Intent, Form and Materiality
in the Design of Interaction Technology

In a recently published Swedish textbook on Interaction Design, Löwgren and Stolterman have polemically suggested seeing information technology as the material without qualities [Löwgren & Stolterman 1998]. They do this, with reference to the many attempts among software designers to come to grips with their design material [Winograd 1996]. But the suggestion is also paraphrasing the title of Robert Musils book "The Man without Qualities" [Musil 1995]. Musil writes his book in the 1920'ties in an attempt to capture modernity as the purified intentionality, in which structure and form have evaporated. The mirroring of information technology and its embedding in a design discourse of intent and instrumentality in the emblematic image of the 20'th century modern man is well spotted and far from coincidental. With this double anchoring of software design in a heritage of purified instrumentality and a strive for a workable notion of quality, the authors hit the tune to which much concern with an emerging new field of design is played. But taken literally the statement is misleading. Information technology (or rather, as I will argue by the end of this article: interaction technology) has as any other class of artifacts a 'materiality'. This

‘materiality’ is not only shapeable, it is also only through the ‘objectness’ of the artifact, that we as designers can hope to convey anything from setting to setting.

Through my personal journey of design projects aiming at informing the skilled work of industrial technicians and operators, the issues of ‘materiality’ and embodiment seem to emerge out of a simple and straight forward engagement with what it means to be informed. Having taken a starting point in participation and work practice it has become increasingly clear that what we can channel with information technology is not information with any assured resemblance to what the ‘reciever’ perceives. Rather it is cues and clues for a constructing-sense-of-the-world that is basically not unlike the design process itself [Reddy 1985]. I will argue that this implies an urgent need to escape a dominant utilitarian discourse of design which is centered on intent and instead engage in a more open-ended inquiry into what I will call the formation of artifacts.

I will develop my argument in three steps following retrospectively my own movements in the field. First I will look at the fragile nature of the matrices in which we have been considering information technology. From my

own experience of working with information systems for the industrial shop floor, I will pin point the break down not only of a unifying intentionality but also of any kind of smooth transition from (design) intentions to actual lived in practice. I will with a detour to Herbert Simons ' Science of the Artificial' look at how both I and the Scandinavian environment, which I see my self as a part of, have had difficulties with coming to grips with this insight without loosing sight of the distinction between artifact and context. Second I will dwell on what I with a reference to Donald Schön call a more conversational approach to designing. With a starting point in a design project where we developed concepts for an industrial PDA, I will look at how leaping into design from a contextual inquiry runs the risk of adopting uncritically some of the technological 'forms' already embedded in this context. Finally I will take up how recent attempts to look for tangibility, perhaps open a route to a new language of formation in the design of IT artifacts.

Taking IT design beyond bounds

For a number of years I was designing hypermedia-type shop floor information systems for various industrial settings. We wanted to use the then new option of multimedia presentations to provide a richer and less

abstract type of information for industrial workers directly on the shop floor. We designed the POSTI information system for postal workers and technicians working with automatic letter sorting machines. POSTI contained information on maintenance, faultfinding and repair designed with the intention of softening the boundaries between the two groups and between novices and experienced workers. Later we designed the SPRING multimedia-based training package, meant for on-the-job training of machinists setting up spring coiling machines [Binder and Passarge 1996]. As a design group we all had our roots in the Scandinavian tradition of collaborative design. We developed a way of working where we involved experienced workers extensively in the design work. We worked with industrial partners. These had typically organizational goals, such as softening the division of labor or reducing time for off-line training. We saw our work as creating systems that facilitated such organization change.

