because the bloom is conceptualized as a newborn with great vital life force, women who have had difficulties with childbirth in the past go to a smelting furnace to deliver their babies. In sub-Saharan Africa, Gošić and Gilead found, metalworkers are required to undergo sacred and secret initiation rituals before learning their craft. Hence, since it is evident that rituals are commonly part of metallurgy, Gošić and Gilead deduce that Ghassulian copper smiths probably also performed initiation rites.[194]

Figure 22 Left: An example of Ghassulian copper work with ibexes, widely believed to be for ritual use, from the Masters of Copper show, Eretz-Israel Museum, Tel Aviv, Israel. Photographed by Casondra Sobieralski, 2019.

Figure 23 Right: Copper snakes from Timna, on exhibit at the Eretz-Israel Museum in Tel Aviv, Israel. Snakes in the Negev region represented breath or life force, “ruah” in Hebrew. These snakes were created by local copper producers after the Egyptians left. Photographed by Casondra Sobieralski, 2017.



[194] Ibid., 30-33.

The same symbols that occur in Ghassulian ceremonial artifacts–and among some copper artifacts found in Timna–occur in rock art through the Negev. This rock art seems to record nomads' constellations in the sky. Thus petroglyph art and star lore of the Negev offer additional clues about relationships between smelting and spiritual practices among the Ghassulians in the northern Negev, and perhaps among early Timna inhabitants in the southern Negev. Petroglyph scholar George F. Steiner writes that metallurgy practices impacted what nomads of the Negev desert represented in their rock carvings, such as ibexes, snakes, birds, and a goddess. Ibexes, as also depicted on a Ghassulian copper staff and on Chalcolithic Negev pottery, were transmediators between day, night, and unseen realms, according to Steiner. They represented the shaman in disguise, and smelting itself. Snakes, also found on pottery as well as in petroglyphs, symbolized air. Beyond being just a mechanical force that smelters pumped into the furnace to stoke heat, air was equated to "ruah," a Hebrew word meaning breath, life force, or spirit. Breath gave life to the furnace. Slag streaming out of the furnace mimicked the shape and movement of slithering snakes. Birds symbolized messengers between the realms, something akin to "proto-angels." Representations of a Semitic goddess, also mirroring a constellation, symbolizing regeneration. Sometimes she was depicted with a snake arm. Negev petroglyphs also depict a dome shape, like an upside down "u," with a dot in the middle. Steiner says this shape represents the pregnant furnace, with the dot signifying the gestating ore.[195] [196]

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[195] George F. Steiner, "The Goddess and the Copper Snake: Metallurgy, Star-lore and Ritual in the Rock Art of the Southern Levant," *Expression Quarterly Journal of Atelier Editions in Cooperation with UISSP-CISNEP (International Scientific Commission on the Intellectual and Spiritual Expressions of Non-Literate Peoples)*, no. 12 (June, 2016): 73-95.

[196] Interestingly, the ibex, snake, and bird themes also made their way to redware pottery in Cyprus. Exquisite examples are on exhibit at the Pierides Museum in Larnaca, but the

Determining whether the Egyptian Hathor connection between motherhood/ sexuality and copper influenced deeper Africa or vice-versa might be elucidated by extensive technology transfer tracing during the Bronze Age and beyond. It seems reasonable to presume that spiritual technologies were probably traded with production technologies via social contact. Certainly Egyptians spread into Sudan (then called Nubia), and the British Museum houses part of a Nubian Hathor temple plus related artifacts.[197] Is it possible that ideas spread from Sudan further south and further west? Thinking archetypically, however, it is easy to understand why goddesses of sexuality, fertility, and sometimes motherhood became associated with the process of copper production vis-a-vis smelting, and not just with the ores mined from the fecund earth.

Eventually it seems that, in Timna specifically, these goddesses associated with natural resources and the birthing of copper were replaced by a Canaanite god who was associated with mineral resources and fiery volcanoes. While the Timna Park gift shop version of the story follows Rothenberg's suggestion that Midianites took over after the Egyptians left, Ben-Yosef suggests that it was likely Edomites, who learned how to form or strengthen their political power through the example of the Egyptians.[198] Amazallag argues that Edomites/Kenites worshiped Yahweh (YHWH), described in the Old Testament as a Canaanite deity who was assumed to dwell in

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historian there was unaware that there were similar motifs on ceramic vessels from the Negev. These symbols are yet another sort of recurring representation that I was able to trace by working in multiple countries.

[197] See: https://www.britishmuseum.org/collection/term/x30470 with link to 107 related objects.

[198] Erez Ben-Yosef, B Liss, OA Yagel, O Tirosh, M Najjar, and TE Levy, "Ancient Technology and Punctuated Change: Detecting the Emergence of the Edomite Kingdom in the Southern Levant," *Plos One* 14, no. 9 (2019): 11, https://doi-org.oca.ucsc.edu/10.1371/journal.pone.0221967.

the mountains of copper, close to mining areas.[199] Amazallag explains that Hathor is not explicitly mentioned in the Bible, but she might have been conflated in the text with the Canaanite goddess Asherah, whose cult is repeatedly prohibited in the Old Testament.[200] For the prohibition of the goddess in the Arabah region to be so central to the campaign for Yaweh, and for the Hathor pillars at Timna to be effaced, she must have been a difficult ember for the tribes in southern Canaan to stamp out.

Hathor certainly was not stamped out everywhere, though; she obviously continued to thrive in Egypt. To the Phoenicians in northern Canaan, Astarte—so closely linked with Hathor—remained a primary deity for centuries more. The Phoenicians carried Hathor and Astarte to Cyprus with them and built goddess temples next to their copper workshops there.

Cyprus: Aphrodite, Astarte, Hathor...and Copper

The island of Cyprus is largely associated with two things: copper and the goddess Aphrodite. Today Aphrodite is popularly known as a goddess of love and sexuality. In ancient mythology, her reputation was also that of an invincible, sometimes furious, ruler over all species.[201] According to the legend told (and sold) in Cyprus, Aphrodite was born of the foam of the sea near the town of Palaepaphos (now called Kouklia). This romantic legend is but one of Aphrodite's origin myths as described in Greek mythology.

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[199] Nissim Amazallag, "Who Was the Deity Worshipped at the Tent Sanctuary at Timna?" in *Mining for Ancient Copper: Essays in Memory of Beno Rothenberg*, ed. Erez Ben-Yosef. Monograph Series of the Sonia and Marco Nadler Institute of Archaeology, 37. (University Park, Pennsylvania: Eisenbrauns, 2018), 129.
[200] Ibid., 129.
[201] Jacqueline Karageorghis, *Kypri: The Aphrodite of Cyprus: Ancient Sources and Archaeological Evidence* (Nicosia: A.G. Leventis Foundation, 2005), 6-7.

Aphrodite, however, is not the original name of this goddess. Rather, hers is the Greek name for a goddess whom Greek settlers found to be popular in Cyprus when they arrived. Understanding the importance of Aphrodite on the island of Cyprus, and her role as a copper goddess, necessitates an investigation of how she seems to have emerged from Astarte, or possibly even a remix of Astarte with a concept of Hathor born of oral transmission.[202] The popular culture narrative, contested but provided to tourists via brochures and on interpretive panels at archaeology sites, suggests that Aphrodite's roots stretch back to Neolithic/Chalcolithic times, and that she represents a syncretism between a prehistoric, indigenous, Cypriot fertility goddess and the Near Eastern Astarte. This narrative is particularly influenced by the work of J. Karageorghis, who began writing about Cypriot Archaeology in the 1950s and continued publishing well into the twenty-first century (she died in 2018). Archaeologists who are critical of this popular narrative–including Knapp, Bolger, and Knox–argue that there is no definitive proof of a bonafide goddess in Cyprus until the Late Bronze Age, so it makes no sense to assert that Aphrodite traces all the way back to a Stone Age goddess. Since prehistoric times by definition lack textual sources, arguments in favor of the existence of a Stone Age goddess center around Neolithic and Chalcolithic female figurines from those eras. Counterarguments question what evidences a "goddess" figurine, as opposed to a human or other mythical form. The debates among all of these archaeologists enrich the idea that female figurines functioned as ancient media representations demonstrating Cyprus's position as a cosmopolitan nexus of information exchange across space and over time. Such debates also raise questions about how female figurines,

[202] I argue this ahead by coupling the work of Daisy-Kate Knox with my museum research in Israel.

whether they clearly indicate copper goddesses or not, might offer clues as to how copper as an agential medium shaped religion, socio-political structures, and gender roles.

Figure 24: Petra tou Romiou, near Palaepaphos on the southeast coast of Cyprus, is the mythical birthplace of the goddess Aphrodite. Photographed by Casondra Sobieralski, 2019.

A General [Art] Historical Overview of Cyprus for Temporal Context

Establishing a general material culture chronology for ancient Cyprus creates a contextual framework to explain what artifacts—tools, figurines, ritual objects—seem to relate copper to cult and why. Tracing pathways of material culture over time also helps to demonstrate just how early on Cyprus became a nexus point for information exchange. This general historical overview draws largely from the classic work of Vassos Karageorghis (spouse of J. Karageorghis) but also incorporates knowledge from my own site visits and talks with Cypriot archaeologists. These general timelines are certainly open to revision given that new archaeological theories emerge constantly.

Shifts from Neolithic (circa 7000 BCE - 4000 BCE) through Chalcolithic (circa 4000 BCE - 3000 BCE) Periods in Cyprus

The Neolithic and Chalcolithic periods evidence early trends in female representation, but archaeologists have varied opinions as to which representations were goddesses. The Neolithic (Stone Age) period in Cyprus lasted about 3000 years. It had two phases, with a 1500 year gap in between. During that gap, new people with new customs settled in Cyprus. Their architectural styles, echoing those of Syro-Palestine to the east, suggest the origin of the newcomers.[203] The Cypriot Neolithic also evidences an artistic style of stone figurines that are flat, limbless, and hinting at the female form. My museum research in Tel Aviv and Jerusalem attests that such figurines were also found in Syro-Palestine, again suggesting a link between the populations. V. Karageorghis says it is unclear as to whether these figurines were funerary objects or just made for self-expression, but there is no evidence to date that they were deities.[204] Regardless of their function, as far back as the Neolithic Era, the stage was already set for Cyprus to act as a nexus point for the melding of styles and ideas.

At the start of the Chalcolithic (Stone-Copper) Age, another wave of immigrants, probably from Anatolia, populated the Western side of Cyprus.[205] A famous statue named as “Lemba Lady” in art history books and museums is a hallmark of Chalcolithic figurative representation on the island. “Lemba Lady” is a thirty-six centimeter high, nude, female form with a phallic-shaped head. V. Karageorghis ascribes possible cultic significance to the artifact because of the context in which it was found: inside a structure with a plastered (as opposed to dirt) floor, which might

[203] Vassos Karageorghis, *Ancient Cyprus: 7,000 Years of Art and Archaeology* (Baton Rouge: Louisiana State University Press, 1981), 13-15.
[204] Ibid., 13.
[205] Ibid., 15.

have marked it as a ritual place.[206] Further, Lemba–the settlement where this statue was found–was a Chalcolithic settlement north of Paphos that was associated with a fertility cult.[207] So by the Chalcolithic, in the view of V. Karageorghis, Cypriots were associating femininity with spiritual forces.

Figure 25 Left: Syro-Palestinian artifacts (violin shaped female figurines) found in Israel. from the Masters of Copper show at the Eretz-Israel Museum, Tel Aviv, Israel, 2019.

Figure 26 Right: A violin shaped female figurine artifact found in Israel, now in the Israel Museum, Jerusalem, Israel, 2018.
Both photographs by Casondra Sobieralski.

Figure 27: The famous “Lemba Lady” statue, exhibited in the Cyprus Archaeology Museum in Nicosia, Cyprus. Photographed by Casondra Sobieralski, 2019.

[206] Ibid., 15-16. Note, one might be inclined to think that this structure was just a more elite house, but there was no “elite” yet; inhabitants farmed and fished along with making copper tools and ornaments.
[207] V. Karageorghis claims that large statues such as “Lemba Lady” “may have served as cult figures for a fertility goddess, as it is known that a number of other small terracotta nudes with conspicuously grooved genitals served this purpose.” Ibid., 16.

More common in Chalcolithic times than figures as large as “Lemba Lady” were small picrolite (soapstone) figurines of black, light-gray, and green ranging from five to fifteen centimeters tall. They were so common that today they are today featured on Euro coins as a representative symbol of Cyprus. Picrolite is especially found in the southwest of Cyprus, and it is found near copper deposits. Thus when ancients found this stone, they knew copper was nearby.[208] Some of these small figurines are female as connoted by small breasts; distinctly male picrolite figures are very rare; most are sexually ambiguous.[209] They have outstretched cruciform arms, long necks, legs individuated by an incised line, faces carved in relief, and perhaps most perplexing, necklaces of figures just like themselves. Their purpose or meaning is unknown.

Figure 28: Chalcolithic picrolite figurine from Cyprus exhibited in the Leventis Museum, Nicosia, Cyprus. Photographed by Casondra Sobieralski, 2019.

Early Bronze Age (circa 3000 BCE - 1900/1800 BCE)

In Cyprus, the Chalcolithic Period and the Early Bronze Age (EBA) overlap a bit because the EBA signature cultural material appears later in the southwest part of the island, near Lemba. Around 3000 BCE another new population, likely also from Anatolia, arrived in Cyprus. International trade started to pick up in the EBA, as evidenced by artifacts that originally came from Egypt, Crete, and Syria. Whether

[208] Conversation with Dr. Lindy Crew, Bronze Age archaeologist and Director, Cyprus American Archaeology Research Institute (CAARI). Nicosia, Cyprus. September 11, 2019.
[209] Vassos Karageorghis, *Ancient Cyprus: 7,000 Years of Art and Archaeology* (Baton Rouge: Louisiana State University Press, 1981), 16.

these goods were traded for copper or something else is not yet known.[210] Locally produced flat rectangular "plank" figurines (*xoana*) associated with funerary sites became popular. While museum visitor texts and scholarly texts alike debate whether they represent actual individual humans, sources widely agree that these plank personas are probably not representations of goddesses. However, some later figurines found at copper sites in Cyprus, which are indeed generally thought to represent goddesses, might have stylistic roots in this indigenous art form.[211]

Figure 29: Early Bronze Age plank figurines at the Pierides Museum in Larnaca, Cyprus. These figurines are associated with funerary contexts and might represent individuals. Photograph by Casondra Sobieralski, 2019.

Middle Bronze Age (circa 1900/1800-1600/1550 BCE)

The Middle Bronze Age (MBA) in Cyprus lasted only about 300 years. Whereas the EBA seems to have been relatively peaceful, remains of military fortresses suggest that the MBA was tumultuous. Archaeologists suspect that the threats were internal and resulted from shifts in wealth and settlement patterns; control of copper shifted from the island's southwest to its north coast. V. Karageorghis explains that

[210] Vassos Karageorghis, *Ancient Cyprus: 7,000 Years of Art and Archaeology* (Baton Rouge: Louisiana State University Press, 1981), 31-32.
[211] See Daisy Knox's discussion on "Flathead" figurines, which she interprets as possibly being a Cypriot interpretation of Hathor. Her argument is discussed later in this chapter: Daisy-Kate Knox, "Making Sense of Figurines in Bronze Age Cyprus: A Comprehensive Analysis of Cypriot Ceramic Figurative Material from EC I - LC IIIA (c. 2300 BC - 1100 BC)" (PhD diss., The University of Manchester, 2012), 179-182.

the growth of metallurgy foreshadowed that copper would become the major source of Cyprus' wealth during the Late Bronze Age.[212] Minoan imports entered Cyprus, and Cypriot artifacts found in Egypt and Palestine evidence the island's export patterns. Again, such fluid trade patterns show how Cyprus was becoming an international hub for the exchange of material items as information, or "media," that broadcast new ideas, styles, and mythologies, including those centered around goddesses.

Late Bronze Age (c. 1600/1500 BCE- c. 1100 BCE)

During the Late Bronze Age (LBA), the connection between cult and copper became most clear. Kition, which V. Karageorghis excavated from 1959-1986 for the Cyprus Department of Antiquities, shows some of the strongest evidence linking cult and copper. Core to this research project is the fact that at Kition the sacred architecture is, surely by intention, adjacent to copper workshops. Nothing is known about the divinity originally worshiped in the earliest built Holy of Holies in Kition because the sanctuary was reused later by the Phoenicians, whose copper goddess was Astarte. However, as the next section outlines, suggestions of a female deity, as per the interpretation of J. Karageorghis, are abundant.

This time of peace and stability in the Mediterranean enabled Cyprus to trade with the Aegean and even more so with the Near East. LBA tomb gifts attest to the wealth Cyprus accumulated from copper export.[213] Workshops for copper smelting, as evidenced by kilns, fragments of crucibles, bellows, pounders, ashes, and slag (the byproduct of the smelting process), were established in the coastal towns of

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[212] Vassos Karageorghis, *Ancient Cyprus: 7,000 Years of Art and Archaeology* (Baton Rouge: Louisiana State University Press, 1981), 49.
[213] Ibid., 60.

Kition and Enkomi.[214] Near Eastern style influenced both funerary and sacred architecture. The former echoed Palestine, the latter echoed Egypt. At Kition, for example, two Egyptian-style LBA sanctuaries demonstrate narrow Holy of Holies, open courtyards, "sacred lakes," and irrigation channels, all trademarks of Egyptian cult architecture.[215] The relationship between Cyprus and Egypt is documented through fourteenth century BCE letters between Cyprus's king and Egypt's pharaoh Akhenaten. The king addresses the pharaoh as "brother" and sends him gifts including copper ingots.[216] Thus the role of Cyprus as a Mediterranean nexus of information exchange, largely because of copper, intensified.

A Brief Mention of the Iron Age (c. 1050 BCE- c. 525 BCE)

Though this historical research centers on the Bronze Age, here I briefly acknowledge the Iron Age because this time period exemplifies additional important networked information points that validate the link between a goddess, or goddesses, and copper. Namely, both the Phoencianization and Hellenization of Cyprus resulted in an increase in recognizable Hathor imagery appearing at temples affiliated with copper production. After the Trojan War (1260-1180 BCE), a wave of Hellenic settlers arrived in the Palaepaphos area, the mythical birthplace of Aphrodite. The earliest evidence of the Greek language in Cyprus dates to the Early Iron Age. From that point, Greek culture and the indigenous Cypriot cultures fused together.[217]

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[214] Ibid., 56.
[215] Ibid., 58-59.
[216] Ibid., 61.
[217] Vassos Karageorghis, *Ancient Cyprus: 7,000 Years of Art and Archaeology* (Baton Rouge: Louisiana State University Press, 1981), 105-113.

Overview of the Copper "Goddess" in Palaepaphos, Kition, Enkomi: Jacqueline Karageorghis, Her Followers, and Her Challengers

Palaepaphos[218]

The work of J. Karageorghis coexists comfortably with that of V. Karageorghis. J. Karageorghis's main argument is that the roots of Aphrodite lie in a fusion of Astarte and a Chalcolithic fertility goddess cult centered in the region around Palaepaphos. This early Paphian fertility cult, she says, thrived during the fourth and third millennia BCE and seems to have faded after 2500 BCE. As source material she cites sexualized figurines from the Late Neolithic found near Palaepaphos, along with pregnant and birthing figurines from the Chalcolithic found at the nearby settlements of Souskiou, Lemba, and Kissonerga. J. Karageorghis further offers that both a Chalcolithic sanctuary and a model of a sanctuary discovered near Paphos suggest birthing houses. (She posits that these houses might have been under the protection of midwives or priestesses, but she offers no supporting evidence.)[219] [220] A generation of scholars including Stephanie Budin echo these ideas, citing Aphrodite as a goddess who ruled over copper, originated in prehistoric Cypriot fertility cults, and then took on characteristics of a Near Eastern goddess.[221] While such a hybridized evolution of indigenous, Near Eastern, and Greek mythologies exemplifies how representations of the mythic feminine conveyed

[218] To clarify a confusing distinction, Palaepaphos, or Old Paphos, is an archaeological site near a town that today is called Kouklia. Nea Paphos, or just plain Paphos, is a nearby harbor town and Roman archaeological site. Relevant to this story is Palaepaphos.
[219] Ibid., 11-12.
[220] Her analysis includes such figurines as the previously mentioned "Lemba Lady," though more recent scholars debate whether "Lemba Lady" definitively represents a goddess.
[221] Budin hypothesizes that this goddess was the primary deity of Cyprus, says Boudin, and before being named "Aphrodite" she held textual titles such as "Queen," "Goddess," and "the Paphian." See: Stephanie Budin, "Before Kypris Was Aphrodite," in *Transformation of a Goddess: Ishtar – Astarte – Aphrodite,* ed. by David T. Sugimoto (Fribourg, Switzerland: Academic Press Fribourg, 2014), 195.

the exchange of ideas among a network of neighboring lands, other archaeologists are skeptical that J. Karageorghis's scholarship and its legacy interprets that hybridization process accurately. Palaepaphos, along with the ancient copper export centers of Kition and Enkomi, are three sites that are particularly important in debates about establishing the relationship between copper and a goddess or goddesses in ancient Cyprus.

Copper connections to Palaepahos are more subtle and less understood than those at Kition and Enkomi, but this archaeological site served as a sanctuary to Aphrodite and her predecessors–including the Syro-Palestinian Astarte–for at least 5000 years.[222] J. Karageorghis describes Astarte as being akin to the Mesopotamian Ishtar–a goddess of war and battles, but also of love and unbridled passion, the source of fertility and therefore all of life. Astarte, like Ishtar, possessed universal power. Associated with the sea and mountains, Astarte also became the goddess associated with copper, according to Cypriot legend, in the Bronze Age when she became a primary goddess of the copper-rich island.[223] Based on Astarte's history in Syro-Palestine and the Sinai, however, I would argue that her relationship with mining, via her association with Hathor and via her association with the fecundity of the land, was probably long-established before she arrived in Cyprus.

J. Karageorghis informs that no reference to a goddess named Aphrodite can be found in Greek texts or inscriptions prior to the Iron Age.[224] The architectural style of Aphrodite's Palaepaphos sanctuary, with its open air altar and open courtyard, is

[222] Jacqueline Karageorghis, *Kypri: The Aphrodite of Cyprus: Ancient Sources and Archaeological Evidence* (Nicosia: A.G. Leventis Foundation, 2005), 7.
[223] Ibid., 155.
[224] Ibid., 20.

Near Eastern.[225] She writes that when the goddess of Cyprus started being called Aphrodite, dedications at Palaepaphos were made to her and Astarte both.[226] A towering betyl (standing stone) at this site represents the goddess. Smaller betlys from Palaepaphos are also on display at the site's visitor center. Standing stones representing deities is a Near Eastern tradition. It also occurs at Timna in Israel, where such stones are called *masseboth*

Figure 30 Left: A towering standing stone representing the goddess at Palaepaphos, a UNESCO World Heritage site in Cyprus.

Figure 31 Right: A standing stone representing an unspecified deity at the Hathor sanctuary in Timna Park, Israel. Note the cultic basin in the background.
Both photographed by Casondra Sobieralski, 2019 (left) and 2017(right).


Mycenaean "Horns of Consecration," another indicator of goddess-centered mythology as a vehicle for networked information exchange among cultures, are also found at Palaepaphos (as well as at Kition and Enkomi). J. Karageorghis notes that the horns are likely Aegean religious monuments associated with the cult of a fertility deity. The sanctuary where they were found dates to the thirteenth century BCE, but it might have been built atop an older sanctuary.[227] According to J. Karageorghis,

[225] Ibid., 14-16.
[226] Ibid., 38.
[227] Ibid., 29.

eleventh century representations of a Mycenaean style goddess with upraised arms (or her priestesses) became popular at Palaepaphos. This Mycenaean goddess, like Astarte, was associated with universal power.[228] I am cautious, however, about assuming that this deity that looked like the Mycenaean goddess necessarily represented the same foreign goddess; I have not found any suggestion that a goddess was associated with copper in Mycenae at this stage of history, yet these Mycenaean style figurines are found at several copper production sites in Cyprus. It seems plausible that Mycenaean-influenced figurines could have been a restyling of an indigenous goddess, or Astarte, based on what became artistically chic at the time; this would be consistent with the ancient Cypriot tendency to hybridize styles from their network. Or perhaps there is another historical story thread that is still occluded.

As a worldbuilder, it is inspiring to consider what rites and rituals might have taken place at Palaepaphos. While this intangible heritage is not necessarily verifiable, J. Karageorghis speculates that plausible rites include offerings of myrtle, pomegranate, apples, myrrh, incense, libations of honey, fire and prayer. Perfumed oils were also likely offerings because Cyprus became famous for perfumes in the second millennium BCE and exported them to Egypt, Crete, and Mycenae. She claims that ritual music and circle dances were part of goddess worship at this site, and mothers brought children to seek divine protection for them, but she offers no supporting evidence for any of these speculations about ritual life.[229]

[228] Ibid., 35.
[229] Ibid., 55-58.

Figure 32 Left: “Horns of Consecration” at Palaepaphos in southeast Cyprus.

Figure 33 Right, “Horns of Consecration” at Kition in southwest Cyprus. In the Kition example, note what appears to be a stela of Hathor’s head in the background (upper left). Both images photographed by Casondra Sobieralski, 2019.


Kition Kathari

Kition is in the contemporary southeast coastal town of Larnaca. As with Palaepaphos and Enkomi, the wealth established at Kition evolved from copper production and copper trade networks with Syro-Palestine, Egypt, and Greece. According to J. Karageorghis, Kition was clearly linked to this copper production by the early thirteen century BCE, and at this time Kition also had sanctuaries that were probably dedicated to a female deity.[230] Centuries later, at the start of the ninth century BCE (Early Iron Age), the Phoencians established at Kition the largest temple to Astarte in the Mediterranean. They erected their temple on the site of an earlier goddess.[231] The question is, then, who was that original female deity at Kition? Was this goddess at Kition related to the fertility cult tradition that the Karageorghises attribute to the Palaepaphos region?

[230] Ibid., 115-117.
[231] Ibid., 113.

Excavations of tombs and houses at Kition yield figurines from the fifteenth through the thirteenth centuries BCE that are styled similarly to Syro-Palestinian representations. These used to be identified as Astarte-type figurines. However, sometimes these Cypriot-excavated female figurines hold a child, which is not an attribute of Astarte. Knox disputes that these earliest Near Eastern-influenced figurines at Kition are goddesses at all due to lack of contextual evidence.[232] J. Karageorghis, conversely, interprets them to mean the sanctuaries at Kition appear to be the oldest evidence of [a formalized] Cypriot fertility goddess cult. If these fifteenth century BCE figurines are indeed cultic, then they also indicate the first known association between copper and religious sanctuaries in Cyprus. J. Karageorghis asserts that in the Bronze Age Near East, it is common for a female deity, like Hathor in Egypt, to be associated with mining and metallurgy. She supposes the reason to be that goddesses associated with fertility protected all of the productions of nature, including ores.[233] As detailed in the previous section on Timna, my research suggests that the association between goddesses and metallurgy is probably more complex than that.

Kition Temples 4 and 5 offer further suggestion that the interplay between copper and cult enabled information exchange in the Bronze Age. In Temple 4's Holy of Holies, V. Karageorghis unearthed a stash of ivory objects that included an opium pipe and a furniture embellishment depicting Bes, an Egyptian god who protected women in childbirth. Both are from circa 1200 BCE, and both are inscribed in Cypro-Minoan,

[232] Daisy-Kate Knox, "Making Sense of Figurines in Bronze Age Cyprus: A Comprehensive Analysis of Cypriot Ceramic Figurative Material from EC I - LC IIIA (c. 2300 BC - 1100 BC)" (PhD diss., The University of Manchester, 2012), 175-179.
[233] Jacqueline Karageorghis, *Kypri: The Aphrodite of Cyprus: Ancient Sources and Archaeological Evidence* (Nicosia: A.G. Leventis Foundation, 2005), 119.

so they seem to be locally made rather than imports.[234] Temple 5 housed a cylindrical vase, thought to be used for burning opium and inhaling opium smoke. It is very similar, says V. Karageorghis, to an opium vase from the sanctuary of the opium goddess in Crete. Egypt exported opium to Cyprus in the Late Bronze Age. This opium could have been used for medical purposes in temples.[235] However J. Karagheoris, drawing upon her own experience birthing, speculates a little differently: perhaps temple priestesses used opium for trance or oracular prophecy, or perhaps it was used for childbirth pain.[236] This mother's hypothesis about a pain killer for birthing seems especially plausible given that the opium pipes and the Egyptian god Bes were found in the same place.

