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Commercializing Iceland: Biotechnology, Culture and Global-Local Linkages in the Information Society

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I) Abstract

The development of the Iceland Genetic Database provides an entry point into considerations of some of the most essential social questions arising from new economic and technological changes in the global environment. On one level, there are very serious issues of privacy, competition, commercialization and individual rights that challenge or extend existing legal codes and social norms in very fundamental ways. On a higher level, the developments in Iceland provide a way to outline how global economic, social and technological trends shape and connect with local resources, needs and policies. This second aspect, that will be the considered here, is crucial exactly because it frames and establishes the lower level concerns as central social issues of the coming decades.

Information technologies, both as a process and product, contain embedded social knowledge, and thus represent the construction of new social norms and institutions. However, the construction of such new social structures on the local level is intimately tied broader global trends. As such cases like Iceland demonstrate how information technologies like biotechnology are a mechanism for linking the local and global. This is not to downplay the concerns of rights and access that characterize the majority of local debates around biotechnology and genetics in general. However, focusing on the broader issues helps elaborate on how these more specific issues are defined by and a part of a more basic restructuring of social relationships within an information-driven environment.

Simply, Iceland matters not only because of concerns over privacy or commercialization of genetic information, but because the debate itself only exists when broader global trends impact in very real and powerful ways on specific regions and populations. A fuller understanding of an information society, and by extension develop a detailed understanding of developments in Iceland, requires that we develop an analysis of both the local and global, social and personal, and economic and cultural. The aim is to move beyond narrow considerations of privacy or ethics to understand that the experience of Iceland represents general trends in the global environment that are simultaneously extremely personal and local events.

II) Iceland and the Global Environment

Biotechnology is an information technology. Such a direct statement usually does not instigate much debate, and seems reasonable and a part of common knowledge. However, what exactly are the implications of defining biotechnology as an information technology (IT)? It clearly raises the question of what is IT, as well as what distinguishes biotechnology from previous forms of genetic and biological research. The importance of defining and clarifying what is unique about biotechnology lies in understanding the broader implications of information technologies on societies. In other words, understanding biotechnology as an information-driven process, product and industry helps explain essential (and often seemingly contradictory) economic, political and social features of the global environment. It is this combination, of IT and social transformation, that is playing out in the case of Iceland.

The global environment is dynamic, structured by simultaneous economic, technological and social interactions. These changes are said to constitute the forces propelling the structuring of a new society, the "information" or "networked" society (Webster 1995). The informational society is characterized by the predominance of information as the central resource of both economic and social relationships. Looking at the case of Iceland, it is possible to see how these new relationships are slowly becoming structured within new identities, organizations and institutions designed to produce, manipulate and disseminate information (Castells 1996). The Iceland Genetic Database is an example of how the "information society" creates new beliefs and norms that slowly become institutionalized in new patterns and categories, be they personal, economic, social or political (Held et al 1999).

While there is broad analysis of the macro-patterns of the information society (Castells 1996, Gordon 1994, Held et al 1999, Amin 1994), it still remains difficult to understand why or how such forces play out at the local or personal level. Part of this lack of explanation stems from not defining or elaborating on exactly what is the "informational" aspect of this new environment. In other words, what does it mean to live in an "information society"? Which information is valuable and which isn't? How is information transformed into new products and power? How do networked organizations, global economics, and local culture and politics conform to or transform an information-structured environment?

The complex nature of the global environment creates a tension between these broader theoretical perspectives that explore the impacts of information from either economic (the daily practice of surviving and producing the tools for survival) or social/cultural (new identities, social movements and discourses) viewpoints. Such one sided approaches, however, miss essential features of social change in an information-driven environment. On the economic side, it is easy to slip into economic determinism, ignoring completely the socially embedded nature of material and scientific practices that structure how information is produced and marketed. On the social and cultural side, it is far too easy to forget that material practices matter, that the marshalling of culture and power through information often determines who eats, who receives medical care (and what kind) and who lives. Outlining the nature and impact of information technologies within the global environment provides a means to bring together each of these viewpoints, providing a deeper understanding of both local processes (as in the case of Iceland) and the larger global trends that structure such local developments.