Our basic idea of what information to provide had two sources. We had an image of the type of industrial work we were to inform as being highly dependent on experienced practice and we wanted to mirror this by making room for content generated by experienced workers in a format that avoided generalizations and were rich

with examples. Slide shows and later small video sequences recorded with master craftsmen became the content backbone of our information systems. Secondly we worked from the idea that having free access to instructional information on the shop floor would enable the users of the system to take turns with tasks they had little or no previous experience with. One can say that we in our own understanding were creating a very odd 'Trojan horse'. We saw the opportunity of creating an artifact that could initiate change by making skill acquisition possible on the floor. At the same time we were convinced that the information our system provided, had to be generated by skilled workers at the very same shop floor. Or to put it in other words: We took a fairly conventional idea of knowledge-based systems and tried to translate it into an environment were relevant information seemed to be documentation of best practice. We also envisioned mixed groups of users to pull relevant information whenever they found it relevant. If we as designers within that framework had the role as 'documentarists' and 'librarians', the people we worked together with were both 'domain experts' and 'users'.

We were quit successful in setting up a participatory design process in these design projects, but a number of our initial assumptions became increasingly questioned as

we gained experience in the field. Our idea of documenting best practice seemed straight forward but it turned out that the dialogue between us and the experienced workers in the field became much more of a design process in itself [Binder 1995]. The workers did not agree among themselves as to what should count as best practice. At first we saw that as an indication of a large diversity in actual work practice, but even if this may still be true to some extend I increasingly came to see the dialogue as a genuine construction process were 'stories' of appropriate practice emerged. This spilled over to the understanding of the designer role. We tended to see ourselves as the information systems designers that worked with domain expert and users who provided and evaluated information content. But as we continued to see a pattern were core 'users' seemed to take on authorship of the systems, we started to wonder what was our contribution.

When we started to look closer at our systems in use, we learned that what we had was much less than a fully negotiated information system put in place. In the POSTI project the physical set up of the information system, became an issue of dispute and contest among technicians and operators. Where should the POSTI system be placed, should it be on wheels, have keyboard etc. turned out to

be very concrete questions through which not only the system itself but also the symbolic value attached to it, had to be settled. And negotiations were not once and for all. To the extend that we could follow what happened after we left, it seemed as if the POSTI system continued to be moved around, and re-interpreted. The only thing that seemed fixed (and important) was the simple fact that something new was there.

With the SPRING application, continuous re-interpretation seemed to go even deeper. In a follow up study of how the hypermedia material was used by inexperienced machinists, we found that even the informational content had to be re-constructed in the light of both the social setting of use and of the experiential horizon of the machinist [Meier 1998]. A pattern very similar to what we had seen when we created the application together with experienced machinists of re-inventing practice appeared to re-occur in use.

Designing the artificial - change agency or world making

Herbert Simon was among the first to phrase a broader concept of design that has been highly influential for our way of looking upon the development of information systems [Simon 1976]. For Simon the core competency of

professionals is to design artifacts that interface between different systems in order to obtain certain goals. This calls according to Simon for a Science of the artificial where the rigor of science gets applied to the intricate network of societal means and ends. The approach of Simon created the foundation for a discourse on systems design in which intent became the central issue. In Scandinavia the participatory design tradition argued for a multiplicity of legitimate intentions that have to be incorporated in the process of design. With such notions as 'user-involvement', and 'socio technical systems design', information system designers have tried to broaden both the scope and the methodological approach of designing [Greenbaum and Kyng 1991]. Such positions can however still be inscribed in a rationalistic design discourse of intentionality.

What is more problematic however is that the increasing sensitivity to the multitude of interests and perspectives engaged in 'implementing technology', seems to have blurred the distinction between artifact and context [Binder 1996a]. In the discussion on differentiating between computer science and informatics, authors such as Rolf has argued for a design orientation in informatics, which takes seriously the designers role as change agent enrolled in a particular project with

social goals [Rolf 1992].This position is developed in dispute with a dominant self image among technologists of being in a realm outside of social discourse. For Rolf the principal distinction to make is consequently the distinction between designing and producing. This in it self does not set him apart from Simon, but as he develops his view on design the actual artifact seem to disappear behind the call for accounts of intented change. Bödker seeks to reinstate the artifact in the discussion of design and use of computer applications [Bödker 1999]. Taking her starting point in the activity theory perspective on mediation, she see computer applications as mediators enabling or restricting various ways of engaging with the world.Seing these mediating artifacts as historical devises crystalizing works practices of the time they were made open up for an analysis distinguishing (allthough only vaguely) design from actual use. But as she appears to apply an almost all encompassing notion of artifacts she does not in my view manage to take apart design project (in terms of change agency) from evolving practice.

