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AN ARTIFICIAL WORLD
An invitation to creative conversations on future use and design of computer technology[1]

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Abstract

Aims and methods for the practice of system development were formulated in relation to early computer technology use in the sixties. These aims and methods provided a foundation for research and a framework for discussion which still set the agenda for theoretical work. Changes in computer technology use in the eighties raise issues that tend to fall outside the established research tradition. New user groups, the industrialization of software development, a tremendous diversification of computer technology use, and profound changes in society, everyday life, and world view broaden the need for research on how to put computer technology to good human use. In this paper we want to contribute to a discussion of how this challenge can be met, in general, and by the system development community, in particular.

Keywords: system development, information system, technology use, computer artifacts, interaction, world views, design.

1 The future is not what it used to be[2]

Imagine that you were an electrician way back in the late 19th century, pondering the future use of electricity. What would you be able to come up with? Would you think of lighting and heating your house, cooking, welding, lifting heavy things, as power to motors, as information carrier? Or, would you be so stuck in the usage of your time that all you could think of was simple variations on use as a light source? How ill prepared for the future you would be! And how could you possibly do a good job, as an electrician, in your own time, with such a shallow and mistaken conception of electricity?[3]

You could always turn to philosophy, of course, to get a better understanding of where electric technology might take us. This is what Hegel would have told you, as early as 1817:

> Electricity is the purpose of the form from which it emancipates itself, it is the form that is just about to overcome its own indifference; for electricity is the immediate emergence, or the actuality just emerging, from the proximity of the form, and still determined by it—not yet the dissolution, however, of the form itself, but rather the more superficial condition, having not yet grown into independence of and through them.

Now what do we do in system development? Aren't we stuck in our own time, or rather the time of the 60's, when we go on talking about computer technology use in terms of "information systems"? As if the computers still were the "data machines" of the 60's, in spite of the fact that our most spectacular research experiences in Scandinavia have been with computers as more or less UTOPIAn design tools.[4] To speak of current and future use of computer technology in terms of "information systems" seems to us as misleading as to speak of use of electricity in terms of "light bulbs." Why would one want to restrict the field of system design and development to dealing with information systems, in a time when such systems are crowded out by other uses of computer technology?

And what do the philosophers tell us? Are they much more to the point than Hegel was, when they go on warning us for losing our tacit knowledge, trying to teach us Heidegger and Wittgenstein? The dangers of deskilling, loss of tacit knowledge, and alienation were substantial when computer technology had the shape of huge machine-like information systems. But to go on about tacit knowledge in the 90's will be as relevant to the practice of system development as Hegel's comments were to the practicing electrician. Hegel's views on electricity were too far out from the core of concrete technology to be relevant to the practice. That does not make them uninteresting. But if we turn to philosophy to get guidance in our practice we had better look for ideas that we can turn into comments on the current state of the art. Often the best results will be achieved by doing a little philosophizing oneself rather than go hunting for catchwords in the works of famous philosophers. So let us try.

Technologies develop and so does their use. Technologies live their lives through cycles characterized by different kinds of attention. Examples of such cycles are: engineering, understanding, social consequences, environmental consequences, innovation. In an engineering cycle, resources are spent on developing the basics of the technology, on making it work. This cycle is often, as in the case of electricity, preceded by attempts to understand the basic phenomena underlying the technology. At other stages in the life of a technology it becomes more important to take seriously its (social and environmental) consequences, working back from them to change, restrain or even abandon the use of the technology. A fourth cycle is dominated by innovative efforts to diversify the use of a given technology. These cycles overlap but are still distinguishable in the history of most technologies, as dominating perspectives on the technology in a certain community.

If we look at computer technology from the perspective of Scandinavian system development research, it is not difficult to see that the 60's was a period of engineering—the problem was to get the technology working. Börje Langefors worried about file handling and CPU-time. In the 70's, the consequences sailed up as the hottest topic. Kristen Nygaard agitated for democracy at work, and his disciples worried about deskilling. The 80's began with attempts at understanding, then turned into a decade of use, with a growing interest in the proliferation of applications and interfaces.