Information technologies (IT) are increasingly one of the central determinates of the direction and pace of economic and social change in the global environment (Castells 1989, Eischen 2000b, Dicken 1998,

Held et al 1999). However, the role that IT plays in this environment is often undefined or misconstrued. Information technologies have a very specific and distinct social basis that shapes their development as a process, product and industry (Agre 1995a &b, Kelly1998, Lessig 1999, Mitchell 1998). As such, IT is much more than just increasing means of transmitting information or increasing the speed and geographic spread of communication. Information technology, as a process of generating, manipulating and commercializing information, is a mechanism that links together culture and economics in the global environment. In this way, information technologies like biotechnology are much more than a an architecture for communication in which an information society develops, but a way to understand why information is valuable and how it is structured and valorized in the global economy.

The development of the Iceland Genetic Database is a way to outline exactly this mixing of social, economic and cultural factors that structure an information society. Thinking carefully about Iceland helps clarify how the broader economic and social patterns in the global environment work in a very specific and local way. The point here is to tease out some of the aspects of the "information society" through a consideration of biomedical policy in Iceland. A fuller understanding of an information society, and by extension develop a detailed understanding of development in Iceland, requires that we develop an analysis of both the local and global, social and personal, and economic and cultural. The aim is to move beyond narrow considerations of privacy or ethics to understand that the experience of Iceland represents general trends in the global environment that are simultaneously extremely personal and local events.

III) Linking Information Technology to Social Practices and Institutions

IT processes deal directly with the creation, manipulation, commercialization and distribution of knowledge and information in the global environment (Armour 1999, Negroponte 1995). This basic process is facilitated by the algorithmic patterns that are at the core of information technologies, enabling the manipulation of diverse information in its digital and algorithmic forms. This basic process shapes both the products produced and the organizational characteristics of IT industries. In other words, IT industries like biotechnology develop around the need to produce and commercialize information in specific products.

Many of the most common features of the global environment (networked organizations, regional centers of innovation, skilled labor as a central resource, global immigrant networks) can be much more easily explained by viewing them through exactly such a perspective. For example, "information" focused economic initiatives are by definition specifically created to integrate and operate within global networks of production, immigration, innovation and competition (Karolak 1998), the basic patterns that structure the generation and production of information products. IT industries, because they are based around information and knowledge-based production practices, create organizations and institutions that operate in the global environment very differently than past economic models. One of the central characteristics of IT industries like biotechnology is the need to capture or control the sources of unique information that drive innovation and competition globally. Such sources of competition mean the networking of diverse regions across the globe to capture unique characteristics and sources of information (Eischen 2000b). Biotechnology in this way is about the controls of flows of information and the specific skills to handle that information, rather than the capturing of fixed, defined and pre-determined resources (Eischen 2000a).

Genetics is ideally suited to such an informational focused environment, exactly because they one of the most fundamental means of storing, transmitting and transforming information known (Armour 1999). This is enhanced because genetic information is structured around naturally occurring, if yet to be fully explained, algorithmic patterns (Ridley 1999, Berlinksi 2000) that are potentially easily digitalized. Combined with other information technologies, particularly software and supercomputer technologies, this basic genetic information has been transformed into a biotechnology industry. Like other IT industries, the informational aspect of genetic research creates unique economic patterns. In this way biotechnology, is simultaneously a process of mapping genetic information, a defined product derived from that mapping, and an industry structured around replicating such processes and products.

The unique development processes, resources and geographic organization of the information industry are central to understanding global processes. The uniqueness stems from the role of information as both a product and input of not how that knowledge is necessarily applied in a specific technological format. It is important to recognize that this unique aspect of information production processes actively structure organizational and institutional policies and practices on a local level. In other words, the advantages and challenges of information increasingly shape the strategic and organizational choices of governments, firms and social actors, whether conscious or not (Lessig 1999, Williams 1998, Agre and Schuler 1997) through the defining, discovery and application of information. This means that the building of a biotechnology industry in Iceland by definition as an information-focused process has potential social impacts far beyond questions of privacy or competitive advantage as defined within traditional analysis.