A short walk from this older Kition site, Kition Kathari, is the later Phoenician site of Kition Bamboula. Kition Bamboula is an Iron Age site, so beyond the scope of the Bronze Age, but the site provides textual information about rituals to Astarte. These include water rites and ritual hair cutting as offerings to the goddess as per the Syrio-Palestinan tradition. It seems plausible that these rites would have taken place at the older site of Kition Kathari as well. Kition Bamboula also provides an abundance of stone stelae featuring a female icon with flipped hair. Tourist information identifies these carved images as Hathor. Being that this temple was specifically dedicated to Astarte, however, and given that Hathor and Astarte imagery mixed in Syro-Palestine and in New Kingdom Egypt, whom do these stelae actually represent? If it is indeed Hathor, did she appear because of her association with copper as in Timna? Did

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[234] Vassos Karageorghis, *Ancient Cyprus: 7,000 Years of Art and Archaeology* (Baton Rouge: Louisiana State University Press, 1981), 98.
[235] Ibid., 65.
[236] Jacqueline Karageorghis, *Kypri: The Aphrodite of Cyprus: Ancient Sources and Archaeological Evidence* (Nicosia: A.G. Leventis Foundation, 2005), 128.

she appear only because she was a goddess that the Phoenicians closely associated with their own Astarte? I suggest there is a more entangled association going on here that dates back to the Canaanites' evident embrace of Hathor in the mainland Levant.

Enkomi

Cypriot archaeometallurgist Vasiliki Kassianidou describes Enkomi, in a fairly remote part of the Turkish-occupied eastern side of the island, as being the most significant commercial harbor until modern times, ideal for trade with the Eastern Mediterranean. Founded at the end of the seventeenth century BCE, Enkomi was abandoned between 1200 and 1100 BCE. Thus its habitation spans the entire Late Bronze Age, and metallurgy was practiced there from the beginning of its settlement. This is evidenced by copper workshops that include tuyères (tubes that blow air into a furnace), stone and ceramic bellows, slag, stone molds, scrap metal, and to date three complete copper ingots.[237]

J. Karageorghis posits that a cult devoted to a Cypriot goddess at Enkomi dates back to the fourteenth or thirteenth century BCE. She bases this (disputed) assertion on a series of more than ten figurines found in tombs there that resemble the same "Astarte type" figurines with hoop earrings and sexualized features that were found at Kition and echo Syro-Palestinian forms.[238] As at Kition, some of these figurines are depicted holding babies which marks them as being specifically Cypriot because Astarte represented sexuality, but not motherhood. J. Karageorghis leaps to the

[237] Vasiliki Kassianidou, "Oxhide Ingots in Cyprus," in *Oxhide Ingots in the Central Mediterranean,* ed. Fulvia Lo Schiav (Rome: A.G. Leventis Foundation and CNR - Istituto di Studi Sulle Civiltà Dell´Egeo e Del Vicino Oriente, 2009), 42.
[238] Jacqueline Karageorghis, *Kypri: The Aphrodite of Cyprus: Ancient Sources and Archaeological Evidence* (Nicosia: A.G. Leventis Foundation, 2005), 213.

conclusion that these figurines indicate the worship of a goddess as a life giver. The Mycenaean-style figurines with raised arms, again interpreted by J. Karageorghis to represent a goddess or her priestesses, also occur at Enkomi.[239]

Figure 34: Bronze Age Cypriot figurines from the British Museum. The two figurines on the left exemplify the "bird type" or "Astarte-type" that have similarities to Syro-Palestinian figurines thought to be Astarte; however, unlike the Syro-Palestinan figurines, Cypriot examples of this type hold babies. The figurine type with flat heads and cow-like ears, as shown in the center, could possibly be a Cypriot interpretation of Hathor. Photographed by Casondra Sobieralski, 2018.

The most well known "goddess" figurine from Enkomi, however, is a female figurine standing on a copper ingot. V. Karageorghis refers to this figurine as the "Ingot Goddess." Nancy Serwint writes, "Her nudity and heavy jewelry recall a tradition of Near Eastern fertility goddesses, and the placement of the goddess on top of her cult symbol is in keeping with the established Near Eastern convention of a deity on a sacred token." Serwint adds that the fecundity of the land was so important on the island that divine protection was invoked in relation to the earth's riches, including ores.[240]

Again, these interpretations of a Cypriot female divinity or divinities represent a popular version of Archaeology, one that is articulated in museums and at

[239] Ibid., 213.
[240] Nancy Serwint, "Aphrodite and Her Near Eastern Sisters," in *Engendering Aphrodite: Women and Society in Ancient Cyprus*, *Vol. 3;7*, ed. Bolger, Diane and Nancy J. Serwint (Boston, MA: American Schools of Oriental Research, 2002), 337.

archaeology site visitor centers. Not all archaeologists agree with these interpretations. Those who disagree are not necessarily embracing conservative patriarchal views. Rather, in some instances, their interpretations raise interesting questions about the role and status of real women in Cyprus, including what role or roles women might have played in the copper industry.

Theorizing and Problematizing the "Goddesses," Cult, and Gender as per Bernard Knapp, Diane Bolger, and Daisy Knox

Knapp, Bolger, and Knox are three archaeologists with related but distinct viewpoints who problematize the common narrative about the Cypriot goddess as popularized by J. Karageorghis. Coming from a Materialist/Neo-Marxist position, Knapp is less concerned with which representations do and do not count as "goddesses," and more concerned with the relationship between artifacts, power, and religion. Bolinger is in dialogue with Knapp, but her primary interests are gender roles, power, and representation. For her, figurines, whether cultic or secular, provide opportunities for garnering information about gendered practices and inspire speculations regarding gender performativity; to Bolinger, figurines can signify and carry information about unexpected roles for real women. Knox writes detailed data analysis about the microcontexts of figurines, and she uses that statistical information to inform her interpretations about what constitutes a goddess. Using numeric data, Knox offers a particularly original perspective regarding early representations of Hathor in Cyprus, suggesting these representations are based on oral (rather than pictorial/sculptural) descriptions of the Egyptian goddess with cow ears.

Analyses by Knapp and Bolger compliment one another particularly well in regard to Chalcolithic figurines prior to the Bronze Age, and in regard to the bronze "Ingot Goddess" type known from Enkomi. Knapp agrees with widely accepted views, including those of the Karageorghis duo, that Chalcolithic figurines in general were associated with childbirth or birthing rituals, and that they were used ceremonially to promote fertility.[241] Knapp urges alternative interpretations of larger nude female figurines (typically interpreted as a deity or a "mother goddess") due to a lack of contextual evidence. "Instead of viewing these figurines as goddesses or even servants of a deity...how might they represent other roles or daily practices on protohistoric Cyprus—mothers and motherhood, priestesses, sexual objects, dancers or celebrants?"[242]

Similarly, Bolger finds richness in secular interpretations of Chalcolithic and earlier figurines. In her opinion, projecting Aphrodite all the way back to the Stone Age has led to a tendency among archaeologists to generalize all Neolithic, Chalcolithic, and Bronze Age figurines as ""proto" Aphrodites." Rather than associate these prehistoric figurines with deities, Bolger focuses on the funerary contexts of some; she contemplates others as charms for birthing.[243] To support her theory that some Chalcolithic figurines were used in domestic birth rituals—and not goddesses— Bogler notes their use pattern: the figurines, some of which are depicted in parturition, seem to have been destroyed, buried, and abandoned in

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[241] Arthur Bernar Knapp, *The Archaeology of Cyprus: From Earliest Prehistory through the Bronze Age* (Cambridge: Cambridge University Press, 2013), 234.
[242] Ibid., 390.
[243] She also offers for consideration that both female and male figures hold infants, so this challenges essentialist ideas about gender roles from our own recent cultures. Perhaps social constructs around gender in Cyprus were more flexible. See: Diane Bolger, *Gender in Ancient Cyprus: Narratives of Social Change on a Mediterranean Island*, Gender and Archaeology Series, V. 6. (Walnut Creek, CA: AltaMira Press, 2003), 93-96.

deposits.[244] Bolger thus argues that figurines were used in performance rituals that allowed individuals to negotiate gender identities within communities. She describes figurines as media through which experiences of the body—menarche, pregnancy, childbirth, male reproductive capacity, and death—were communicated within the social sphere to create the appearance of social norms, to promote social stability, to process intense emotions. Echoing Judith Butler, Bolger describes gender as a dialectic between actors and audience whereby performance allows the construction and reconstruction of gender over the course of life and life changes.[245] Important to establishing a worldbuilding perspective, Bolger notes that rituals centering around reproduction tend to occur in societies where women have relatively high status, i.e. relatively egalitarian and matrifocal societies. Material evidence suggests to her that birthing rituals, which ended in the first half of the third millenium BCE, endured in Cyprus for over 2000 years.[246] Thus one can tentatively suggest an important status for women during that time span.

Knapp and Bolger also overlap in their thinking about the Late Bronze Age "Ingot Goddess" from Enkomi. Knapp bucks the generally accepted norm that interprets this figurine as Astarte in Canaanite style. He refers to her as "The Bomford Figurine" because he is not interested in whether she is a goddess at all. Instead he is concerned with her ideological importance and her connection to the Cypriot copper industry:

> Is there any justification in identifying the figurines as Astarte or Aphrodite, Apollo, Hephaistos, or Negel-Resheph? What are the implications of the spatial proximity of industrial (copper working) installations and monumental architecture for the understanding of

[244] Ibid., 104-105.
[245] Ibid., 109-110.
[246] Ibid., 121.

> social processes or political organization on Bronze Age Cyprus? Who regulated the copper industry and how did they do it?[247]

Knapp acknowledges that Enkomi artifacts indeed indicate ritual activity, but more importantly to him, they symbolize the power of an emerging elite. He suggests that the proximity between ceremonial structures and metallurgical workshops might simultaneously symbolize the cultic associations of copper production and also represent the relationship between the managers of, and producers within, the copper industry. The archaeology of Enkomi suggests that a single politico-economic institution controlled both "temple" and "workshop," and that institution used religion to project and centralize authority. "As power created religion, religion stabilized power."[248] Again, if one interprets the "Ingot Goddess"/"Bomford Figurine" as media, then Knapp and Peters would find common ground: Peters says, "Media always concentrate power...cultural authorities have always sought to influence how people act and think...digital media are the latest step in population management."[249]

Bolger has a similar perspective on the "Ingot Goddess," but she heightens a focus on gender. She ponders, was the "Ingot Goddess" an elite "copper maven?" Like Knapp, Bolger questions whether the "Ingot Goddess" and the "Ingot God" were actually deities as traditionally identified, or whether they represented real people who were elites. She questions what each interpretation, sacred or secular, implies about gender roles. Does the bronze figurine styled as Astarte assure "fruitfulness of the mines" or the fertility of the smelting furnace? Or, rather, did women hold political

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[247] Arthur Bernard Knapp, *Copper Production and Divine Protection: Archaeology, Ideology and Social Complexity on Bronze Age Cyprus*, Studies in Mediterranean Archaeology, Pocket-Book, 42 (Goteborg: P. Astroms Forlag, 1986), 61-62.
[248] Ibid., 116-117.
[249] John Durham Peters, *The Marvelous Clouds: Toward a Philosophy of Elemental Media* (Chicago, London: University of Chicago Press, 2015), 5-7.

power in mining? Could women have organized production, transportation, and distribution? Could they have held authority? Further, Bolger questions, could these ideas have been linked, such that figurines acted as sacred vehicles of authority through which elites established control?[250] I find this linkage to be an especially rich hypothesis because I do not see any way of getting around this figurine being a representation of Astarte. It includes too many of the attributes of said goddess as she is depicted in Syro-Palestine, as Serwint describes.[251]

In support of ideas about women in mining, Bolger looks for parallels in textile manufacture and she looks to experimental smelting projects. In regard to textiles, Bolger's research deduces a gendered division of labor in the Early Bronze, but less

[250] Diane Bolger, *Gender in Ancient Cyprus: Narratives of Social Change on a Mediterranean Island*, Gender and Archaeology Series, V. 6. (Walnut Creek, CA: AltaMira Press, 2003), 98-99.

[251] Given Knapp's and Bolger's probing questions about the Enkomi figurines in relation to labor, I am inspired to ask my own: what about the connotative media makers who were part of the copper establishment? Whereas osteoarchaeology and ethnography give us clues about the high status of ancient copper smelters in ancient Palestine, and graves tell us that Cypriot mountain mine owners and coastal bureaucrats became elites, history has not left a record about the inner lives of these ancient craftspersons who shaped the medium of copper into copper media messages. It is Timna that is called the "Pittsburgh of the Ancient Near East" because of its importance to industrial production. However, as a native Pittsburgher myself, I cannot help but think of Knapp's and Bolger's speculations about Enkomi's interrelationships among production, religion, and power in relation to Pittsburgh-born Andy Warhol and his Factory. Like Enkomi, the Factory exemplifies the tangling of labor, the materiality of media, and the semiotics of media with economics, and power. In Enkomi, the material medium is copper, the semiotics are expressed through figurines; according to the aforementioned archaeologists, these figurines could perhaps represent and reinforce political and economic power in a copper-driven society. In the Factory, where Warhol functioned like the high priest of a temple, the materiality tended towards mass producible choices like screen prints, and the semiotics blended the hypnotism of Byzantine icons with the religion of corporate commodification. In terms of power, Warhol was like the magician wielding chimera tricks through which the blending of medium and message both reinforced, and reduced through naked exposure, capitalism's power to induce trance through commercialization. Looking at the production of Bronze Age copper-cult connections and ancient Cypriot icons with Warhol in mind, I cannot help but wonder about the mindset of the ancient *makers* of cultic and other figurines. Were they pious and meditative in their craft? Were they just doing a job as ordered, as dutiful workers? Were they more like revered Michaelangelos? Were they part of an establishment intent on crafting a media message, like political propagandists? Did they run things in the assembly line fashion of Warhol? Did they, like Warhol, hold celebrity status, or where they looked upon as laborers?

division by the Late Bronze Age Age. She speculates that women's labor in Cyprus was not as tightly regulated as in other Near Eastern societies.[252] Further, copper smelting, like textiles and ceramics, is tedious and labor-intensive, so it probably required the labor of both [or perhaps many] genders. She offers ethnographic evidence of women mining into the twentieth century CE, and she points to Walter Fascnacht's experimental archaeology smelting reenactments at Ayia Varvara (a lesser-known copper site, near Kition). His experiments reveal that women have superb coordination and stamina for operating bellows that force air into smelting furnaces, for example.[253] Bolger questions, if copper extraction, production, manufacture, and trade had been exclusively controlled by men, how would this have affected gender relations in a once heterarchical society?[254]

Thus Knapp and Bolger both look at figurines through a lens of materiality, labor, and power. Bolger extracts gender as a particular point of power analysis:

> In addition to reflecting ideology, ritual symbols promote political agendas when individuals or groups intent on gaining or maintaining power manipulate them for their own ends. By interpreting the Cypriot figurines as instruments of power rather than as dolls, charms, works of art, or static symbols of fertility, we are able to gain insights into the way changes in gender roles were constructed, performed, and reiterated.[255]

Both archaeologists maintain that looking at all figurines as goddesses limits other insights that they can provide about ancient Cypriot culture. Their perspectives offer rich material with which the media archaelogist, and the worldbuilder, can work.

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[252]Diane Bolger, *Gender in Ancient Cyprus: Narratives of Social Change on a Mediterranean Island*, Gender and Archaeology Series, V. 6. (Walnut Creek, CA: AltaMira Press, 2003), Ibid., 75.
[253] Ibid., 75-77.
[254] Ibid., 80.
[255] Ibid., 106.

Knox represents a subsequent generation of archaeologists. Her data-driven approach quantifies, for example, how frequently specific figurines occur in specific micro-contexts. She quantifies attributes of artifacts to analyze patterns. Knox, like Knapp and Bolger, rejects J. Karagoeghis's effort to trace the origin of Aphrodite/ Kypris back to the Paphos area Chalcolithic figurines of 3000 BCE. She rejects identifying each Bronze Age figurine type as representing the same goddess, and urges more critical analyses of how each figurine type functioned and/or signified.[256] She critiques:

> The final consequence of esteem for Bronze Age Cypriot figurines is an intellectual one, perhaps best described as the 'curse of Aphrodite'... It is doubtless in the interests of the Cyprus Tourism Organisation (CTO) to promote the association of Cyprus with romance. By pushing Aphrodite further back into the history of the island, it is possible to embed her ever more deeply into its national identity.[257]

According to Knox, most scholars deduce that the first for-certain female deities date to the Late Cypriot period [1650-1050 BCE according to the British Museum time tables, i.e. Late Bronze Age]. Thus interpretations of figurines as goddesses prior to that are speculation.[258]

Knox's analysis of the "Flathead Figurine" type is particularly relevant to my investigation of how the concept of a Hathor-Astarte helix traveled through ancient lands as a copper goddess or goddess duo. Museums tend to label these Flathead figurines as being Mycenaean types. (Note, these are distinct from the Mycenaean types with raised arms.) Knox puts forth the fascinating interpretation that these Flathead types are instead styled after the Egyptian Hathor; but she suggests that

[256] Daisy-Kate Knox, "Making Sense of Figurines in Bronze Age Cyprus: A Comprehensive Analysis of Cypriot Ceramic Figurative Material from EC I - LC IIIA (c. 2300 BC - 1100 BC)." (PhD diss., The University of Manchester, 2012), 92.
[257] Ibid., 92.
[258] Ibid., 36.

these figurines are based on oral transmission about Hathor rather than on actually seeing visual representations of Hathor. Knox points out several clues: trade with Egypt in the Late Bronze Age is well documented textually; the figurines consistently sport Hathor's signature cow ears; and forty-three of forty-nine samples had sculpted hair curls that are distinctly Cypriot, but echo Hathor's hair flips. Knox, who emphasizes stylistic features of indigeneity in her interpretations, deduces that these figurines are a "Cypriot version" of Hathor that visually harken old Cypriot figurine forms traceable back to Early Bronze Age funerary plank figurines.[259]

I also disagree with interpreting Flathead types as being stylistically Mycenaean because in museums I saw a clear mix of Near Eastern elements expressed in these artifacts. However, at first I was skeptical of Knox's interpretation as well, for the same reason. Viewing these artifacts through display cases, I could not see the cow ears that Knox describes, but I could plainly see that these forms have characteristics that occur both in Syro-Palestinian figurines and in Egyptian folk art figurines. For example, the Flatheads have Levantine postures with hands held near their breasts, and a cross hatched pattern incised along the pubic area as seen in both Levantine and Egyptian fertility figurines. The Flatheads are nude, like Astarte and other Near Eastern goddesses, whereas Hathor is always clothed. So I build on Knox to suggest that perhaps these Flatheads represent another *fusion* of Hathor and Ba'alat/Astarte, distilled through contact with Canaan/Phoenicia. I think they are another example of Syro-Palestinian iconography and Hathor's melding, as I researched in Israel.

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[259] Daisy-Kate Knox, "Making Sense of Figurines in Bronze Age Cyprus: A Comprehensive Analysis of Cypriot Ceramic Figurative Material from EC I - LC IIIA (c. 2300 BC - 1100 BC)" (PhD diss., The University of Manchester, 2012), 181-182.

As established earlier in this chapter, at Timna (and at Serabit el-Khadim) Hathor was unequivocally associated with copper mining. Knox says that in Cyprus, [numerically indexed] contextual evidence for the use of Flathead Figurines is limited, but "what exists points to a spatial association with the paraphernalia of copper processing."[260] In addition, Knox uniquely elucidates a resemblance between Flathead Figurines and the twelfth century Cypriot bronze "Ingot Goddess" type [from Enkomi, Palaepaphos]. Both types are apparently naked with flat heads, pinched, protruding ears and curled hair, she notes. Both types hold their arms in similar gestures towards their breasts, and both types have similarly styled eyes. Knox hypothesizes that any differences are attributable to differences in media. The extended curls on the bronze versions, for example, would have been too fragile to include on a clay figurine. The heavy necklace worn by the bronze figurine is absent from most clay examples, though they could have worn necklaces made from some ephemeral material.[261]

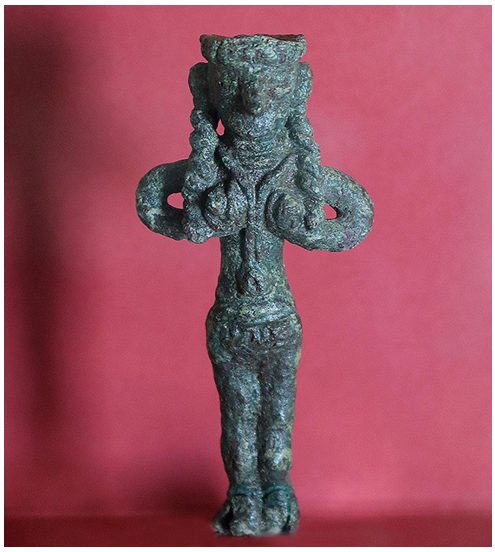
However, despite the Hathoric features of Flatheads, and despite their spatial associations indicating a probable relationship to the copper industry, Knox argues that these figurines still might not have represented deities to the Cypriots:

> Indeed, given the absence of built temple facilities and other ritual paraphernalia akin to those associated with the worship of Hathor in Egypt and the Levant, it is unlikely that Flathead Figurines were part of any cult which functioned in a comparable way. In fact, the similarity between the findspots of Flathead and Earring figurines may indicate that both functioned in a peculiarly Cypriot way, relevant to both burial contexts and those of domestic industry.[262]

[260] Ibid., 181.
[261] Ibid., 181-182.
[262] Ibid., 182.

Figure 35 Left, “Flathead” figurines exhibited in the Leventis Museum, Nicosia, Cyprus.

Figure 36 Right: Knox compares these to the “Ingot Goddess” type. Though the most famous “Ingot Goddess” type example is from Enkomi, Cyprus, the one pictured above is exhibited in the collection at, and excavated from, Palaepaphos.
Photographs by Casondra Sobieralski, 2019.

I challenge this assertion: if the Cypriots knew of Hathor by oral transmission, surely part of that transmission identified Hathor as a deity, and specifically as a deity associated with copper. Otherwise, the Cypriots could have chosen to represent any one of a number of other characters from Egyptian tales, such as Isis, Nephthys, Sekhmet... It just seems too coincidental that they would choose the one Egyptian goddess associated with copper to use near the copper processing facilities. Further, since these figurines share traits representative of both Hathor and Syro-Palestinian figurines, might that suggest that this Hathoric oral transmission, as Knox hypothetically describes is, made its way from copper-rich Timna via routes through Canaan?

In summary of the differing interpretations, many archaeologists challenge J. Karageorghis’s arguments that Aphrodite, an icon of the island, is a direct

descendent of, or has roots in, a Chalcolithic “mother goddess”/fertility goddess. Archaeologists also debate whether all female figurines that are labeled “goddesses” in museums really do represent deities or even cultic devotees. They debate the stylistic cultural origins of different female representations called goddesses. They debate whether and why it matters if particular figurines signify goddesses; sometimes secular interpretations provoke even more radical and exciting possibilities about gender in ancient Cyprus prior to or during the Bronze Age. No one is disputing, however, that there have been important goddesses as a part of Cypriot history and culture, and they are associated with copper. An abundance of textual, pictorial, and architectural sources make clear that people from Syro-Palestine brought Astarte worship to their copper production sites in Cyprus. Iconographic evidence on stelae, columns, and pottery also indicate that the Egyptian Hathor, often via the Phoenician’s connection to her, had an important role at many temples situated near copper production sites. Today the tourism industry celebrates that Aphrodite, named by the Greeks in the Iron Age, was beloved on the island, and that she, too, was associated with copper. It is the origins of Aphrodite, and the early relationship between cult and political power, that are fiercely contested.

Kypris/Astarte/Aphrodite’s dual-gender nature

To further complicate the identity of the Cypriot Aphrodite and her predecessors, I will note that this goddess, or cluster of goddesses, sometimes had a bisexual or dual-gender persona. Though archaeologists cannot conclusively answer why, this topic was worth examining as information for worldbuilding.

Two small terracotta sixth century BCE (Helenistic) figurines near Kition possess female pubic areas and male upper bodies. Each is believed to be linked to the cult of Astarte.[263] David T. Sugimoto notes that hermaphroditic figurines representing Astarte, with both breasts and beards, have been found in Transjordan, an area of the southern Levant not far from Timna.[264] This challenges the notion that Astarte's dual-gender representation was unique to Cyprus.

I have found no consensus about this dual-gendering of goddesses. It seems reductive and essentialist to suggest that it has to do with representing Astarte's "masculine" warrior side, particularly since the dual-gendering tradition in Cyprus predates Astarte's arrival; early examples of gender ambiguous or dual gendered artifacts include "Lemba Lady" to picrolite cruciform figurines to those funerary plank personas that were popular in Early-Middle Chalcolithic times.[265] Bonnie MacLaughlan suggests that dual-gendering could represent the wholeness of male and female that is born of the experience of sexual union in a heterosexual context.[266] If so, this becomes interesting in relation to artifacts found at sites associated with copper because this links back to previously articulated ideas about metal smelting being understood as a sexual union in some cultures, an alchemy

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[263] Bonnie MacLauchlan, "The Ungendering of Aphrodite", in *Engendering Aphrodite: Women and Society in Ancient Cyprus*. Vol. 3;7, ed. Bolger, Diane and Nancy J. Serwint (Boston, MA: American Schools of Oriental Research, 2002), 366. doi:10.5615/j.ctt2jc9sc.

[264] David. T. Sugimoto, "The Judean Pillar Figurines and the "Queen of Heaven"", in *Transformation of a Goddess: Ishtar--Astarte--Aphrodite*, *Orbis Biblicus Et Orientalis, 263,* ed. David. T. Sugimoto (Fribourg: Academic Press, 2014), 163.

[265] Bonnie MacLaughlan notes a particular example of a plank figure that possesses breasts, a penis, and holds an infant. See: Bonnie MacLauchlan, "The Ungendering of Aphrodite", in *Engendering Aphrodite: Women and Society in Ancient Cyprus*. Vol. 3;7, ed. Bolger, Diane and Nancy J. Serwint (Boston, MA: American Schools of Oriental Research, 2002), 366. doi:10.5615/j.ctt2jc9sc.

[266] Bonnie MacLauchlan, "The Ungendering of Aphrodite", in *Engendering Aphrodite: Women and Society in Ancient Cyprus*. Vol. 3;7, ed. Bolger, Diane and Nancy J. Serwint (Boston, MA: American Schools of Oriental Research, 2002), 370. doi:10.5615/j.ctt2jc9sc.

fusing the “masculine” and “feminine” properties of the ores. To be clear, I have found no evidence so far to support that this belief was held in Cyprus specifically. However, these dual-gendered figures keep the question open, if one applies a cross-cultural lens.

Diane Bolger takes a more theoretical approach; she says that sexually ambiguous and dual-sexed figurines might suggest that ancients did not ascribe to the same binary gender constructs from which our own culture is just breaking free: “Male/female dichotomies restrict our understanding of gender to a single pattern, thereby failing to consider the fluidity and multiplicity of gender constructs common in non-Western preindustrial societies.”[267] In museum collections, I found the occurrence of Cypriot artifacts of males holding infants to be common. This could indicate more fluid gender roles than past generations of archaeologists might have presumed. Overall, questions about representations of gender ambiguity in Cyprus and the wider Levant remain a fascinating question for further study.