In this light our work on shop floor information systems is also conventional. We started out with an organizational intention of having operators take responsibility of maintenance tasks. From this initial

goal we set in motion a process by which relevant task-specific information could get documented and channeled to the operators. If the system we designed had been a support system for office work or an instructional system for assembly line workers; we may never have been confronted with the puzzling questions to the artifact we designed. The fact that we went for a participatory design process can be seen as an attempt to deal with the apparent complexity of the social context. By defining our collaborators as users and domain experts we had carved out roles for them that established a firm playground for arbitrating between intentions.

What emerged was different. Moving outside the established informational formats of i.e. text based instructions that we could comprehend and control and into the much more ambiguous formats of multimedia documentation, came to illuminate in a very practical manner how information has to be interpreted and appropriated in order to make sense. Similarly the fact that our system was to be placed in an environment on the shop floor where information technology was still rare, made the actual instances of use highly uncertain. Our framework of participatory design was in this setting not unlike what Donald Schön ironically labeled 'the negotiation of the platonic republic' (Schön in [Binder

1996b]). We believed (as most other systems designers) that we through the process of participation could manage to negotiate these new issues on the level of exposing and negotiating interest. What we did not see was that we had entered a new realm of form that we were incapable of addressing directly.

The writings of Simon still have relevance for the expanded notion of designing as the crafting of artifacts interfacing people and things. As argued also by [Dahlbohm et al. 2000] Simon points out the imidiate relevance of inquiring into the specific ways artifacts get designed and succesively may change social constellations. What we have to realize is however, that the bodiless concept of systems design is highly dependent on the bureaucratic installation of a regime of form. Such a regime has been strong in the long historical period of monolithic technological development in many areas of social life [Banta 1993], but taking this kind of systems design outside bounds immediately reveals the unsettled issues of formation.

Providing windows rather than systems

The shop floor information systems tended to become 'over-designed' as self-contained socio technical

systems. The growing amount of open networked infrastructures with multiple point of access invites new types of applications. The image of information ’browsers’ giving access to a large and to the design external mass of information, opens up for new types of IT artifacts. After some years working mainly with a tool perspective on IT support, I had the opportunity to make a design oriented exploration of PDA type interfaces for service technicians at industrial process plants. I worked at the time at an industrial manufacturer of actuators, sensors and controls. We had in a number of design projects sought to develop a concept of local inspection and control based on portable interfaces, labeled SMARTTOOLS. This effort was only partly successful for several reasons. The notion of local inspection of i.e. a motor drive or a motor controlled valve never became fully satisfying. The components were always interconnected with other components and could hardly be said to be functionally located at one particular spot. That each component typically has associated instantiations that turn up in control panels or monitoring units did not make the picture clearer. Secondly the tool metaphor as adpated from Ehn [Ehn 1988] although easily understandable, was difficult to put in place because it supposes a ’nice fit’ between the technicians task and the often unknown state of the

inspected components. This seductiveness of the chosen metaphor did even have repercussions for our own approach to design. My colleagues and I entered the design projects from a usability engineering perspective (we were a usability design team within corporate research) [Bagger et al.1997]. The search for tools gave us too much of an easy ride in matching usability needs on the side of the technicians with sought for qualities of the portable interfaces without being sufficiently challenged by the overall environment in which these tools were going to be used.