a) Producing Information: Defining and Understanding IT Production Patterns

Information technologies are increasingly structuring the global environment, not simply because they "compress time and space" and enable a greater extensivity and speed of interaction (Held et al 1999), but rather because IT as a process, product and industry defines how information is produced and translated into power and profit on the "shop floor" (or cubicle) level. Organizational and institutional structures form to maximize this type of production and transformation of information. In this way, information development processes are the way in which micro and macro levels are connected in a global knowledge-driven environment. This helps understand how information-focused industries like biotechnology organize and produce social and economic goods in an information society. It also helps understand some of the new social and institutional patterns that will develop in Iceland around the establishment of the Genetic Database. A simplified typology of the key aspects and implication of IT can be outlined as follows (Eischen 2000a):

- A process that is organized around the definition, generation, manipulation and transmission of information into socially and economically applicable forms.
- The social nature of domain knowledge, that is the place and context specific nature of information, insures that specific regions and culture (either by historical accident or plan) will play a significant role as resources and locations for IT industries.
- Because it is socially structured and often determined, the production of predominately information-based products will take the form of craft-like production where tacit information and synergies are essential.
- Value-added will be relatively greater in the designing or mapping the algorithmic patterns of a process, that is in the ability to define and model a process than in its actual implementation, manufacture or replication.
- Flexible organizational forms, especially networked forms, that are able to efficiently and rapidly manage the flows of information (both its creation and applications) and manage "information or knowledge workers".
- Production and firms will increasingly be globally defined, though product markets will remain fragmented.

b) Information Technology as Embedded Knowledge and Culture

IT describes the general process through which social and economic trends overlap and interconnect within the information economy. As simultaneously a process, product and industry, IT is an essential feature in the global environment for transforming and linking together local social knowledge and information, and thus culture and economics. In this way, the specific features of IT outlined above, particularly the need for locally specific domain knowledge, represents one of the essential mechanism through which local information is linked into global economic and social patterns (Geertz 1983). Information technologies like biotechnology thus are incredibly flexible and dynamic processes, not only comprising how information moves in the global environment but also embedding such knowledge in the technologies themselves. As such, IT— whether in biotechnology, software, telecommunications or multimedia — builds on existing institutions and norms while simultaneously creating new patterns that slowly intertwine and transform these existing social relationships.

Exploring the implications for societies of these broader global patterns is thus understanding the opportunities and challenges presented by the shift to information-focused processes, products, norms and institutions. The case of Iceland should be considered within a framework of the general patterns that initiate and support information industries and production processes, and then establish new norms and institutions around such industries and processes. In Iceland, the choice of genetic information as a central focus of government policy and economic strategy represents a social model quite different than previous industrial and bureaucratic forms, even if it is not recognized as such. This means that focusing on biotechnology is not just a simple choice of industry or policy, but a transition to a new pattern of social and economic relationships.

IV) The Case of Iceland: Biotechnology, Culture and Global Economics[1]

Iceland is at the center of a growing movement to isolate the genetic processes that cause disease and patent those key gene sequences. The case of Iceland represents a confluence of national government policies, global trends, history and cultural traits that bring to light many of the central themes above. Importantly it not only elaborates on the broader trends of IT and the global environment, but also details how global changes intimately interact with the personal lives and practices of Iceland's 270,000 people.

While Iceland is perhaps the most well documented and pristine 'human genetic biopreserve', it is not the only sight of new trends in "bioprospecting" and "genomics" within biotechnology (Shreeve 1999, Economist 1998). In general, there is a global push to develop universal genetic databases and new processes of genetic screening. Both Millennium Pharmaceuticals and Myriad Genetics have extracted DNA samples from "inbred" societies in Finland and Costa Rica, as well as the Mormon population in Utah (Billings 1999). Other initiatives, initially sponsored by the National Institutes of Health and the Department of Energy (Marshall 1998), have been sought to build vast archives of human genes for basic research. Some efforts have failed, as in China, where companies were accused of "biopiracy" and forbidden to transport genetic materials. Other private efforts, such as Axys Pharmaceuticals research on asthma in the Atlantic island of Tristan da Cunha, have been potentially commercially viable.

These general global industry patterns, however, have overlapped with unique cultural and historical factors to make Iceland a central site of such research efforts. Historically, Iceland has been characterized by an intense and unplanned genetic homogeneity. Since its founding by ten thousand

[1] The following section is drawn from in part Nightline 1999a & b, and deCode Genetics unless otherwise stated.

