The U.K. Government Program in Engineering Design Research

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ABSTRACT

Britain Has Targeted Design Research, Design Tool Development, And Technology Transfer. It May Get Increased Visibility In The New Government, According To Professor Peter Hills

Dr Hills is the coordinator for the UK government's SERC (Science and Engineering Research Council, similar to our NSF) program on research in engineering design. Out of SERC's annual budget of £450 million, £1.2 million goes to design research, roughly equal to NSF's budget in the same area and thus twice or as high or more comparatively. Dr. Hills keeps an office at the Design Council in The Haymarket in London as SERC's contractor to administer the program. The DC promotes design quality and education by a variety of means, including annual awards, book publication, sales of educational materials, and so on. The US does not have anything quite like the Design Council, although the Design Management Institute in Boston is similar in some respects, with less emphasis on engineering and more on management.

The aim of the SERC Design Initiative, now just two years old, is "to establish a coherent body of scholarship and knowledge in engineering design, directed towards the development of design tools of real help to the wealth-creating industries of this country." There are several code words in this statement as well as several distinct differences between it and corresponding statements from NSF in Washington. (A copy of the SERC program summary is attached as Appendix 1.)

The term "wealth-creation" was used often by Hills during our discussions, and refers to emerging "politically correct" terminology among British Conservatives. Its use by the former minister for Domestic Trade and Industry (DTI), Mr. Peter Lilly, in a recent speech at Warwick University gave it correctness. Many people hope that the new government of Mr. John Major will modify the Thatcher policy of non-interference in industry, replacing it with "benign encouragement." Further, this encouragement will/ought to include more than lowering interest rates. This recalls US debates about "industrial policy," "dual use," and so on. He hopes that the new minister for DTI, Mr. Michael Heseltine, will push this area strongly, perhaps making it a cornerstone for his own ambitions to be PM.

In fact, the DTI has not been completely passive, as a brochure I obtained at Hills' suggestion indicates. It is from the DTI's Enterprise Initiative, a "comprehensive package of advice, guidance, and practical help for British business." It includes consulting, legal and export advice, tips on establishing relationships with universities, pointers to EC R&D programs, modest funding for small businesses, and local technology centers. However, the aim is to "help businesses to help themselves," and the department dispenses mostly advice, information, and contacts.

The second code words are "development of design tools of real help" since this strongly implies applied research and technology transfer. This part of the aim has given him considerable difficulty, as discussed below, since it challenges many established norms and what he called "class barriers" among engineering disciplines and between academia and industry. He admires what he sees as the lack of such barriers in the US.

By contrast, NSF's newly released statement of objectives for its design research activity reads as follows: "...development of a scientific foundation of principles and procedures for engineering design...theories of design, methodologies and models of design, and organization and management of engineering design systems." This is almost pure research. There is no mention here or elsewhere of tool development, real help, or wealth-creation.
In March of this year, DTI established an Innovation Department within the Enterprise Initiative staffed by a career civil servant and five assistants seconded from industry. Its first job is to define innovation in relation to wealth creation. Hills has submitted his suggestion, but here, as elsewhere, the biggest debates are over the most basic things: in the UK, innovation has in the past meant the processes downstream of the original idea for a product, the steps after identifying the need in the marketplace. By omitting market studies, this definition misses one of the most important and precarious steps, says Hills.

"Our efforts in design are equivalent to taking on all the problems of British industry"

Hills is an engineer and strongly believes that design is an engineering activity, further that design education and research should be strongly linked to industry as the ultimate "customer." He agrees with me that manufacturing, defined in the broadest sense to include design and making things, is a practitioner's world and that researchers are often behind, in some areas perhaps permanently behind.

Yet design is so pivotal to wealth creation that he views his efforts in promoting design as equivalent to trying singlehandedly to cure Britain's ills by taking advantage of design's leverage. In short, he feels that design gains its effect by being a creature of management, as I found it to be in Japan. The degree to which industry fails to see the importance of design is a source of deep worry to him since it presages a decline in industrial competitiveness. A similar worry is often expressed about the US, with obvious consequences for the commercial and defense industrial bases.

If management needs to better appreciate the importance of design, then the management sciences must be more involved in design research, but so far that is not happening. His program is in fact quite new and so far supports only recognizably engineering-style activities. He has trouble finding a home for proposals he would like to fund that deal with market research and other "soft" issues. Yet he is happy with most of the centres he has funded so far and is especially gratified by the amount of outside industry funding they have attracted, often exceeding the government input by a factor of three to five.

Another problem he has is convincing some academics to consider more applied research. They look down their noses at it, he says. The professional societies are just as bad, being very old-fashioned, aligned with the traditional disciplines, and disinclined to talk to each other. Yet design and manufacturing are inherently inter- and multi-disciplinary and becoming more so. It is clear that researchers who don't become more interdisciplinary and willing to engage in some development of their ideas find it difficult to obtain funding from his program.

