



nies solicited our input, and adjusted their own architectures to correspond to our refinement. Exploratory software prototypes (e.g., groupware, multimedia, intelligent interface architectures) adopted our architecture, despite their freedom to explore other architectural alternatives.

## CONCLUSION

We found that a user centered design process can produce satisfied users even when we focus on non-traditional users, and even when our product is not a system, but an architecture. We conclude that the concept of user-centered design sometimes has applicability to more than just the traditional end-users, and that technology transfer requires that *all* users hear and validate one another's concerns.

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## HUMAN-COMPUTER INTERACTION DESIGN MUST BE EMBEDDED IN SYSTEM DESIGN: LESSONS FROM NASA INTELLIGENT SYSTEMS

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A multi-year, interdisciplinary effort is currently in progress to assist the design of effective human-computer interaction (HCI) for systems with real-time process monitoring and control capabilities shared between human and computer agents. Based on observations and experiences from this research, a persistent problem in the design of such systems is inadequate consideration of HCI requirements.

We have studied intelligent systems within NASA as examples of systems with complex HCI. Our conclusions are based on a broad range of activities, including:

- 1) Case Study of Intelligent System Development.  
Intelligent systems for real-time fault management have been studied to identify useful forms of design guidance and to characterize the design process.
- 2) Participation in Design of Intelligent Systems.  
We have participated in design of a Space Shuttle flight

support expert system and a Space Station prototype by providing HCI expertise and design concepts.

- 3) Development of a Candidate Design Toolkit.  
A prototype design tool, the User-Intelligent System Interface Toolkit (UISIT), has been developed to investigate design methodology and embedding HCI design tools in expert system development toolkits.

Results from the case study are presented in the NASA report titled "Making Intelligent Systems Team Players: Case Studies and Design Issues" by J. Malin, D. Schreckenghost, D. Woods, S. Potter, L. Johannesen, M. Holloway, and K. Forbus.

Many of our insights into system design result from viewing the user as another type of agent in a heterogeneous, cooperating, distributed system. System design becomes the design of an architecture for accomplishing domain tasks with the available human and computer agents. HCI considerations, an important part of such system design, can be specified as requirements for the information exchanged between the human and the computer. System development should include the explicit identification of information requirements. We are developing approaches to assist information requirements analysis. This assistance includes design recommendations and examples useful in identifying these requirements.

Evaluation of the development process has identified a difficulty with traditional task analysis for systems with complex agent interaction and multi-tasking. For such systems, many agent activities can be classified as coordination activities, which are independent of the domain task but are required for the human and computer to work together effectively. Such activities are not identified by task analysis yet are critical to successful system operation. A design approach that specifies architectures for cooperation between human and computer agents is a promising way to incorporate coordination activities into system design.

The development methodology should integrate the HCI perspective into system design by:

- 1) Supporting the definition of system information required for effective HCI based on task analysis
- 2) Assisting designers in extracting requirements and design specifications from prototypes, for both the intelligent system and the user interface
- 3) Supporting the definition of operational sequences that include HCI challenges to focus design efforts
- 4) Testing design concepts using operational sequences that forces consideration of HCI issues early in design
- 5) Facilitating use of HCI guidelines, both in identifying information requirements and specifying the design
- 6) Providing mechanisms for coordination and communication within the design team

Another aspect of integrating HCI design into system design is the participation of HCI and user interface experts in the system design team. A design effort involves multiple activities (e.g., software engineering, visual design) often conducted in parallel. The design team should reflect the composite, multi-perspective nature of system design. HCI experts would address such issues as effective agent interaction and availability of information, while user interface experts would address graphic design and information presentation.

Design tools should assist in embedding HCI design in system design. We are evaluating the UISIT prototype to investigate integrating HCI design tools in development environments. Using an object-oriented approach, UISIT provides a distinct communication layer of objects that transmit information between the application and the user interface. These objects represent a specification of required information, which can be used in identifying HCI requirements.

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### **INTEGRATING USABILITY AND MARKETING ACTIVITIES: A METHOD FOR SUPPORTING ACCELERATED DESIGN STRATEGIES**

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#### **ABSTRACT**

Although the practice of user-centered design is advocated in many organizations, engineering management issues may prevent early focus on system usability. Within the usability engineering cycle, practitioners consider task analysis and customer needs assessment a high priority. Market research activities occur early in the process, but usability information is not collected or passed to system developers. To improve and to accelerate the design process and to validate user preference findings, task analysis and market research surveys were performed concurrently during the design validation phase of a data communications product. The basic process steps included: forming a multidisciplinary team, identifying data sources, collecting data via interviews and event record review, transforming data into task models and product opinion matrices, and using the models and matrices to design a sample product. A number of benefits were observed using this method: improved economies of research and analysis

time, increased strength of product opinion data, early product improvements, increased customer understanding of the product, and an improved product engineering process.

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### **ARTIST-DESIGNERS AND INTERACTION DESIGN**

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The computer is now more than a tool. It is a medium.

Until recently visual displays for human-computer interface were limited. Ten years ago, for instance, a PC offered just four variables: normal, inverse and flashing type, and position on the screen—comparable to designing a type-written page.

Today's workstation display is equivalent to a complex book or TV program. Designing with its armory is more powerful and more demanding. Different skills to those of the software engineer are needed to exploit its potential.

Many of these are the traditional skills of artist-designers, particularly of industrial or graphic information designers and film and video makers. But few HCI professionals have mastered these skills, and few artist-designers have understood computers.

The Masters course in Computer Related Design at the Royal College of Art in London, Europe's only graduate institute of art and design, bridges this gap.

#### **THE SKILLS OF ARTIST-DESIGNERS**

- visualisation: generation and mock-up of alternatives for testing and appraisal
- invention: divergent thinking, visual imagination, new forms for new functions
- communication: simplifying and clarifying information through visual arrangement and symbols
- aesthetic appraisal: attracting users, readers, viewers through visual form

#### **USING THEIR CONTRIBUTION**

Artist-designers are often called in at the later stages of an application's development—to clothe it agreeably for final marketing. Less frequently they accompany the earlier