Vikings in 874 BCE, Iceland has remained genetically homogenous due to extreme geographic isolation compounded by natural disasters, including the Plague in the 1400s (which killed two-thirds of the inhabitants), small pox, and volcanic eruptions that caused wide spread famine. Such disasters and the small founding population have caused population “bottlenecks” that have reduced the gene pool even further. As such, by historic accident the Icelanders possess one of the "clearest bloodlines on the planet" (Moukheiber 1998), making them “ideal” subjects for genetic research seeking to isolate individual genes linked to specific diseases.

It is not, however, only this accidental homogeneity that makes Iceland so important. Four other factors linked to culture, government policy, and social networks have also been essential to shaping Iceland as a central site of biotechnology research.

1. Genealogy is practiced widely. Most Icelanders can trace their ancestry back centuries, most to the year 1000 when Iceland converted to Christianity and priests began recording births and deaths. This enables the linking of current genetic information to family bloodlines.
2. Iceland has medical files on the entire population going back to 1915, when the centralized state-run medical and welfare system was implemented.
3. Since the mid-1940's, tissue samples have been taken from every person in the population, as part of the same national health and welfare system.
4. Key players in the promotion of both Iceland as a site and information source of biotechnology research have been returning overseas Icelandic biotechnology researchers, chiefly Kari Stefansson and the other founding members of deCode Genetics Inc. in Reykjavik.

a) Developing Iceland as a Global Site of Genetics Research

The role of deCode in developing the genetic database is a clear example of how global migration, economic flows and business networks shape and connect regions to the broader global environment. Kari Stefansson is an Icelander who immigrated to the United States and became a Harvard Medical School professor specializing in neurogenetics. He returned to Iceland and founded deCode Genetics

Incorporated in 1997, supported by $12 million of US venture capital funding and a group of US trained Icelandic doctors. DeCode focused on two initial projects: 1) researching genetic based disorders such as multiple sclerosis and essential tremor, and 2) digitalizing Iceland's genealogical records from the last 1000 years. The two projects were complementary halves of an overall model to use the unique nature of Iceland's population and culture to track genetic disease.

The first project was initiated using teams of physicians from around Iceland that would interact with patients, and patient's relatives, and collect blood samples. It is important to note that this initial pattern of research through a network of affiliated local doctors would come to be standard operating procedure at deCode for all future projects. Once collected, patient history and blood sample information were sent to deCode in encrypted code format based on a proprietary algorithm developed by the firm. At deCode the DNA samples are genotyped (that is genetically profiled), matched with phenotype, then linked to the genealogical information of the second project in order to trace patterns and isolate genes. The first success came quickly. Using automated sequencing machines from Perken-Elmer, the gene that caused Essential Tremor was located in six months, rather than the two years it would have taken in a non-homogenous population.

It is the second project, though really an integral part of the overall research described above, that has driven the most controversy. DeCode's proprietary genealogical database traces the ancestry of 75% of the 750,000 Icelanders who have ever lived in history. It is deCode's most valuable asset because it allows for tracing of disease along family lines over a thousand years, enabling genetic traits to be more quickly identified, as in the case of Essential Tremor. The rapid identification of such genes is an invaluable asset for any company developing new drug therapies in an innovative, global market for new pharmaceuticals.

On December 17th, 1998, the Icelandic parliament, the Althing, passed a legislative bill (with only one dissenting vote) that give deCode not only proprietary control over the genealogical database, but the right to link these genealogical records with medical records and tissue sample DNA that the Icelandic government has meticulously kept during the twentieth century. The bill gives deCode a *de facto* and *de jure* monopoly over Icelandic genetic and genealogical data. However, deCode will not use the database solely (or even mostly) for in-house proprietary research. DeCode will sell access to the Genotypes, Genealogy, Phenotypes and Resources (GGPR) database, as it is officially known, to global pharmaceutical firms seeking to isolate genes and potential treatments more rapidly, following the pattern established in the Essential Tremors trial by deCode itself (Henderson 1999).

Within two months of the bill's passage, the first such agreement was reached. DeCode signed a five year $200 million agreement with Switzerland's F. Hoffmann-LaRoche that will focus on the discovery of genes with alleles or mutations that predispose people to 12 different diseases/illnesses including cardiovascular, neurological/psychiatric and metabolic conditions. The $200 million includes equity investment, research and milestone payments and royalties, with Hoffman-LaRouche having exclusive rights to develop and commercialize all pharmaceuticals and diagnostics. The exception to the last is that deCode will control all antisense and gene therapy products. Any drug therapies developed from the use of the GGPR will be freely available to the population of Iceland during the life of the patent (17 to 20 years).