Conclusions

At least one site in modern Israel–Timna–and at three sites in Cyprus–Palaepaphos, Kition, and Enkomi–show distinct relationships between copper production and goddess cults. In Timna, tourist information celebrates Hathor as this goddess. My own research, especially as informed by the writings of Uzi Avner, Erez Ben-Yosef, Andrés Diego Espinel, the Israel Museum and the Bible Lands Museum in Jerusalem, and the Eretz-Israel Museum in Tel Aviv, suggests that Hathor was not necessarily the only female deity recognized at Timna. Rather,

[267] Diane Bolger, *Gender in Ancient Cyprus: Narratives of Social Change on a Mediterranean Island*. Gender and Archaeology Series, V. 6. (Walnut Creek, CA: AltaMira Press, 2003), 107.

throughout ancient Canaan, Hathor was entangled with a Semitic goddess who possessed similar attributes; both were goddesses associated with love, sexuality and the fecundity of the earth. That fecundity included copper ores, in the Bronze Age worldview. In other pre-modern cultures, including Greek and African cultures, smelting was seen as an alchemical process fusing “masculine” and “feminine” principles, whereby a sexual union in the smelting furnace gave birth to metal. Archetypically, this is likely an additional, more complex reason that Hathor and Astarte, as sexuality goddesses, were linked to copper production in the Negev and in the Sinai. Hathor and Astarte then danced their way to Cyprus by way of the Phoenician Canaanites. In both Israel and in Cyprus, it can be difficult to discern when a representation signifies Hathor or Astarte, and in some instances scholars are unclear to what degree they were worshiped as two distinct goddesses versus one amalgamated deity. Tracing representations of these goddesses through a media archaeology lens demonstrates how these representations functioned as media, carrying information about the copper-cult connection and its evolution. Female figurines, including those representing Hathor and Astarte, might also carry information about relationships among women, copper production, and power in Cyprus in particular. Questioning such relationships becomes especially rich if one considers, as Bolger and Knapp do, that elites could have represented themselves as gods to reinforce their political power. More broadly, tracing stylistic evolutions of Bronze Age material culture, including material representations of the feminine, is one means of mapping the general exchange of knowledge and information between Cyprus and its Mediterranean neighbors. Such tracing demonstrates that Cypriot copper trade itself was a networked information system, even before copper as a

medium became integral to Victorian and digital networked information systems that relied on the metal: the telegraph, the telephone, and the internet as detailed in chapter one.

As a worldbuilder, researching the relationship between Hathor/Astarte, and copper in the Bronze Age Levant allowed me to see that the Bronze Age is not one world, but many interconnected worlds. In exploring these worlds, I questioned what interanimations could have existed among people, their tools, their environments, and how those might have been expressed through ritual practices. I speculated about what agents, from among these categories, could have intra-acted and dynamically performed with one another in different scenarios. How did copper shape human activity, including cultic activity? Chapter three maps these questions, and my VR project design process, in a way that stakes an intervention in contemporary digital heritage theory and practice.

Research for this chapter also helped me to narrow my focus in designing for my cyber-archaeology experience. I came to realize that for the scope of this particular project, Timna lent itself better to building a consistent, immersive world. Because Bronze Age Cyprus was such an amalgamation of hybridized styles and ideas, it would be difficult to use Cypriot artifacts to build a clear and consistent sense of place for an audience beyond art historians with prior knowledge. In Timna, the stylistics are more consistent, limited, and distinct, and therefore easier for a general museum-going audience to understand. Also archaeology sites in Cyprus, particularly Kition, exist within contemporary towns. This makes for confusing backdrops of intersecting temporalities. Timna, conversely, is a remote national park with a rich landscape. The desert setting, which includes archaeology sites

surrounded by hills, is already an immersive, 360-degree experience. The palette of Timna is also distinct, with warm, golden and red earth tones evoking the heat of the smelting process. Thus Timna's artifacts, landscape, and hues allow for more consistent art direction. Further, Negev star lore as expressed in petroglyphs allowed me to design a mythically relevant Timna sky when skies tend to be inadequately considered in 360-degree outdoor environments.

Research in Cyprus was still useful for world building applied to Timna, however, because examining cult related to copper on the island broadened my contextual understanding. Research in Cyprus also gave me ideas to include more gender-fluid speculations about how labor at Timna might have been conducted, and by whom. Astarte's dual-gender nature in Cyprus and in Transjordan informs my worldbuilding as well. Allowing players in a Virtual Reality environment to choose male, female, gender-ambiguous/dual-gendered avatars and characters could create a sense of inclusivity for contemporary people who identify as genders beyond "male" or "female." It could empower them to know that there is a historical precedent that honors fluidity of gender expression. It could also empower people who do identify more traditionally as male or female to challenge assumptions about rigid roles and gender constructions.

Chapter 3: Expressing History Through Intra-Action: Contributions to Cyber-Archaeology through the "Cult and Copper" Virtual Reality Game

Cyber-archaeology trends encourage the creation of multi-sensory projects that leverage the affordances of multi-media and strive to create embodied experiences. Few projects dare, however, to speculate about intangible heritage. "Cult and Copper" is a Virtual Reality cyber-archaeology game that boldly explores the intangible heritage of copper smelting and its relationship to shamanism in the ancient Levant. Early smelting methods, which employed blowpipes to heat smelting furnaces, necessarily used deep and sustained breathing techniques. Today, breathwork methods such as those used in pranayama yoga are associated with achieving altered states of consciousness. Thus this game questions whether the sustained deep breathing that early smelting methods required could have been a factor in the connection between this copper production and cultic practice. In "Cult and Copper," players use their own breath, via a simulated breath interface, to control a smelting fire.[268] The game objectives are to both achieve a meditative state and to ensure a successful copper smelt such that copper is "born" of the furnace. The immersive game's unique interface design facilitates an embodied awareness of the physiological effects of deep, sustained breathing. The game design overall encourages players to ask questions about, and hopefully further investigate, the intangible heritage aspects of copper smelting. The experiential, non-competitive

[268] My game designs and the original prototype stages used an actual breath interface using a sensor and an Arduino microcontroller, but the surge of the omicron variant of covid-19 required a last-minute change. This is detailed later in this chapter.

game is intended for a museum setting and embraces a posthumanist, intra-active theoretical framework.

The project uses a theory-praxis methodology, meaning theory and research inform critical making. Designs for the game, including the interface design, are the result of research about Chalcolithic and Bronze Age copper production and its relation to cultic practices; current cyber-archaeology discourse; theories of immersion from the arts; and theories of human-computer interaction (HCI) design. This chapter details the research, design, and collaborative processes for "Cult and Copper." This process map can serve as a guide for similar cyber-archaeology projects.

Cyber-archaeology represents the maturation of approaches that apply computer technologies to heritage. Earlier techniques, which gained popularity in the 1990s/early 2000s, typically focused on improving computer graphics methods to create virtual 3D models of static temples, monuments, and artifacts. They privileged visuality over other means of perception and empirical data over story.[269] The cyber-archaeologists who inform this project seek to go beyond 3D modeling to bring interpretation, meaning, and context to digital archaeology. Often they do so

[269] As noted in the introduction, see as examples: Mauritzio Forte, "Cyber Archaeology: 3D Sensing and Digital Embodiment," in *Digital Methods and Remote Sensing in Archaeology: Archaeology in the Age of Sensing*, ed. Maurizio Forte and Stefano Campana (Cham: Springer International Publishing, 2016), 276-277, 282, 287; Eva Pietroni, "From Remote to Embodied Sensing: New Perspectives for Virtual Museums and Archaeological Landscape Communication." in *Digital Methods and Remote Sensing in Archaeology: Archaeology in the Age of Sensing*, ed. Maurizio Forte and Stefano Campana (Cham: Springer International Publishing, 2016), 438-439; Jeffrey Stuart, *"Challenging Heritage Visualisation: Beauty, Aura and Democratisation," Open Archaeology 1, no. 1 (n.d.):* 144–145, https://doaj.org/article/b6a0e825a9a744a79ed72c7d64d2abb5; and Alice Watterson, "Beyond Digital Dwelling: Re-Thinking Interpretive Visualisation in Archaeology." *Open Archaeology 1, no. 1 (n.d.): 119-121,* https://doaj.org/article/184fd6853fcf45e8917f96b705280730.

via embodied, experiential means that go beyond visual design to include sound and vibration, touch, movement, and even scent.

This cyber-archaeology case study about ancient smelting evolved from an investigation as to why cultic evidence of Bronze Age love/sexuality goddesses exists at multiple copper production sites throughout the Levant. These goddesses included the Egyptian Hathor and the Canaanite Ba'alat, later called Astarte. Breath later became central to this design concept because Walter Fasnacht, an experimental archaeologist from University of Zurich, suggested that the early relationship between smelting and shamanism might have had something to do, in part, with hallucinatory states related to breath.[270] Meditative breath practices including pranayama yoga and Holotropic breathwork can lead to experiences of altered states of consciousness for some practitioners.[271] Fasnacht explained that prior to the invention of bellows for pumping air into furnaces, smelters used blowpipes. A smelt using blowpipes required a group of about four to six smelters to engage in deep, sustained breathing for about two hours, assuming that they were starting with a furnace that was not already heated. In Fasnacht's years' worth of smelting experiments, he found that if a furnace is indeed "pre-heated," then a copper smelt with blowpipes takes about twenty minutes.[272] Thus this cyber-

[270] Fasnacht noted that toxic smelting fumes and oxygen deprivation can also create hallucinatory states if novice smelters sit too close to the smelting crucible. Obviously, though, these variables are not safe to experiment with in a museum experience. (Conversation with Walter Fasnacht, Experimental Archaeologist at University of Zurich, Switzerland. Interviews via Zoom, December 23, 2020.)

[271] As noted in the introduction, for general explanations on these various forms of breathwork, see: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3415184/ & https://www.yogajournal.com/practice/beginners/how-to/pranayama (pranayama), http://www.holotropic.com/holotropic-breathwork/about-holotropic-breathwork/ (Holotropic), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3209750/ (Lamaze)

[272] Conversations with Walter Fasnacht, Experimental Archaeologist at University of Zurich, Switzerland. Interviews via Zoom, December 23, 2020 and April 16, 2021.

archaeology project creates a virtual experience that allows participants to explore and speculate, through an experiential embodied approach, breath as an aspect of intangible heritage surrounding cult and copper.

The aim of the game is for a singular player to ensure a successful smelt by aptly regulating one's breath for about ten minutes. Though that is half of the time of Fasnacht's smelts, asking museum visitors to invest twenty minutes is a high expectation. The immersive characteristics of the game, including the interface, were designed to at least partly evoke (the sensation of temperature, for example, is not realized in this prototype) a bodily sense of what it might have been like to be an ancient smelter using blowpipe technologies, under a night sky in the Timna desert, to heat a small crucible. Note, archaeological literature and artifacts widely support that by the Late Bronze Age, bellows were in use. In order to keep with the theme of breath without temporally mis-matching technologies, then, the narrator of the game (an old man smelter-shaman) specifies that he is teaching the player "the old ways."[273] Virtual Reality is the chosen medium for the game over Augmented Reality because VR is ideal for withdrawing from the ordinary world into an immersive cocoon. AR is best utilized for creating a virtual overlay onto an existing world. Thus AR lends itself well to site specific experiences and to facilitating more extroverted, socially and place-based engaged experiences, whereas single-player VR can lend itself well to internal, meditative experiences.

[273] Later iterations of the game could include "leveling up" to utilize an interface that mimics bellows so players could experientially learn how technologies evolved. A section near the end of this chapter details this strategy as a proposed further development of "Cult and Copper."

Cyber-Archaeology Design Research Questions for "Cult and Copper"

A primary design research question for this project was how to improve upon interaction for virtual heritage/cyber-archaeology design because in the historical VR pieces I played while conducting research–such as *Historium VR-Relive the History of Bruges*[274] or *Horizon of History*[275]–interaction design was the weakest point of the storytelling. Subjectively, the interactions afforded invariably broke my sense of immersion because they seemed unrelated to the story. This brought my attention to mechanics in a way that took me out of the stories. The interactions also did not enhance my understanding of the history presented, probably because they conveyed nothing about the time periods expressed. In this cult and copper VR game, player interaction via breath instead co-creates the story and harkens tools and techniques of the ancient time presented. Further, the focus on breathing adds an immersion strategy which game designer and yogini Carrie Heeter calls interoception. Interoception implies a sensory awareness of bodily systems (like breath or heartbeat), the environment that the body occupies, and the interplay between the two. Interoception, Heeter says, focuses on the present moment and is synonymous with embodied presence.[276]

A secondary design research question was how to redefine interaction design as "intra-action" design in order to establish animism as a design metaphor. "Intra-action," as part of agential realism, is a term used by feminist physicist-

[274] *Historium VR - Relive the History of Bruges* (Sevenedge Interactive Media, Historium Bruges, 2016), Virtual reality simulation.
[275] *Horizon of History (*Immersion, 2016), Virtual reality simulation.
[276] Carrie Heeter, "A Meditation on Meditation and Embodied Presence," *Presence: Teleoperators & Virtual Environments* 25, no.2 (November 2016): 175-183, DOI: 10.1162/PRES_a_00256.

philosopher Karen Barad. Barad defines intra-actions as being causal relationships between (social, cultural, technical) apparatuses of physical production and phenomena. To Barad, objects—with their individual boundaries and properties—are not primary ontological units. Rather, in agential realism the primary units of being are phenomena.[277] In simplified terms, intra-action recognizes interdependent webs of ever-changing (dynamic) relational events, or entanglements. This fluid model dismantles the typical interaction design framework which assumes that independent entities (subjects) act upon other independent entities (objects). Designing intra-actively thereby flattens subject-object hierarchies, including human-animal, human-element, and/or human-tool hierarchies. To Barad, apparati–including tools–are part of producing phenomena; rather than being separate and distinct from the people that use them, apparati are part of open-ended practices that constitute matter and meaning.[278] "Cult and Copper" VR game, then, grants agential roles to both human and non-human actors. This posthumanist design strategy explores: What non-human aspects of an archaeological story can have agency? How does their agency entangle with human agency? How do both the apparatus of the game interface, and the tools within the VR world, dynamically configure and reconfigure the world inside and outside the game? How does entangled intra-action enhance a sense of immersion?

Of course, Barad's concept of entangled agencies dovetails well with existing archaeological thought processes; Archaeology has long examined the relational aspects among people, technologies, social spaces, and even landscapes. Kevin

[277] Karen Michelle Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham N.C.: Duke University Press, 2007), 139.
[278] Ibid., 19-27, 140-146.

Fisher, for example, an archaeologist specializing in the Bronze Age, looks at the ancient past through the lens of what he calls "interanimations." He defines interanimations as the recursive relationships between people, place, and, one could certainly add, artifacts.[279] Applying Barad's concepts of intra-action to design for cyber-archaeology projects in particular, then, seems especially useful because this approach can help to illustrate such relational archaeological thought processes. Experimental media can perhaps convey such concepts more effectively than the linear medium of linear text.

Preparatory Content Research on the Topic: Cult and Copper

The relationship between cult and copper in the Bronze Age Levant, particularly as related to copper goddesses in the copper producing regions of Syro-Palestine and Cyprus, is the focus of chapter two. Here, then, I summarize that research process. Archaeological research for this project served to provide me with some understanding of the Bronze Age Levant as a worldbuilder. Being that I am not a field archaeologist, I stepped into these ancient worlds via mining archaeological texts, engaging in field investigations at archaeological sites, researching museum artifacts, and meeting with museum curators. These resources informed my speculative imagination as a designer. In the context of cyber-archaeology, necessary speculation is not pure fiction, though there can be a fiction within speculation. The fictive elements that fill in gaps where empirical knowledge is lacking can serve as useful tools for modeling, simulating, and thinking through

[279] Kevin D. Fisher, "Investigating Monumental Social Space in Late Bronze Age Cyprus, an Integrative Approach," in *Spatial Analysis and Social Spaces: Interdisciplinary Approaches to the Interpretation of Prehistoric and Historic Built Environments*, ed. Eleftheria Paliou, Undine Lieberwirth, and Silvia Polla (Berlin/Boston: De Gruyter, 2014), 30.

possibilities. This is true in seeking to understand ancient material culture and intangible heritage alike. However, in decoding intangible heritage, such as rituals and techno-craft practices, informed speculation becomes especially necessary because these practices were ephemeral and often undocumented. Ideally, cyber-archaeology designers distinguish speculative elements from what is historically verifiable through supporting text, paradata, or design cues.

Questioning the possible reasons for Archaeology texts' presumed relationship between shamanism and smelting evolved from seeking to understand why Hathor and Astarte, as goddesses of love/sexuality, were associated with copper and copper production. These two goddesses entangled in the ancient Canaanite lands of Syro-Palestine and then made their way to the copper producing island of Cyprus via the Phoenicians of northern Canaan. I first researched at Timna in modern Israel, where copper miners utilized–seemingly recycled–a sanctuary that they devoted to Hathor.[280] I continued tracing threads through archaeology sites in Cyprus where connections between copper and goddess cults were evident. I particularly focused on Kition (where Astarte temples were built next to copper production workshops) and Palaepaphos (a site that stood as a goddess cult center for 5000 years). Additionally I sought and was informed by artifacts and other resources from museums in Israel, including the Israel Museum and the Bible Lands Museum, both in Jerusalem. Most of the artifacts found at Timna specifically are now at the Eretz-Israel Museum in Tel Aviv, where an entire building of the museum complex is devoted to ancient copper production. In 2019 the Eretz-Israel Museum

[280] See: Uzi Avner, "Egyptian Timna Reconsidered," in *Unearthing the Wilderness: Studies on the History and Archaeology of the Negev and Edom in the Iron Age*, ed. Juan Manuel Tebes (Leuven: Peeters, 2014), 122-124. Avner's analysis of the Hathor sanctuary, and his critiques of earlier theories about the sanctuary, are detailed in chapter two.

also exhibited a show about cult and copper in the Negev during the Chalcolithic era, which is the Stone-Copper Age preceding the Bronze Age. Thus I made three research excursions to this museum. In Cyprus, I scoured the Cyprus Archaeology Museum and the Leventis Museum in the capital city of Nicosia. Major archeology sites in Cyprus also each have associated small museums, so I hunted for museum artifacts at Kition, Palaepaphos, and Limassol, a town near the archaeology site of Amathus. (Amathus is a cult and copper site that yielded more Iron Age artifacts than Bronze Age treasures, but it was still a useful site for understanding how mythologies and practices carried through Cypriot eras.) In England, I researched at the British Museum. This museum is known worldwide for its extensive Egyptian collection, and hence this collection revealed clues about the spread of Hathor worship into deeper East Africa.[281] Perhaps less generally known, the British Museum also maintains a permanent exhibit about copper goddesses in Cyprus. The Kelso Museum of Near Eastern Archaeology in Pittsburgh, Pennsylvania proved to be very useful, as did the Egyptian and Rosicrucian Museum in San Jose, California.

This three year research process resulted in finding plausible answers to my original historical questions about why Hathor and Astarte, as love/sexuality goddesses, were also goddesses associated with copper. Earlier I argued that, first, mythology associates both goddesses with the fecundity of the earth, and that copper ore was counted as part of that bounty. Second, ethnographic evidence from Africa, and mythologies from other parts of the Near East, the Mediterranean, and

[281] The British Museum does not have online digitized images of the Temple of Hathor, Faras, parts of which they moved from Sudan into their public gallery space. However, they do provide one digitized artifact from that temple: https://www.britishmuseum.org/collection/object/Y_EA51263

elsewhere demonstrate that metallurgy was often conceptualized as a sexual union that resulted in the smelting furnace giving birth to metal.[282] According to religion historian Mircea Eliade, smelting represented a sacred sexual union, or sacred marriage, that took place in the furnace.[283]

I ultimately set the "Cult and Copper" Virtual Reality game in Timna, where my research revealed that Egyptians used local Canaanite technologies to produce copper.[284] So for the purposes of this chapter, decoding the relationship between cult and copper in that region is most pertinent. Uzi Avner explains that Levantine copper production, particularly smelting, must be contextualized in terms of magic, alchemy, and shamanism; metallurgists possessed the mysterious knowledge of how to create metal from rock.[285] Prior to Hathor's worship as a copper goddess at Timna, the Chalcolithic Ghassulian people, who lived in the Negev desert and the Jordan Valley, produced ceremonial copper tools. Archaeologists interpret that these highly aesthetic artifacts show a link between copper production and cultic

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[282] I provide detailed analysis with numerous citation in chapter 2, but just some of my sources supporting this summary of research presented therein are: Jacqueline Karageorghis, *Kypri: The Aphrodite of Cyprus: Ancient Sources and Archaeological Evidence* (Nicosia: A.G. Leventis Foundation, 2005), 119; Rachel Shalomi-Hen, "The Goddess Hathor" in *Pharaoh in Canaan, The Untold Story,* ed. Daphna Ben-Tor (Jerusalem: The Israel Museum, 2016), 149-153; Jack Lindsay, *The Origins of Alchemy in Graeco-Roman Egypt* (New York: Barnes and Noble, Inc., 1970), 290-291; Sandra Blakely, *Myth, Ritual, and Metallurgy in Ancient Greece and Recent Africa* (Cambridge: Cambridge University Press, 2006), 2-123; Carlyn Saltman, Eugenia W. Herbert, and Candice Gaucher, *The Blooms of Banjeli: Technology and Gender in African Ironmaking* (Watertown, MA: Documentary Educational Resources (DER), 1986), Documentary Film.

[283] Mircea Eliade, *The Forge and the Crucible*, 2nd ed. (Chicago: University of Chicago Press, 1978), 60, also see 212-213.

[284] See broadly, Uzi Avner, "Egyptian Timna Reconsidered," and Erez Ben-Yosef, B Liss, OA Yagel, O Tirosh, M Najjar, and TE Levy, "Ancient Technology and Punctuated Change: Detecting the Emergence of the Edomite Kingdom in the Southern Levant," *Plos One* 14, no. 9 (2019), https://doi-org.oca.ucsc.edu/10.1371/journal.pone.0221967. This rich topic, also, is investigated deeply in chapter 2.

[285] Uzi Avner, "Egyptian Timna Reconsidered," in *Unearthing the Wilderness: Studies on the History and Archaeology of the Negev and Edom in the Iron Age*, ed. Juan Manuel Tebes (Leuven: Peeters, 2014), 144.

practices because of the contexts in which the artifacts were found and because these objects lack any indication (wear patterns) of functional use.[286] The symbols that occur in Ghassulian ceremonial artifacts–snakes, birds, and ibexes–also occur in rock art, which seems to map constellations, through the Negev.[287]

Research regarding the apparent contributions of both local tribes and Egyptians in Timna, Near Eastern goddess mythologies, and cultural perspectives on mystical beliefs about smelting informed the worldbuilding, visual design, interface design, intra-action design, and character narration (by humans and non-humans) of the "Cult and Copper" Virtual Reality game. The game design documents include characters in both Semitic and Egyptian dress and adornment working together. Iconographic and artifact allusions to Hathor and Astarte pervade. Since VR allows for a 360-degree experience, intra-active animistic characters (snakes, ibexes, and Astarte) emerge from the Negev starlore skyscape to assist the player who performs as a novice smelter. When the copper is born, the player is rewarded with Hathor-inspired birthing festivities.

Establishing an Understanding of Cyber-Archaeology Trends and Debates

In designing for cyber-archaeology, it is imperative to consider trends and debates within current discourse. A list of scholars influencing this "Cult and Copper" project including Eva Pietroni, Tara Jane Copplestone, Christopher Johanson, Diane

[286] Milena Gošić and Isaac Gilead, "Unveiling Hidden Rituals: Ghassulian Metallurgy of the Southern Levant in Light of the Ethnographical Record," *Bar International Series* 2753 (2015): 25-29.
[287] George F. Steiner, "The Goddess and the Copper Snake: Metallurgy, Star-lore and Ritual in the Rock Art of the Southern Levant," *Expression Quarterly Journal of Atelier Editions in Cooperation with UISSP-CISNEP (International Scientific Commission on the Intellectual and Spiritual Expressions of Non-Literate Peoples)*, no. 12 (June, 2016): 73-95.

Favro, Alice Watterson, Mauritzio Forte, Jeffrey Stuart, critical games scholar Erik Champion, and sensory Archaeology proponent Jo Day. All offer considerations about how to effectively employ the affordances of multimedia to create multi-sensory digital archaeology experiences that move beyond mere documentation to instead create meaning and aid in new knowledge production. They seek to make the past seem more tangible, relevant, and "alive" to new audiences as well as to scholars. Many insist on the value of process in creating cyber-archaeology models, games, and simulations. They take stands on how to balance subjectivity and objectivity, i.e. empirical data with speculation and imagination. They question what methodologies can clarify to an audience what is known fact versus what is speculative interpretation. Such indications become especially challenging when attempting to represent intangible heritage as "Cult and Copper" does.

For example, Eva Pietroni (2016) laments that storytelling for virtual heritage is still weak compared to that of cinema and video games.[288] Pietroni thinks that virtual museum storytelling should strive for emotional and cognitive impacts, embodied experiences, innovative interaction design, and smoother media integration.[289] Pietroni is concerned that most virtual heritage environments are still not places for generating knowledge, and she points out that a phenomenological approach that heightens sensing and intuitive experience is still missing.[290] She thus recommends that designers think about the affordances of virtual technologies in relation to perception and usability by integrating visualization, multi-layered models, metadata,

[288] Eva Pietroni, "From Remote to Embodied Sensing: New Perspectives for Virtual Museums and Archaeological Landscape Communication." in *Digital Methods and Remote Sensing in Archaeology: Archaeology in the Age of Sensing*, ed. Maurizio Forte and Stefano Campana (Cham: Springer International Publishing, 2016), 438-439.
[289] Ibid., 437-439.
[290] Ibid., 438-439.

story, and tools of interpretation (such in-world performative spaces). She recommends that digital heritage embrace non-linear narrative techniques, natural interaction interfaces, cinematography and theater techniques, augmented reality potentials, and soundscapes.[291] "Cult and Copper" heeds many of Pietroni's recommendations.

Copplestone argues that the *process* of creating historical games can "disrupt normative practices," and encourage new ways of thinking that do not fit the traditional academic models.[292] Favro also argues for the value in the process of creating these projects because they expand methods of investigation and they allow for simulated experiments within virtual environments.[293] Watterson aligns with Copplestone and Johanson in arguing that the artistic/design process can change how archaeologists approach problems. Like Pietroni, Watterson cautions that early virtual archaeology projects were mostly about "techno-fetishism," not analytical advancement.[294] As one suggested remedy, Watterson strongly advocates for engaging artists in archaeological interpretation because to her, archaeological visualization should be a convergence of evidence, interpretation, scientific data collection, and storytelling.[295] Copplestone and Waterson legitimize the

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[291] Pietroni, 442-443.
[292] Tara Jane Copplestone, ""Designing and Developing a Playful Past in Video Games," in *The Interactive Past: Archaeology, Heritage & Video Games*, ed. Angus A. A. Mol, Csilla E. Ariese-Vandemeulebroucke, Krijn H. J. Boom, and Politopoulos, Aris (Leiden: Sidestone Press, 2017), 95.
[293] Diane Favro, "Se Non è Vero, è Ben Trovato (If Not True, It Is Well Conceived): Digital Immersive Reconstructions of Historical Environments," *Journal of the Society of Architectural Historians* 71, no. 3 (2012): 276, https://doi.org/10.1525/jsah.2012.71.3.273.
[294] Alice Watterson, "Beyond Digital Dwelling: Re-Thinking Interpretive Visualisation in Archaeology," *Open Archaeology* 1, no. 1 (n.d.): 119, https://doaj.org/article/184fd6853fcf45e8917f96b705280730.
[295] Ibid., 127.

complementary role of artists, designers, and storytellers within cyber-archaeology discourse.

Erik Champion is interested in how to use digital media to convey history to an audience beyond "academic specialists," such as museum [or heritage site] visitors. Champion, who researches historical games, questions how to make history seem more relevant to the public's lives. Museums, he says, make the process of historians opaque and tend to instill a "master narrative" with little room for visitor interpretation.[296] To allow for such interpretation, Champion recommends that designers consider the relationship between historical simulation and interactivity in regard to: ritual knowledge, webs of cause and effect, and "what if" scenarios.[297]

Forte strives for embodied, haptic/kinetic simulations, not just remote visual ones. He maintains that intersubjectivity, emotions, and sensations are vital to the hermeneutics of interpretation, part of how knowledge is acquired. Forte, too, cautions against "techno-festishism," which he defines as valuing the resolution of a computer rendering over determining how to achieve the strongest benefits of human-computer interaction.[298] Aligned with the idea of embodiment, Stuart, perhaps more than any of the aforementioned scholars, really stresses the importance of considering feeling in cyber-archaeology: "If we do not consider how digital representations actually feel to access, to use and re-use, and significantly how they feel to make one connected to the past emotionally as well as intellectually (i.e. their artistic auratic), then digital visualizations will continue to exist as as

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[296] Erik Champion, *Critical Gaming: Interactive History and Virtual Heritage* (Surrey, England: Ashgate Publishing Limited, 2015), 75-76.
[297] Champion, 87.
[298] Mauritzio Forte, "Cyber Archaeology: 3D Sensing and Digital Embodiment," in *Digital Methods and Remote Sensing in Archaeology: Archaeology in the Age of Sensing*, ed. Maurizio Forte and Stefano Campana (Cham: Springer International Publishing, 2016), 283.

remote, disconnected, and sanitized entities…" In accord with Champion, he argues that researchers would miss the opportunity to reach an audience beyond academic specialists.[299] Being that "Cult and Copper" is intended for a museum audience, it might reach, but is not limited to, academic specialists.