When we want to understand computer technology we ask questions like "What is a computer?," but when we're in a cycle of innovative use we'll ask instead "What can we make of computers?" And we are not looking for a single answer, and we are not looking for the general kind of answers, like tools, media for communication, information systems etc. Such answers can at best provide starting-points for the more detailed answers we are interested in.

We live in an artificial world, and more and more of the artifacts, physical as well as social, of that world contain computer technology. What kinds of artifacts can we design in which computer technology plays interesting roles? That is, how can computer technology be used in producing a richer world of artifacts? To ask such questions is to take an active interest in the shaping of future computer artifacts. As system developers we are, perhaps, more used to dealing with a slightly different question, namely, how to put the already existing artifacts, containing computer technology, to good use. When technology is undergoing rapid changes we need to be less passive, but we will return, more explicitly, to the latter question in the final section.

The computer is today more of an open technical possibility than a determinate object. The vital question today is not what we can do with the computer, but what we can make of the computer. The underlying assumption is the rather trivial observation that computer technology is, within its defining boundaries, what we (but who are we?) make it to be. And that we still are in the very beginning of computer technology use, with a wide open future ahead. And that we'd better try to take an active part in shaping that future, rather than being content to predict it on the basis of the kind of technology we have become used to.

Being thus in a cycle of innovative use diversification, we think it is unfruitful to discuss methods and aims of system development without a clear appreciation of current and future use of computer technology. Such a discussion is still often carried on with the implicit assumption that the future will de dominated by the kind of technology dominating the 60's and the 70's. But the future is no longer what it used to be, and we therefore need to take a hard look at the details of that future.

Such an undertaking is not easy. We are not interested in predicting the future. We all know the pitfalls of such attempts.[5] In the vein suggested by Richard Rorty in the last chapter of Philosophy and the Mirror of Nature, we invite you to a conversation, not an inquiry, to abnormal rather than normal discourse, to a play with many perspectives rather than a search for objective truth. To get such a creative conversation going, we need to formulate categories for computer technology use to help us generate ideas. What principles could one use in such an attempt at categorization?

2 Varieties of Computer Technology Use

Technology use can be categorized in different dimensions, depending on the purpose with the categorization. Categories can be invented or they can be taken over from tradition. Categories can be developed from the top down, by looking closer at the general characteristics of technology use, or from the bottom up, by generalizing from actual examples of technology use. Categories will differ substantially depending on what we take 'technology use' to include, depending on what cycle in the life of a technology we are in.

When engineering is our business we will categorize technology use in terms of the different ways the technology can be used in creating artifacts. When our major interest is in the consequences, we will view technology use in terms of the organizational (or environmental) variation permitted by the technology. In a cycle of use diversification, our categories will be of different ways of interacting with different artifacts. And so on. There will be parallels between these different systems of categorizations, of course, but that does not make it any less important to keep track of what system one is operating with.[6]

The world of technology that system developers have to deal with is like a series of Chinese boxes with engineering, use, and consequences (in that order) as three of the boxes. Our claim in this paper is that current changes in the inner boxes are substantial enough to warrant our attention. We cannot go on discussing system development as if those boxes were fixed. And we need categories of technology use, of how technology is used to create computer artifacts and how we use (interact with) those artifacts, to carry on such a discussion.

Nurminen's (1988) categorization, systems-theoretical, socio-technical, humanistic, is a categorization of artifact use in terms of the power relation between the individual user and her computer. Nurminen describes it as a top down categorization, expressing the fact that the relation between man and computer can be varied in such a way that man is an appendix to the computer, or the computer to man, or they are partners in a (socio-technical) system. Nurminen wants to distinguish three perspectives in system development, but yet his categories amount to a categorization of computer artifact use and gain their main interest from this fact. The different schools distinguished by Nurminen give different advice to system developers, based on their very different conceptions of how computer artifacts should be used.