Proponents of the legislation and the deCode mission generally are primarily government based, being led by the Prime Minister’s party and government bureaucrats centered around the Health Ministry's Medical Ethics Committee. The project is justified on both economic and medical grounds. The main

benefits are said to be improved preventative medicine, improved cost management in the health care system, better understanding of the genetic basis of disease, improved health services management, and local economic development. Opponents include the Icelandic Medical Association (IMA) and Mannvernd (the Association of Icelanders for Ethical Science) established in October 1998 specifically to oppose the passage of the legislation. Public opinion prior to the passage of the bill hovered around 60% in favor (Henderson 1999).

Three issues frame the debates around passage of the legislation and continue to be central issues that have not been solved with the passage of the bill (Masood 2000). First, privacy is central. Even though data will be encrypted, there is the clear possibility that identities, especially for rare conditions, will be revealed. Furthermore, the system is dynamic with new patient information being added continuously, which clearly leaves open the possibility of privacy being violated. Interestingly, the debate centers more on social concerns of privacy than denial of access to medical care based on the revelation of specific genetic diseases or markers. The reason for this is that medical care is government sponsored within a national health-care system, thus insuring some accountability that would not be available in the private sector. Second, trust between doctors and patients is stretched as patient consent to pass information on to deCode has not been required up to now. The legislation was structured around *de facto* consent, meaning that if a patient does not opt out of the system, consent is assumed to be given. Furthermore, information once entered cannot be retrieved, if the patient opts out at a future date. The dead, however, can never opt out, which implies that family patterns can be established even if an individual personally chooses not to participate. Lastly, by giving deCode and its partners an effective monopoly over the database, domestic researchers and competitors are essentially locked out of future research and, perhaps most importantly, oversight of deCode research.

V) Commercializing Culture: Iceland as a Sign of Things to Come

The case of Iceland's genetic database, and the controversies flowing from it, open the possibility of understanding not only the specific issues of privacy, trust and competition, but also how such issues are framed by broader economic, social and technological trends in the global environment. Looking at the Iceland database project helps clarify the multiple challenges and opportunities arising from an information-structured society. A traditional viewpoint would imply that Iceland is symbolic of what might occur in other countries, but that is not entirely accurate and misses a much deeper point. First, an Icelandic database could never happen elsewhere in the exact same way, because the mix of history, culture, government policy and economics is unique to Iceland. However, and this is the deeper point, it is this uniqueness that is a competitive advantage for Iceland in the current global environment exactly because it is unreplicateable. Simultaneously, the world benefits from this uniqueness through the linking of Iceland into global networks of research, information, capital and migration. In other words, the structure of the global environment means that a database (or any information resource) does not need to be replicated everywhere, because essentially, Iceland's database is accessible to the world through global firms and markets.

The fact that Iceland's 270,000 people (a midsize town in the US) represent a unique confluence of culture, geography and knowledge that represents an ideal laboratory for "bioprospecting" and "genomics" intimately links them to broader global trends. The genetic inheritance of Iceland, and its current economic and social value, is derived directly from the intersection of a historic situated combination of local culture (a combination of natural selection, cultural homogeneity, and economic and geographic isolation) and global trends (global networks of economics and technology). Traditional approaches to understanding this, either by communities or governments, may not explain this interaction. For example, to say that selling 1000 years of genetic knowledge for $800/person,

including the dead, is not a good bargain, doesn't really capture the full magnitude of what is occurring. It may, in fact, be a very good deal, considering that for a thousand years such information meant nothing outside of Iceland, and maybe very little inside of Iceland outside of social norms. The key question is what has changed that has allowed such information to be valuable now, and how does that help explain new social institutions and tensions.

