skill development, while reinterpreting the traditional skill base with regard to ubiquitous computing, the design community should, where possible:

1. Participate in the development of augmented reality representational tools through alliances with the appropriate developmental industries.
2. Continuously re-skill in relation to these evolving tools.
3. Consider the use of such tools as conceptual drivers and not merely as facilitators.

The designer's indemnity, and claim to professionalism, is to adopt the successive technological developments ahead of their diffusion to the wider public. The necessary reskilling of designers will take place within economic volatility: employment is increasingly characterized by part-time, discontinuous work, self-employment, subcontracting and multi-skilling. Adaptability and flexibility are crucial to survival in all professions, and the skills required by the practitioner will be the ability to discern the transferable core, and the relevance and use of leading-edge technologies. To stay ahead, practitioners should move towards an augmented reality, be capable of continuously reconfiguring attitudes to skill to exploit further innovation, and develop a more proactive realization of tools. Proactive practitioners should address:

- The active pursuit of technologies that directly connect artificial intelligence with physical dexterity.
- Continuous rather than segmented design data processing.
- The deployment of technologies for individual/organizational learning and representational skills acquisition.
- The implementation of comprehensive, coherent virtual, and tangible working environments.
- Design alliances that identify new computational tools and develop new methods of use/application.

Developing a body of work that bridges virtual, augmented, and tangible realities is fundamental to the optimization of personal skills (Figure 8.5), a process that has much in common with the systematic exploration of materials, processes, tools, images, and finishes practised by designer-makers. "Systematic play" could aptly describe this form of design learning, allowing multiple media to record a personal body of work recording and analyzing the applications and outcomes. A significant aspect of an augmented reality environment encompassing design representation would be integrated analytical tools that allow personal development to be tracked through the augmented reality equivalents of sketchbooks, notebooks, sample collections, and test pieces. This aspect would form an effective new basis for Schön's (1998, p. 157) reflective practitioner model and is echoed in the aims of advanced industrial training: "Integrating state-of-the-art rapid product development technologies with fundamental master workmanship" (Industrial Centre 2000, p. 1).

This integrated approach supports the development of tools by, rather than for, designers. Investigation into the nature of design skills will provide constructive guidelines for developing representational tools and applications for the emerging technologies, including haptic feedback devices which redefine body/eye/brain skills. The most useful transferable skills facilitate the transfer of the design process between tangible and virtual worlds, with the partial

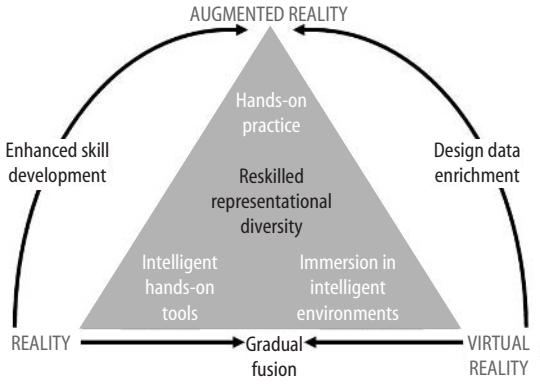

Figure 8.5 The high performance studio.

rather than total immersion of the designer within a digitized environment being more relevant to the changing design process.

To imbue an object with visible quality requires an effective relationship between tools, methods, and skills. A symbiosis between these factors is more difficult to maintain in data processing; representational machine intelligence is able to present a perfect surface image, a holistic vision of high quality design, and, as systems become more sophisticated, this potential increases. However, such "perfection" ultimately represents orthodoxy imposed by the software industry, rather than meaningful design choice. Practitioners should seek visualization tools that allow genuine exploration and run counter to this orthodoxy. If reflecting on design is "like looking at the film of a car crash run backwards," associated representational technologies should possess the facility to re-create barely controlled chaos. The availability of such systems will not come about by waiting: progress inevitably requires coaxing, including lobbying by both design practitioners and theorists to form creative alliances with technology developers.

The design practitioners' industry should be equipped with both transferable and specialized representational skills to fulfil this alliance and reflect the value placed on broader intellectual capital. The attributes of positive action and ownership within the emerging technologies should be considered essential and include the ability to conduct personal design technology audits and provide a related specification. Technology is moving so quickly, becoming so diverse, that designers need to become involved in the structural make-up of representational systems, not merely their deployment. Knowledge that allows designers to determine the form, as well as to take control of their new tools, will make them more flexible and support the continuous creativity of their work.

In this context, a frequently overlooked limitation of current IT training for designers concerns the customization of hardware and software. Practitioners exploit their equipment resources, but are not necessarily responsible for their specification. A prerequisite of advanced skill in this context is understanding, responsibility and bonding, achieving an intimate relationship between the applications and the tools. With traditional skills, knowledge was handed down from craftsman to apprentice, the user