Analysis Method

Video Interaction Analysis (VIA) (Jordan and Henderson 1995) was used to investigate the dialogue and gestures of students as they worked with hardware. VIA is a qualitative analysis method that has its roots in the social sciences. It is suitable for helping to formulate hypotheses and find patterns in complex data. Video captures social interaction and learning activities as they occur and yet allows playback and scrutiny. It provides access to conversation, gestures, expressions, actions, and the immediate workplace context. It allows repeated viewing of the original data to examine the consistency and generality of the observations. It reveals the unanticipated and immerses us in the activity with the student.

In Video Interaction Analysis, the primary investigator watches each tape, making a log of the content and selecting segments of tape that are representative of the activity or of particular interest. An interdisciplinary team then observes the selected segments of tapes and identifies routine practices, problems, and resources for their solution. Only those practices confirmed by the raw data that occur repeatedly in different parts of the tape are admissible in the analysis. Conjecture that is not supported by the video data is dismissed. Activities do not reveal the individual cognitive processes of learning, but they reveal all the verbal and gestural interactions – that is, the inputs and outputs of the individual thinking processes that were made available to the group. Thus, they provide the researcher access to the external representations used in activity.

Some fundamental assumptions of the Interaction Analysis method are that:

1. Knowledge and action are fundamentally social in origin – knowledge and information lies within the social milieu of people, artefacts, books, the world etc., and people access and construct this information into personal knowledge through interaction with the social milieu.
2. Theories of knowledge and action should be grounded in verifiable observable empirical evidence.
3. Theorizing should be responsive to the phenomenon itself rather than to the characteristics of the representational systems that reconstruct it – analysis is done directly on videotape data, rather than on transcripts, or other reduced forms of data. It is acknowledged that video does not capture the broader context of events in the videotape and that the view from the camera is the only view available.

Several Video Interaction Analysis sessions were undertaken with people from a variety of different disciplines: engineers, architects, social scientists, cognitive scientists, education researchers, computer scientists, linguistics researchers, and anthropologists.

Results of Video Analysis

The video analysis of the activities revealed that hardware plays a very formative role in learning and designing, rather than simply serving as a final physical testing ground for ideas that have been developed through abstract

reasoning. Hardware acts as an intermediary through which students develop and convey their thoughts to each other. Learning is constantly mediated through feedback from hardware or, in the absence of hardware, reasoning based on physical experience.

Negotiating between abstract and material representations

The general process of learning and designing with hardware is shown in Figure 4.3. The designers negotiated the demands of the requirements (abstract representations) against the performance of the current prototype (a material representation) and tried to bridge the gap by making design proposals, taking actions until the two reached a satisfactory agreement. This process led designers from the externally defined requirements and their own theoretical and hardware starting points through to a refined understanding of theoretical concepts and an extended hardware repertoire.

A plot of references to material in the workspace and to abstract constructs (such as design requirements, theories, and functions) in the crane and scales exercises revealed that the references were heavily interleaved, as shown in Figure 4.4. This quantitative analysis is described in Brereton and Leifer (1997) and Brereton (1998).

A series of events from the crane exercise that illustrates a typical process of designing with kit hardware is shown in Figure 4.5. The design advanced through students making and testing design proposals. These design proposals arose from seeing possible configurations of the ready-made kit hardware that would meet the design requirements. Design proposals were made through gestures with hardware augmented with speech (transient representations). Each proposal introduced a hardware configuration supported by rationale that referred to a physical property such as "strength" or "torsion"

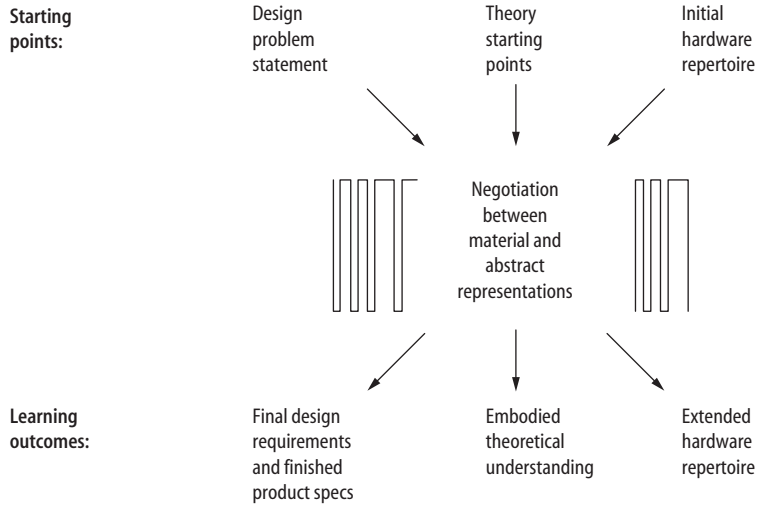

Figure 4.3 A negotiation process leads students from the task definition and their own theoretical and hardware starting points through to a refined understanding of theoretical concepts and an extended hardware repertoire.