Biology has always been an important source of both material and symbolic practice.[2] The specific global trends of "biomedicalization" and the building of a global "biomedical industrial complex" (Clarke and Olesen: 19-21), as in the case of Iceland, help to elaborate on not only the continued importance of biological models, but also on the specific nature of the informational aspects of the global environment itself. The case of Iceland is an entry point into the blurring of distinctions and the multiple combined meanings that an information society produces. While the creation of various genetic collections around the world is clearly exclusionary, excluding groups with too much genetic "noise" and alienating people from what is in some ways their most basic material inheritance, it is at the same moment intimately inclusionary. It, in fact, requires that those inside the chosen group all participate to yield the greatest results, and it includes them individually as each DNA is considered to possess unique information. The most personal of information, DNA, becomes an input into a global biomedical industry that potentially links an individual Icelandic family with completely unrelated communities and individuals globally. In this way, the Genetic Database links together the utmost local with the utmost global trends.

The very process of building the database reinvents the relationships between doctors and patients, states and firms, publics and governments, building on traditional norms and institutions while altering

them in the process. Each actor acts and reacts to both local and global challenges and opportunities, building new social relationships in the process. States privatize medical knowledge, weakening the link between the public and democratic regulation, while expanding the need for firms to work within the boundaries of the state's protection, which in turn is constantly seeking to justify to the public the benefits of such privatization. Weaknesses, in this case the geographic and cultural isolation of Iceland, become strengths that can be commodified as digital knowledge and information. Yet the very act of using those strengths alters the isolation of Iceland within a global world. By placing itself within networks of firms, people, biomedicalization and knowledge, Iceland becomes intimately tied to global economic and social networks. Decode, founded by an American trained Icelandic Harvard doctor with US venture capital funds digitalizes and monopolizes the genetic history of Iceland and places it at the services of global genomics firms. Icelandic uniqueness becomes the basis for a universal understanding of gene traits through a global economic structure that requires exactly such unique information to operate.

In this way, the cultural and historical uniqueness of Iceland is reinforced at the same time it is universalized. The specific collective knowledge of a people, its cultural capital or genetic commons, becomes the basic material for universal concepts of health. The culture and information become divorced from a specific place, experience and time, becoming a global resource to be mined through "bioprospecting". The information society draws on the diversity of culture for basic very specific information to create competitive asymmetries while simultaneously establishing a universal framework of information technology in which specific information is valued and traded. It is important to note that these information technologies recreate with information very old practices: prospecting, mining, surveying. At the same time these networks are dynamic, requiring constant

[2] See Haraway 1997 chapters 1 and 2, and Haraway 1991, chapter 1 for further elaboration on this.

inputs of blood, records and history that are directly derived from the lived experience of the Icelanders. Such common events as births and deaths, sicknesses and marriage become the basic material for competition and development in the global environment.

As such, the information society is a merging of both old and new, the local and the global, the personal and the social. This merging, as is so clear in the case of Iceland, is universal while it is extremely specific and local. It takes material practices and makes them into immaterial, informational, digital knowledges while seeking to draw on and supply those same localized material practices. It does this by building on previous institutional forms and practices (the construction of centralized mass consumption medical services) that interact with new forms (digitalized global biomedicine aimed at individualized medicine). Understanding the impact of this means understanding these processes and how they form into new institutions that structure social behavior. In this way, the questions of privacy and access are really smaller question derived from what institutions, laws and norms will govern and structure the information society and economy (Lessig 1999, Mitchell 1998, Kurzweil 1999).

VI) Implications for Information Societies: Local Issues and Global Trends

The case of Iceland opens up a window through which to consider both how IT and global trends are initiated and sustained over the long term. Both aspects create dichotomies that need to be carefully understood. The case of Iceland clearly highlights this tension. National legacies played a key role in establishing the genetic resources that the nation drew on to establish a credible and viable information initiative as the global environment evolved to value exactly these resources. The dichotomy for Iceland is that biotechnology, by its unique production and organizational forms, creates new social tensions and contradictions that challenge the very institutions and social norms that supported the creation of the genetic and social resources initially. Simultaneously, biotechnology in its increasing

importance as a central global industry, it's knowledge-based production process, it's ability to absorb and valorize the specific local knowledge that Iceland possesses also offers an excellent, in relative terms to other industries, chance for long term economic and social development.