There are only three categories in Nurminen's schema, and they are well worn. They are, in fact, the standard categories in the 19th century technology debate. In that debate, Romantic philosophers reacted to the inflexibility of the machine by suggesting more organic relations between man and his utensils, sometimes even turning back to pre-industrialized 'crafty' use of technology.

Now, if one is really interested in taking a hard look at the possible use of computer artifacts, one cannot be satisfied with traditional categories like these. One can begin instead by asking oneself, top down, what it means to use technology. Use, was ist das? The first thing to notice is that the term 'use' itself is misleading. Much of our interaction with technical artifacts is not well described as 'use'. But it is easy to be, like Heidegger, misled into thinking so, by examples like hammering, writing, etc. But think only of how we interact with cars: most of us use them as means of transportation, mechanics and gas station owners make a living out of them, clerks at the central automobile register keep files on them, driving instructors teach people to drive them, etc, etc. To say that the cab driver (the official) and her passenger (the citizen) both use the cab (social security system) tends to cover up rather than illuminate important 'facts of use' (Janlert 1987). In spite of this, we will go on talking about 'use', meaning 'interaction' in general, sometimes using the latter term to avoid misunderstanding.

You use something as means to certain ends. It is easy, but maybe dangerous, to begin thinking of the use of artifacts as replacing or extending the use of bodily organs: shovels dig better than hands, with glasses we see better, a notebook is a memory substitute, etc. So, there we have two starting-points for a categorization: our ends and our natural means (organs). What are our ends? People like Maslow give us lists: eat, drink, shelter, sex, love, respect, fame, fortune, fun. These ends can themselves be categorized, (as in Zetterberg *et al.* 1984) into ends of subsistence, consumption, and expression. These categories are too general to give us much help, but certainly the advice is good to spend more time in technology development on discussing ends.

What are our natural means? We could categorize computer artifact use as they do in AI, in terms of what human capacities the artifacts replace or extend: movement, perception, memory, calculation, imagination, language, etc, but also with this kind of starting-point we are too far away from the technology to be able to say anything worthwhile about computer artifact use. Categories like these will not exactly send the mind into soaring flight. They leave no empty boxes to fill in. So let us try to be a little more concrete.

An artifact in use plays a role, has a place in some human activity. We can categorize computer artifact use by looking at different ways in which the artifact relates to its environment. To use an artifact is to put it in play. The simple example is our causing a tool to have a certain effect. Artifacts can be categorized in terms of their causal side, in terms of their autonomy. Or they can be categorized in terms of their effective side, in terms of how they are geared to their environment. Some artifacts are geared to their environment physically, some symbolically.

We could develop a categorization based on how the computer fits into its environment, how it interacts with the world. We could classify its interaction domain in terms of the number and types of objects in it. We could classify each of its input and output channels in terms of its rate of flow (null, low, or high) and its pattern (one-shot, intermittent, or steady), its level (physical, symbolic, or rational interaction) and its modality (physical level modalities: mechanical, chemical, optical, sound, etc; symbolic level modalities: written language, spoken language, pictures, notes, gestures, etc; rational level modalities: questions, answers, suggestions, commitments, arguments, jokes, encouragements, etc).

Object types in the interaction domain could be things, humans, teams, organizations. We could make a finer division into roles, for instance in the case of a human environment, perhaps controller, user, and client or consumer. Even with as few as three objects in the interaction domain, this will give us an umpteen-dimensional table with many boxes not yet filled in by some existing computer application.

Or maybe we should try with a categorization based on functionality. But if we already have decided on the permissible functions, how are we ever going to come up with something new? Put a symbolic interface onto anything, and then the power of the computer can be applied to it. Its power is to relate anything to anything else in any conceivable way. (Almost.) What can we conceive? Perhaps it would be better to start by making a long list of conceivable and inconceivable use of computer technology to design computer applications: automata, tools, toys, possibility explorers, collaborators, guardian angels, media, artificial worlds ("Through the Computer-Screen. Everyman's Adventures in Wonderland").