For any of their intended audiences, these cyber-archaeologists recognize that digital technologies afford more than just visuality; yet Western culture tends to privilege visuality, especially as an epistemological tool. Some cyber-archaeologists have set out to challenge that. Day provokes archaeologists/designers to consider *all* of the sensory aspects of the past, including those of rituals, play, labor and craft processes (intangible heritage). In relation to "Cult and Copper," for example, one could ask what did an ancient smelter reaching into a hot furnace possibly hear, smell, and taste? When an ancient copper miner traversed the Negev desert, what did the geology sound like under his feet? How did the atmosphere and lighting shape perception? What animals did workers hear? Day prompts thinking phenomenologically about what other people might have experienced, and where our own cultural biases come in. In using our imaginations to ask questions about the past, Day poses, "What can archaeologists accomplish by using fiction, and what is given up in the process?"[300] "Cult and Copper" asks players to co-create a fiction, but one based on a degree of plausibility, for the sake of expanding inquiry about ancient techno-practices.

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[299] Jeffrey Stuart, *"Challenging Heritage Visualisation: Beauty, Aura and Democratisation," Open Archaeology 1, no. 1 (n.d.):* 144–145, 151, https://doaj.org/article/b6a0e825a9a744a79ed72c7d64d2abb5.

[300] Jo Day, "Introduction," in *Making Senses of the Past: Toward a Sensory Archaeology*, ed. Jo Day (Carbondale: Center for Archaeological Investigations, Southern Illinois University Carbondale and Southern Illinois University Press, 2013), 21.

Questions about how to balance representations of historical "truth," versus how to engage with a process of interpretation, are critically debated within cyber-archaeology scholarship. Processual Archaeology, for example, posited that history could reach completely "objective" conclusions via the scientific method. Post-processual archaeology then offered a rebuttal to that notion. Theoretically grounded in structuralism, phenomenology, and Neo-Marxism (because of the relationship of material culture to labor), post-processualism recognizes multiple points of view and multiple points of entry as gateways to examining the past. Therefore, post-processual methods can allow for subjective interpretation.[301] Processualist and post-processualist approaches can of course represent a spectrum rather than a binary. For example, at a surface level, most of the cyber-archaeology/digital heritage scholars cited above echo the ideals of post-processualism by emphasizing process, embracing storytelling, and valuing an embodied, multisensory, interpretive, understanding of history. However, the classical (binary) computers that drive these efforts are rooted in empirical thinking. Processualism values using empirical data to "prove" (or disprove) historical "truths." Thus cyber-archaeology can contain elements that are typically associated with processualism.

Johanson–who explores the interrelationships among mapping, modeling, representation, and digital reconstruction in the discipline of Archaeology–critiques that early Virtual Reality efforts in Archaeology that strove for large and "accurate" data models were merely aggregating knowledge in an encyclopedic manner. He is skeptical about what "factual" or "scientifically accurate" even means in the context of

[301] Rupert Till, "Sound Archaeology: An Interdisciplinary Perspective," in *Archaeoacoustics: The Archaeology of Sound, Publication Proceedings from the 2014 Conference of Malta,* ed. Linda C. Eneix (Myakka City, Florida: The OTS Foundation, 2014), 23-32.

digital representations: is it "accurate" to depict a moment after the ribbon cutting ceremony for a temple, the moment the pigeon droppings have hardened on that temple's roof, or a moment after a later ruler amends features of the temple? Johanson instead advocates for using historical models similarly to the way that models are used in science: to build abstractions, to test hypotheses, to explore inquiries and play with data abstractions. "Modeling is the creation of a useful fiction," he says.[302]

While Johanson, Favro, and Waterson all celebrate process, Watterson steps further out onto an artist-friendly limb by celebrating a significant role for imagination and creativity in virtual archeology. She argues that melding the apparent contradiction between subjectivity and objectivity can be a strength because creativity destabilizes established methods; art fosters "messy thinking." Thus Watterson says the field needs more artists:

> ...the advantage of integrating artistic process into archaeology is not necessarily in an ability to collapse or reinvent conventional processes; instead, its power lies in the negotiation of a complimentary partnership between subjective and objective methods and perspectives, facilitating a practice-based methodology of thinking through doing.[303]

However, in order for this approach to communicate or foster knowledge, audiences need to understand nuances of interpretation, storytelling, and display. How does the public know where subjective, creative, editorial processes come into play even with a photograph? It thus falls on designers, with archaeologists, to ascertain how to demonstrate that computer visualizations are speculative interpretations because

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[302] Christopher Johanson, "Visualizing History: Modeling in the Eternal City," *Visual Resources* 25, no. 4 (2009): 403–408.
[303] Alice Watterson, "Beyond Digital Dwelling: Re-Thinking Interpretive Visualisation in Archaeology." *Open Archaeology 1, no. 1 (n.d.): 125,* https://doaj.org/article/184fd6853fcf45e8917f96b705280730.

people's tendency is to cling to them as representations of "truth." Her proposed solution is for archaeologists to use paradata to document the ambiguous and interpretive intellectual processes that go into digital projects, including mistakes made along the way. This practice of transparency might help to elucidate how digital archaeology creates new knowledge.[304]

Ideally in "Cult and Copper," I would have liked to have experimented with and playtested the feasibility of incorporating in-world paradata as part of game design (whereby clicking or hovering over an object reveals information about how speculative choices were made). In-world paradata has the advantage of being more readily accessible, but it could compromise the sense of immersion if players read it as an interruption. However, given the limitations of my engineering collaborators in building the playable prototype for the game, for this stage of development I created a sample paradata document that can be utilized if I acquire funding for next-stage prototypes. (See Appendix 4.) At minimum, if the game becomes publicly accessible, the paradata text and images could easily be imported into a webpage. Game instructions can provide the URL to the document.

Considering Theories of Immersion and Presence from the Arts to Apply to Cyber-Archaeology

In cyber-archaeology, a sense of immersion and presence can help to establish a sense of "being there." Champion argues that virtual archaeology can enhance that sense by employing kinetics, by repositioning the agency of spaces and objects, and by creating a sense of atmosphere and place that distinguish one site from

[304] Watterson, 119–123.

another.[305] However, designers can go a step further to create a sense of cultural presence–the feeling of being *there and then*–by establishing a sense of how and why people valued things, and by conveying the interrelationship among rituals, artifacts, landscapes.[306]

Champion is describing the art of worldbuilding, and the arts–including literature, games, theater, and architecture–offer volumes of research on how to approach worldbuilding to establish a sense of immersion. Virtual Reality storyteller John Bucher, for example, asserts that environmental storytelling–building a story from its narrative space–is key.[307] Henri Jenkins urges game designers to consider a sense of place, and to think of design as narrative architecture.[308] Mark J.P. Wolf outlines methods to create a cognitive sense of place. He defines infrastructures and frameworks by which authors and audiences can conceptually organize immersive worlds into consistent wholes. He suggests narrative, maps (space), timelines (temporal anchors), nature, culture—including language, mythology, and philosophies—and genealogies of characters (social maps).[309] Utilizing the distinct natural features of Timna automatically creates a ready-made narrative space for "Cult and Copper." Timna lends itself well to immersive VR representation because the landscape itself is already immersive. Hills and rock formations surround the

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[305] Erik Champion, *Critical Gaming: Interactive History and Virtual Heritage* (Surrey, England: Ashgate Publishing Limited, 2015), 98-99.
[306] Champion, 101-103.
[307] John K. Bucher, *Storytelling for Virtual Reality: Methods and Principles for Crafting Immersive Narratives* (New York and London: Routledge, Taylor & Francis Group, 2018), 26-40.
[308] Henry Jenkins,"Game Design as Narrative Architecture," in *First Person: New Media as Story, Performance, and Game,* ed. Noah Wardrip-Fruin and Pat Harrigan (Cambridge: MIT Press, 2004), 129.
[309] Mark J. P. Wolf, *Building Imaginary Worlds: The Theory and History of Subcreation* (New York: Routledge, 2013), 154-155.

visitor in every direction, the wind hewn geology itself is part of the story, and the visibility of the vast sky is unimpeded. The warm tones of the 360-degree landscape create a palette that evokes the heat of smelting. Whereas Cypriot sites of Bronze Age copper production, such as Kition, are surrounded by active contemporary towns creating disjointed layered temporalities, Timna is a vast national park with few visual or sonic distractions from other, competing "worlds." Timna offers a game stage to be documented rather than invented. Then weaving in Bronze Age Levantine artifacts, clothing and jewelry styles, mythologies, rituals, and craft processes creates a sense of cultural immersion and cognitive sense of place as Wolf advises.

Janet Murray and Marie-Laure Ryan are two other names that are familiar to Media/Games Studies and Literature scholars in relation to theories of immersion, but they might be less familiar names among archaeologists. Ryan introduces the term *metalepsis*, which describes the mental phenomenon one has as one feels the sense of becoming a character in the story one reads, watches, or enters.[310] As a VR game, "Cult and Copper" allows a player to achieve this state from the start by entering the game as an in-world smelter. Ryan also categorizes types of immersion, noting that spatial immersion is a response to setting, temporal immersion is a response to story, and emotional immersion is a response to characters.[311] Ryan also sees ritual and its techniques—gesture, performative speech, and/or manipulation of symbolic objects—as means of establishing

[310] Marie-Laure Ryan, *Narrative as Virtual Reality 2: Revisiting Immersion and Interactivity in Literature and Electronic Media* (Baltimore: Johns Hopkins University Press, 2015), 37.
[311] Ibid., 85-86.

immersion.[312] "Cult and Copper" successfully creates spatial and temporal immersion using Wolf's recommendations. The old man smelter shaman, as techno-craft instructor and spiritual guide in the game, could potentially create a sense of emotional immersion. The game certainly creates a ritualistic aura through visuality, sound, and importantly, its meditative pace.

Murrray, being attuned to the physical and sensual–similarly to cyber-archaeologists such as Forte–notes that haptic devices (those that allow touch, feeling, bodily engagement) heighten a sense of immersion.[313] Murray cautions that immersion requires consistency and a regulation of the boundary between imaginary and real in order for that sense of immersion to be maintained.[314] How is a participant cued as to when they are entering and exiting the fantasy space, which some in the gaming world call "the magic circle"? Here, archaeologists could well advise the media and literary theorists based on various approaches ancient cultures used to navigate crossing such boundaries. The design document for "Cult and Copper" cues players with a museum installation setting that is evocative of Timna. To demarcate a "magic circle" space, the installation design includes a "sandbox" (or sand and cooled slag box) inspired by the Phoenician exhibit[315] at University of Haifa's Hecht Museum[316] and wall art suggesting the Timna landscape.

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[312] Ibid., 214-215.
[313] Janet H. Murray, *Hamlet on the Holodeck: The Future of Narrative in Cyberspace* [Updated edition] (Cambridge: The MIT Press, 2017), 155-156.
[314] Ibid., 139.
[315] https://www.youtube.com/watch?v=VuJaFQYqlTw&t=1s
[316] https://mushecht.haifa.ac.il/index.php?lang=en

Heeter's advocacy for the use of interoception in games, as described in the design goals, of course adds a dimension to discourse about immersion.[317] Her methods of facilitating embodied presence in virtual experiences are informed by her meditation practices. "Cult and Copper" strives towards Heeter's recommendations by using breath to affect a smelting fire. It also does so by choosing to employ the introverted, meditative qualities of single-player VR over the social affordances of AR.

Thus in regard to strategizing immersion, cyber-archaeologists need not reinvent the wheel, so to speak. By including a variety approaches to immersion borrowed from Literature and Media/Games Studies as described here, but also from Architecture, Theatre Design, Sound Studies, cyber-archaeology designers can more effectively induce a sense of "being in" another place in time. Likewise, the unique expertises of archaeologists can surely inform immersion strategies from the arts/media because archaeologists are especially well skilled at inferring site-level stories, considering the roles of artifacts in stories, and using maps and timelines to better understand time periods.

Interaction Design as an Underrecognized Component of Immersion: Archaeology, HCI Design Theory, and Intra-Action

Since creating better harmonization between immersion and interaction in historical VR pieces was a design goal of this project, human-computer interaction (HCI) research also became important. The aforementioned term intra-action, which Barad defines as mutually entangled/relational agencies, is used by two

[317] Carrie Heeter, "A Meditation on Meditation and Embodied Presence," *Presence: Teleoperators & Virtual Environments* 25, no.2 (November 2016): 175-183, DOI: 10.1162/PRES_a_00256.

contemporary HCI designers, Lucy Suchman and Josh McVeigh-Schultz. Thus Suchman and McVeigh-Schultz offered inspiration to this project.

Suchman approaches HCI–and intra-actions among humans and technologies more broadly–from anthropological and feminist perspectives. Just as Barad points out that there is no full division between a tool of observation (apparatus) and that which one is studying, Suchman is interested in breaking down subject-object binaries and encourages the reader to think of technologies as artifacts and active co-agents.[318] Suchman is an advocate of situated action, meaning that human machine interaction should be an embodied, responsive process.[319]

McVeigh-Schultz engages in what he calls "tangible imaginaries and fictive practices." McVeigh-Schultz explains:

> Tangible imaginaries can include prototypes from a range of techniques including: speculative design, discursive design, imaginary media, critical making, world-building, situation design, and–of course my own topic of–speculative ritual design. In each case, the prototype includes a tangible element, something you can hold, experience, or understand as having qualities of an artifact or experience. And in each case there is a mediation between a structure (whether social rule set or system of technical affordances), on the one hand, and a vision of some kind of inhabited world or context of experience on the other.[320]

McVeigh-Schultz also posits that animism as a design metaphor can open up practices of myth-making about, and through, objects.[321] "Cult and Copper," which is

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[318] For notes on Barad's influential philosophies of the apparatus in regard to agential realism, see: Karen Michelle Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham N.C.: Duke University Press, 2007), 19-27, 140-146.

[319] Lucy A. Suchman, *Human-Machine Reconfigurations: Plans and Situated Actions* (Cambridge: Cambridge University Press, 2007), 67.

[320] Joshua McVeigh-Schultz, "Designing Speculative Rituals: Tangible Imaginaries and Fictive Practices from the (Inter)Personal to the Political," (PhD diss., University of Southern California, 2016), 21-22, http://joshuamcveighschultz.com/wp-content/uploads/2013/08/Designing-Speculative-Rituals-8-7-16.pdf.

what McVeigh-Schultz would consider to be a speculative ritual design prototype, explores entangled agencies of the human and copper. It looks at the flames of the smelting fire as agents and media because the color of the flames communicate the state of the ore to a smelter as the ore transforms from solid to liquid. The flames then serve as one animistic design element, but so, too, do snakes from the flames and a transmediating ibex into which the old man smelter-shaman (narrator) can shape-shift. These animistic qualities of the game serve to break subject-object binaries which Suchman describes as a femininist intra-action design goal.

Brenda Laurel, an early VR pioneer, also provided foundational design approaches. Laurel, a human-computer interaction designer with a drama background, is famous for promoting interactivity design based on theatrical strategies: designers, like playwrights, she says, should keep *action* as their guiding principle to create exciting, embodied experiences.[322] Laurel says that the amount of interactive options a user has does not matter so much as the *feeling* that the user has agency to act within a representation.[323] This lack of agency was part of what was breaking my sense of immersion in the historical VR pieces I played. In "Cult and Copper," the player has minimal interactive options, but a high degree of agency in controlling the smelt through their breathing and endurance. These choices I modeled after Laurel.

Collaborative Design Ideation via "Bronze Age Productions"

The archaeological research phase of the project–spanning from Timna to Cyprus–revealed that the Levantine Bronze Age was a complex network of

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[321] Ibid., 108-110.
[322] Brenda Laurel, *Computers as Theatre* (Reading, Mass.: Addison-Wesley Publishing Company, 1993), 63.
[323] Ibid., 21.

intersecting worlds, so I had to narrow my focus to determine what "slice" of this spatial and temporal map could function best as the setting of a game. What elements of that world would intra-act and how? Thus, in the midst of a global pandemic that barred researchers from fieldwork and in-person collaborations, I became the director and producer of "Bronze Age Productions" (BAP) to experiment with possibilities. BAP was a Zoom-based, international improvisational theater troupe comprised of archaeologists, digital heritage enthusiasts, game designers, and performers.[324] This series of improvisation theater games served as a means of collaborative design ideation; performance served as a method to collectively think through some of the many possibilities for intra-actions among human and non-human characters within a Bronze Age copper context, and to narrow a specific setting for the game.

We held three improv jams between August 2020 and January 2021. Each was based on the classic participatory improvisational theater game Freeze Tag. In this game, the audience (in our case, other players) suggests characters and a situation for two players to improvise. Then at any time that an additional player feels inspired to do so–which usually happens when the action between the two original characters starts to lag–he or she can shout, "Freeze" to stop the scene, replace one of the existing performers, assume a new character, and invent a new scene. In our BAP

[324] In our original improv group, ages ranged from young adult to 70-something. Our respective cultures represented a wide swath of Europe (England, Italy, Greece, Switzerland), the United States, and at least one person of Levantine ancestry. Voices from Latin America, East Asia, and especially Africa because of the region's rich ritual traditions of iron smelting, surely would have added valuable perspectives. With Only one male player, females predominated. All players had college degrees, and most had or were pursuing a PhD. The perspective of someone working in the trades would have been valuable, but at least one archaeologist's specialty was experimental smelting so he had hands-on knowledge of processes and materials that we were enacting (such as copper in the form of ore, molten liquid, and metal).

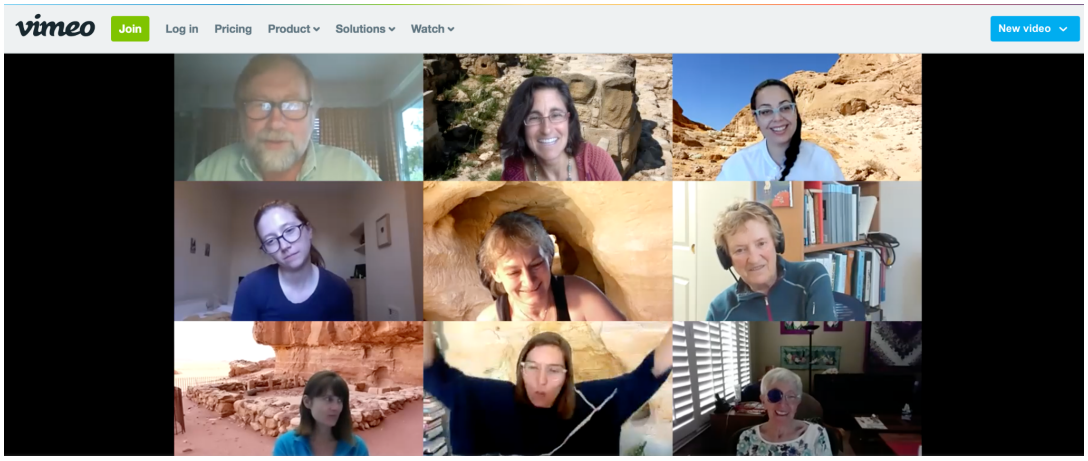
version of Freeze, however, the character set and situations were limited to the Bronze Age copper production sites at which I was researching. In accordance with design goals, I directed actors to consider both human and non-human agents as potential characters.[325]

Bronze Age Productions performers improvised scenes in copper mines, at Hathor's Timna sanctuary, at Astarte's Kition temple, et cetera. Some characters enacted in the first two jams included Hathor, Astarte, a priestess, a sacred barber of Astarte, a Timna mountain, the wind, copper ore melting in a smelting furnace, birds, snakes, the Earth herself, copper miners, musicians, and sacred artifacts. Informed by the first two jams, for the third I narrowed choices for scenes and characters to those specific to the process of copper smelting. Additional intra-active characters became mining tools, the smelting furnace, an ingot as a fetus being born of a furnace, the air and fire that are part of the smelting process, and a child miner speaking on behalf of a (fictional) children's "mining union." Fasnacht assumed the role of a narrator, in the form of speaking copper ore, to teach the actors about the smelting process so that they could enact it. He narrated that blow pipes were used before bellows to heat the fire, that the smelters read the colors of the flames, and that the flames turned green when the ore reached a liquid state. He educated about the risks that oxygen deprivation from the consuming flames posed to

[325] To prepare Bronze Age Productions participants, I provided players with curated folders of research photos I had taken at museums and at archaeological sites. These photos included artifacts, ruins of temples, sanctuaries, and copper workshops, tourist information placards with texts, images and timelines. I created a folder of "fake Zoom backgrounds" to use as "set design," and I demonstrated how to create a fake background effect as one of the theatrical affordances of Zoom. I also provided participants with drafts of my written research if they requested more information about Hathor, Astarte, Timna, or other elements they would be enacting. (Generally the participants who were not archaeologists requested such information to garner more background knowledge.)

smelters, and how noxious fumes became a threat if a furnace cools too quickly and cracks near the bottom.[326]

Figures 37 and 38: Screenshots from two Bronze Age Productions improvisational theater jams on Zoom. Jams informed scholarship and design, sometimes through humor and sometimes through serious tones.



Cyber-archaeologists cited including Watterson, Copplestone and Johanson defend the importance of the design process as a means of generating new knowledge, perhaps sometimes more than the finished product does. Improvisational

[326] Walter Fasnacht, Bronze Age Productions improvisational theater jam via Zoom, April 16, 2021.

theater via BAP functioned best as an epistemological engine when we hit up against ignorance in acting out a scene. For example, in our second improv, a character made a reference to starting a job at Astarte's temple in "two weeks." Then she paused in thought for a moment: "How is time measured in this culture?" The group agreed that was an important question. Luckily, an archaeologist on our team had insight. Without this creative process, though, we probably never would have considered such aspects of intangible heritage. More importantly, in realizing one cultural presupposition–how time is marked–we became critically aware of the need to question what else we project from our own cultural experience.

The knowledge imparted and the ideas collaboratively generated by BAP jams established the clarity I needed to conceptualize more specifically the sort of intra-active project I wanted to design, one about the shamanic aspects of copper smelting vis-a-vis breath. These performance games also clarified that Timna should provide the setting for the Virtual Reality game. Having performers who were not archaeologists showed that Bronze Age Cyprus, with its hybridized styles, is difficult for nonspecialists to parse as a "world." Timna makes for more consistent worldbuilding in that the landscape and stylistics are easier to identify and perform with.

As a design research method, improvisational theater relates well to Barad's thinking. She explains how intra-actions are about phenomena and performativity instead of "thing-ness." Via performative interrelationships, observer and observed are inseparable, subject-object dichotomies are dissolved as per posthumanist

philosophies.[327] Barad also explains that quantum systems do not adhere to strict determinism, nor to wide-open free will, but rather they allow for a large set of possibilities.[328] Using improvisational theater as a design ideation method thereby broke with the strict determinism of a pre-programmed choice set that is represented by a conventional algorithmic information design map. The fluid, real-time process of improvisation instead functioned like an emergent system, i.e. one that dynamically learns and adapts. This is important to highlight for the future of cyber-archaeology because emergent systems driven by Artificial Intelligence (AI) will define the next generation of storytelling in virtual worlds.

Establishing How to Use Breath as an Interface

In April 2021, BAP met for a fourth time to playtest how to sustain breathing, collectively, for the duration of time needed to complete a smelt. As preparation I worked with professional breathwork coaches to learn different breathwork techniques. While contemporary people cannot know exactly how ancients breathed, some methods with which I experimented seemed completely implausible for smelting work because over a long session, for me they resulted in headaches, dizziness, muscle cramps, and/or they used a quick, forceful exhale that seemed conducive to extinguishing, rather than sustaining, a fire. Bonnie Coberly of San Francisco Breathwork taught me a comfortable technique that she described as a "two-part pranayama."[329] It entails breathing deeply into the belly, inhaling a bit more into the upper chest, and letting the exhale fall out. For playtesting this method,

[327] Karen Michelle Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham N.C.: Duke University Press, 2007), 32-33, 139.
[328] Ibid., 139.
[329] https://www.sanfranciscobreathwork.com/resources

people used props like wrapping paper tubes to simulate exhaling through a three-foot blowpipe. Doing so guided the exhale much differently than using no prop. Most of the group found the technique to be profoundly relaxing. I experienced the breathwork as creating a space for meditative imaginings, intuitive insights.

One main takeaway from the breathwork playtesting was, there is no one breathing pace that feels comfortable to all, and it is not adequate to choose a median point. Among BAP playtesters–some of whom were runners and singers and some of whom were not physically active–what felt comfortable to one person felt straining to another. This was a vital realization from a design perspective, including for physical safety considerations. Playtesting informed that the breath interface design for "Cult and Copper" would need to offer at least three breath speeds for players, just as a treadmill at the gymnasium necessarily allows speed choice.

A second important result of playtesting the breathwork technique was that people unanimously expressed the need for a rhythm, like drumming, to guide them. Fragments of sistra and menat necklaces–rhythm instruments sacred to Hathor–were found at Timna; these are part of a permanent exhibit at the Eretz-Israel Museum in Tel Aviv. My research did not reveal any evidence of drums at Timna. However, Dendara temple in Egypt, which is a Hathor temple, includes a hallway with reliefs depicting thirty-two priestesses dressed as Hathor playing frame drums. The hall ends in what archaeologists interpret to be a birthing chamber. The architectural decoration seems to suggest that priestesses used rhythm to guide women through labor contractions and through the dangerous journey of birth.[330] Drums could also, then, tie to the idea of smelting being a birthing process. Using

[330] Layne Redmond, *When the Drummers Were Women: a Spiritual History of Rhythm* (New York: Three Rivers Press, 1997), 101-103.

the specific aural aesthetic and mythic connotations of a frame drum, instead of using rhythm instruments that were factually specific to Timna, became a design decision. This is an example of choice that requires a paradata notation, either within the game or via external documentation. Since Hathor was a goddess associated with music and dance as well as with copper, sexuality, and motherhood, this playtest raised questions for further research: might the natural pairing of copper smelting with rhythm be yet another reason that Hathor was associated with copper? What did smelting sessions sound like? And if rhythm musicians attended smelts, did people dance, too?

The Collaborative Process of Creating a Playable Prototype: Successes and Visions Yet to Be Realized

Realizing a built playable prototype of the "Cult and Copper" VR game was the result of a collaboration with graduate students in the Serious Games program at the University of California, Santa Cruz (UCSC). The following sections describe and reflect upon that endeavor. The process involved my assembling a team for that collaboration, authoring design documents to guide their build, and providing feedback on prototype iterations that they built. Then together the builders and I playtested the prototype. A prototype represents a slice of a game that serves as a proof of concept. A prototype does not represent the complete vision of a designer, but it can be used, for example, to apply for grants to keep building towards that vision. A prototype also serves as an experimental "sandbox" to see what elements of the original vision are achievable given time, budget, and the skills of the team, versus what elements might need to be reworked or released. Considering those

factors, this section also suggests what further development of the prototype would ideally include.

Creating a Team within the UCSC Serious Games Program

In 2019, UCSC launched a Serious Games program within the Engineering department. I approached Program Co-Director Magy Seif El-Nasr about forging a collaboration with this new sub-department to realize a playable prototype of my "Cult and Copper" VR game. El-Nasr invited me to present a "pitch" to the graduate students in the program, some of whom were specifically interested in cultural heritage games. In response to my presentation, four Serious Games students decided to build a sample section of my game as the "capstone project" required for completing their Master's of Science degree. We assembled "Team Timna," which included Technical Director and Programmer Amber Sargeant, 3D Modeler Wenbo Xie, 2D and Sound Designer Yichen Yao, Producer Yuanzhu Wu, and me as their "client." Industry mentor Steven Goodale, whose resume includes having been the Creative Director and Lead Systems Designer on the "Tomb Raider" series, oversaw their work.

Authoring Design Documents for the Serious Games Team

To communicate my "Cult and Copper" game vision to the engineering students, I provided a collection of design documents. These included reference materials/assets for worldbuilding, a scope of build document, a sound specification document, and a detailed "player walkthrough." Goodale, the industry mentor for Team Timna, additionally guided me in how to clearly and concisely articulate game

goals, as per industry conventions, so that the engineers knew what game elements were the most important to realize for this prototype. (See appendices 1, 2, and 3.)

