Invention as an Opportunistic Enterprise

Marin Simina, Janet Kolodner, Ashwin Ram
College of Computing
Georgia Institute of Technology
Atlanta, GA 30332-0280
{marin, jlk, ashwin}@cc.gatech.edu

Michael Gorman
TCC, SEAS
University of Virginia
Charlottesville, VA 22901
meg3c@virginia.edu

This poster identifies goal handling processes that begin to account for the kind of processes involved in invention. We identify new kinds of goals with special properties and mechanisms for processing such goals, as well as means of integrating opportunism, deliberation, and social interaction into goal/plan processes. We focus on *invention goals*, which address significant *enterprises* associated with an inventor. Invention goals represent "seed" goals of an expert, around which the whole knowledge of an expert gets reorganized and grows more or less opportunistically. Invention goals reflect the idiosyncrasy of thematic goals among experts. They constantly increase the sensitivity of individuals for particular events that might contribute to their satisfaction. Our exploration is based on a well-documented example: the invention of the telephone by Alexander Graham Bell[1]. We propose mechanisms to explain: (1) how Bell's early thematic goals gave rise to the new goals to invent the multiple telegraph and the telephone, and (2) how the new goals interacted opportunistically. Finally, we describe our distributed model of invention (a "society" of reasoners). Each reasoner has the same ALEC[2] architecture, but different knowledge.

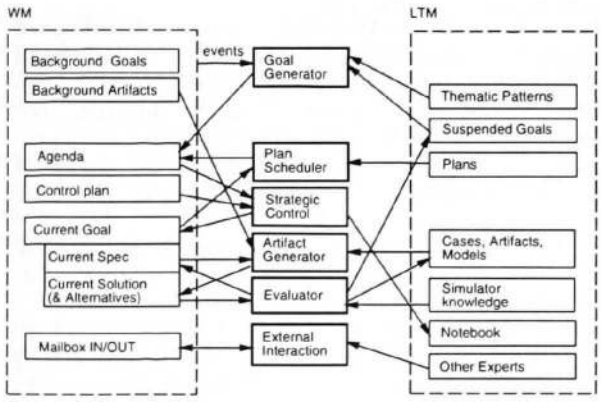

Figure 1: ALEC: a Framework for Invention

Invention goal generation is part of the Goal Generator process. Whenever ALEC learns about a new design idea (by social interaction or experimentation), it performs the following steps: (1) identify if the idea is *interesting* (does the implementation of the idea result in postconditions that match those of important unsatisfied thematic goals?), (2) estimate its own expertise to implement the idea as an artifact (given the idea's rough design spec, can the Artifactor Generator generate an artifact, judged/simulated as promising by the Evaluator?) (3) generate an invention goal (instrumental for satisfying specific thematic goals), if the results of steps (1) and (2) are positive.

Given an invention goal specification, the Artifact Generator uses the following retrieval algorithm: (1) if the design specification matches any of the BACKGROUND ARTIFACTS, return it, (2) otherwise, if LTM retrieval is successful, return the remembered devices, (3) otherwise, *ask* (send message to) other experts for such an artifact and suspend the invention goal in memory, indexed by its design specification.

If the Artifact Generator is unable to retrieve an artifact that satisfies all the design spec constraints, it attempts to decompose the initial invention goal in subgoals to facilitate the further synthesis of the desired artifact. The algorithm for decomposing an invention goal in subgoals, given the design specification of the artifact is: (1) find a design alternative that satisfies the *main* constraint, (2) identify which components of this design alternative are responsible for satisfying the secondary constraints, (3) generate subproblems for designing components, to satisfy (better) the secondary constraints.

But Evaluator is essential to validate the design solutions proposed by the Artifact Generator. Here are the steps: (1) perform simulation of the artifact and critique it, if ALEC has enough domain knowledge, (2) otherwise, implement the artifact, perform experiments and interpret the results, if this is possible, (3) otherwise, send message to relevant experts to remotely perform the evaluation.

Step (3) of the Artifact Generator retrieval and Evaluator algorithms may result in the deliberative generation of an *expertise goal* (i.e., a learning goal to provide a broader expertise).

References

Ram, A. and Hunter, L. (1992). The Use of Explicit Goals for Knowledge to Guide Inference and Learning. *Journal of Applied Intelligence*, 2(1) (pp.47–73).

Simina, M. and Kolodner, J. (1997) Creative Design: Reasoning and Understanding. *Proceedings of ICCBR-97*, Springer Verlag.

[1] Alexander Graham Bell's Notebooks are available on the WWW at: *http://jefferson.village.virginia.edu/~meg3c/id/albell/homepage.html*

[2] Alec was Alexander Graham Bell's nickname, but serendipitously it is also an acronym for Analogical Learning by Explaining Cases . . . more or less creatively.