What do you do with (in) artificial subworlds created in a computer? Have fun, learn things about the real (?) world or possible outgrowths of it, learn things about yourself, develop new abilities, create works of art, adventure. Or you sink into the artificial world making it the real world. Change your old life to a brand new life of your own choice, put yourself in a life-support system, enter your own world and earn your living (that is pay for the life-support system and computer power) with some symbolic, intellectual work you can do within your new world.

If you're not satisfied with making the new worlds by symbols alone, let's make them by hands, supported in our worldmaking by possibility explorers, computer collaborators, design environments, industrial robots, and computerized guardian angels. We could start with small things, smart objects like radios and TVs, cars, houses, books. Why not a smart desk? Combine the electronic desktop with a solid one by putting identification tags on all items.

We can deconstruct the mechanical world and reconstruct it with symbolic manipulations between the parts. Simulate physics not of this world. Give null-inertia to heavy motor parts, hold a ship steady as a rock in full storm. We can impose arbitrary relations, that can be changed according to any parameters, increasing flexibility, checking constraints, make the world a safer place. A sudden full turn of the steering wheel at high speed on the highway does not mean death, if it's a symbolic turn.

Or we could make something more ambitious, something that involves people in a deeper way, like new ways of using an electronic message system to get things done in a group or a team. How about a new group decision technique, somewhat like the Delphi method, with a point moving between decision alternatives in the force-fields of mouse-clicking decision makers? Can we deconstruct and reconstruct social institutions analogous to reconstructions of the mechanical world? Isn't that what system designers have been doing all the time? Now that we realize what we have been doing, could we use the technique for something better?

These wanderings through possible varieties and categorizations of computer technology use should not be taken as proposals seriously defended by the authors. The ideas may be good or bad, their sole purpose here is to be gestures exemplifying the kind of creative outbursts and wild thinking that will be necessary to escape the context of present computer technology use. Our intention is only to provoke and inspire the reader to proceed with similar explorations, and to follow through these starts in the hope of clearing up new vistas in the space of possibilities. This whole article is only an exhortation to creation.

To be sure, more than exhortations may be needed to get people to think creatively, to step out of their secure entrenchments in present practice into the open air of ideas and fantasy. At a Scandinavian workshop (see note 1), to our disappointment, little new issued from the discussion following the presentation of our paper. Significantly, the exception was a participant that turned out to be a statistician who had joined the workshop by mistake.

We have wondered about this and have come up with a rather complex explanation which, somewhat simplified, goes like this. Scandinavian system developers share a strong conviction that their natural place is in the reality of everyday working life, yes, in the trenches. Only in that context, in close contact with the users, taking their reality and their very real worries and wishes seriously, can worthwhile and creative system development be done, they say. Serious, morally responsible system development is reality driven, with human beings as the major resource, and therefore has neither time nor patience with extravagant fantasizing about future computer gadgetry and its possible use. We tend to think this is a non sequitur.

3 A Computer-Supported World View

Computer technology can be used for data storage, but the computer certainly is no data machine, its use is not restricted to information system support. But then again, the computer is not really a data machine either. Or better, to think of the computer as a machine requires a rather sophisticated notion of what a machine is. A machine is not a clock.

Just as the clock played a central role in the 17th century development of the mechanistic world view, so one could try to formulate a world view on the basis of the computer. What would such a world view look like, and how would it differ from the mechanistic world view?

It is common practice in systems development to identify basic assumptions expressing different perspectives on the use of computer technology. A standard categorization is that of Nurminen (1988), that we have looked at above, into three such perspectives. We prefer to think of Nurminen's three perspectives—the systems-theoretical, the socio-technical, and the humanistic perspective—as each exemplifying a more fundamental world view: a mechanistic, an organic, and a traditional. You can say interesting things about computer technology in these terms, but what you then do is try to understand this new technology in terms of categories developed for old technologies.