Clearly understanding a region's economic, political, cultural and social inheritance shapes how a region will interact with the global environment. The structure of this interaction depends on the local adaptation of resources to address the challenges to these legacies of the interaction with broader economic and social trends. The opportunity around information, and industries following information production patterns, is that local knowledge is needed and valorized within the production process itself. This means that nations or regions are really developing a mastery of information-based economic and social processes, and not information as an industry per se. Building a successful environment to manage these new social structures means creating synergy between various sectors of the economy and society that can consciously generate the resources to manage and synthesize local needs with global structures. The opportunities of IT (as process, product and industry) is that while local knowledge is valorized on a global level, the flows of information and knowledge can go both ways with global skills able to be applied to local needs or local norms becoming standard global practice. This is the unique opportunity provided by an information-focused strategy, if the global-local relationship can be structured to achieve this end.

The importance of understanding Iceland's development within new global structures is directly linked to the evaluating how well Iceland understands these opportunities and challenges inherent in its Genetic Database initiative. The case outline above seems to question if government officials and local entrepreneurs fully understand the dichotomies and opportunities of an information focused environment that is simultaneously local and global. In other words, the very process of establishing

the database has built institutional bridges between global trends and local social structures. The concern is that the policies in Iceland reflect a failure to understand that such linkages are being built. While it may be impossible to capture the benefits of the global environment without such linkages, not recognizing that such linkages exists means a limit on the ability of Iceland to structure such relationships around local, rather than private or global priorities.

Understanding the impact of biotechnology is intimately linked to tracing how local and global interactions become institutionalized and structured within the information society. Overall, the Genetic Database strategy in Iceland is an ideal example of how interactions with the global environment transforms both the local and global simultaneously. Iceland presents a case where the personal links to the global, where local information, culture and practice are transformed into a global resource, and where the impact of IT as process, product and industry shapes new social structures. It is exactly such combinations that will increasingly come to matter in other regions and other IT industries. The institutions and norms that come to be established around early interactions as in Iceland foreshadow the possibilities and challenges of things to come.

VII) Bibliography

Agre, Phillip (1995a) “Institutional Circuitry: Thinking about the Forms and Uses of Information”, Information Technology and Librarians, Volume 14, Number 4, Page 225

Agre, Phillip (1995b) “From High Tech to Human Tech: Empowerment, Measurement, and Social Studies of Computing”, Computer Supported Cooperative Work, Volume 3, Number 2, Page 167

Amin, Ash and Jerzy Hausner (1997) Beyond Market and Hierarchy: Interactive Governance and Social Complexity, Edward Elgar Publishing Limited, Lyme, New Hampshire

Armour, Phillip G. (2000) “The Case for a New Business Model”, Communications of the ACM, August, Volume 43, Number 8

Berger, Abi (1999) "Private Company Wins Rights to Icelandic Gene Database", British Medical Journal, volume 318, number 7175, Jan, 11

Berlinski, David (2000) The Advent of the Algorithm: The Idea that Rules the World, Harcourt, Inc., New York

Billings, Paul R. (1999) "Iceland, Blood and Science: Biotechnology and its Social Implications", American Scientist, volume 87, number 3, May-June, 199

Castells, Manuel (1989) The Informational City: Information Technology, Economic Restructuring, and the Urban-regional Process, Blackwell, Oxford

Castells, Manuel (1996a) The Information Age: The Rise of the Network Society, Cambridge, Mass.: Blackwell Publishers

Chadwick, Ruth (1999) “The Icelandic Database: Do Modern Times Need Modern Sagas?”, British Medical Journal, August 14, No. 7207, Vol. 319, PP. 441

Clarke, Adele and Virginia Olesen (1999) “Revising, Diffracting, Acting,” in Revisioning Women, Health and Healing : Feminist, Cultural, and Technoscience Perspectives, Clarke and Olesen, Editors, Routledge, New York

deCode Genetics Inc. (1999) http://www.database.is/

De Vol, Ross C. (1999) America's High-Tech Economy: Growth, Development, and Risks for Metropolitan Areas, Milken Institute, www.milken-inst.org

Dicken, Peter (1998) Global Shift: Transforming the World Economy, London: Paul Chapman

Economist (1998) "Norse Code: Bioprospecting in Iceland", volume 349, number 8097, Dec 5, 99

Eischen, Kyle (2000a) Regional Development under Software Globalization: Software Development Processes, Human Networks and Social Capital in Hyderabad, Andhra Pradesh, Working Paper 2000-2, Center for Global, International and Regional Studies, www2.ucsc.edu/cgirs

Eischen, Kyle (2000b) Information Technology: History, Practice and Implications for Development, Working Paper, Forthcoming at the Center for Global, International and Regional Studies, www2.ucsc.edu/cgirs

