in favour of the simple memorizing of control options. Thus the responsibility for the definition and development of skills is effectively passed on to the user and such skills become, by definition, self-originated. This transfer of responsibility can have unexpected benefits in allowing the skill-conscious practitioner to seek out novel ways of exploiting or combining control options. In this context, it is suggested later that specific personal aptitudes, plus fresh forms of lateral thinking, can be developed to provide a foundation for reskilling.

Representational Futures

Training for life: "ubiquitous computing" and professional development

A word processor's primary value is that it provides the option for the text to "evolve" non-sequentially, replacing the linear process that is required in traditional writing. There are comparative similarities in subcomponents of the design process; however, the lack of integrated systems inherent in computer modelling has so far largely prevented continuous data processing and its associated benefits. The position becomes clearer when tracking the recent history of computing. The development of computers began with the first-phase mainframe revolution which took place in the 1940s and 1950s; the second phase, which occurred in the 1970s, was the PC era; the current third phase, "ubiquitous computing," commonly denotes an explosion in the numbers of computers, other intelligent devices and computer connectivity. Design representation has become a more fluid, continuous parallel to the design and development process, rather than a series of milestone snapshots. In design terms, this transition is increasingly allowing representational processes to reflect continuously and parallel a fused mature design and production system (Figure 8.4). The notion that specialized, hands-on peripheral devices might be linked to advanced representational technologies is demonstrated in the increasing number of highly skilled professional fields – for example, the training for, and practice of, medical surgery.

The extension of sensitive control peripherals beyond the mouse and screen pen is evolving at a rapid pace in fields as diverse as music, computer games, and surgery and is slowly gaining momentum in design. With the emergence of such sophisticated control extensions, the common view that the simplistic virtual reality environment will be the next natural extension of the design toolbox should be reappraised. In contrast, the notion of an augmented reality could be considered, in which control peripherals bridge the gap between hand, eye, and machine intelligence. These peripherals would be combined with viewing tools that allow the "real" world to be blended with the virtual, and doing tools that integrate the electronic hand implement with the haptic feedback device.

Clearly, design and production are fusing, driven by the malleability of data. Tools that exemplify this fusion include initially crude, but increasingly adaptable, "sketching" systems that are linked directly to rapid prototyping equipment and integrated manufacturing systems. This connectivity enables fundamental design changes to be made throughout the duration of the

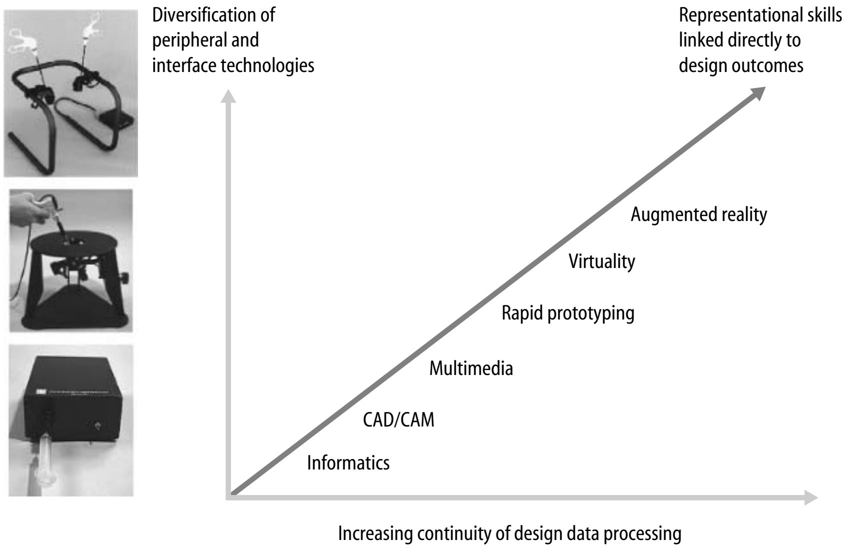

Figure 8.4 The increasing continuity of design processing has facilitated the development of skill-based tools.

project, a crucial factor when responding to a volatile consumer market, as evidenced by stereo-lithography which allows some aspects of modelling to become a form of productionization. The "rules" that govern manufacture can be in-built for the duration of the project, informing all modelling processes. Rapid prototyping used in tandem with production detailing permits a conceptual and contextual view to be retained throughout the process.

Evidence in support of this progression can be found in a recent doctoral thesis by Yi-Luen Do (1998, p. 6). A "Right-Tool-Right-Time" prototype program demonstrates how a freehand sketching system that infers intentions would support the automatic activation of different design tools based on a designer's drawing acts. Such an example identifies the interactive duality of augmented reality in that it both interprets and informs representation, while simultaneously allowing real world tools to provide the primary data input. Thus an augmented reality would both simulate and interact with a tangible reality in order to provide enhanced cognitive and control potentials. Not that the skills associated with such systems would necessarily remain apparent, as Mark Weiser, former head of the Computer Science Laboratory, Xerox Park, suggests: "Disappearance is a fundamental consequence not of technology but of human psychology. Whenever people learn something sufficiently well, they cease to be aware of it" (Weiser 1995, p. 78).

Despite this evidence, such an augmented reality, which deals effectively with skill-as-creative stimulus, has yet to become available. In the meantime, although skill is an essential factor in the human psyche and an important component of the design process, professional development lacks coherence. Computing has not deskilled design but created confusion; skills have become isolated and short-term, difficult to maintain and develop because of the pace of new system introduction. To prepare for innovative and unpredictable