The discussion of technology has since the early 19th century at least, put up these three world views against one another. What we would suggest is an attempt to develop new perspectives, ideas for new world views based on the new technology, and then a discussion of those ideas. Since technologies influence our ways of thinking, let us ask ourselves what ideas this new technology will give us, will encourage, etc. And then, let us go on to ask if these are good or bad ideas, if they are humanistic or degrading, oppressive or liberating, etc. And let us consider what should be said and done in order to push these ideas, within their degrees of freedom, in good directions.[7]

There are ample opportunities to study the effects on ideologies and culture of earlier technologies. It is more difficult to determine the role of such technology-inspired ideas in changing society. An example from Mumford (1934) illustrates these difficulties. Mumford argues that mining technology was used as an exemplary model when the factories and factory work were designed, and when railways and subways were built. He also claims that the power of the mining technology as a model was enhanced by the fact that the new physics described a colorless reality, very much like the world of a mine. One wonders if this ideological detour had any importance, and one wonders how the mining technology could become such a powerful model. Why was it not met with more stubborn resistance?

It is even more difficult, today, to comment on the possible effects of computer technology on our new world views, and the practical implications of such world views. But that is just what we want to do. We won't look at the concrete details of computer technology in the near future. We'll look at its potential, in a longer perspective, to change our ideas about society, man, work, and at the possible consequences such new world views can have on the details of social life.

Again we are not interested in prediction. We believe that there is an important relation between what people today think computer technology is, and our future use of this technology. When we become conscious of our preconceptions about the computer technology it becomes possible to liberate ourselves from them and consider other ways of conceiving this technology. We are not the fateful victims of a historically determined computer technological ideology. But unless we consciously work on the preconceptions we have, making efforts to discover and consider alternative conceptions, and their consequences, it will look as if that were the case. We need to keep many possibilities in the air in this period of rapid diversification of the use of computer technology.

Old ideology still rests its heavy hand upon computer technology. Still, more than forty years since the birth of the computer, people either view the computer from a pre-industrial tool perspective or as a sort of clockwork ticking zeros and ones rather than cogs. They go on thinking and talking of the computer as a "data machine," of the typical computer application as an "information system." Today it is necessary to try to develop many different new, untested perspectives, and consider the consequences of these different viewpoints. And we want your help.

Here we shall exemplify only one fairly coherent way of looking at computer technology and its use. It is based on what we think is a particularly important novelty in a budding computerized world view, namely the fact that the given, unique, necessary world of the old mechanistic world view is being replaced by a constructive, ambiguous world of possibilities. Again, the sketch we give below is only intended as a first start, as an invitation to further thinking on this important issue.

We tried to sketch seven elements of a computer-based world view in Dahlbom & Janlert (1988). Computer technology, as we saw it then, invites us to a world that is artificial, external, cognitive, simulated, designed, interactive, and parallel. This sketch can certainly be developed and questioned, and more elements can be added. Let us give a summary of what we then wrote about these elements:

Our artifacts are shaped by our experiences. Our way of thinking, our culture is materialized in our artifacts. It is but a small step to the conscious use of artifacts to think with, to support memory, problem-solving and planning. Thinking is then 'externalized' in artifacts. Language, mathematics, methods of book-keeping are examples of intellectual artifacts which expand our power of thinking by subjecting thought to external, socially controlled systems of rules. As far as thinking consists in the manipulation of symbols in such systems, it is 'artificial' rather than 'natural'.[8]

These intellectual artifacts, systems of rules, are materialized in physical objects of various types. Intellectual work is becoming increasingly dependent on these concrete artifacts. In a society without books you must keep all your knowledge in your head. With books as secondary storage you can handle a vastly greater amount of knowledge, but now priorities change with regard to how your primary storage, your brain, should best be used. You need to handle your secondary mass storage expertly. You need fast reading and writing, skills in finding information, in reasoning, analyzing, synthesizing and communicating. This externalization is amplified by computer technology. As our knowledge grows, more and more of it is external to us, and our internal knowledge will be about knowledge, what there is, how to find it, how to apply it, etc. The substance of what we know is no longer inside us, but in the networks of men and computers we belong to.

