The Cognitive Disappearance of the Computer: Intelligent Artefacts and Embedded Agents

(or, do artefact based computers need to be intelligent to disappear?)

V Callaghan, M Colley, G Clarke, H Hagras
Intelligent Inhabited Environment Research Group
University of Essex, Colchester, England
robots@essex.ac.uk cswww.essex.ac.uk/intelligent-buildings

Summary:

In this paper we argue that embedding intelligence into artefacts is an essential step in making the computer cognitively disappear; or controlling the extent of the disappearance we wish to enable.

1. Introduction

Today people's personal spaces are increasingly "decorated" by electronic or computer-based artifacts (gadgets) varying from, mobile telephones through CD players to cars and beyond. Compact microelectronics make most everyday artifacts (e.g. shoes, cups) potential targets for embedded computers and networks. However in order for non-technical users to benefit from such advances they must be shielded from the necessity to understand or work directly with the technology "hidden" inside; *the computer must disappear!* How can this aim be achieved? In this paper we will argue that embedding intelligence into artefacts could provide one viable solution.

2. Embedded-Intelligence and Artefacts

A Turing inspired question for a "disappearing computer" might be "*is the user of a computer based artefact both physically and cognitively aware of the existence of the computer?*" Clearly if the computer is physically small and well hidden the user might not be able see it. For example by looking at a washing machine it is not obvious whether it contains a computer (or equivalent programmable machine). However, by using the washing machine one very quickly become aware there is a programmable mechanism (or computer) inside it; thus, cognitively, the computer (via the machine interface) remains very evident. This is the case wherever a user is forced to refer to complicated manuals and to use his own *reasoning* and *learning* processes to use a machine successfully.

From the above line of thinking we have formed the view that, "*the cognitive disappearance of the computer*" is intimately linked to the amount of cognitive processes in the form of reasoning, planning or learning that the user is required to undertake in order to use a particular artefact, or collection of artefacts). Following this, we would argue that if some degree of the reasoning, planning and learning, normally provided by a gadget user, were embedded into the gadget itself, then by that degree the computer would cognitively disappear. Put another way, the proportion of reasoning, planning and learning transferred to the gadget (collectively referred to as "embedded-intelligence") is a "cognitive disappearance " metric! It maybe that one values and wishes to retain some of the cognitive interaction with artefacts but, from the above, it is apparent that *embedded intelligence is an essential property of artifacts for the cognitive disappearance of the computer*.

Our work at Essex University is focused on the development of computationally compact mechanisms of embedding intelligence into artefacts (see figure 2) for the development of intelligent inhabited environments [Callaghan 01, Cayci 00, Clarke 00, Colley 01].

3. Disappearance: The AI Challenges

Embedded intelligence can be regarded as the inclusion of some of the *reasoning*, *planning* and *learning* processes in an artefact that, if a person did it, we would regard as requiring intelligence. An *intelligent artefact* would normally contain only a minimal amount of "*embedded-intelligence*"; only sufficient to do the artefact task in question. Embedded-computers that contain such an intelligent capability are normally referred to as "*embedded-agents*" [Callaghan 00]. It is now common for such "*embedded-agents*" (as intrinsic parts of "*intelligent artefacts*") to have an Internet connection thereby facilitating multi embedded-agent systems. Intelligent Artefacts would, in effect, contain an embedded-agent. Individually, such an embedded-agent can harness intelligence to; *enhance artefact functionality* (enabling the artefact to do more complex tasks), *simplify or automate the user interface* (in effect, providing an intelligent assistant) or *reduce programming costs* (the system learns its own program rules)

However, this is far from easy as such "intelligent artefacts" operate in a computationally complex and challenging physical environment which is significantly different to that encountered in more traditional PC programming or AI. In respect of embedding intelligence into artefacts issues include; what AI techniques are appropriate, how does physical size and cost impact the design, how should computation and AI be distributed

© Intelligent Inhabited Environments Group, Essex University, 2001

and how are issues such non-determinacy, intractability, dynamism as sensor dimensionality and processing temporality dealt with? These technical issues are too complex to be explained in this short summary paper (which has largely concerned itself about arguments relating to the need for intelligent in artefacts). However readers with a more technical interest are referred to the full version of this paper and [Callaghan 01].