The industrial PDA project gave us an opportunity to re-consider what kind of distribution of information we could think of for technicians operating in a highly IT rich environment as a process plant. We named our device the SMARTWINDOW to indicate that what we were looking for was an artifact that could provide the technicians with a particular view of the environment where they were working. The starting point was still human-centered design, with a mix of user workshops and anthropologically inspired fieldwork as the recurring steps in the design process. Where we in other design projects early had identified core users and mainly focused on understanding their task, we sought in this project to widen our outlook. The Window metaphor in

itself called for an understanding of the environment to which our device should produce a view. We searched for some of the structuring images that already exist in the setting. The control room 'panopticon' is one such strong structuring image. Most information technology somehow links up to this unifying image of global monitoring and control. This did however not exhaust the environment as an information system. The group of operators and technicians continuously re-tell stories of the moment-to-moment operation based on strolls through the plant. These stories are typically based on carefully matching redundant information collected from sensors on the spot, visual inspection of processes and a general alertness to smell, sound etc. in various 'regions' of the plant. Even patterns of action seem to be anchored in an overlay of these systems of information both shattered over the plant and (for some parts) concentrated in the control room. What stood out from these encounters with work practice at the plant was that technicians more or less lost IT-support when they were working outside the control room (or had to connect to it by mobile phones). To see the SMARTWINDOW as a down scaled portable control room that enables the technician to keep in touch with the overall network of sensors, actuators and controls seemed to be a reasonable route to take.

Based on simple physical mock-ups of the SMARTWINDOW the technicians and operators we worked with developed a number of video scenarios that envisioned some prototypical examples of how the SMARTWINDOW could be used. We carried these scenarios from plant to plant, and had them evaluated at workshops with participants from different types of plants [Binder 1999]. This became an example-driven specification process that enabled us to work with detailing the design without needing to abstract a more generic concept or go into detailed task analysis. We supplemented the participatory engagement with users and use, with an examination of what we called interaction style [Øritsland and Buur 2000]. We had earlier been working with stylized user characters as a way to get hold of diversities among user, but we had found that this easily led us into a mix of different task profiles and societal prototypes. To avoid this we tried to bring together a sort of distilled image of interaction style from the Science fiction literature. With Flash Gordon from the Sixties, Spock from the Seventies and Neuromancer Molly from the Eighties we had an encapsulated style history that we could map to the things we found in the plant environment [Bødker et. al. 2000]. This lead us to the production of what we called interaction style sheets which worked quit well as inspiration for interaction design.

We ended the project with mock-ups; interaction prototypes and a functional prototype where we used an existing PDA interfaced to a simple SCADA system and a few sensors and actuators to demonstrate that we had a viable concept.

Conversational design

If the Scandinavian tradition of participatory design for a large part can be said to be contained within a instrumental discourse on systems design, the SMARTWINDOW project can be seen as an attempt to break free usability design or interaction design as a design field in its own right. Within this new field we attempted to establish a focus on shaping issues which derived their relevance from an inquiry into the context of use and a more freestanding examination of interaction 'gestalt'. The prize for this free zone is however high and continues to threaten the new won freedom of the interaction designer. We are still struggling with the utilitarian notions of 'use' and 'user', and by giving up aspirations for socio technical systems design we are also black-boxing both the existing system of tasks and the overall design of information technology.

By picking up on on-going developments towards miniaturized and mobile interfaces and by choosing 'the window' and 'the control room in the pocket' as guiding images we got the opportunity to deal with a less formatted context of future use. We did however also inherit the underlying assumptions of the feasibility of global and coherent views on the industrial process, and could hardly struggle with more detailed conceptions like alarm driven operator action. We wanted to be more modest in our aspirations and confined ourselves to the realm of technicians fixing the plant. Within this area we could pursue a user-centered design approach being safeguarded from larger issues of system functionality (which we by and large presumed). But as I see it our approach is still vulnerable to Schöns criticism of the participatory designer negotiating the platonic republic of agreed upon use.