This externalization changes our view of our selves and of what it means to know oneself. When a person's identity is made up of external artifacts she can only learn to know herself through these artifacts and they are as easily accessible to other people. The self is no longer private. It becomes public and objective, social or cultural rather than natural.

A computer-based world view puts great weight on knowledge. But not just any kind of knowledge. It is only the representational, Cartesian kind that counts. In perceiving and thinking about the world we are manipulating symbols that represent the world, rather than the world itself. With symbols we construct worlds. The symbols are not natural images but artifacts we've made which represent by virtue of our conventions. When we realize that "the limits of our language mean the limits of our world" our quest for knowledge becomes dependent on our ability to construct artificial symbol systems.

Artificialization leads to a view of knowledge where what can be known coincides with what can be constructed. Computer technology makes it possible to automatize the construction. Computers enable us to study processes by simulating them. They make it possible to study not just the actual processes but also possible processes. Computer technology transforms all intellectual work into design, construction.

As automata for simulation, the role of computers will be more active than that of traditional intellectual artifacts. In the same way that we obtain information of the world by interacting with it, our computerized design experiments will involve interaction. We will be engaged in a multitude of such experiments in a world filled with computer artifacts interacting with us. We will live parallel lives in different possible worlds.

The most revolutionary change in our world view brought upon us by computer technology is perhaps its reconstruction of space and time, the fundamental categories of the mechanistic world view, and of a modern capitalistic, industrialized society. Our movements in space will be individualized and eclipsed by movements in computerized memory spaces. Our need for local and personal coordinations will be supported by computers, at the same time as the need for central synchronization becomes less, and with that goes our interest in a common, standard time.

In mechanistic space I can never be in two places at the same time, in mechanistic time I have to do things in sequence. In computer space I can be in many places at the same time, in computer time I constantly do things in parallel, and skip freely backwards and forwards in time. A symptomatic, simple, example is the popularity of video-taping TV programs to get control over time, get rid of commercials, boring parts, etc.

Together these elements of a computer-based world view give us a picture of a world where man is moving further away from nature, further out into a world of artifacts.

4 System Development in the Future

System development is still generally conceived as the "design and development of information systems." System developers go on thinking of their practice in the very terms used in the 60's when computer technology was used in administrations as information systems. But so much has happened since then, in the production of computer applications, that it is high time to reconsider the practice of system development in view of a more general and diversified notion of computer technology use.

Even if it is possible to think of design tools, computerized tools (from golf clubs to chain saws), word processing systems, calculation systems, communication systems, smart houses, systems for limited abilities etc, as "information systems," it is not very informative. The differences between applications like these, which were not available in the 60's, and the kinds of systems then being introduced—client registers, salary systems, inventory systems, book-keeping systems, etc—are deep-going enough to warrant a whole new conception of what system development is all about.

As long as we think of the standard computer application as a huge computerized information system, we will worry about deskilling, alienation, loss of liberty and flexibility, dreary and meaningless work tasks, and other forms of dehumanization. Our natural alternative will be a return to pre-industrial, individual tools. The background for our moral standpoints will be the computer as an element in a mechanistic world view, and Marx' and Braverman's analysis of the consequences of such technology. But once we start thinking about future computer technology use along totally different lines, once we see that technology as part of a whole new world view, we shall have to reconsider our moral obligations.