Reference materials included 360-degree video, photographic, and audio assets that I gathered from field documentation at Timna. These assets provided a sense of forms, colors, mood, textures, and tones inherent to the distinctive landscape of the national park. The assets also included documentation of the remains of a smelting camp in Timna's "Mushroom Area," i.e. copper workshops with furnaces and slag (a byproduct of the smelting process). From my museum research I included photographs of artifacts to enhance worldbuilding, such as jewelry that characters of that time and place would have worn and ritual items that they would have used. For reference on the process of copper smelting using Bronze Age techniques, I provided video footage of experimental smelting from the Central Timna Valley archaeological team (led by Dr. Erez Ben-Yosef)[331] and documentary film footage of an experimental smelt led by Fasnacht.

The Serious Games students requested a "scope of build" design document (Appendix 2) to serve as a brief reference guide. This short document outlined the fundamental steps of the smelting process, the key objects that would be needed for that process (such as the furnace, blowpipes, ore, charcoal), and what additional objects/characters (human and non-human) were essential to the core game concept. The lists within this document served to provide a broad understanding of the basic elements of the game world to the whole team, but they were especially vital to Xie, the 3D modeler, so he could visualize what needed to be modeled. I also

[331] See: https://www.facebook.com/CentralTimnaValleyProjectCtv/videos/270100387406102

created a similar reference guide to recommend sound assets to implement within the VR environment.

Additionally, the Serious Games students requested a list of clear game goals (Appendix 1) so they knew what functions and affordances of the game were the most important to realize. I separated design goals from gameplay goals and defined both. I specified design goals as: 1) to improve upon immersion strategies relative to other history games; 2) to develop a breath interface that gives players an embodied, experiential sense of blowpipe technology for copper smelting; and 3) to redefine interaction design as intra-action design (i.e. to break subject-object binaries and instead establish "animistic" relationality). I articulated gameplay goals for players as: 1) to ensure a successful copper smelt using simulated blowpipe technologies; 2) to achieve a meditative state; and 3) to generate questions about intangible heritage related to Bronze Age copper smelting.

To communicate my complete vision for "Cult and Copper" to my collaborators, I combined historical knowledge acquired from three years of research with imagination to create a "player walkthrough" (abridged as Appendix 3). This player walkthrough served as a detailed articulation of player personas (to define an audience), what the player sees and experiences upon encountering the game in the museum setting, what the player sees and experiences upon entering the game in Virtual Reality, and what the player does/experiences over the course of the game play. The player walkthrough includes spoken parts for (human and non-human) characters in the game in playwriting style. Characters' speech serves to guide and instruct the player–a novice smelter– through the process of birthing copper from the fire. As with playwriting, this "script" also includes "stage directions" for the Serious

Games student builders. To further assist the Serious Games students with visualizing the game space and worldbuilding, the player walkthrough is illustrated with photographs from my research to contextualize those assets.

Figure 39 Left: The “Cult and Copper” VR game is modeled after the landscape at the Mushroom Area of Timna Park, Israel, where evidence of copper smelting, such as workshops and slag, abounds. There is a small local cult shrine in the Mushroom area as well. (The Hathor sanctuary and “Slaves Hill”–where copper was smelted in the Iron Age”–are in another part of the park.)

Figure 40 Right: Tourist markers promote the idea of Egyptian involvement in copper production. The Egyptian characters here use foot bellows, which are the next technological advancement for smelting, after blowpipes. Photographs by Casondra Sobieralski in Timna Park, Israel, 2017.

Though full implementation of the player walkthrough is not realized in this initial prototype, the document specifies that upon entering the game world, the player can

choose a Canaanite or Egyptian avatar, and that character can be male, female, or gender nonconforming.[332] In the design document, players also choose characters representing in-world smelters. These additional smelters indicate historicity in that it took four to six people with blowpipes to keep the fire going; but these characters also allow for a mechanism by which the player can take a break if needed. (Long periods of deep breathing take endurance and practice. Rather than have a player quit in frustration if she cannot maintain her breathing pattern for long, an in-world smelter can take over her role to allow her a rest period.)

An old man smelter-shaman, through narration, guides the player as to how to regulate the crucible temperature with breath and charcoal, and how to read the colors of flames to indicate the state of the copper ore. A drummer keeps rhythm as per breathwork playtesting results. As the fire heats, snakes dance in the flames in trance-like fashion to act as intermediaries that aid communication between the fire and the player. As the ore starts to melt, an ibex from a constellation rides across the sky with the goddess, an allusion to the sexual union taking place in the crucible. The ibex, symbol of the smelter-shaman, descends from the sky to merge with the old man for a moment, showing the mythic relationship between the two. The ibex can also move closer/farther from the player as she gets closer to/farther from becoming a shaman herself (by realizing a successful smelt). Birds serve to deliver

[332] The choice of a non-binary character is in harmony with UC Santa Cruz's long tradition of being a welcoming place to all genders; however, it is also a historically relevant nod to Astarte/Aphrodite's dual-gender nature as expressed in Levantine art. See: Bonnie MacLauchlan, "The Ungendering of Aphrodite", in *Engendering Aphrodite: Women and Society in Ancient Cyprus*. Vol. 3;7, ed. Bolger, Diane and Nancy J. Serwint (Boston, MA: American Schools of Oriental Research, 2002), 366. doi:10.5615/j.ctt2jc9sc. However, one dual-gendered Astarte figurine was also discovered in Transjordan, not far from Timna. See: David. T. Sugimoto, "The Judean Pillar Figurines and the "Queen of Heaven"", in *Transformation of a Goddess: Ishtar--Astarte--Aphrodite*, *Orbis Biblicus Et Orientalis, 263,* ed. David. T. Sugimoto (Fribourg: Academic Press, 2014), 163.

data upon request, such as how many liters of breath per minute the player is producing, and how much time has elapsed since the start of the smelt. At the end of the smelt, when the copper is "born" from the furnace, the player is rewarded with a Hathoric birthing celebration. This celebration is a simplified version of the celebrations that were held for new mothers in ancient Egypt: Bes (the Egyptian dwarf god who protected newborns and mothers) dances and plays a frame drum while the player, as a new smelter, is presented with a Hathor mirror.[333]

As with the collaborative ideation process of Bronze Age Productions, and in accord with the experiences of previously noted cyber-archaeology theorists such as Johanson and Waterson, the process of writing these design documents necessitated a lot of problem solving that built knowledge. For example, I had to further research what period of copper furnace went with blowpipes (rather than with bellows) so that I was not temporally mis-matching technologies. Knowing what an ancient Hathoric birthing celebration actually entailed in antiquity required further investigation in order to represent such a celebration in virtual space. How does one indicate this relationship between historical research and design choices? I authored a paradata document (Appendix 4) to indicate what elements of the game are based on specific, cited material evidence, and what elements are speculative or imaginative.

Figures 41 and 42: Two furnace types as represented by reconstructions at the Eretz-Israel Museum, Tel Aviv. On the left is a Late Bronze Age furnace from the 13th-12th century BCE. On the right is an Iron Age furnace from the 10th century BCE, with the technological advancement of a taller shaft. Notice that both have holes in the sides where tuyeres would have guided air from bellows.

[333] Specific ideas for the birthing celebration were inspired by: *The Birthing Room* [Permanent installation with didactic audio], Egyptian and Rosicrucian Museum, San Jose, California, viewed October 2021.

Figure 43: In writing my design document script, I realized that I needed to have the correct furnace for use with blowpipes before I passed visual information to my 3D modeler. This Chalcolithic furnace below, also a replica at the Eretz-Israel Museum, would have been used with blowpipes. Therefore, it was a better model for our game. Then from supplemental texts, such as Paul T. Craddock's *Early Metal Mining and Production*, from experimental archaeology videos/films from Ben-Yosef and Fasnacht, and from archaeological evidence in the Mushroom Area of Timna Park, I was able to refine details such as furnace dimensions for a more correct historicity. All three furnace photographs by Casondra Sobieralski, 2018/2019.

Prototyping

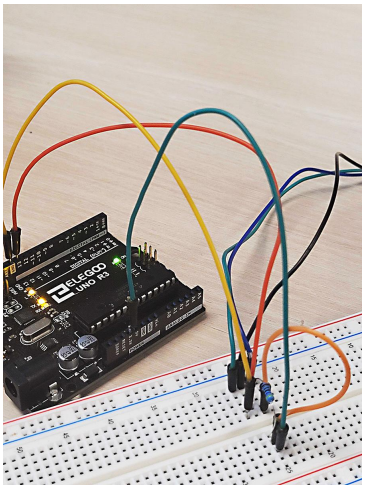
The Serious Games graduate students were afforded two, ten-week academic quarters–Fall 2021 and Winter 2022–to build a playable Virtual Reality prototype of "Cult and Copper" from the design documents. Pre-production included meetings to review design documents, clarify goals, and set realistic expectations. The production team created user interface mock-ups –visual designs suggesting "look and feel"–which I critiqued. The team determined the "core flow" (primary sequence) of the game to be: ore selection followed by breathing results in the birth of copper.

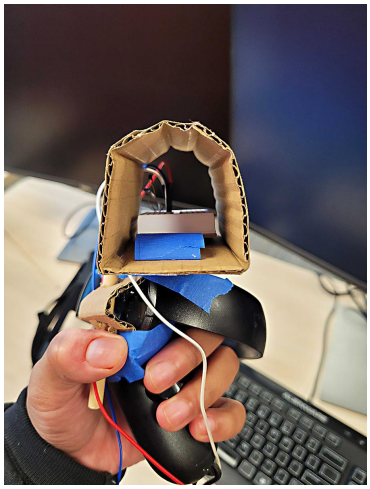
They defined the “core loop” (primary game mechanics) to be: breath influences temperature influences the behavior/color shifts of the flames heating a crucible.

Figures 44 and 45: Two representation of Team Timna’s initial user interface–or “UI”–mockups representing a possible “look and feel” for the game. I provided feedback that the environment was very evocative of Timna and appropriately relaxing in support of a meditative effect. UI images courtesy of Team Timna.

With these core concepts articulated, the team focused on “minimum prototype” design for stage one, meaning they developed the core experience of the game: the copper smelt. The player’s avatar hand grasps pieces of ore and pieces of charcoal, places them in a crucible saucer, and places the saucer in the fire. The player then uses slow, sustained breath to control the heat of the flames. Xie (3D modeler) created the Virtual Reality environment, including an immersive landscape to evoke Timna, and 3D game assets relevant to the core experience (such as the fire pit, the crucible, and bits of copper ore). Yao (2D artist) developed a breath meter graphic to guide the player as to when to inhale/exhale. Yao also implemented ambient sound design. For this stage, Sargeant (technical director) programmed the mechanics of picking up in-world objects with the handheld VR controller.

Sargeant also built and playtested iterations of the breath interface, which used an Ardunio microcontroller to interpret data from a temperature sensor called a thermistor.[334] In the first iteration, the player held the breath interface in one hand and the VR controller in the other. To make managing the breath interface easier, in a second iteration Sargeant optimized the design such that the Arduino-driven device attached to the VR controller. This design modification allowed the player to hold just one device instead of two.





Figures 46 and 47: To make managing the breath interface easier, Sargeant optimized the design by attaching the Arduino-driven device to the VR controller. This allowed the player to manage both the controller and the breath interface with one hand. Photo by Amber Sargeant of Team Timna, 2021.

The "iteration phase" of the project involved polishing the minimum prototype and inventing a VR tutorial, set in a mock Timna visitor center, at the beginning of the game.[335] The tutorial instructs the player as to how to use the VR controller to

[334] What sort of interface to use to convert breath to data within a VR world became another design problem to solve. Research by Andrew Sobieralski, an electrical and robotics engineer in Pennsylvania, yielded an open source "DIY" spirometer to use as a starting point breath interface. It uses a piece of tube and an Arduino microcontroller to convert pressure into digital data: https://www.instructables.com/Low-Cost-Spirometer/

[335] This tutorial was not part of my design documents. Rather, it was a requirement from their mentor. I thought the tutorial was a solid idea, but I did not like that it was set in a modernist architectural space because it disrupted the sense of immersion in the outdoor Timna setting that I sought to establish, as per the player walkthrough, from the point of encountering the game installation in the museum.

activate game elements. In this early phase of the tutorial design, a male “old miner” voice narrated those instructions.[336]

Figure 48: An establishing shot at dusk within “Cult and Copper” VR world, meant to evoke the sense of Timna, Phase I prototype. Gameplay video still by Timna Studios, 2021.

Figure 49: An establishing shot within “Cult and Copper” VR world, after dusk has turned to night, Phase I prototype. Negev starlore will inform the constellations in the sky in Phase II of prototyping. Gameplay video still by Timna Studios, 2021.

[336] Dr. Stephen Martin, a physicist who did not previously know he could act so well, performed “the old miner” voice. Martin works as a Senior Data Scientist at Included Health.

Figure 50: The player approaches the smelting fire in “Cult and Copper” VR world, Phase I prototype. Gameplay video still by Timna Studios, 2021.

Figure 51: In the Phase I prototype, the “Cult and Copper” player’s avatar uses the VR controller to select pieces of copper ore. Gameplay video still by Timna Studios, 2021.

Figure 52: The “Cult and Copper” player’s avatar uses the VR controller to place their selected pieces of copper ore into the smelting saucer, or “crucible” in Phase I prototype. Gameplay video still by Timna Studios, 2021.

Figure 53: In Prototype 1 of “Cult and Copper,” the player’s avatar used the breath interface to add oxygen to the fire. The original breath interface, driven by an Arduino micro-controller that converted analogue sensor data to digital data, calculated the rate at which the fire temperature rose. Gameplay video still by Timna Studios, 2021.

Figure 54: Here, too, in Prototype 1 the "Cult and Copper" player's avatar used the breath interface to add oxygen to the fire. This image is an example of where the researcher needed to collaborate iteratively with the game builders because the image suggests that copper flames turn green–indicating that copper has reached a liquid state–as the fire temperature reaches 1150-degrees Fahrenheit. However, this transformation happens at about 1200-degrees *Celsius*. So Prototype II will correct this as per production notes by the researcher. Gameplay video still by Timna Studios, 2021.

For stage two of prototyping, Team Timna team further refined all visual, sonic and interactive aspects of the game. Yao integrated a meditative Hathor frame drum rhythm that plays during the smelt to help regulate breathing.[337] They created game "illusions" from the script. Illusions are defined as aspects of the game that go beyond the core game experience. In this instance, they include the snakes hypnotically appearing from the flames and the ibex descending from its constellation in the sky. The Hathoric birthing celebration, which marks the successful "birth" of the copper from the crucible, is classified as an illusion as well.[338] Also as part of stage two prototyping, Sargeant intended to add precision to the breath interface; the

[337] The frame drum recording for this celebration was generously performed and recorded specifically for this "Cult and Copper" game by Heather Kelley, Assistant Teaching Professor at the Entertainment Technology Center, Carnegie Mellon University.
[338] This frame drum rhythm was also performed and contributed by Kelley.

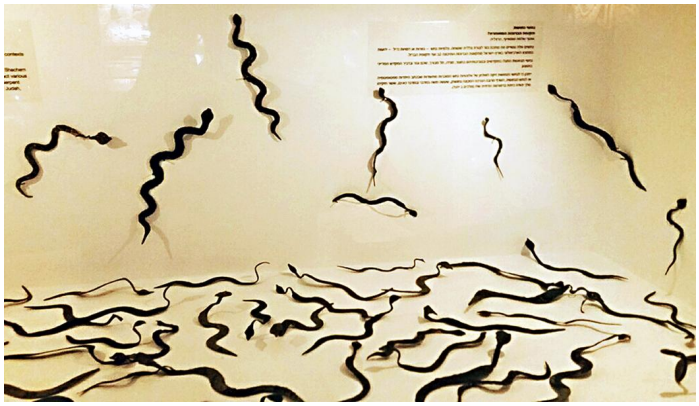
sensor worked but the sensitivity was inconsistent. However, at the start of this prototyping stage, we hit an unexpected obstacle. The San Francisco Bay Area (our location) faced a covid-19 surge with an unprecedented positivity rate because of the highly transmissible omicron variant. Even individuals vaccinated and boosted against the original covid-19 virus were susceptible to infection with omicron. As of January 11, 2022, one in five covid-19 tests administered by the city of San Francisco was coming back positive.[339] Local public health officials expected the surge to continue through February into March 2022.[340] With the students graduating in March, Team Timna decided there was no way to work safely with the breath interface anymore because we had to remove our hygiene masks and blow on it, which would disperse respiratory aerosols that could carry the virus. We could not even playtest among ourselves. As a safer alternative, Sargeant with her faculty mentors designed a *simulated* breath interface. The in-world breath meter still functions the same way, instructing the player as to when to inhale and when to exhale. However, now the player indicates her inhalation and exhalation by pressing and releasing a trigger on the VR controller. While omicron unexpectedly thwarted my original interface ideal, our solution did have a second advantage in addition to better safety. That is, by canceling the need for special hardware to operate "Cult and Copper," the game can be disseminated more easily. It could still be used in a museum setting, but players could also enjoy it at home.

[339] https://www.kron4.com/news/bay-area/san-francisco-mayor-announces-new-order-amid-covid-19-surge/

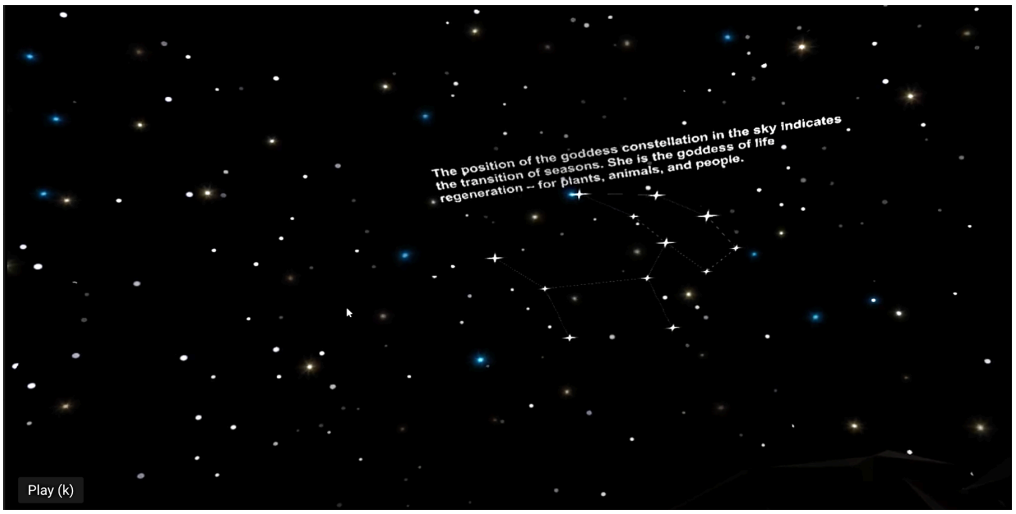
[340] https://sanfrancisco.cbslocal.com/2022/01/07/covid-omicron-surge-ucsf-expert-projects-peak/

Research photos from the Eretz-Israel Museum in Tel Aviv, first introduced in chapter 2, influenced game illusions in “Cult and Copper.”
Figure 55 Left: Copper snakes that were found near the Hathor sanctuary at Timna.

Figure 56 Right: A ceremonial Gaussulian copper staff with ibex heads.
Photos are by Casondra Sobieralski, 2017 and 2019.



Figures 57-61: Below are video stills of the game illusions inspired by the snake and ibex artifacts pictured. Images courtesy of Team Timna, 2022.


The position of the goddess constellation in the sky indicates
the transition of seasons. She is the goddess of life
regeneration -- for plants, animals, and people.
Play (k)


9:04

Below: Three examples of Bronze Age copper Hathor mirrors to inform worldbuilding. Such mirrors were given to new mothers.
Figures 62 and 63 Left, Center: Hathor mirrors from the Israel Museum in Jerusalem, photographs by Casondra Sobieralski, 2018.

Figure 64 Right: Hathor mirror from the Egyptian and Rosicrucian Museum, photograph by Casondra Sobieralski, 2021.

Figure 65: The player is awarded a Hathor mirror, a form of layered symbolic transmission, for a successful copper smelt. Video still images courtesy of Team Timna, 2022.

Figure 66: “The Birthing Room” at the Egyptian and Rosicrucian Museum in San Jose, California depicts the goddess Hathor in her cow guise (top register) and Bes (bottom register). Ancient Egyptians believed that Bes protected mothers and newborns. The red button pictured on the post activates audio narration that describes how a villager dressed as Bes would dance and play music at a birthing celebration. The narration further details that Hathor mirrors, jewelry, and cosmetics were bestowed upon the new mother.
Photo by Casondra Sobieralski, 2021.

Figure 67: “The Birthing Room” installation from the Egyptian and Rosicrucian Museum influenced the visual and sonic design for the Hathoric birthing celebration that rewards the player at the end of the virtual copper smelt in “Cult and Copper.” For the prototype, Team Timna used a dancing blue lion stock character as a placeholder for a dancing Bes, which would require custom modeling.
Video still image courtesy of Team Timna, 2022.

Playtesting

Team Timna playtested incremental aspects of game development with other people in the Serious Games program. Playtesting methods used direct observation of game play, plus short questionnaires designed to assess responses to specific elements of design and mechanics as part of troubleshooting. However, upon completion of stage two prototyping, playtesting also served to determine how the target audience–museum goers with interests related to the game–engaged with the game in a museum setting. Does the game promote the intended state of deep relaxation, as measured by qualitative assessment? (We were not equipped to measure pulse rate or cortisol levels, though this would have been ideal.) How long did players engage with the game? What game content communicates successfully, and what is confusing? What did players take away from the game in terms of new knowledge and new questions to investigate? (Appendix 5 provides a complete list of playtesting questions.)

The Egyptian and Rosicrucian Museum in San Jose, California agreed to host a playtesting session with museum members (for greater covid-19 safety relative to the general public) in February 2022. This particular museum is well-suited for providing a target audience for “Cult and Copper” for three reasons: 1) they serve a community interested in Ancient Egypt, 2) the Rosicrucians are a spiritual movement that values mediation, and 3) the Rosicrucians are interested in alchemy (associated with metallurgy) as a transformative process in both the material sense and in the psychological/spiritual sense. In fact, the museum recently opened a new alchemy

exhibit hall which includes allusions to copper and a later (Roman) love/sexuality goddess, Venus.[341]

Playtesting results from six participants revealed that people engaged with the game for ten to twelve minutes. All but our first two players (who were subject to a frustrating technical glitch) reported feeling more relaxed, kind, and/or creative after the game; this was our qualitative measure of how "meditative" the game was. The Serious Games students also collected eye tracking data from within the game world to test players' focus on/distraction from the central smelting fire; they took this as an additional measure of how meditative the game was. The presumption was that if a player's focus was not fixed on the smelting fire, she was anxious or distracted. I suggest, however, that this empirical approach was perhaps ultimately as open to subjective interpretation as qualitative questions because perhaps some players (including me) found visual explorations of the virtual environment to be relaxing/ meditative. In fact, players in the museum, just as players in the Serious Games studio, commented on how calming the VR environment itself was. This eye tracking approach also did not take into account neurotype differences (such as autism or attention deficit hyperactivity disorder) that might create different focus/distraction patterns. All players, including the initial two participants, found the drum rhythm and the breath rate for smelting within the game to be favorable to relaxation. Two players thought that the breath rate could be a bit faster, if anything, which reiterates what playtesting breathwork with Bronze Age Productions revealed: there is no standard rate of breath that is comfortable and relaxing for all.

[341] See the new Rosicrucian Alchemy exhibit at the Egyptian and Rosicrucian Museum: https://egyptianmuseum.org/alchemy-exhibit

In terms of what was confusing within the game, some players thought that the language used for game instruction was at times unclear. We modified the voice narration and in-world text in accordance with their collective feedback. Players had mixed levels of understanding regarding the role of the old man shaman-smelter. Half said that they felt guided and supported by his 3D character (as was my intention); half said that they perceived his form to be that of a companion smelter and thought that the narrator's guiding voice was a separate character "off-camera."

Those four museum players who were not frustrated by the early technical problem all attested that they learned something about the intangible heritage of Bronze Age smelting from the game; each felt inspired to learn more. All of these players successfully interpreted at least some intended part of the "esoteric secret" that the game reveals; they all recognized that in the Bronze Age Levant smelting was somehow related to transformation and to birthing. Player Three interpreted that the link between smelting and shamanism had to do with "bringing out the fire within and raising kundalini [energy]."[342] Player Four reported learning that smelting had to do with breath and that it was a spiritual, not just an industrial, activity. She wanted to know more about the connection of goddesses to smelting and whether women were involved in the process. She interpreted the "esoteric secret" to be, "The power of breath can change states of matter, changing matter changes states of consciousness, and higher states of consciousness allow connection to the goddess." Player Five found the relationship among folkloric, alchemical, and metallurgical traditions at the forge to be "intriguing," and realized that the spiritual

[342] Merriam-Webster defines kundalini, a sanskrit term from yoga, as life force. In yogic tradition, kundalini is conceptualized as lying coiled at the base of the spine. When it is stimulated, it passes through six energy centers in the body. When it rises to the head, spiritual enlightenment results. See: https://www.merriam-webster.com/dictionary/kundalini

aspects of metallurgy practice are forgotten in materials science today. Player Six learned that smelting was done in community over an open fire at night. For him, the storytelling approach of the game provoked contemplation about the oral transmission of traditions. He interpreted the esoteric secret of the game to be that smelting was blessed by Hathor. Thus playtesting revealed that the game was remarkably successful in meeting my game play goals of conveying knowledge, and provoking further speculation/questions, about intangible heritage.

Proposed Further Development of the Game

The Serious Games students achieved an admirable level of problem solving to establish a solid prototype in just two academic quarters. If funding were available to further develop this prototype, however, there are several elements that I would like to improve upon. First, this prototype does not yet realize the ability for the player to choose an avatar's gender or ethnic identity, or to select additional characters as smelters, as outlined in the player walkthrough. The design documents call for the player to be able to choose an Egyptian or Canaanite avatar, and Egyptian or Canaanite supporting characters. This design feature is an important one for establishing the idea that Bronze Age copper production at Timna was an effort that relied on the labor of both Egyptians and local desert tribes. (The notion of equal collaboration is speculative, but on-location interpretive materials about rock art in the "Chariot Area" of Timna Park decipher that the two groups worked together.[343]) The ability to select the gender identities of "Cult and Copper" in-world characters is

[343] https://www.youtube.com/watch?v=YG0GHFGJhiQ (Note, the audio I created for this video about the Chariot Area is deliberately uncomfortable to represent the abrading wind that threatens the rock art.)

intended to prompt a player to consider whether women or genders other than cismen were involved in Bronze Age copper production, and what their roles might have been. Having many animated, responsive, 3D characters in a game, with all the modeling, kinematic rigging, and programming that would entail, would obviously require a greater amount of additional design/engineering labor. A grant or an investor would be necessary to pay for that labor.

Sound is another aspect of the game that deserves enhancement if funding is secured. To sonify the fire and most other ambient game elements, the sound designer for this prototype (Yao) used my design documents to select audio files available for download from the internet. She imported custom-recorded frame drum rhythms to represent those used by priestesses of Hathor. Ideally, however, sounds captured on site at Timna would establish more "documentary" veracity in establishing a sense of place. For example, the reflection of sound bouncing off rock formations at Timna is quite remarkable. Thus I could create a sense of a site-specific acoustic ecology by recording an impulse response produced by a quick, sharp sound (such as a balloon popping) reverberating off the rocks on location. By digitizing that impulse response, I could create a custom convolution reverberation filter. Then I could apply that filter to character voices, drums, the ibex, and the fire to digitally simulate the site-specific reverberation of those sounds. A fire burning in the crisp desert air would also have a particular tonal quality specific to low humidity. The acoustics of the wind sweeping across the sands at Timna have a particular signature. Walking on ancient slag at Timna has a distinct sonic quality; harmonic layers of "tinkling" sounds underfoot speak of past industrial processes specific to the

time and place.[344] Sound is such a powerful and important means of creating a sense of presence that another funded trip to Timna, to spend concentrated time on sound design, would take this project to a much more powerful level.[345] In fact, developing sound for "Cult and Copper" could be its own separate research project, whereas the goals for this prototype revolved around making new contributions to embodied, intra-active approaches to interaction design and knowledge production.