Schöns own concept of designing is not foreign to engagement with context. He suggests what he called conversational design where the designer engages in a reflective dialogue with 'the materials of the design situation' [Schön 1988]. He was not particularly in dispute with participatory design. His project was from the outset somewhat similar to Simons seeking grounding for the design professions [Schön 1987]. But unlike Simon

he saw the designer as engaged in a basically outward loop of engagement with the environment. He did not accept Simon's notion of the design problem as an externally generated starting point rooted in societal needs or objectives. For Schön the setting of the problem is intrinsically connected to the generative cycle of constructing and perceiving the world. In this cycle nothing can be seen before the designer projects herself on to the situation. By framing the situation and eventually imposing order to it the designer enters into a constructive relationship in which images of the new can evolve. The introduction of the 'materials of the design situation' is here important, to grasp the significant difference to Simon's perspective on design. Simon and Schön can be said to agree that the designed artifact is a human construct that may or may not turn out to be feasible when translated into new interfaces between various systems. But where Simon seems much in line with the PD tradition when assuming that the designer has direct access to reason on the problems of the context, Schön propagates a different kind of modesty, by introducing the representational issues of design. For Schön the designer must be understood as herself situated in a reflective cycle with the materials at hand.

From the POSTI and SPRING projects to the SMARTWINDOW project we moved both along the axis laid out by Simon and Schön. The Shop floor Information Systems can retrospectively be seen as confusing the designed artifact with aspirations on the part of the designer (and users) with respect to the future of work. The SMARTWINDOW project takes more seriously to differentiate between the artifact interfacing between various sub-systems (i.e. the overall instrumentation of the plant and the particularities of plant maintenance), and the larger context of use. The SMARTWINDOW device has however its strong imprints of both existing technological systems and of the work practice of plant technicians.

Along the lines laid out by Schön, the SMARTWINDOW project was a move towards a more conversational approach to design and participation. As designers we were more explicitly moulding our conceptions of the new device, and we were deliberately seeking an open conversation by handing it over to a mixed community of potential 'users'. Our inquiry into interaction styles can be seen as an attempt to come to grips with an extended language of representations. Still it is somewhat obscure how we distinguish between the envisioned artifact and the representations crafted in the materials of the design situation.

Seen from a 'birds-eye' perspective the design projects are all struggling with how to locate information technology and they are based on the assumption that different people and different jobs call for different informational perspectives to the same overall information ecology. In the Shop Floor Information Systems projects emphasize was on tailoring information to a particular context of use. The lessons learned were that this issue could not be dealt with without looking at the particular embodiment of the artifact designed. The SMARTWINDOW project corresponds to this insight by taking as its starting point the way a freely moveable interface can be embodied and put in place in a larger environment. In this way the physical shaping of the new device becomes the prime design material with which the designer and his collaborating users engage in a constructive dialogue. What is not clear from the projects is the status of dealing with these issues of embodiment. Is it so that considering the actual physical set-up in which the information technology is enacted, is just yet another design parameter to consider? Or is it rather so that embodiment is an essential feature also of information technology that we have been neglecting in the past. The projects do not answer this question, as they have both limited themselves in scope to consider

merely the provision of information to particular localities. A more radical approach would have to also call into question the more fundamental issues of overall information systems design.

The PUCKETIZER – getting hands on the 'system'

In a recent design project – the PUCKETIZER project [Nilsson et al.2000] we wanted to take the conversational design approach further. We wanted to see if we were able not only to add to but also to confront more fundamental issues of conventional systems design. We wanted again to work with the apparent tension between local inspection and maintenance and centralized control as we had found it in the process plants of the SMARTWINDOW project. This time we wanted to position our design project in such a way that we could work with the overall system of plant monitoring and control. We were inspired by the growing literature on ubiquitous computing starting with Weiser [Weiser 1991], and we wanted to rival the idea of centralized and hierarchical control. In terms of our own design thinking we also wanted to overcome the fixation we felt we still had to the notion of 'users' and 'use'.

As in earlier projects we worked closely with people in the field. We established a collaboration with a large

waste water treatment plant and decided to work mainly with process operators rather than technicians to loosen up for a potential fixation with discrete tasks. We did not from the outset have any clear understanding of a problem we were going to solve. What we had was a number of examples from earlier projects on the shortcomings of conventional control. As baseline for our design activities we assumed a not so distant future where we can expect to have a multitude of input and output devices.