What will be the role of future system developers, and what will be their moral problems? Where will they be employed, what will they do, what will be their specific competence? Again, we supply some tentative answers which certainly aren't by far creative enough compared to what we hope will come out of further discussions, but which may serve as some sort of background for such discussions. We want to point to three interconnected factors changing both the practice of and research in system development: new user groups, the industrialization of software development, and diversified use of computer technology.[9]

The nature of early computer technology use and the nature of its users made the business school a natural home, management the natural customer, for a research discipline supporting the practice of designing information systems for the control of large organizations. But long before the term "end-user" was coined, moral and political values made Scandinavian researchers prefer trade unions and end-users as collaborators in a program for a user-oriented, democratic, system development. Putting technology to good human use, achieving quality of work rather than maximizing profit, was what motivated the Scandinavian research efforts, so well exemplified by the UTOPIA project.

As computer artifact use spreads outside the working life, invading all aspects of everyday life, the application area of the phrase "putting computer technology to good human use" is extended. The research discipline of system development can respond to this extension by including among the "users", whose interests one wishes to protect, everyone whose life is changed by computer technology be it as professionals, consumers, school children, teachers, citizens, or whatnot. Such user groups lack the resources and organization of big business management or trade unions, but should that be a reason for not taking responsibility for the conditions of their interaction with computer artifacts?

Our understanding of what system development should be must change with the changes in computer technology and its use. Practitioners have to adjust their practice to these changes, and as researchers we have to pay close attention to changes in the practice of system development. This practice is currently undergoing a process of industrialization. From having had the character of consulting in short-term projects, at the time of buying, installing and breaking-in of personnel and machines, system work is changing into being (1)-a permanent part of maintenance, (2)-a part of the software industry, (3)-a part of the manufacturing industry, (4) done by end-users, (5)-product information, and (6)-general, non-technical organizational development.

To our mind, Scandinavian research on system development has been much too slow in its reaction to these changes. The discussion of system development practice is still dominated by a conception of it as "project-work," and major efforts are spent on the details of "project-design." (A good example is Bjerknes 1989.) But there will soon be few opportunities for detailed system analysis and design work in the field. The typical "system designer" will be assembling ready-made products. And those ready-made systems will be developed at a rate making projects impossible. Like in the UTOPIA project, the desired tool will be developed by industry while the project is still playing around with cardboard prototypes (Ehn 1988).[10]

After having been fully occupied with the engineering aspects of the technology, system development research began, in the seventies, to pay more attention to the changes in work situations brought about by the new technology. From having been a discipline for engineers, it became also a discipline for (engineers turned) social scientists and philosophers. Both these approaches to system development research had a relatively unimaginative notion of the possible varieties of computer technology use. The engineers had their hands full with file handling and database management, the philosophers with tacit knowledge, democracy and the dequalification of work. In the meantime a revolution began in the area of computer technology use.

The growing supply of factory-made software and standard systems makes the system consultant as craftsman—engineer in a pioneering field—the victim of industrialization. The increasing variety and complexity of use makes it less and less interesting to discuss the consequences of computer technology in general. The two research approaches that were established to support the practice of system development have to adjust to these changes as the engineering consultants are entering software laboratories and the organization-oriented consultants become advanced sales persons or general consultants. So, the research approaches has to change orientation, and they do so by moving in the direction of (2) and (5) above, thus moving further apart.

But all that can change now that more and more of us begin to realize that the exciting future of computer technology research lies in questions of use. The field of 'human-computer interaction' understood in a most general sense, covering everything from the research approach so called to questions of how to live with computers, is bridging the gap between engineering and social consequences (Janlert 1989). Future system developers will need a rich picture of the possibilities and varieties of human-computer interaction. They will have to specialize, of course, but nothing in the world of human interaction with computer artifacts, from the production of such artifacts in manufacturing industry to computer-based world views, will be outside their province. They will meet the tendency of industrialization to standardize use with a fascinated interest in the possibilities of diversifying the world of computer artifacts, and a moral obligation to put that diversification to the service of mankind.