Flower, Joe (2000) "The Uncomfortable and the Unanswerable," Health Forum Journal, May, June

Geertz, Clifford (1973) The Interpretations of Cultures; Selected Essays, Basic Books, New York

Gordon, Richard (1994) "State, Milieu, Network: Systems of Innovation in Silicon Valley", Working Paper 94-4, Center for the Study of Global Transformations, University of California, Santa Cruz

Greely, Henry T. (2000) "Iceland's Plan for Genomics Research: Facts and Implications" Juremetics, Vol. 40, pp. 153-191

Haraway, Donna J. (1991) Simians, Cyborgs, and Women: the Reinvention of Nature, Routledge, New York

Haraway, Donna Jeanne (1997) Modest-Witness@Second-Millennium.FemaleMan-Meets-OncoMouse: Feminism and Technoscience, Routledge, New York

Harvey, David (1990) The Condition of PostModernity, Blackwell, Cambridge MA

Held, David, Anthony McGrew, David Goldblatt and Jonathan Perraton (1999) Global Transformations: Politics, Economics and Culture, Stanford University Press, Stanford, California

Henderson, Charles W. (1999) "Government Approves Plan to Sell Iceland's DNA", World Disease Weekly Plus, Feb

Kelly, Kevin (1998) New Rules for the New Economy: 10 Radical Strategies for a Connected World, Viking, New York

Kranzberg, Melvin (1985) "The Information Age: Evolution or Revolution?", in Information Technologies and Social Transformation, Bruce R. Guile, Editor, National Academy Press, Washington D.C.

Kunzig, Robert (1998) "Blood of the Vikings," Discover, December 1st

Kurzweil, Ray (1999) The Age of Spiritual Machines: When Computers Exceed Human Intelligence, Viking, New York

Lash, Scott and John Urry (1994) Economies of Signs and Space, Sage, Thousand Oaks

Lessig, Lawrence (1999) Code: and Other Laws of Cyberspace, Basic Books, New York

Loader, Brian D., Editor (1997) The Governance of Cyberspace, Routledge, New York

Malecki, Edward J. (1997) Technology and Economic Development: the Dynamics of Local, Regional, and National Competitiveness, Longman, Essex, England

Malecki, Edward and Paivi Oinas, Editors (1999) Making Connections: Technological Learning and Regional Economic Change, Ashgate, Brookfield USA

Marshall, Eliot (1998) "Iceland's Blond Ambition: Genetic Research on Icelanders", Mother Jones, volume 22, number 3, May-June, 53

Masood, Ehsan (2000) "Gene Warrior," New Scientist, July 15th

Miller, Riel (1996) Territorial Development and Human Capital in the Knowledge Economy: Towards a Policy Framework, OECD Working Papers, Volume 4, Number 64, Lead Notebook Number 23, Paris

Mitchell, William J. (1998) City of Bits: Space, Place and the Infobahn, MIT Press, Cambridge

Moukheiber, Zina (1998) "Genes for Sale: Genetic Research in Iceland by Decode Genetics Inc.", Forbes, volume 162, number 2, July 27th, 203

Negroponte, Nicholas (1995) Being Digital, Alfred A. Knopf, New York

Nightline (1999a) Iceland, Transcript of Broadcast, May 13th, http://abcnews.go.com/onair/Nightline/nl990513.html

Nightline (1999b) Iceland, RealMovie Broadcast, May 13th, http://play.rbn.com/?swave/abc/demand/990513ntl.rm

Palsson, Gisli and Paul Rabinow (1999) "Iceland**:** The Case of a National Human Genome Project," Anthropology Today, 15 (2): 14-18;

Ridley, Matt (1999) Genome: The Autobiography of a Species in 23 Chapters, Perrenial, New York

Shreeve, James (1999) "Secrets of the Gene" National Geographic, No. 4, Vol. 196, Pg. 42

Weber, Max (1968) Economy and Society; An Outline of Interpretive Sociology, New York, Bedminster Press

Webster, Frank (1995) Theories of the Information Society, Routledge, New York

Zucker, Lynne G., Michael Darby and Marilynn Brewer (1994) Intellectual Capital and the Birth of U.S. Biotechnology Enterprises, NBER Working Paper #4653