Figure 68: From the "Mushroom Area" of Timna Park, a visual example of the interplay among wind, rocks, and sand. This dynamic dance, performed by nature in an extremely arid atmosphere, makes for a unique acoustic ecology that should ideally be conveyed through the "Cult and Copper" VR game to enhance a sense of presence.
Photo by Casondra Sobieralski, 2017.

[344] I did do quite a bit of site-specific sound recording in Timna during my 2017 trip, but at that early research phase of the project, I was seeking answers to different research questions. I was seeking to understand Hathor worship and sistra playing, whereby the sistrum is an instrument sacred to Hathor, in relation to place. I focused on recording in a different part of the park, near the Hathor chapel.

[345] See: Rolf Nordahl and Niels Christian Nilsson, "The Sound of Being There: Presence and Interactive Audio in Immersive Virtual Reality," in *The Oxford Handbook of Interactive Audio,* eds. Karen Collins, Bill Kapralos, and Holly Tessler (Oxford: Oxford University Press, 2016), 213-233.

In terms of advancing intra-action design even further, later iterations of this game could become a multiplayer experience, whereby each player is a smelter working through an avatar, and the fire responds to a collective of agents. The game would thus become more cooperative and social. Can a game be both mediative and social? Determining that would require more playtesting, but I would hypothesize that it could be if players held that intention, just as group rituals, yoga classes, and drum circles can be both meditative and social.

With investment in subsequent development of interface design, the player could also "level up" (in game parlance) such that mastering smelting skills with one generation of smelting technology led to game play with the next generation of smelting technology. E.g., once the player mastered the blowpipe, the next level of the game could use bellows operated by foot pumps, as are depicted in Egyptian art.[346] The player would then learn a lineage of technology history.

Reflections Upon Results

The "Cult and Copper" Virtual Reality game that resulted from my historical and theoretical research conducted from 2017 through 2020, my collaborative ideation with Bronze Age Productions, and my technical collaboration with the UCSC Serious Games program, did indeed meet many of my project goals. My game designs improve upon immersion strategies used in existing history/heritage VR games. They do so in part by employing worldbuilding advice offered by Jenkins, Wolf, and Champion. Worldbuilding techniques such as utilizing Timna's distinctive landscape, Levantine Bronze Age artifacts, and ancient mythologies from the region work

[346] Images of Egyptian tomb paintings depicting the use of foot bellows are abundant in scholarly sources online. See for example: https://www.e-education.psu.edu/matse81/node/2126

together to create a coherent, consistent sense of being in a particular time and place, i.e. being *there and then* as advised by Champion.[347]

The game build, however–meaning the playable prototype–realized some of my design goals and fell short of others. This was far from being a problem, as realistic expectations were established from the outset of my collaboration with the Serious Games team. It proved to be unrealistic, for example, to include a cast of 3D animated, intra-active human characters in the playable prototype. In my player walkthrough, these characters serve as vehicles to prompt questions about who participated in labor and cultic practices at Timna and in what capacities. Archaeologists do not have concrete answers to labor questions in regard to ethnicity or genders, so this design choice was intended to invite speculative imagination that could perhaps prompt further research into these questions. Sound design also fell far short of my ideal, but again, this was not at all surprising.

The game prototype does realize my design goal of redefining interaction design as relational intra-action design. Snakes, ibexes, copper, fire, air, slag, blowpipes, rhythm, and humans all have roles in the game, which affords them posthumanist agencies that challenge anthropocentrism. The game achieves a degree of animism by incorporating shape shifting animal helpers from Negev desert mythology and by suggesting that copper is a living thing that can be "birthed." The strategy of using intra-active agents to drive the story enhances immersion by creating a magical world that is separate from ordinary reality.

The built prototype for "Cult and Copper" was on its way to meeting my interface design specifications absolutely. The programmer was able to successfully realize a

[347] As noted earlier in this chapter, see: Erik Champion, *Critical Gaming: Interactive History and Virtual Heritage* (Surrey, England: Ashgate Publishing Limited, 2015), 98-99.

custom breath interface to evoke an embodied sense of what it might have been like to be an ancient smelter using blowpipe technologies to heat a small crucible. While the consistency of the breath meter needed to be improved upon in the second ten weeks of production, already in the first stages of prototyping the breath interface created the sense of interoception–-bodily awareness–that Heeter says is necessary for creating a sense of presence.[348] The simulated breath interface necessitated by the virus surge falls a bit short of my original interface goals, but it still keeps the important goal of embodiment and interoception central. The simulated breath interface successfully brings awareness to the breath, and it successfully creates the illusion that breath is driving the game.

This game generally met my game play goals, both among our Serious Games student playtesters and among museum playtesters. In the initial prototype stage, other Serious Games students in Team Timna's program did find the game to be meditative via the facilitation of conscious breathing. The nighttime atmosphere around the fire pit, with the sound of the cracking flames and the trance-inducing pace of drifting embers, evoked responses of relaxation as well. A presentation of the first stage game prototype to the Serious Games classes indeed prompted questions about intangible heritage aspects of copper smelting, such as inquiries about blowpipe versus bellows technology, and about why breathing might be linked to shamanic states. Then Team Timna playtested aspects of visual/sonic design, mechanics, and audience reception with members of the Egyptian and Rosicrucian Museum in San Jose, California. These museum members, representing the target

[348] Carrie Heeter, "A Meditation on Meditation and Embodied Presence," *Presence: Teleoperators & Virtual Environments* 25, no.2 (November 2016): 175-183, DOI: 10.1162/PRES_a_00256.

audience for the game, generally found the game to be relaxing. They demonstrated that the game does successfully educate about the intangible heritage surrounding copper smelting in the ancient Negev desert, and they were inspired to ask further questions, postulate their own speculations.

While some aspects of my design vision remain to be realized, my collaborators enabled the mechanics of the core game loop and created the animistic game illusions that convey intra-action. The culmination of the game–the Hathoric birthing celebration with music and dance that occurs when the copper is birthed from the fire–allows the player to feel a sense of reward. At least as importantly, however, it suggests why sexuality goddesses are associated with copper smelting. Thus the player earns not just a party, but an esoteric secret.

The collaborations I guided to birth this contemporary techno-craft product echo the necessity for collaboration in techno-crafting in the Bronze Age. To realize a VR game prototype, I consulted with archaeologists and museum curators in multiple countries. I directed performers and gamers in Zoom-based theater games to generate design ideas, then guided graduate students in UCSC's Engineering Department to see the implementation of those designs. Similarly, ancient metallurgy required the specialization and skills of many. Copper production relied on miners, mining managers, furnace and bellows designers/engineers, ore crushers and sorters, wood gatherers and charcoal makers, food transporters, smelter-shamans, and perhaps, as Bronze Age Productions breathwork exercises suggested, musicians who could have been, speculatively, priestesses of Hathor. From an intra-active posthumanist perspective, the copper, the mountains, the wind, and the trees (charcoal) were also agents in such Bronze Age collaborations.

Conclusion

This research project, "Cult and Copper: Intra-Actions from the Bronze Age to A-Life," germinated from the seed of one primary curiosity: why was the Egyptian goddess Hathor, popularly known as a goddess of love, music, motherhood, and sexuality, also a goddess of copper? I originally generated this question in 2017 when I was doing research at Timna Park, Israel, seeking to better understand Hathor worship by New Kingdom Egyptian copper producers there. These ancient Egyptians even established a sanctuary for Hathor at Timna, though the architectural remains of this sanctuary suggest that the structure was part of a site that had originally been sacred to local tribes.[349]

In seeking to decipher the relationship between this Egyptian deity and copper, I discovered that Hathor was also beloved by the ancient Canaanite tribes of the area. Hathor was similar to their own love and sexuality goddess, Ba'alat. Both goddesses were associated with the fecundity of the Earth, and this fecundity included ores and minerals such as the copper, malachite, and turquoise mined in the Negev desert and in the nearby Sinai Peninsula. Further research revealed that many cultures of the Mediterranean and Africa conceptualized smelting–the fiery process whereby ore was melted in a crucible to become an ingot of metal–as a birthing process; metal was born of the smelting furnace. While archaeologists can only speculate as to whether this archetypal pattern held true in Timna specifically, evidence from the broader Negev region does link copper production and cultic practices. To the north of Timna, near Beer Sheva, such evidence includes a trove of ceremonial copper

[349] Uzi Avner, "Egyptian Timna Reconsidered," in *Unearthing the Wilderness: Studies on the History and Archaeology of the Negev and Edom in the Iron Age*, ed. Juan Manuel Tebes (Leuven: Peeters, 2014), 116-125.

artifacts crafted by the Ghassulian people who inhabited lands today known as Israel, Palestine, and Jordan.[350] Elsewhere in the Negev evidence also includes petroglyphs that tie the story of copper production to mythological iconography representing a goddess of regeneration, a gestating furnace, and animals with shamanic significance.[351]

The area near Timna Park continues to be an active copper mining site today.[352] From the point of view of media and communications technology history, the conductivity of copper was what allowed networked communications technologies to pass signals. I thus began to think about Hathor and Ba'alat as "proto-cyber goddesses" because of their association with copper production. I set out to restore recognition of these goddesses in media technology history. This involved furthering the work of media archaeologists such as Jussi Parikka. Parikka calls attention to the geology of media–the idea that media has a materiality that comes from resources of the Earth–but he only looks as far back as the Victorian Era in discussing the extraction of minerals for use in human technologies.[353] By tracing the history of copper production as techno-craft through the ancient Levant, I demonstrated that the roots of the Digital Era go much deeper in time, to the Bronze Age. At that time, copper production shifted from a small scale–that provided for home/village use–to a scale that fostered an international copper trade network in

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[350] Milena Gošić and Isaac Gilead, "Unveiling Hidden Rituals: Ghassulian Metallurgy of the Southern Levant in Light of the Ethnographical Record," *Bar International Series* 2753 (2015): 25-33.
[351] George F. Steiner, "The Goddess and the Copper Snake: Metallurgy, Star-lore and Ritual in the Rock Art of the Southern Levant," *Expression Quarterly Journal of Atelier Editions in Cooperation with UISSP-CISNEP (International Scientific Commission on the Intellectual and Spiritual Expressions of Non-Literate Peoples)*, no. 12 (June, 2016): 73-95.
[352] http://www.timna.co.il/92847/COMPANY-PROFILE
[353] Jussi Parikka, *A Geology of Media* (Minneapolis: University of Minnesota Press, 2016), 31-35.

the Eastern Mediterranean. This expansion of copper production was one key element in shifting socio-political structures towards greater class hierarchy and increased religious complexity. Syro-Palestine, then Cyprus, were the centers of copper production for the Eastern Mediterranean region in the Bronze Age. In both countries, archaeology sites evidence that Hathor and Bala'at were important characters in this techno-historical story.

I speculated about future roles for copper, when quantum computing becomes more accessible and more common. Currently, the "brain" of a quantum computer is a copper disc encased with gold,[354] and the fragility of quantum data must be stabilized at extremely cold temperatures enabled by a copper compound.[355] Quantum computers, with their ability to model highly complex systems at fast speeds, will hasten the evolution of self-replicating, self-learning, artificial life, or a-life.[356] I considered the appropriateness of the worship of ancient copper goddesses, who were also fecundity goddesses, being part of a techno-historical chain that leads to a-life. A-life will have applications to media in the near-future, such as facilitating emergent narratives and enabling modeling real-time, responsive flocking/herding behaviors (as demonstrated by birds, fish, and Savannah animals) in video games and Virtual Reality. Exploring the relevance of copper to Media Studies through a

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[354] "Inside the Machine," Rigetti Computing, accessed Sept 25, 2020, https://www.rigetti.com/.

[355] National Academies of Sciences, Engineering, and Medicine, *Quantum Computing: Progress and Prospects,* ed. Emily Grumbling and Mark Horowitz (Washington, D.C.: The National Academies Press, 2019), 208, http://nap.edu/25196. https://doi.org/10.17226/25196.

[356] For a basic understanding about quantum computing and its potential for simulating complex systems, see: Chris Bernhardt, *Quantum Computing for Everyone (*Cambridge, Massachusetts: The MIT Press, 2019), 188.

media archaeology lens allowed me to frame how and why copper goddesses deserve a place in media technology history.

When the center of copper production for the Eastern Mediterranean did eventually shift from the Canaanite lands of Syro-Palestine (now Israel) to Cyprus, northern Canaanites–the Phoenicians–colonized the island.[357] They took their goddess Ba'alat with them. By this point, however, she was known as Astarte. The Phonecians built temples to this love goddess next to their copper production workshops. The archaeological site of Kition, near the town of Larnaca, provides a key example.

Figure 69: Remains of copper workshops at Kition, near Larnaca in Cyprus.
Photo by Casondra Sobieralski, 2019.

[357] For more information on the copper industry's shift from Timna to Cyprus, see: Erez Ben-Yosef and Omer Sergi, "The Destruction of Gath by Hazael and the Arabah," in *Tell It in Gath: Studies in the History and Archaeology of Israel: Essays in Honor of Aren M. Maeir on the Occasion of His Sixtieth Birthday*, ed. Itzhaq Shai, Ägypten Und Altes Testament, Band 90 (Münster, Germany: Zaphon, 2018), 461-480.

Thus when the opportunity arose, it made sense to follow the story of copper and the goddess from Timna to Cyprus. Prior to the covid-19 pandemic, my colleague Dr. Danelia De Angeli–a computer scientist who creates Serious Games for museums and cultural heritage projects–established an invitation for her and I to collaborate with a lab in Nicosia (the capital of Cyprus) that specialized in interactive technologies for museums. Though I was quite enthralled with Timna, I accepted my colleague's request to join her in Cyprus because it made sense from a historical perspective: additional investigation via Cypriot sites would deepen my understanding of copper goddesses. Three weeks on the island allowed for field research, museum research, specialized library research, and meetings with numerous curators and archaeologists. De Angleli and I also met, of course, with the museum lab and, in consultation with archaeology site officers, planned a collaboration whereby I would research and design an interactive cyber-archaeology/ art installation at an exhibit space on site at Kition. De Angeli would code it and help me build it, and the museum lab would provide equipment and work space. Then, however, the global pandemic hit. I had to come up with a new project that could be supported by virtual collaborations. I decided to instead design a cyber-archaeology Virtual Reality game.

I had researched such a broad scope of archeological sites across two countries, however, I was not sure what, specifically, to make a game about. That is where Bronze Age Productions (BAP) became a valuable tool. I assembled a team of digital heritage enthusiasts, archaeologists, performers, and game designers and led them in a series of improvisational theater games with a project-specific twist: all of the characters and locations for our improvisational performances had to be limited

to those related to my research, i.e. Levantine Bronze Age archaeology sites that showed evidence of the connection between copper production and goddess cults.

The character set, however, could expand beyond the human to include tools, technologies, land and sky features, animals, and elements such as fire and air. Along with narrowing the scope for designing a game, my goal with BAP theater games was to generate ideas about what human and non-human elements could act relationally with one another. BAP was a collaborative ideation process for determining ways to redefine interaction design as intra-action design. Intra-action, a term that drove this research project, was coined by feminist physicist-philosopher Karen Barad to describe how subject-object binaries and hierarchies dissolve at a quantum level. The idea that subjects and objects exist as separate entities is an illusion; rather, from a quantum physics perspective, "being" is a state of ever-changing entanglements among entities. "Being" is defined by dynamic relationships among agents.[358]

Barad's philosophy has been embraced by human-computer interaction (HCI) designers such as Lucy Suchman and Josh Schultz-McVeigh. Having spent a decade of my career as an information architect and interaction designer for large data-driven websites, I had been trained to consider human-centered design. I appreciated that Barad's ideas, first conveyed to me through the work of Suchman who in turn influenced Schulz-McVeigh, radically re-worked that convention.[359] Intra-

[358] See: Karen Michelle Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham N.C.: Duke University Press, 2007), 32-33, 139.
[359] See: Lucy A. Suchman, *Human-Machine Reconfigurations: Plans and Situated Actions* (Cambridge: Cambridge University Press, 2007), 67. Also see broadly: Joshua McVeigh-Schultz, "Designing Speculative Rituals: Tangible Imaginaries and Fictive Practices from the (Inter)Personal to the Political," (PhD diss., University of Southern California, 2016),

action instead puts the human in a reciprocal relationship with other elements of the environment. In my VR game, this relational environment came to include copper, fire, air, charcoal (once trees), goddesses, shamanic animals, tools of techno-craft such as blowpipes and a crucible, novice and experienced smelters. All are characters. All have agencies.

Working with BAP also clarified that Timna was the best setting for my media project afterall. Timna tells a clear story in a clear setting. It lends itself to more cohesive worldbuilding. Cyprus, being situated in the middle of the Mediterranean Sea, was a nexus point for the exchange of information and ideas during the seafaring times of the Bronze Age. This led to rich amalgamation of thought systems, religious/mythological iconographies, and art historical styles of representation. Cyprus is a fascinating place to study for this reason. However, this complexity also makes Cyprus a confusing place to set a story for an audience that does not know all of the art historical "code" represented in that story.

Yet another important outcome of BAP was, it brought to light a possible relationship among smelting, shamanism, and breath. This concept became the core of the "Cult and Copper" VR game. Performance contributions by Swiss experimental archaeologist Walter Fasnacht inspired the decision to focus the game on this concept. When researching in Cyprus, I tried to meet Fasnacht by attending one of his experimental smelting demonstrations in the town of Agia Varvara-Almyras. My timing was a bit off, however, as he had already left the summer heat of the island. Then for the following two summers, I obtained funding to go work with Fasnacht in person, and for two summers in a row the global pandemic thwarted our

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http://joshuamcveighschultz.com/wp-content/uploads/2013/08/Designing-Speculative-Rituals-8-7-16.pdf.

plans; travel was risky, and the open air Neolithic museum where we intended to do a smelt for the public closed for safety. Fasnacht did, however, become a generous mentor through Zoom, and an educational contributor to BAP. He taught us about the relationship of breath to smelting in the early days, when smelters heated fires with oxygen via three-foot blowpipes tipped with clay nozzles. He conveyed his experimental smelting experiences to us, including a story about how he and his team all ended up in the hospital from what they initially thought was poisoning from noxious fumes from the furnace. It turned out they had been sitting too close to the fire, fire consumes oxygen, and they all suffered from oxygen deprivation.[360] Thus we learned how to smelt as well as how *not* to smelt.

With the clarity I gained from collaborative ideation via BAP, I conceptualized "Cult and Copper," a VR game about copper smelting and its relationship to shamanism and Hathor/Ba'alat. I forged another collaboration, this one with Serious Games Master's degree students at University of California, Santa Cruz's Silicon Valley campus. I provided them historical content, media assets, and design documents to work with; they provided me with their technical prowess including 3D modeling, coding in a Unity game engine for an Oculus headset, and engineering an interface strategy to guide each player's breathing to simulate smelting via a blowpipe. The intention of this interface is to give players an embodied, experiential understanding about what the smelting process might have been like.

In the "Cult and Copper" game, a successful smelt is achieved by regulating the smelting fire temperature through the right balance of oxygen (via breath) and charcoal. When the copper is "born" from the furnace, representing ancient belief

[360] Walter Fasnacht, Bronze Age Productions improvisational theater jam via Zoom, April 16, 2021.

systems, the player is rewarded with a Hathoric birthing celebration: Bes, an Ancient Egyptian dwarf god charged with the protection of mothers and newborns, dances to the rhythm of frame drums.[361] Beyond being rewarded with a virtual Bronze Age party, however, via this culminating game experience the player is initiated with an esoteric secret. The birthing celebration is the answer to the question that motivated this whole research project: why is Hathor as a goddess of music, motherhood, and sexuality also associated with copper? The conclusion is speculative, though plausible based on extensive historical research.

The idea of copper as a newborn, along with other game illusions such as snakes and ibexes guiding the player on her journey to becoming a smelter-shaman, create a sense of animism that hopefully brings some sense of environmental awareness to the techno-craft of smelting. Since my broader thesis links copper goddesses to the history of networked information systems, it is my hope that this project as a whole can plant some kernel of an awareness that digital technology comes from the Earth: communications systems including the internet have relied on copper, and electronics more broadly rely on copper.[362] Through his writings, Douglas Khan demonstrates that copper has something to say, so to speak, without a human operator if you consider that copper wires can interact audibly with electromagnetic signals that travel across them.[363] What would copper voice, if it could, about the extraction of resources required for the production and powering of our tech toys?

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[361] Inspired by: *The Birthing Room* [Permanent installation with didactic audio], Egyptian and Rosicrucian Museum, San Jose, California, viewed October 2021.
[362] See broadly: Tom Standage, *The Victorian Internet: The Remarkable Story of the Telegraph and the Nineteenth Century's On-Line Pioneers* (New York, N.Y.: Berkley Books, 1999).
[363] See: Douglas Kahn, *Earth Sound, Earth Signal: Energies and Earth Magnitude in the Arts* (Berkeley: University of California Press, 2013), 26.

As digitization and networked virtualization takes over more of our lives, what would copper scream about the environmental impact of mining Bitcoin and powering the Metaverse? Only when we can see past marketing hyperbole to the material reality of digital media and communications can we properly design technologies that work in harmony with, rather than against, goals of environmental sustainability.

As for Hathor, this Goddess of the Mountain carries another important message that the Earth we need to protect is shared among peoples. It is in the common interest of all contemporary tribes to cooperate towards this stewardship aim. Levantine people who are now sworn enemies had ancestors who might have been dancing together in celebration of their shared goddesses. What can "digital natives"–those people brought up with digital technologies–learn from that?

The Arava Institute operates less than fifteen miles north of the entrance of Timna Park. Both the institute and the park sit near Israel's border with Jordan. Arabic music from the Jordanian side of the Red Sea plays on the car radio as one drives to the Timna's "Mushroom Area," a section of the park which features the remnants of an ancient copper smelting workshop. The Arava Institute brings together Israeli, Palestinian, and Jordanian students to work towards environmental solutions. Their motto is, "Nature knows no borders."[364] Perhaps Arava's slogan can offer a Hathoric model of how to approach sustainable solutions to managing the materiality of media.

My research concludes by recognizing that techno-craft has always been a collaboration among human and non-human agents. Copper production involved the air, the fire, the earth, the ore, the smelters, their tools. Copper trade required,

[364] See: https://arava.org/

additionally, ships, the sea, sailers, merchants, and managers. The research for, and production of, the "Cult and Copper" VR game required my collaborating with archaeologists in Israel, Switzerland, and Cyprus. It required the collaborative efforts of curators/museum directors in Jerusalem, Pittsburgh, and San Jose. The game design ideation was a collaborative effort via improvisational theater games conducted by Bronze Age Productions using the internet-based, networked communication technology of Zoom. Building the playable game prototype could only have been achieved through my collaboration with the UCSC Serious Games program and "Timna Studios." Finding design and policy remedies to the environmental challenges created by some of today's most influential techno-crafts–those pertaining to digital technology–will require collaboration as well.

Perhaps such a collaboration could begin close to where copper was mined at Timna, among tribes that used to share love for the same goddess/es, at a place like the Arava Institute. Perhaps it can begin in Silicon Valley, which was enabled by a historical chain of innovations, not always linear, that started with ancient copper mining and production. Perhaps solutions will be generated using the internet platforms that copper enabled, platforms that allow for translocative problem solving. In all but the most heavily censored parts of the world, digital communications dance right across and through geopolitical borders as Hathor worship did. Just like "Cult and Copper" the VR game, such a mode of problem solving would also demonstrate Barad's concept of intra-action, whereby people, their tools, and the materiality of technologies dynamically influence one another.

Appendix 1: “Cult and Copper” Game Goals

1) **This game should give players an embodied, experiential understanding of how trance states might have been achieved by Bronze Age smelter-shamans, particularly before the advent of bellows, when breath pipes used by teams of 4-6 smelters heated the smelting crucible.**
    a) Players should experience a deep state of relaxation via a sustained deep
       breathing technique akin to pranayama yoga.
    b) Players should experience an increased interoceptive awareness, which game designer Carrie Heeter cites as a prerequisite for embodied presence.
    c) Players might experience a mental state of increased imagination, intuition, or
       trance.

2) **This game should break subject-object binaries to establish animism as a design metaphor. A significant theme of this research project is redefining interaction design as intra-action design.** Intra-action is a term from feminist physics (Karen Barad) that stresses dynamic, fluid, entanglements among actants. Intra-action stresses relationality as an alternative to subject-object hierarchies. This sense of animism will be achieved by making non-human agents active. Examples:
        a) The fire is a primary character that communicates through changes.
        b) The copper will communicate through the colors of the fire (e.g. “I am now molten.”)
        c) Snakes, ibexes, and birds represent hallucinatory agents and guides. Snakes represent breath/spirit/divine spirit (“ruah” in Hebrew) and regeneration.
        d) Ibexes symbolize mediation between day and night, earthly and heavenly realms; the form assumed by shamans; copper smelters and smithing, as they take over the role of shamans; the moon as a symbol of renewal and transformation and as a symbol of the Semitic moon-god Sin, who was married to Ishtar. (Ishtar became Astarte in Canaan, and Astarte was closely related to Hathor. They had similar attributes, and the Canaanites embraced Hathor.)
        e) Birds mediate between earthly and celestial realms. They mythologically pre-figure “angels.”

f) Constellations/stars overhead might play a role, or provide a place for hallucinations to originate. (Smelting probably occurred at night because of intense daytime heat, and because flames were easier to "read" in the dark.) Draco is an ibex. Cepheus is a goddess of renewal, visible between winter solstice and spring equinox. One of her arms is a snake.
g) Venus represents Astarte and Hathor.

3) **This game should raise questions for players about intangible heritage related to Bronze Age copper smelting, including copper production's relationship to cult/goddess cults.** Possible examples:
   a) What roles might women have had in copper production, and how would we know?
   b) What attributes made for a good smelter, physically and mentally?
   c) Did smelters create a rhythm [with breath, or later bellows] that enhanced trance states or entrainment among the smelters? Were they guided by a rhythm? Did a rhythm increase endurance and coordination among the team? [Imagine oarsmen rowing a longboat, or pharaonic workmen moving a heavy stone with a chant.] And could a relationship between smelting and rhythm be an additional reason that copper and Hathor were linked? If rhythm or music was used to guide the labor, what instruments were used, who played them, and how? (The sistrum, frame drums, and menat necklaces were favored by musicians of Hathor, and fragments of sistrums and menats were found in Timna.)
   d) At Timna, how did Egyptians and Canaanites collaborate in regard to copper production? In this period, Egyptians managed the mining, and the technologies used were Semitic. But was the labor--mining, crushing, sorting, smelting, smithing--shared? Who did what?
   e) How did people dress? If Egyptian? If Canaanite?
   f) Why did it make more sense to smelt at night? What times of year made sense to smelt?

4) BONUS POINTS IF WE FIGURE OUT HOW TO MAKE THIS CLEAR: **Players should gain an awareness that shared cultural heritage practices (such as Hathor-Astarte veneration related to copper production)--on the ground and in embodied social space--offer a feminist alternative to mapping borne of militarism.** British colonial borders, created from depersonalized aerial viewpoints, are not the only way to map the Middle East. Mapping humanized social practices is another. (On some subliminal level Hathor-Astarte become agents for a model of coexistence.)

Appendix 2: Scope of Build & Outline of Copper Smelting Process (Specifically for Blowpipe Technology)

Authored by Casondra Sobieralski 2020 for reference for Timna Studios game design team

- Build a clay-lined fire pit as a “furnace.” (This is done before the player arrives on the scene; it is waiting to be prepared for the player. More sophisticated furnaces came later, with bellows.)
    - *The fire pit/furnace is about 60 cm in diameter (23.5 inches), about 40 cm (15 inches) high, ringed in stone. I have pictures of fire pits at Timna, and the sorts of stones used.*

- Light the fire with charcoal and sticks as starting fuel (Also done before the player arrives, a smolder of a fire is going when s/he starts the game.)