If they are successful, industrialization will result in a richer world of really useful artifacts, and system development will become a richer practice. Design methods will diversify, paralleling the diversification of use, ranging from tightly controlled top-down rationalistic projects of the old style, to creative tinkering by end-users themselves. Much design will be done in medias res, on location. We will need a type of system designer that works somewhat as a researching journalist. The designer becomes an idea engineer, an assembler of ideas, a builder of conceptual buildings, a creator of worlds. Much design will be for professionals, rather than for organizations. And we must not forget the computerization of artifacts in general, design for consumers, design for customers. Where is the research on computer-supported cooperative work for process industry, for traffic, or for retailing (including the consumer, of course)?

There is the danger that industrialization will shape a corps of system developers who see their job as working with a plethora of hardware and software on one side and with users and user organizations on the other, and that their job is to make the twain meet. They will think of themselves as experts on what to do with all the artifacts produced by computer industries, rather than on how to produce those artifacts. Such a system developer is satisfied with much too passive a role in the process of computerizing life.

What we need is instead a system developer with a professional interest in every aspect of that computerization process. And an appreciation of how in that process we become more and more dependent on the nature of our artifacts. If that dependence is not to turn into a trap we need take seriously the construction of our artificial world, and that means constantly rethinking technology use from the bottom of engineering to the top of world views and down again. Or what do you say?

5 Conclusion

You have just read something out of the way. Unlike most other articles in scientific journals, the main point of this one is not to solemnly present a thesis and vigorously defend it by arguments and evidence. We want to put a question to the reader—and we don't want a conclusive answer. And so the present conclusion must remain inconclusive. We do believe that some creative conversations would be wholesome to the discipline, and we have given arguments for this here and there in the article. But we do not want to turn this into the thesis that creative conversations are necessary, because we do not want to delay indefinitely such creative conversations until the meta-issue is conclusively settled. In summary: we assert, and argue, that creative conversations are needed, but first and foremost we urge the reader to join the creative conversations initiated here. Those who find some grain of sense in the exhortation can respond to it, and those who don't, are welcome to start a metadiscussion. Let the conversations begin...

Notes

1. This paper began its life as an invitation to a workshop at the 12th Information systems Research seminar in Scandinavia held in Skagen, Denmark in August of 1989. Turning it into a paper we have tried to preserve its character as an invitation to a joint endeavor.

2. Anonymous graffiti in a California restroom in the early 70's, quoted from Corn (1986).

3. The question mark indicates that this is a debatable point. Giving people light, without technological foresight, might certainly have meant doing a good job. But when technology changes fast, and its social impact is substantial, the lack of such foresight becomes a liability.

4. See Ehn (1988) for a discussion of the UTOPIA project and its view on computer artifacs.

5. See Ceruzzi (1986) for some nice examples of mistaken predictions of the future use of computer technology.

6. See the discussion in (Dahlbom & Janlert 1988, chapter 3), where we distinguish between 'structural,' 'functional,' and 'systemic' metaphors for the computer (corresponding to what we here call 'engineering', 'use' and 'consequences' respectively), and discuss relations between the three.

7. Lewis Mumford (1934) set an outstanding example for this kind of work dealing with the machine and the mechanistic world view. Bolter (1984) is a laudable attempt to do with the computer what Mumford did with the machine. There is overlap between his view of Turing's Man and ours (simulation, games, creativity, artificiality) and there is disagreement (finitude, lack of emotional intensity), but this is not the place for a comparison of our views. The major difference is that Bolter, in spite of what he says he does, relies more on what he can infer about a new world view from computer science, than from an increased use of computer artifacts.

8. See (Dahlbom 1989 and 1991) for more on this.

9. The following is based on (Dahlbom 1990) and (Janlert 1987).

10. We should perhaps stress that we are not predicting the demise of "the project" as a way of organizing work. On the contrary, project-thinking is becoming more and more popular and project management skills will become even more important. But the nature of system development projects are changing, and one such change is the effect of industrialization on what can and should be done in the field.

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