In the first part of the project we followed a number of process operators during a normal working day and made extensive video footage, with the camera as a very visible third party in the on-the-spot conversations [Binder 1999]. From the early visits we edited small video documentaries, that we brought back for discussion with the group. After further visits we started to edit what we called type scenarios, which in our view expressed some interesting aspects of the work at the plant [Buur et al. 2000]. The image that emerged was that the entire plant could be seen as one large composite interface to the process of water cleaning. Dealing with upcoming problems such as pump breakdown or clotting of pipes is generally a collaborative effort that often involves experimentation. Leaving traces of on-going or

newly finished activities seemed to be a wide spread practice. Alarm handling, which is a well-supported feature of the monitoring and control systems, played a relatively minor role. As we ended the fieldwork we had 6-8 small video stories that we had negotiated with the plant operators. They depicted plant monitoring as a rather fluent and ad hoc activity that have to deal with a plant which seems never to be in any simple sense 'just up and running'. We did still not have a well-defined problem to solve. We started to get a sense of a new environment and we had developed a representation of this environment with our edited videos.

In the second part of the project we moved in a variety of props that were generated from more or less generic IT building blocks. We introduced an idea of moveable displays of varying size. The displays could be positioned at various locations where there is a need to establish a view to electronically collected data. We suggested moveable sensors that will allow for flexible instrumentation, so that monitoring can be established with increasing intensity in areas which are particularly troublesome. And finally we suggested new input devices that could work on the entire plant much the same way as mouse and keyboard on the computer. All our suggestions were brought up in workshops with the process operators

and we supplemented them with images of how we could imagine to 'dress up' the operators, the plant or the operator areas to accommodate these building blocks. As representations of the different designs we used simple cardboard mock-ups to provide a sense of size, portability etc. [Brandt and Grunnet 2000].

From the discussions with the process operators and our own attempts to sketch in more detail different concepts, it seemed promising to concentrate on a design where the operators establish temporary interfaces according to day-to-day concerns of the plant. We also wanted to minimize the amount of devices that the operators would need to carry along with them. We ended up detailing a personal device that would keep the operator connected and still leave as much of the interaction with the plant to semi-stationary devices. This led us to design a device called the Personal Bucket Organizer (PUCKETIZER). With this device the operators can collect items for a particular view on the process in a 'bucket' for later being able to monitor relations between the items when 'pouring' the content of the bucket to a display.

The functionality and interaction of the PUCKETIZER was again developed in a number of scenarios created and acted out in front of the video camera in the plant. The

video scenarios formed the representational medium in which we could share with the operators the emerging design. We ended the design project by making a scaled down functional model of the device. This did not only function as proof of concept, but did also provide us with a way to more closely examine the viability of the design as a prototypical model for other interactive systems.

Beyond Information and Software

This account of design projects over a decade is likely to resemble that of many other designers. Already in the POSTI and SPRING projects we were sensitized to the calling of Winograd and others to be true designers of the virtual world of the users [Winograd 1996]. We did exercise our prototyping skills and we engaged seriously with the people in the context we designed for. But we failed to see that although our job was to prepare the software, we were dealing with a setting where 'the delivery platform' was not self-evidently encompassing anything like a 'world'. We were also stuck with the idea that our design material was information instead of seeing that what we provided was material that might eventually be turned into information.

We moved with our field into the new world of mobile informatics, and we sought modestly to carve out a niche for ourselves as interaction designers. This tought us more about design at large. We came to work with the physical embodiment of new devices, and we learned to engage with a larger repertoire of design representations. But as we had taken to our heart the new self-image of the architect-designer we had also fenced in ourselves in a reservation for user consent that left us out of touch with the design of the larger technological structures.

The recent interest in graspable user interfaces [Fitzmaurice et al.1995] and tangibility [Ishii and Ullmer 1997] holds promises for a future in which software and systems thinking are again searching their bodies in the mixed media environments of everyday life. These environments are likely to resemble the artificial world of e.g. the process plants we have engaged with. This will leave the questions of how to deal with the immateriality of software and its lack of quality behind us. Instead it will enevitably put software designers back into the larger community of engineers, architects and others puzzling with interaction technology and trying to come to terms with a full-bodied notion of ' the Science of the Artificial'.

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