- Crush the copper ore to 3-5 cm pieces--process called benefaction
    - *Malachite, a copper carbonate ore of a lovely greenish hue, is good for this level of smelting technology.*
    - *There is a female character in the game doing this benefaction as the game starts.*
    - *The player can have the opportunity to select pieces of ore. Old Man Smelter tells the player to try again if pieces chosen are too big/small.*

- With instruction from the Old Man Smelter, the player can put the copper into a small ceramic saucer-style vessel. The Old Man Smelter or any virtual character can take it and nestle it into the smoldering coals.
    - *You can invent the shape. But in terms of size, it should be about 30% of the size of the fire pit, and a couple of inches deep.*

- Any virtual character can add more charcoal to the smolder. More charcoal can also cover the saucer so that it is surrounded by heat all around, above and below.
    - *This layer of charcoal should be made up of 3-5 cm pieces because the size of the charcoal actually influences how the gasses circulate in the furnace.*
    - *In Timna specifically, the charcoal is likely from Acacia trees. But there are not a lot of trees around. We can show one/some in the distance if you want, but I will verbalize this in the Old Man Smelter’s script.*

- Now the fun part: add air via breath with the clay nozzle tipped blowpipes. (The clay tip is necessary to keep the flammable blowpipe--made of hollow wood--from incinerating. The hottest temperatures are reached close to the tip of the clay nozzle.)
    - *The blowpipe is 3 feet long.*
    - *The nozzle is pointed towards the base layer of charcoal. The hole in the nozzle is about 8 mm in diameter.*
    - *The Old Man Smelter narrates instructions throughout—which I am writing–for the breathing technique, how to select a comfortable breathing speed, what to do if you grow tired or uncomfortable, how to read the flames as information/communication, etc.*
    - *Musicians of Hathor are keeping rhythm with frame drums, and perhaps menat necklaces and/or sistrums. (Conveniently, Heather Kelley, Professor of Entertainment Technology at CMU and Hathor enthusiast, is taking frame drum lessons. So she will record some sound for us!)*

- Changes in the flames show how the smelt is progressing. Green flames mean the copper is turning molten. --but a bit of blue might also waft through the flames. (A copper reducing atmosphere is achieved when carbon monoxide produced by the burning charcoal bonds with the carbon in the ore producing carbon dioxide and metal.)
    - *Plenty of room for imagination, creativity, hallucinatory inferences, here!*
    - *The flames can be a way to work in the snakes, representing air/life force/Ruah.*
    - *In my script, the ibex, coming from the constellation Draco, gallops to the star Venus which morphs into the Semitic goddess Astarte. Astarte rides the Ibex around the celestial circumference three times. This is my G-rated implication of sex so that the copper-baby can be conceived, but you might have better ideas for a "family-friendly" audience.*
    - *The ibex also descends from the sky to morph with the Old Man Smelter to show the shamanic relationship between the two.*
    - *And the ibex, after separating from the Old Man Smelter, gets closer to/farther from the player according to how well s/he is maintaining the fire temperature. This shows the potential for the player to achieve shamanic "powers," too, like an apprentice to the Old Man.*
    - *Flames turning green can be a good time to start hinting at the concept of birthing. For example, faint images of the green Hathor mask could appear in the flames, baby sounds could start coming*

intermittently from the flames, and the volume could wax and wane if the fire temperature waxes and wanes…ideas welcome!

- As the copper melts, red slag is forming and rising to the top of the saucer, while the copper is sinking to the bottom.
    - *Slag (mostly iron oxide) can be encouraged by a virtual smelter sprinkling sand onto the hot, charcoal-topped saucer. (You can probably only see bubbling hints of slag at this point because, remember, there is charcoal on top.)*

- The copper will melt after about 20, 25 minutes if the breathing is steady enough, and the breath volume is adequate enough to heat and keep the temperature at about 1200-degrees Celsius / 2192-degrees Fahrenheit.
    - *If the furnace starts to cool, the player can choose to add more charcoal, or increase volume of breath as per instructions of Old Man Smelter.*
    - *But too much charcoal will make the slag too "gooey" and allow for impurities in the copper.*

- **The copper is "born" from the furnace!**
    - The copper, successfully smelted, is coagulated into little irregular-shaped, pinky-yellow clumps.
    - To reveal it, the ceramic saucer is removed from the fire with wooden tongs.
    - Any remaining charcoal is flecked away, and the slag is poured off the top.
        - *The slag could turn into animate molten snake/s? --see image of metal snakes from Timna.*
        - *Remember the slag is dangerously hot, so consider proximity to seated characters.*
    - We can run wild with imagination as to how we represent copper as birth! --but whatever we come up with should include Hathor.
        - *Priestess of Hathor with frame drums guided birthing labor in Ancient Egypt, so this concept could be incorporated.*
        - *The birthing could potentially also include hallucinations of Bes (the Egyptian dwarf god who oversaw birth, protected newborns and pregnant women) and/or Taweret (an Egyptian hippo goddess that protected childbirth).*
        - *I think some sort of celebration should happen to represent "you succeeded!" which here is "winning" the game. Besides sex, motherhood, and copper, Hathor was all about music, dance...and beer! There is lots of archaeological material on*

festivals of Hathor we can look at–the trick again is keeping it "family friendly" for a museum audience.

- [The next step would be to return fragments of copper to the saucer, put the saucer back in the furnace, melt the purified copper, and pour it into a mold for whatever object you want to make --tool, weapon, jewelry. But I think the birth is the culmination here to best illustrate the theme of my dissertation project.]

Clarifying historical note for you: By the time the Egyptians were in Timna, bellows and a different type of furnace were used for greater fuel efficiency, greater time efficiency, and greater copper output. But because the game is to explore the very ancient relationship between smelting and shamanism via *breath* specifically, the Old Man Smelter tells the player that he is "teaching the old ways."

Technical note:

It takes 20-50 kg of charcoal to produce ~1 kg of copper.
2kg of fuel (charcoal) yields ~1 kg of slag.

(I don't think this will come into play with design, though I might include it in the script to emphasize the environmental impact of early smelting.)

List of Human Characters

- The player, a smelter-shaman in training
- Female ore crusher
- Old Man Smelter-Shaman (narrator)
- 4 additional active virtual smelters + 1 "stand-by" smelter to give others--including the player--breaks if needed
    - for each, the player choses Egyptian or Semitic ethnicity, and male, female, or non-binary gender expression
      (Remember both Astarte and her priests had non-binary aspects. This is actually a historical allusion.)
- Musicians of Hathor (unspecified number)
- (via sound) Baby

List of Non-Human Characters

Hathor
Astarte (in the sky)
Ibex
Snakes
Birds → as messengers, can they "on-click" deliver data, like fire temperature and breath
volume of players?
Fire → Flames as communicators of fire conditions, smelt progress
Copper ore → becomes baby
Air, wind
Planet Venus
Stars, constellations
[Furnace? Considered a "womb"]
[Acacia trees and charcoal, maybe?]
[Potentially hallucinatory roles for Egyptian deities Bes and/or Taweret, as protectors of
Childbirth]

Props and Potential Props

Clay-tipped blowpipes
Saucer for ore
Tongs to remove ore
Frame Drums
Sistrums and menat necklaces (can be used at birthing celebration if not to keep rhythm)
Copper mirrors of Hathor (photos available)
Any offerings to Hathor? --seashells, jewelry, beer…
Clothing and jewelry of characters (photos available)

Appendix 3: Player Walkthrough: “Cult and Copper” installation instructions, game instructions, and character script

Authored by Casondra Sobieralski.
Original version Sept 10, 2021, condensed for appendix March 30, 2022

This Player Walkthrough serves as archival material representing part of the design research process for the “Cult and Copper” VR game. The document as presented here, however, has been condensed for this appendix. Through my two quarters of collaboration with the Serious Games graduate students, the Player Walkthrough communicated my design vision to my engineering team and grounded their work in historicity. The document also serves to archive my full vision for the game because the VR playable prototype could only realize a “slice,” in design terminology, of that vision.

Where the VR Game is Situated/The Use Setting

This VR game/experience is in a public educational context. Ideally it should be installed at the Timna Park Visitors’ Center in the southern Negev, Israel, since Timna is the setting of the game. However, other museums with Near Eastern archaeology collections on display, particularly museums that integrate interactive media with tangible objects and artifacts, are also appropriate. Examples include the Egyptian and Rosicrucian Museum in San Jose, California (https://egyptianmuseum.org/gallery-d-religion); the Kelso Near Eastern Archaeology at the Pittsburgh Theological Seminary in Pittsburgh, Pennsylvania; the Israel Museum in Jerusalem; and the Hecht Museum at University of Haifa.

As the visitor enters the gallery space hosting the VR installation, she encounters a VR play space designated by a “stage” area 6 feet deep by 8 feel wide, situated

against the longer wall in the room. That stage is demarcated by a three-inch deep sandbox with Timna-colored sand and some sonifying slag. Realizing that museum staff might get frustrated with sand and rocks ending up outside the sandbox, perhaps the Hecht Museum in Haifa could offer maintenance advice; in the Phoenician section of this museum, the visitor walks on pebbles: https://www.youtube.com/watch?v=4FrvXiAOKes. A low-relief Timna-inspired rock formation (using set design tricks) emerges from the rust-colored wall. The depth at center stage is one inch, the depth at stage right is about eight inches.

Near the middle of the sandbox, offset slightly stage left, is one Bedouin-style cushion for sitting. (A future iteration of this game could be multiplayer, but this first prototype is designed for one human player who is accompanied by virtual human smelters in-world, one of whom acts as a guide/narrator.) This game is played sitting because smelting with blowpipes is done sitting. This is also for safety, however, in case any player experiences lightheadedness from sustained deep breathing.

To the right of the sandbox/stage is a computer and VR headset station staffed by a visitor services attendant dressed as an Egyptian mining manager. (Docents and staff at the Egyptian and Rosicrucian Museum often wear costumes, so this is a reasonable expectation.) The attendant oversees the use of, and cares for, the VR headsets. She also is responsible for handing out “blowpipes” and maintaining hygienic condition of the pipes, especially in the post-covid-19 era. These “pipes,” which are part of the breath interface, might be 3-foot hollow bamboo tubes (as from a horticulture supply store). Blowpipes also had clay nozzles, but unless there is budget enough to replicate actual models, assume the nozzle will be rendered at the end of the pipe in the virtual world only.

On the wall stage right, near the staff attendant, is a panel that says "Bronze Age Copper Smelting in the Negev." The text of the panel is as follows:

> *The Egyptians managed Bronze Age smelting operations at Timna under five pharaohs, probably beginning with Seti I or Rameses II and lasting through Rameses V, so about 1280–1145 BCE according to archaeologist Uzi Avner.*[365] *Timna, now a national park, is in the southern Negev desert in what is now Israel. Copper production seems to have been a collaboration between Egyptians and the local tribes of the Timna area. The Egyptians at TImna maintained a sanctuary to their goddess Hathor. In Thebes, Hathor was associated with music, dance, motherhood, and beer, but in the mining camps of the Negev and Sinai, her role as "Goddess of the Mountain" was highlighted. As such, Hathor was associated with copper, malachite (a kind of copper ore), and turquoise. Hathor was closely related to the Semitic goddess Astarte; so they took on attributes of each other throughout Syro-Palestine, Egypt, and eventually Cyprus when the copper industry migrated there by way of the Phoenicians. Because copper has played an important role in the history of networked information systems from the telegraph to the telephone to computers and the internet, one could argue that the roots of digital culture lie in the Bronze Age, when humans first industrialized copper production. Since ancients in the Eastern Mediterranean associated powerful love goddesses with copper ore as part of the fecundity of the land, and perhaps with the "birthing" of copper from the smelting furnace, these goddesses should be celebrated as part of technology history.*
>
> *Ghassaulian culture from the Chalcolithic Era*[366] *(just before the Bronze Age) and Timna excavations of Iron Age*[367] *(just after the Bronze Age) suggest that copper smelters held shaman status in the Negev. They oversaw a mysterious alchemy-like process. This Virtual Reality experience encourages speculation about the relationship between*

[365] Uzi Avner, "Egyptian Timna Reconsidered," in *Unearthing the Wilderness: Studies on the History and Archaeology of the Negev and Edom in the Iron Age*, ed. Juan Manuel Tebes (Leuven: Peeters, 2014), 104.

[366] Milena Gošić, and Isaac Gilead, "Unveiling Hidden Rituals: Ghassulian Metallurgy of the Southern Levant in Light of the Ethnographical Record," in *Copper and Trade Routes of the South-Eastern Mediterranean,* ed. Karolina Rosińska-Balik Agnieszka Ochał-Czarnowicz Marcin Czarnowicz Joanna Dębowska-Ludwin, Bar International Series 2753 (Oxford: Archaeopress, 2015), 25-30.

[367] Lidar Sapir-Hen, Omri Lernau and Erez Ben-Yosef, "The Diet of the Ancient Metal Metal Workers: The Late Bronze Age and Early Iron Ages in the Arabah Valley (Timna and Fayan)," in *Mining for Ancient Copper: Essays in Memory of Beno Rothenberg*, ed. Erez Ben-Yosef. Monograph Series of the Sonia and Marco Nadler Institute of Archaeology, 37 (University Park, Pennsylvania: Eisenbrauns, 2018), 76-77.

smelting and shamanism. Might this relationship have existed because of altered states of consciousness induced, at least in part, from the sustained deep breathing techniques necessary for heating and operating smelting furnaces with blowpipes? (Altered states and hallucinations can also occur from oxygen deprivation from sitting too close to the fire, or from smelting fumes. One can also speculate, however, that smelters soon learned to correct these errors that would make them feel unwell.)

In this VR game, using a specially designed breath interface, your mission is to ensure a successful smelt using a blowpipe. In the virtual world, you will be instructed and guided along the way by humans, animals, elements, and spirits. Remember if you do not succeed in your mission, computers and Instagram might never come to exist! Smelting prior to bellows took a lot of lung capacity and a lot of endurance, so you can choose to play at beginner, intermediate, or advanced level according to your comfort level. You can adjust your player level at any time, but take a break if at any point you begin to feel lightheaded, dizzy, or uncomfortable. An avatar will take over for you. In fact, because many aspects of intangible heritage–such as craft practices, performing arts, and rituals–are unknowable prior to the invention of recording technologies, we do not know if smelters worked all at the same time, or if they took turns to give each other breaks. What do you think? What other questions does this game raise for you about the intangible heritage of copper smelting?

Please allow about 20-30 minutes for this game experience.[368]

To the left of the sandbox is a bulletin board with a "chalkboard ledge" for a box of mini-pencils and two-inch by four-inch pieces of yellow/orange paper. Visitors can leave their answers to these questions posed about intangible heritage, as well as read other visitors' responses and ideas.

[368] In practice, a 20-30 minute time commitment as an ideal is a very grand expectation for museum visitors. So the actual prototype is built for a shorter time. I suggested a minimum of 10 minutes, the design team argued for less. We shall see what playtesting reveals as being a realistic length of game play.

“Gearing Up” for the Game

The museum attendant hands you a VR headset, a hand controller, and a long tube simulating a blowpipe. This “blowpipe” includes a breath interface. She explains what each component of the game system is. She informs you that the game uses breath as the primary interface, but that the traditional hand controller can be used to stop and start, pause, or stop the game. It can also be used to express choices, or to get informational data during the game if you want it. (These numerical readouts include time spent playing, furnace temperature, and breath volume. They do not appear by default because the game encourages you to use your senses and your body to gather information.) The attendant will introduce the game with safety guidelines. Suggested wording is as follows:

> *An avatar in the VR world will give you instructions as to how to play the game, which is experiential rather than competitive or points driven. The game requires deep rhythmic breathing over a sustained period of time. Most people find this experience to be very relaxing or meditative, but if you feel any discomfort or lightheadedness, or if you just get tired, return to your natural breath pattern. This is not quitting, as the game is designed to give you the option to take breaks. If you need to rest, virtual guides within the game can take over for you. Just use the hand controller to indicate that you do need a break. --unless of course you need to stop immediately for your safety. In that case, simply abandon the game and I will take care of resetting it. If you come back and play the game, each time you will gain more endurance, just like with running or swimming.*

Journey into the Game World

The player puts on the VR headset and sees a still image of the Timna landscape with a text box in the middle of the field of vision: “Use [Button A] on your hand controller to start the game.” The next text box says, “Choose a language,” with English, Arabic, and Hebrew listed vertically as choices. (This first iteration will be in

English only, and later versions can be translated.) For greater accessibility, a third text box says, “Do you need subtitles?” The player uses the controller to choose yes or no.

The game begins with a 360-degree landscape and ambient sounds of the “Mushroom Area” of Timna National Park, which is one location in the park where copper was smelted. It is dusk, and over the duration of the game dusk will turn to night to show the passage of time. The sky overhead will slowly fill with stars and constellations. Paul Craddock suggests that smelting was easier at night because laboring over the fire would have been more difficult in the scorching desert during the day. He also notes that it was easier to see the colors and qualities of the flames at night, and smelters read the flames to monitor the progress of the smelt.[369] Artistically, night often signifies an ambience conducive to dreams and visions. The night is enchanting.

With a high budget, an ideal aesthetic would be a soft and atmospheric Realism ala “Relive the History of Bruges.” (https://store.steampowered.com/app/563830/Historium_VR__Relive_the_history_of_Bruges/).

Alternatively, an appropriate, simpler aesthetic is expressed in the 2D indigenous game “Don’t Wake the Night” (https://store.steampowered.com/app/1431180/DONT_WAKE_THE_NIGHT/ https://brujeriaatwerk.com/dont-wake-the-night/#about). Though the wood and soil colors are not correct for the geographical area represented in this game, this meditative shamanic music video with a smoking fire provides aesthetic inspiration

[369] Paul T. Craddock, *Early Metal Mining and Production (*London: Archetype Publications Ltd., 2010), 200-201.

regarding pace and atmospheric quality:

https://www.youtube.com/watch?v=GIwYon0xTq0

The camera view represents the first-person point of view of the player, who is in the middle of the Timna landscape ringed with hills and rock formations. There is a smelting “furnace” (a fire pit at this stage of blowpipe technology) that is initially about 5 feet in front of her, near the center of the 360 space. The fire pit is about two feet wide, fifteen inches high, and ringed with stone. It is filled with charcoal and acacia wood.

Figures 70 through 83: Worldbuilding reference images of the “Mushroom Are” in Timna Park. Photos by Casondra Sobieralski, 2017.


הפטריה
The Mushroom
הפטריה ומחנה ההתכה
The Mushroom and Smelting Camp


Workshop
חצר מלאכה

On the opposite side of the fire, to the right relative to the player, is the guide and narrator. He is a weathered old man of about 88 years. He is sitting with a three-foot blowpipe by his side. He wears ancient Semitic/Canaanite clothes, as depicted on the informational panels at modern-day Timna Park. Three more blowpipes are propped vertically against the rocks behind him. Each blowpipe has a ceramic nozzle at the end. This nozzle, when pointed at the bottom of the base charcoal layer, directs airflow more precisely to increase heat.

Old Man: I have been waiting for you, my friend. Come closer to the fire and take a seat. But first, use [Button A] on your controller to choose how you want us to see you.

(A menu of characters appears hovering in front of the player, above the horizon line. The player can choose: a young man, woman, or non-binary character (about 18) in Semitic/ Canaanite clothes; a mature man, woman, or non-binary character about 45 in Semitic/Canaanite clothes; a grand-fatherly man/grandmotherly woman (about 65-75) in Semitic/ Canaanite clothes. Or, the player can choose to be an Egyptian worker representing the same ages/genders as the Canaanite characters. All told there are 16 character choices based on age, gender expression, and one of two ethnicities. These ethnicities–Canaanite and Egyptian–represent the people who were involved in the copper industry at Timna in the Bronze Age. After the player choses...)

Figures 84-85 Top Left and Right: For worldbuilding reference, interpretive Panels at Timna Park, 2017.

Figure 86 Bottom Left: For worldbuilding reference, jewelry from Timna in the Eretz-Israel Museum, Tel Aviv, 2017.

Figure 87 Bottom Right: Chalcolithic jewelry from the Israel Museum, Jerusalem, 2018. Photos by Casondra Sobieralski.

Old Man: Ahh! It is nice to have an embodied presence to match your spirit. Now please use [Button A] on your controller to choose 3 companions to sit by the fire.

(The same menu of characters appears, and the player clicks on three choices.)

Old Man: Very good. They will join us shortly. It takes four-to-six people with strong lungs to heat a smelting furnace and keep it going, you know! While we are still alone, let me explain where we are and what we are doing. We are in the Negev desert, a copper-rich place called Timna. It is the Late Bronze Age. On your calendar, the year would be about 1250 BCE, almost 2800 years ago. Long before my day, local tribes mined and smelted copper here. Then the Egyptians came, and stayed under the reign of five of their Pharaohs. We taught them our technologies, and over time, they taught us how to organize our tribes into more powerful political units. We learned from each other.

(The old man stokes the fire with a stick and an apparition of Hathor appears from the fire.)

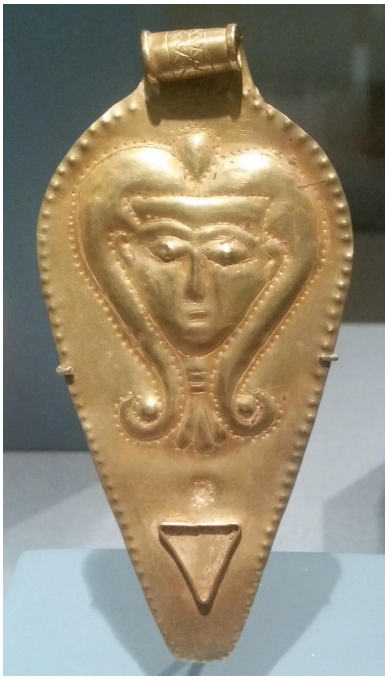
Figure 88: Faience Hathor mask of Hathor, on display at the Eretz-Israel Museum, Tel Aviv, 2017. Photo by Casondra Sobieralski

Old Man: The Egyptians brought one of their favorite goddesses, Hathor. She was a good-time goddess representing all sorts of pleasures–music and rhythm, dance, beer...she was also a goddess of motherhood. And the Egyptians here, they really appreciated her as the Goddess of the Mountain. The Egyptians back in Thebes did not think about this aspect of her so much, but here–copper is in the mountains. We, the local people, really like Hathor, too. She reminds us a lot of our own goddess, Ba'alat, whom people later called her Astarte. Have you heard that name where you come from?

(The apparition in the fire keyframe-morphs into a representation of Astarte with Hathor hair flips.)

Figure 89 Left: For worldbuilding reference, Canaanite goddess with Hathor hairstyle, Bible Lands Museum, Jerusalem, 2018.

Figure 90 Right: For worldbuilding reference, Syro-Palestinian goddess figurine, Israel Museum, Jerusalem, 2018.




Old Man: The Egyptians were very respectful of our gods and goddesses as well. This gained our trust.

(He stokes the fire with the stick again, and the apparition shrinks back into the flames. After a pause…)

Old Man: So what I am going to teach you today is a very, very secret knowledge. Very secret. You must promise not to tell anyone. I cannot say you will turn to a pillar of salt if you do, just…don't. I am going to teach you to smelt copper ore with your breath, the life force, "ruah." This is a very old technology. Today, now that the Egyptians are here, we use bellows–manual air pumps–to speed production. But I am going to teach you the old, traditional ways. Then you can understand why, way back, smelters started to be regarded as shamans. Magicians, in union with the goddess. To be a metalsmith is to be a magician.

(The old man picks up a large rock for emphasis…)

Old Man: It is magic to turn a solid rock into a liquid, and then turn that liquid into a tool, or a weapon, or a piece of art when the copper is born. We and we alone, in concert with the goddess, hold the knowledge of how to do this. That is why you cannot tell anyone. Our power is in maintaining this secret, her secret. Shhhhhhhhhh!

(The wind blows to blend with the breath of his shhhhh.)

Old Man: OK, now grab your blowpipe, hold it in front of you, and watch me.

(The player holds the physical tube representing a blowpipe in front of her physical body. She sees the end of it in the virtual world in front of her virtual body. Added in the virtual world is the clay nozzle that blowpipes had for directing airflow more precisely.)

Old Man: I want you to take a breath deep, deep into your belly. Imagine it filling the space behind your belly button. Take the breath in, try three counts, and then feel the breath expand in the space around your heart for two more counts. Then exhale through the length of the pipe. Just let your breath fall through the pipe. Don't blow like a birthday candle. The pipe will guide your exhale. Ready? Watch twice, and then try that three times with me. First watch. In, 2,3, higher, 2, out through the pipe. In, 2,3, higher, 2, out through the pipe.

(The player watches for 2 rounds of breath. She can see the inhalation filling the old smelter's body then exiting it through the pipe.)

Old Man: Now try it yourself. I will do it with you. Was that pace comfortable for you? People have different lung capacities.

(After three rounds of breathing by the player, a menu appears. The menu says, "Choose your breath rate," followed by three options, listed vertically: "This was just right." "I need to breathe in a little faster to get to five." "I need slower, deeper breaths." The player makes a selection.)

Old Man: OK, so you need to breathe in a little faster [/slower]. We can do that. Now the hard part is, we have to do this breath for twenty minutes. It takes about an hour to "preheat" the smelting furnace to 1100-1200 degrees Celsius, which is 2012-2192 degrees Fahrenheit. That is the temperature needed to melt copper ore. --but I knew you were coming to your first smelt, so I already did that for you. With the

furnace warmed with charcoal and wood, it then takes about twenty minutes to melt each batch of copper ore. We will melt one batch together today. You can come back another time to melt more. So do you think you can maintain that pace of breathing for twenty minutes and be comfortable? If not, we can adjust. Use [Button A] on your controller to reset your pace.

Twenty minutes might seem like a long time on your first smelt. So remember, anytime you need to take a break, just stop breathing into the blowpipe, and another smelter will breathe for you. Most people need to take breaks when they are first learning. It is good to take care of yourself! Whenever you feel rested ready to start again, just start breathing into the pipe again and that smelter will rest while *you* take over.

(A sensor responds to the presence or absence of breath through the breath interface.)

Old Man: It takes practice to get the right rhythm. And speaking of rhythm, it is a lot easier to synchronize our pace as a group if we all listen to the drums of Hathor to help us keep count. The drums are set to match the pace of breath that you selected. But any time you want to turn the drums off, and just listen to your heartbeat, click on any musician with your controller. Click again two times to turn the drums back on. Are you ready?

(At a relaxed pace, six musicians of Hathor make a loose circle around the old man and the player, leaving room for more smelters to enter the scene. They begin to keep rhythm with their frame drums, according to the pace the player sets with the controller. After about one minute of sound, three more smelters walk into the scene. Each picks up a pipe set against the rocks behind the old man, and each sits next to the fire in view of the player. Each of the three smelters joining is characterized as per the tribe and gender expression that the player selected in the beginning. An older woman in the background is cruising rocks. She walks towards the player with a flat, round tray of what look like small pebbles of different sizes.)

Figure 91: Musician with a round frame drum in the temple of Athribis. Photo by H. Köpp-Junk,

https://www.asor.org/anetoday/2018/01/earliest-music-egypt

Old Man: My friend Anat here helps us out by crushing the rocks to free the bits of copper ore. This is a process called benefaction. Use button [Button B] on your controller to pick up a piece of ore.

(The player selects one of the small rocks and picks it up with the VR controller. Keeping the button pressed holds the rock, releasing the button drops the rock.)

Old Man: Ehh, not bad. But it is a little large for today. The best selection would be about 3.5 centimeters. Try again?

(The player selects a more appropriately sized rock and picks it up with the VR controller.)

Old Man: Excellent! You can put that here in the crucible.

(The player releases the rock into the furnace.)

Old Man: There will be four of us smelting, and my friend over there will be on standby in case you need to rest. Remember, use [Button A] to change the rhythm of your breathing if you need to, and click on the drummers if you want them to take a break. If you need to take a break yourself, simply stop exhaling into the blowpipe. To resume after resting, just start exhaling into the pipe again. You will have guides along the way. Are you ready to begin? Start exhaling through the pipe, to the rhythm of the drums, when you are ready to begin, and we will follow. Inhale three

counts into your belly, two counts into your heart, exhale through the pipe. Do not *inhale* through the pipe, or you will inhale smoke! In fact, move the pipe away from your mouth to inhale.

(The player begins using the blowpipe.)

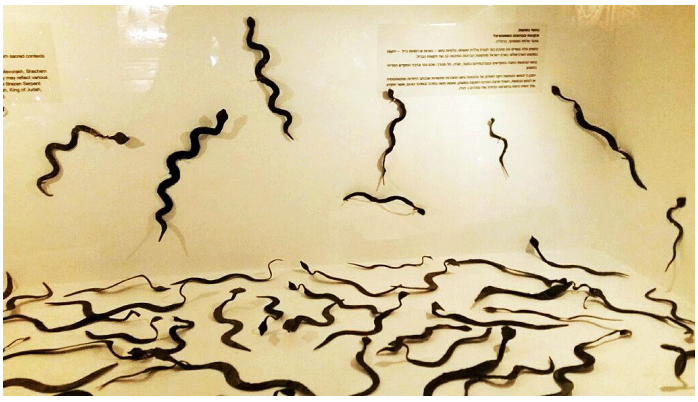
Old Man: Excellent, excellent, count your breaths with the drum beat. Remember to move the pipe away when you inhale. Let's try to keep that going for three minutes. Pay attention to the fire. The fire will communicate to you.