"Our Design Centers are Rousing Successes"

At present there are seven Engineering Design Centres, roughly equivalent in aim and structure to NSF's Engineering Research Centers but funded much more modestly. Five of these are successes in his opinion, with one of the non-successes being essentially the funding agency's fault: it was funded first, got too much money, and was expected to do "generic" research. He now feels that design research must be limited to a discipline or theme, and later centres' goals reflect this.

These centres are:

1. The Engineering Design Research Centre, Glasgow, directed by Prof. D. Harland. The goal is "general research into broad and specific aspects of design."

2. Engineering Design Centre (EDC), Cambridge University, directed by Mr. Ken Wallace. The goal is "mechanical systems design, functional modeling and optimal configuration of mechanical systems, and materials selection."

3. EDC, City University, London, directed by Prof. Alan Jebb. The goal is "quality function deployment and robust design." The Japanese technique of Quality Function Deployment (QFD) seeks to link consumers' descriptions of a product's desired characteristics ("It should be easy to close the door.") to specific engineering parameters such as dimensions, materials, forces, and so on. Robust design, also of Japanese origin and often called the Taguchi method, is a statistical technique for improving the ability of a design to perform in the face of typical variations in materials, processes, or even patterns of use by customers. Among the topics of research at this EDC are tolerances and design for cost.

4. EDC Lancaster University, directed by Prof. Michael French. The goal is "mechatronics." Mechatronics is a word coined in Japan in the early 1980's and refers to engineered items that combine mechanical, electrical, and computational elements. Typical examples include optical shaft encoders, cellular telephones, camcorders, and so on. Topics of study at this EDC include aiding the layout and component choice of mechatronic systems as well as cost modeling and estimating during concept design.

5. EDC Newcastle/Sunderland, directed by Mr. Bill Hills (no relation). The emphasis is on "marine and other made to order products." Some of these topics relate to offshore technology and most of the impressive list of industrial sponsors are oil companies. Projects include feature based design, expert system shells, cost estimating, innovation in design of structures, hydrodynamics, and stress analysis. Another project is aimed at testing the new product data exchange standard (PDES/STEP) for applicability to made-to-order products.

6. EDC Polytechnic South East, directed by Prof. Michael Denham. The goal is genetic algorithms and their application to generation of new designs.

7. EDC Queen's University of Belfast, directed by Prof. Gordon Blair. He is a well known engine designer, responsible for many winning racing motorbike engines and several engines for Ford. The topics focus on integration of design systems for energy-related applications.

Based on the above descriptions, it is clear that there is some overlap.

In addition to these activities, Prof. Hills told me of two related programs. One is the new PhD program, an innovation in curriculum that is currently funded by the government and grants scholarships to engineering students all over the country. Unlike the conventional DPhil, where the student does 100% research and takes no courses, the PhD will be like US PhD's in that the student will do both courses and research. The idea is to encourage a more practical kind of person. It is the brainchild of a Mr. Parnaby, a Director of Lucas Engineering.

The other initiative is the Teaching Company program. This is a combination of the agricultural extension station and co-op education in the US. Here the method is to establish and expand a consulting arrangement between a company and a professor into a long term research activity conducted by one or more students. They may help a company to learn about CAD/CAM or new software development methods. Not surprisingly, the students often go to work for the company when they graduate. Projects can last 4 years or more. SERC cost-shares individual activities at the rate of 50 to 75%. The program dates from 1975 and has been a huge success according to Hills.

Hills also publishes an occasional newsletter. In the August 1991 issue which he gave me are articles by several of the EDC directors explaining in layman's terms what they are up to, the announcement of a new Journal of Engineering Manufacture, and the announcement of an expansion of a program sponsored by the Fellowship of Engineering (roughly equivalent in stature and goals to our National Academy of Engineering) to fund visiting professorships for industrial people at local universities. There is also a complimentary review of a report from the National Academy of Engineering (US) called Improving Engineering Design, which I helped write.

Concluding Remarks

This program is especially interesting because of the attention paid to development and technology transfer, activities that NSF, for example, does not fund. I have noted before that there is no clear technology transfer path for new design tools. The CAD vendors do not provide a route from universities to industry. They typically do not know much about manufacturing and tend to deliver what their customers ask for. The customers do not look very far ahead and are not conversant with design research. A big change in software or hardware would cost them millions. In Japan, I found that the big companies write their own CAD/CAM software to suit their own carefully developed product development process.

In the US, new design technology usually comes from startups, the most recent being Parametric Technology, the first financially successful vendor of CAD with the capability to represent algebraic constraints on geometry. The actual first, Cognition, is essentially out of business. (Both were spurred by research at MIT.) Thus the technology transfer path is treacherous. The UK engineering design research program is to be commended for trying to sponsor and encourage the entire process from innovation to application.

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