4. Intelligent Inhabited Environments – An Intelligent Student Dormitory

The intelligent-artefact space we are constructing at Essex is based around an "*Intelligent Student Dormitory*" (see figure 1); a personal space populated by an assortment of personal computer-based artefacts, many of which can be configured by the occupant. Being a student dormitory it is a *multi-use space* (i.e. contains areas with differing activities such as sleeping, working, entertaining etc). Our expectations are that the occupant would chose to decorate his personal space (the room) with a variety of artefacts ranging from building service devices such as heaters to personal artefacts such as CD/TV etc. A student would move into the dormitory, which contains some existing artefacts (mostly connected with the room infrastructure) but brings other more personal artefacts with him/her.

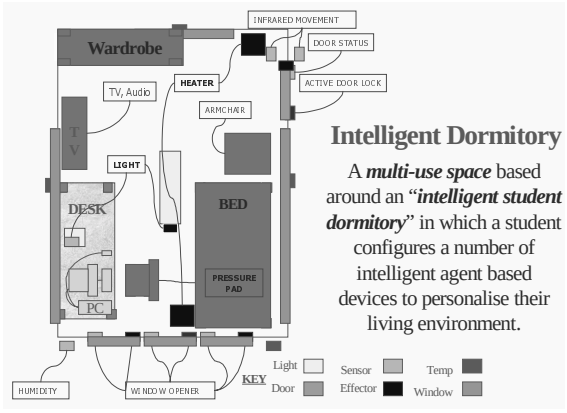

Figure 1 - Intelligent Inhabited Environment

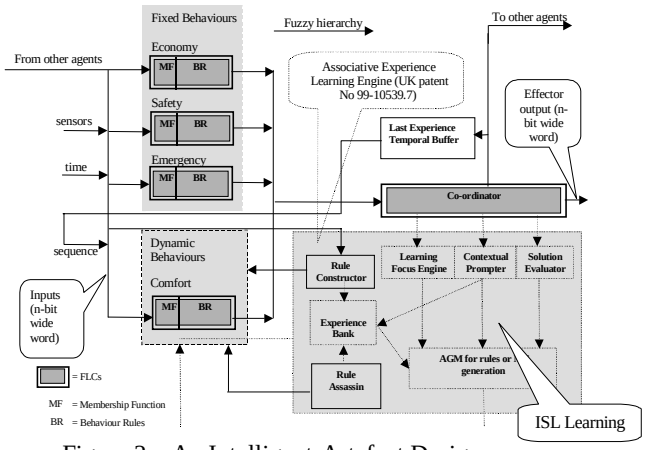

Figure 2 – An Intelligent-Artefact Design

Artefacts may take many forms, from utilitarian heat and light controllers to more imaginative artefacts such as intelligent shoes or cups (all communicating within a micro-locality). By associating intelligent artefacts together (either by a deliberate manual process or an autonomous intelligent learning process) the personal space can be made to operate in all sorts of interesting ways debated in greater detail in the full paper.

5. Summary

In this paper we have argued that transferring some cognitive capabilities from people into artefacts was a natural (if not essential!) way to facilitate the disappearance (or part disappearance) of computers inside artefacts. We introduced one personal multi-use environment which we are using to explore the possibilities for such artefacts; an *intelligent student dormitory*.

6. References

[Callaghan 01] Callaghan V, Clarke, G., Colley, M., Hagras, H. "*A Soft-Computing DAI Architecture for Intelligent Buildings*", Journal of Studies in Fuzziness and Soft Computing on Soft Computing Agents, Physica-Verlag-Springer, July, 2001

[Cayci 00] Cayci F, Callaghan V, Clarke G, "*DIBAL - A Distributed Intelligent Building Agent Language*", The 6th International Conference on Information Systems Analysis and Synthesis (ISAS 2000), Orlando, Florida, July 2000

[Clarke 00] Clarke G, Callaghan V, Pounds-Cornish A "Intelligent Habitats and The Future: The Interaction of People, Agents and Environmental Artefacts", 4S/EASST Conference on Technoscience, Citizenship and Culture in the 21st Century , Vienna, 26-28th September 2000

[Colley 01] Colley, M., Clarke, G., Hagras, H, Callaghan V, "Intelligent Inhabited Environments: Cooperative Robotics & Buildings" 32nd International Symposium on Robotics (ISR 2001), Seoul, Korea April 19-21, 2001.

Acknowledgements: We are pleased to acknowledge the contribution of our *eGadget* project partners from CTI Manolis Koutlis, Achilles Kameas, Irene Mavronmati, Margarita Dekoli & from NMRC Kieran Delaney.

© Intelligent Inhabited Environments Group, Essex University, 2001