(After 3 minutes, a wisp of a rust-colored snake, part of the flames, appears from the crucible and stares the player in the eyes for 5 full inhalation and exhalation cycles. It's as if the snake is dancing to the flute of a snake charmer, but she is dancing to the player's breath. Then the snake speaks.)

Snake: I am Ruah, the divine spirit of breath. I bring life force into your furnace so the copper can be born. We will meet again at the end of your smelting journey. One does not always have to travel far to go somewhere new.

(The snake falls back into the flames and merges with them.)

Figure 92: Copper snakes from Timna, exhibited in the Eretz-Israel Museum, Tel Aviv, 2017. Photo by Casondra Sobieralski



Old Man: In order to meet Ruah again as she predicts, you need to separate the iron from the copper. The copper is heavier, so when the ore is liquified, the copper will sink. The iron will float to the top, and we will tap the furnace to let the iron run out. That iron is slag. You can see and hear it all around us on the ground.

(One of the virtual smelters, who is “on call” for anyone needing a break, picks up a handful of slag and lets it fall through his/her hands. It hits slag on the ground to produce a distinct metallic twinkling sound. *Note: I have 2D and 360 video of this to use for visual and audio reference*.)

Old Man: And how do you know when the copper is liquified? The fire will tell you.

(It is halfway between dusk and dark now. The stars and constellations are becoming visible. From the constellation Draco, the white outline of an ibex appears, shaped like the ibexes on pottery from the Negev and Cyprus. The ibex gently descends from the heavens and merges with the body of the old man until only a faint impression of the old man’s human form remains as a superimposition. The ibex, mediator between day and night, earthly and heavenly realms, speaks through the Old Man as his shamanic form.)

Figure 93 Left: Chalcolithic ritual item from the Negev.

Figure 94 Right: Chalcolithic pottery from the Negev.
Both exhibited at the Eretz-Israel Museum, “Masters of Copper” show, 2019.
Photos by Casondra Sobieralski.

Old Man as Ibex: When the copper becomes liquid, green flames will tell you. But first you must get the furnace hot enough, to 1100-1200 degrees Celsius, or 2012-2192 degrees Fahrenheit. This is the work of your breath. Remember, if you get tired, you can take a break and another smelter will take over for you. But that smelter cannot raise the temperature, only hold it steady for you. At any time you can check the temperature of the furnace by finding a bird in the sky. Use your controller to click on the bird. Birds can bring you data messages. It is best if you can learn to communicate directly with the fire. But as you learn, you can call on the birds to help you.

(If a bird is called upon, it flies within a few feet of the player. It carries a scroll that unrolls downward and provides data on the amount of breath volume being exhaled per minute, the total breath volume exhaled, time elapsed, and the fire temperature. This data is collected through the spirometer breath interface driven by an Arduino converting the air pressure from analogue to digital. The bird flies off and out of view with the scroll when the player clicks on the bird or scroll.)

(From the constellation Draco, an ibex runs to the star Venus. Venus shimmers into Ba'alat/Astarte, and kisses the ibex. She climbs onto his back and rides the ibex around the circumference of the horizon for three of the player's breath cycles. Then the ibex gently places Ba'alat/Astarte back where Venus belongs in the sky, and the goddess turns back into a planet. The ibex goes back to the constellation Draco and fades back into being a collection of stars. The first copper-green wisp of flame rises from the fire. The impression of a snake is in the flame. But this first green snake-like flame is just a foreshadowing of what color to look for, and a foreshadowing of new life from the union of ibex and goddess. So the green snake rises out of, and melds back into, the orange-red flames in the span of 20-30 seconds.)

(When the copper eventually turns molten is determined by real-time breath data. Green flames will probably start appearing after about 15 minutes of breathing; but the temperature can start dropping, too, if the player is not lending enough "ruah" to the fire. When the first green flames start to appear, an ibex starts coming near the player, in her peripheral vision. Sound of hoofs on slag or sand can cue the player to the ibex's presence, which is especially important if

the ibex is behind her. As the copper turns molten, the ibex comes closer to the player. However, if the temperature starts to drop, the ibex can also move further away, even hide. If the player starts to turn and look at the ibex, and/or if the player gets too distracted by the snake, the old man says…)

Old Man: Keep your eyes on the fire. Let it speak to you.

Script if the fire temperature starts dropping:
(first time temperature drops) Snake: If you cannot see us shimmering green, your furnace is cooling. You can choose to add more breath, or use [Button B] to add more charcoal. But don't add too much, or your slag will get sticky!

(Player can breathe deeper and the sensor will register more breath; or the player can click [Button B], which will make a basket of charcoal appear in the menu box. The player can select pieces of charcoal. If she adds the right amount of charcoal, green snakes appear in the flames to confirm a good job. If she adds too much charcoal, the ibex gets more distant, and the **Old Man Smelter** says, "Too much charcoal, so use less breath for a moment. The snakes will show you when you achieve the right balance.")

(When the furnace reaches the right temperature and that temperature stays stable, about 70% of the flames will be and stay green.)

(if the temperature drops subsequent times) Old Man Smelter: Where have your green snake messengers gone? Time to adjust the temperature again with more breath or with charcoal. [Button B] can get you to more charcoal.

(upon completion of the smelt) Old Man Smelter: Look, you have a friend.

(The soft sound of a baby crying comes from the sky, and the ibex becomes an affectionate companion to the new smelter, the player.)

Old Man Smelter: Good work! First, we must slag the copper. Then, it is time to celebrate the birth of the copper!

(The smelter uses wooden tongs to tip the ceramic dish, a safe distance from anyone's skin as the slag is very hot! The slag

runs into the sand as rust color snakes, and the snakes scurry from the fire pit. They cool and freeze into snake shapes on the ground.)

(The drummers release their slow steady breathing rhythm, go into a dance rhythm, and start dancing--party! Musicians playing sistra–a rattle-like instrument sacred to Hathor–join them to bless the newborn copper and banish any ill-will spirits with directed sistrum shakes and focused intention. The smelters drink beer, as beer is sacred to Hathor. They offer a Hathor mirror to the successful player, a new parent! The benefaction lady makes an offering of beer to the perimeter of the furnace--taking care not to cool it, as it needs to stay warm for the next smelt. She places shells and a tiny figurine of the god Bes, who protects newborns and new mothers, around the furnace as offerings to Hathor.)

(**Note:** For a simplified version of this Hathoric birthing celebration, Bes can dance around the smelters to the rhythm of frame drums, and the player is awarded a Hathor mirror by whatever means are easiest to program.)

(References for items that can be awarded to the player: beads, a copper Hathor mirror, a medallion of Astarte, and a sistrum blessing for her success. At minimum, a Hathor mirror should be offered as a “prize.”)

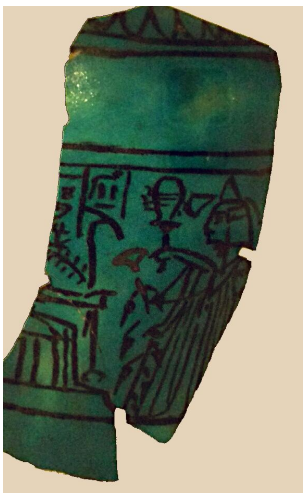
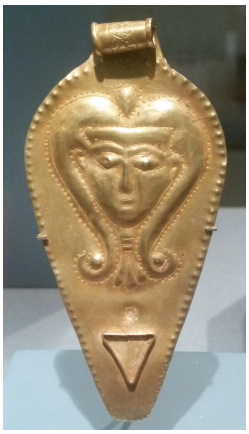


Figure 95: From Timna, a fragment of a faience sistrum that also depicts a sistrum. Eretz-Israel Museum, Tel Aviv, 2017. Photo by Casondra Sobieralski.

Figure 96 Top Left: Canaanite goddess with Hathor hairstyle, Bible Lands Museum, Jerusalem, 2018.

Figure 97 Top Right: Bronze goddess Mirror, Israel Museum, Jerusalem, 2018.

Figure 98 Bottom: Egyptian necklace, Israel Museum, Jerusalem, 2018.
Photos by Casondra Sobieralski.



What happens if the player does not follow instructions?
If it is early in the smelt, the Old Man Smelter can remind the player that the birth of the copper depends on taking this seriously. If the player does not listen, a horrible crying baby sound takes over the game. Game action freezes. If it is later in the smelt, when the ibex is present, the ibex can become “ornery,” snort and stomp like a bull about to charge. If the player does not correct course, again the annoying baby sound dominates the game.

Appendix 4: Paradata Notes for “Cult and Copper” VR Game

Authored by Casondra Sobieralski January 2022

[To be provided as a web page reference for players.] As a cyber-archaeology game about intangible heritage, “Cult and Copper” relies on what archaeological evidence is available to create as much historical veracity as possible. However, all representations of the ancient past require some speculation and imaginative elements because no one can time travel to witness events as they unfolded; no one knows exactly what artifacts meant to people of that time. Intangible heritage, being ephemeral, often necessitates an extra level of speculation. Thus the purpose of this paradata document is to call attention to places in the game where design and script choices were based on evidence, and places where lack of evidence or aesthetics required imaginative choices. Topics covered herein include:

- Landscape and Setting
- Stylistics and Characters
- Technical Aspects of the Smelting Process
- Drumming and Smelting
- Breath, Smelting, and Shamanism
- Ideas About Smelting as Birthing
- Mythologies
- Notes on Sounds/Audio

Landscape and Setting: The setting for “Cult and Copper” is based on/evocative of the Timna Park’s “Mushroom Area.” Timna is now a national park in the southern Negev desert. The park is within the modern borders of Israel. The Mushroom Area is one location in the park that includes evidence of smelting such as architectural remains of workshops, remains of furnaces, and copious amounts of slag (which is a byproduct of smelting). The landscape is not an exact replica of Timna based on GIS, Lidar, or other measurement data. However, it does a good job at creating the “feeling” of this particular area of Timna National Park. The 3D modeler for the game, Wenbo Xie, used field research photos, videos, 360 videos, and sound recordings captured on site by historical researcher and concept artist Casondra Sobieralski in 2017. Sobieralski traveled on research funds from the National Science Foundation (NSF) as part of the International Research Experience for Students in Coastal Zone Research (IRES).

To see Sobieralski’s documentation about the Mushroom Area and other regions of Timna National Park, see “Mapping Hathor Through Canaan” media repository in Google Earth:

https://earth.google.com/earth/d/1jYpjkNpzFza4VU_ojJ1LWN2tk7WE1Csn?usp=sharing

Figures 99 and 100: Images from the Mushroom Area of Timna Park, Israel.
Photos by Casondra Sobieralski, 2017.

Stylistics and Characters: Ideas about collaboration between Egyptians and Canaanites at Timna is supported by research on cultic architecture and smelting technologies as per the writings of Uzi Avner and Erez Ben-Yosef. However, archaeologists to date do not know exactly who did what in terms of labor, or what the relationships were among the different cultures at this location. Avner and Ben-Yosef both suggest that the Middle Kingdom Egyptians involved in copper production used technologies created by local Semitic tribes, though Ben-Yosef suggests that a second wave of Egyptians who came to Timna later might have made additional technological contributions. [See: Uzi Avner, "Egyptian Timna Reconsidered," in *Unearthing the Wilderness: Studies on the History and Archaeology of the Negev and Edom in the Iron Age*, ed. Juan Manuel Tebes (Leuven: Peeters, 2014), 144. Also see: Erez Ben-Yosef, B Liss, OA Yagel, O Tirosh, M Najjar, and TE Levy, "Ancient Technology and Punctuated Change: Detecting the Emergence of the Edomite Kingdom in the Southern Levant," *Plos One* 14, no. 9 (2019), https://doi-org.oca.ucsc.edu/10.1371/journal.pone.0221967.] Petroglyphs in the Chariot Area of Timna Park serve as another reference. They depict Egyptians and local tribes of Timna working together to produce copper. See again Sobieralski's photographs in "Mapping Hathor Through Canaan": https://earth.google.com/earth/d/1jYpjkNpzFza4VU_ojJ1LWN2tk7WE1Csn?usp=sharing

No one knows what the role of women or other genders might have been in mining or other aspects of copper smelting in this area. For research on this topic in Cyprus, specifically, see the work of: Diane Bolger, *Gender in Ancient Cyprus:*

Narratives of Social Change on a Mediterranean Island, Gender and Archaeology Series, V. 6. (Walnut Creek, CA: AltaMira Press, 2003). It is the hope of the author that this game will encourage players to imagine, speculate, and conduct further research on these important topics. Using stylistics from both cultures is a prompt to do so. The design document, if not the 2022 game prototype, also offers a variety of genders for avatar to prompt such questions and speculations.

The option for non-binary characters as expressed in the design document is in part to honor diversity and inclusion, but it is also a historical reference. Two small terracotta sixth century BCE (Helenistic) figurines near Kition possess female pubic areas and male upper bodies. Each is believed to be linked to the cult of Astarte. [See: Bonnie MacLauchlan, "The Ungendering of Aphrodite," in *Engendering Aphrodite: Women and Society in Ancient Cyprus*. Vol. 3;7, ed. Bolger, Diane and Nancy J. Serwint (Boston, MA: American Schools of Oriental Research, 2002), 366. doi:10.5615/j.ctt2jc9sc.] David T. Sugimoto notes that hermaphroditic figurines representing Astarte, with both breasts and beards, have been found in Transjordan, an area of the southern Levant not far from Timna. [See: David. T. Sugimoto, "The Judean Pillar Figurines and the "Queen of Heaven"", in *Transformation of a Goddess: Ishtar--Astarte--Aphrodite*, *Orbis Biblicus Et Orientalis, 263,* ed. David. T. Sugimoto (Fribourg: Academic Press, 2014), 163.] This challenges the notion that Astarte's dual-gender representation was unique to Cyprus, unless the figurines came from Cyprus through trade.

Clothing and jewelry for characters was inspired by museum research at the Israel Museum and the Museum of the Bible Lands in Jerusalem; the Eretz-Israel Museum in Tel Aviv; the British Museum in London; the Kelso Museum of Near Eastern Archaeology at the Pittsburgh Theological Seminary in Pennsylvania; the Egyptian and Rosicrucian Museum in San Jose, California; and by visitor information panels at Timna National Park.

Technical Aspects of the Smelting Process: Technical specifications about the smelting process are abundant in "Cult and Copper." These include what ores were used, what temperatures were needed to melt copper, the approximate durations of copper smelts with a "preheated" furnace versus an initial smelt starting with a cold furnace, the size of the furnace, the use of blow pipes, the fact that flames turn green when copper ore turns molten, the fact that blowpipes were tipped with clay nozzles (so that the blowpipe was not incinerated and for control of the airflow), and the presumption that a successful smelt with blowpipes required 4-6 smelters. Sources for this information include:

Paul T. Craddock, *Early Metal Mining and Production (*London: Archetype Publications Ltd., 2010), 129-348.

Conversations with Walter Fasnacht, Experimental Archaeologist at University of Zurich, Switzerland. Interviews via Zoom, December 23, 2020 and April 16, 2021.

Facebook videos/photos of experimental smelting by Ben-Yosef's Central Timna Valley Team, available at: https://www.facebook.com/CentralTimnaValleyProjectCtv/videos/270100387406102 and https://www.facebook.com/CentralTimnaValleyProjectCtv/posts/3097163837029718.

Drumming and Smelting: No one knows if there was drumming or other guiding rhythm during smelts in the ancient Negev. However, when Sobieralski conducted playtesting of breathwork with volunteers that included performers, game designers, and digital heritage enthusiasts, participants unanimously wanted some sort of rhythm or beat to guide their breathing. Sistra and menat necklace artifacts excavated at Timna are on display at the Eretz-Israel Museum. Both were used as rattle-like instruments by musicians of Hathor. No evidence of frame drums seems to exist at Timna, but drums made a better aesthetic choice for the contemporary ear; sistra have a rather grating sound. The added detail about drumming is not historically verifiable; though plausible, it is the product of informed imagination. Also, frame drumming can further the idea of smelting as birthing: At Dendera temple in Egypt, a hallway with reliefs depicts thirty-two priestesses dressed as Hathor playing frame drums. The hall ends in what archaeologists interpret to be a birthing chamber. The architectural decoration seems to suggest that priestesses used rhythm to guide women through labor contractions and through the dangerous journey of birth. [See Layne Redmond, *When the Drummers Were Women: a Spiritual History of Rhythm* (New York: Three Rivers Press, 1997), 101-103.]

Breath, Smelting, and Shamanism: For sources on the relationship between the link between smelting and shamanism in the ancient Levant, see:

Uzi Avner, "Egyptian Timna Reconsidered," in *Unearthing the Wilderness: Studies on the History and Archaeology of the Negev and Edom in the Iron Age*, ed. Juan Manuel Tebes (Leuven: Peeters, 2014), 144.

Milena Gošić and Isaac Gilead, "Unveiling Hidden Rituals: Ghassulian Metallurgy of the Southern Levant in Light of the Ethnographical Record," *Bar International Series* 2753 (2015):

Erez Ben-Yosef, Dafna Langgut, and Lidar Sapir-Hen, "Beyond Smelting: New Insights on Iron Age (10th C. Bce) Metalworkers Community from Excavations at a Gatehouse and Associated Livestock Pens in Timna, Israel," *Journal of Archaeological Science: Reports* 11 (2017): 411-26. doi:10.1016/j.jasrep.2016.12.010.

Eretz Israel Museum, *Mind and Matter: The World of the First Copper Masters,* ed. Tamar Shenker (Tel Aviv, Israel: Eretz Israel Museum, 2019).

The idea of breath being a link between smelting and shamanism was inspired by conversations with Fasnacht (Interviews via Zoom, December 23, 2020 and April 16, 2021). Before the advent of bellows, smelters used blowpipes. Turning copper ore to a molten state took sustained deep breathing. Today we know that breathwork techniques such as pranayama yoga or Holotropic breathwork can create altered states of consciousness. [For general explanations on these various forms of breathwork, see: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3415184/ & https://www.yogajournal.com/practice/beginners/how-to/pranayama (pranayama), http://www.holotropic.com/holotropic-breathwork/about-holotropic-breathwork/ (Holotropic), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3209750/ (Lamaze).] Thus the game explores the possibility of a relationship among smelting, pranayama-type breathwork, and shamanism.

We cannot know what technique smelters used for their breath-based work, but Sobieralski studied a few kinds of breathwork with coaches. She ruled out that which seemed implausible because the techniques were uncomfortable, and/or seemed more likely to put a fire out than to sustain it. (One technique, for example, used a quick forceful exhale.) Did smelters all blow into their pipes at the same time, did they alternate in a rhythm, or did they take turns using breath as techno-craft labor? We have no way of knowing, so these aspects of the game are speculation. However, if later iterations include multiplayer options, researchers could experiment with data modeling using different scenarios, adjusting for environmental variables such as temperature and humidity that would affect smelting conditions. The game could then be used for working simulations of experimental smelts.

Ideas About Smelting as Birthing: Evidence for the idea of smelting representing a sexual union whereby copper (or iron) ore is "birthed" from the crucible comes from mythology throughout the Mediterranean, alchemy books, and from ethnographic evidence in Africa. See especially:

Sandra Blakely, *Myth, Ritual, and Metallurgy in Ancient Greece and Recent Africa* (Cambridge: Cambridge University Press, 2006), 2-123.

Mircea Eliade, *The Forge and the Crucible*, 2nd ed. (Chicago: University of Chicago Press, 1978), 60, also see 212-213.

Jack Lindsay, *The Origins of Alchemy in Graeco-Roman Egypt* (New York: Barnes and Noble, Inc., 1970), 290-291.

Carlyn Saltman, Eugenia W. Herbert, and Candice Gaucher, *The Blooms of Banjeli: Technology and Gender in African Ironmaking* (Watertown, MA: Documentary Educational Resources (DER), 1986), Documentary Film.

Mythologies: Hathor, as a goddess of sexuality and motherhood, was associated with copper in Syro-Palestine under Egyptian occupation. Canaanites in Syro-Palestine associated their goddess Astarte with sexuality and the fecundity of the earth, including copper ore. These two goddesses traveled to Cyprus via the Phoencians when the copper trade migrated north. Therefore, Hathor/Astarte plays a central role in the "Cult and Copper" game. A few sources on this rich and complex topic include:

Uzi Avner, "Egyptian Timna Reconsidered," in *Unearthing the Wilderness: Studies on the History and Archaeology of the Negev and Edom in the Iron Age*, ed. Juan Manuel Tebes (Leuven: Peeters, 2014), 103-162.

Diane Bolger, *Gender in Ancient Cyprus: Narratives of Social Change on a Mediterranean Island*, Gender and Archaeology Series, V. 6. (Walnut Creek, CA: AltaMira Press, 2003).

Stephanie Budin, "Before Kypris Was Aphrodite," in *Transformation of a Goddess: Ishtar–Astarte –Aphrodite,* ed. by David T. Sugimoto (Fribourg, Switzerland: Academic Press Fribourg, 2014), 195-216.

Jacqueline Karageorghis, *Kypri: The Aphrodite of Cyprus: Ancient Sources and Archaeological Evidence* (Nicosia: A.G. Leventis Foundation, 2005).

Arthur Bernard Knapp, *The Archaeology of Cyprus: From Earliest Prehistory through the Bronze Age* (Cambridge: Cambridge University Press, 2013).

Bonnie MacLauchlan, "The Ungendering of Aphrodite", in *Engendering Aphrodite: Women and Society in Ancient Cyprus*. Vol. 3;7, ed. Bolger, Diane and Nancy J. Serwint (Boston, MA: American Schools of Oriental Research, 2002), 365-378. doi:10.5615/j.ctt2jc9sc.

Nancy Serwint, "Aphrodite and Her Near Eastern Sisters," in *Engendering Aphrodite: Women and Society in Ancient Cyprus*, *Vol. 3;7*, ed. Bolger, Diane and Nancy J. Serwint (Boston, MA: American Schools of Oriental Research, 2002), 325-350.

Rachel Shalomi-Hen, "The Goddess Hathor" in *Pharaoh in Canaan, The Untold Story,* ed. Daphna Ben-Tor (Jerusalem: The Israel Museum, 2016), 148-161.

David. T. Sugimoto, "The Judean Pillar Figurines and the "Queen of Heaven"", in *Transformation of a Goddess: Ishtar–Astarte–Aphrodite*, *Orbis Biblicus Et Orientalis, 263,* ed. David. T. Sugimoto (Fribourg: Academic Press, 2014), 144-156.

Obviously animistic elements–snakes in flames, ibex from sky, birds as messengers, represent imagination, but they are based on Canaanite mythology as expressed on pottery. [See: "*Mind and Matter: The World of the First Copper Masters,"* curated by Dr. Michael Sebbane. Eretz-Israel Museum, Chaim Levanon St 2, Tel Aviv-Yafo, Israel. Show viewed on September 2, 2019. https://www.eretzmuseum.org.il/e/398/ .] These symbols are also found in Negev rock art, which maps star lore. [See

Steiner. George F. Steiner, “The Goddess and the Copper Snake: Metallurgy, Star-lore and Ritual in the Rock Art of the Southern Levant,” *Expression Quarterly Journal of Atelier Editions in Cooperation with UISSP-CISNEP (International Scientific Commission on the Intellectual and Spiritual Expressions of Non-Literate Peoples)*, no. 12 (June, 2016): 73-95.]

The Hathoric birthing celebration, which involves the ancient Egyptian dwarf god Bes as a protector of mothers and newborns, is a simplified version of what is presented as a birthing celebration for new mothers via a permanent installation (with audio narration) called “The Birthing Room” at the Egyptian and Rosicrucian Museum in San Jose, California.

Notes on Sounds/Audio:

Yichen Yao was the sound designer for “Cult and Copper.” She procured “campfire” and other ambient sounds from digital sound banks. Ambient sound was not recorded on site, so the veracity of humidity and the acoustics of the actual area are not captured in this prototype. If funding (and public health data regarding covid-19) allowed, for a later iteration it would be ideal to capture site-specific fire sounds, and other ambient nighttime sounds, at Timna to create an enhanced sense of presence.

Hathor frame drum sounds were performed and recorded specifically for the “Cult and Copper” game by Heather Kelley of the Entertainment Technology Center, Carnegie Mellon University.

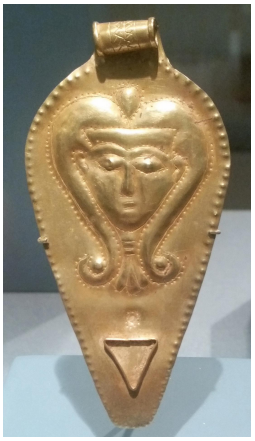


Figure 101: Bronze Age artifact from the Bible Lands Museum, Jerusalem: Canaanite goddess with Hathor hairstyle. Photograph by Casondra Sobieralski, 2018.

Appendix 5: Playtesting Questionnaire

Co-Authored by Casondra Sobieralski
and Team Timna members Amber Sargeant, Yanzhou Wu

(Note, this document includes a broad array of questions to address a variety of playtesting audiences. A selection of questions can be curated for specific audiences.)

1. On a scale of 1 to 10, with 1 being “very relaxed’ and 10 being “at maximum stress level/very anxious,” how relaxed/stressed did you feel **before** you played this game?

2. On a scale of 1 to 10, with 1 being “very relaxed’ and 10 being “at maximum stress level,” how relaxed/stressed did you feel **after** you played this game?

3. What was your pulse rate **before** you played this game? (The playtest facilitators will help you measure.)

4. What was your pulse rate **after** you played this game? (The playtest facilitators will help you measure.)

5. How would you describe your state of mind **before** you played this game?

6. How would you describe your state of mind **after** you played this game?

7. On a scale of 1 to 10 (1=minimum, 10=maximum), how *peaceful* did you feel **before** you played this game?

8. On a scale of 1 to 10 (1=minimum, 10=maximum), how *peaceful* did you feel **after** you played this game?

9. How long did you spend playing this game? (A playtest facilitator will time you.)

10. On a scale of 1 to 10, did the rate of breathing as indicated by the breath meter feel too slow (1), just right (5), or too fast (10)?

11. On a scale of 1 to 10, did the rate of the first drum rhythm–the one played during the smelt–feel too slow (1), just right (5), or too fast (10) for guiding a state of relaxation/meditation?

12. What, if anything, did you find difficult about the mechanical aspects of this game? (Using the controller, picking up objects, et cetera.

13. a) What did you learn about Bronze Age smelting in the Levant from this game?
    b) What visual, sonic, text, and/or interaction elements taught you each of these things most effectively?

14. What **questions** about the **intangible heritage** of Bronze Age smelting in the Levant did this game raise for you? (Intangible heritage, as opposed to material heritage as evidenced by artifacts and architectural remains, is that which is ephemeral or performative so that no tangible record remains prior to recording technologies. Rituals, craft practices, labor practices and who performed them, songs, movement, oral storytelling are all examples of intangible heritage.)

15. a) What did you learn about Egyptian and/or Canaanite mythology through this game?
    b) What visual, sonic, text, and/or interaction elements conveyed each of these things most effectively?

16. Where did you feel confused about what in the game was historically verifiable, and what was speculative/imaginative interpretation? (--what some cyber-archaeologists call “useful fiction” for working out problems and considering possibilities.)

17. a) What emotions did you experience when you entered the Timna landscape?
    b) What emotions did you experience during the smelt?
    c) What emotions did you experience during the Hathoric birthing celebration?

18. In each of the above scenarios, what elements of the game impacted those emotional reactions (colors, sounds, characters…) and how?

19. Were the instructions of the “old man smelter-shaman” narrator in the game clear? Were they educational? Did you feel a sense of guiding “presence” from the old man, even though he was just a voice as opposed to a 3D character?

20. Was the game successful in suggesting a reason, or reasons, why smelting and shamanism might have been linked in the ancient Near East/Mediterranean? What do you interpret that reason/those reasons to be?

21. What ESOTERIC SECRET did you learn about ancient Levantine smelting through this game?

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