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SUMMARY

USER-DRIVEN DEVELOPMENT OF IT IN WORKING LIFE

Evaluating the effect of research and development on the use of information technology in working life

PER TENGBLAD & ÅKE WALLDIUS

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Summary

User-driven development of IT in working life

Evaluating the effect of research and development on the use of information technology in working life

by

Per Tengblad & Åke Walldius – ATK Arbetsliv

Foreword by VINNOVA

Thirty years ago, digital information and communication technology were the exclusive preserve of a few, mainly technical, people. Today, IT is a natural element in both the home and the workplace for the majority of Swedish people. That IT has revolutionised production, working methods and general consumption cannot be denied. Sweden is also one of the leading countries in successfully exploitating the opportunities offered by modern technology, and is also among the leaders regarding people's competence in applying IT at work and in the home.

All technology can be shaped and used in different ways. In the 1970s, apprehensions about the advance of computer technology were evident in many quarters. The main fear was that information technology could constitute a threat to employment, work environment and personal integrity. This unrest was manifest in many ways, and initiated research on the influence of computer technology on working life. However, by the 1980s, the critical attitude to the technology changed to a positive one. Now, it became a matter of harnessing the many opportunities offered by the new technology, through interdisciplinary and applied research, rather than questioning its existence. The fairly extensive research that followed in this discipline in Sweden has been given the generic name here of ITW; in other words, research and development focusing on the design, implementation and use of information and communications technology in working life. Most of the programmes in this field in the mid-1980s and onwards were financed by VINNOVA and its predecessors in the state-financed research sector.[1]

This report presents an analysis of the impact that a selection of these research programmes and projects has had on the socio-political and socio-economic goals of growth, democracy, competence and work environment. The analysis has been carried out from three different perspectives; a working-life perspective, an IT perspective and a research perspective. Each perspective has been characterised by both successes and setbacks.

It is clear that ITW research in general has had a significant and broad influence on the use of IT in business and working life in Sweden. In particular, it has been a driving force behind a body of accumulated competences and skills based on socio-technical and democratic thinking regarding the development and implementation processes and the view that it is the utilisation of the technology that creates its value. By articulating this message, Swedish ITW research has achieved considerable respect internationally.

[1] The Work Environment Fund, the Council for Working Life Research, Swedish Transport and Communications Research Board (KFB), the National Board for Technical Development (STU), and NUTEK (the Swedish Agency for Economic and Regional Growth)

However, for methodological reasons, it is difficult to generalise in simple terms the effects in relation to conditions and time frames. Activities on work place, system and company level have to be linked— from a low level/short time perspective to a high level/long time perspective. It thus follows that it is difficult to be certain about the long-term importance that a local technological and/or commercial success in a local project (several examples of which are included in the report) has had on the sector or working life in general.

The report also shows that the biggest problem that has had to be overcome in ITW research is that of translating research-based knowledge into new products and services. A number of reasons for this have been put forward in the debate, one of which is the way in which the internal IT skills and development work in businesses had to be largely cut back and out-sourced during the 1990s. Systems were being developed elsewhere, often in other countries, which made it difficult to realize the key thesis of ITW research — that collaboration is vital to ensure satisfactory usability. This represents an important challenge to the future advancement of research both in Sweden and abroad.

Finally, it should be emphasised, of course, that ITW research has not come to end following the programmes studied. Technology continues to advance at an increasing pace; changes in society and working life are taking place, bringing with them social and organisational changes in how technology is used. The report estimates that some 700 million working hours per year are today IT-dependent in Sweden, and that more than 5% of these hours are lost because of usability problems. There is therefore enormous scope for improvement. If these shortcomings were to be rectified, the boost to the economy would amount to several billion SEK per year. The report's assessment of the knowledge base and effects of the ITW research conducted so far has naturally remained in the spotlight. VINNOVA and other actors can therefore benefit greatly in their continuing work from the analysis presented here.

The responsibility for carrying out the analysis of the effects of the ITW research was assigned to ATK Arbetsliv in Stockholm, with a team headed up by Per Tengblad, and assisted by Åke Walldius, researcher at the School of Computer Science and Communication at the Royal Institute of Technology (KTH); Anders Wiberg, an employee consultant; and Jenny Maniette, cognitive scientist at Linköping University. Mats Utbult, a working life journalist and experienced writer in this field, has added to the analysis with a report from a number of workplaces that have been involved in ITW projects. VINNOVA and the evaluation team was also supported by a specially appointed external reference group whose members comprised Birgitta Frejhagen, Ove Ivarsen, Cecilia Katzeff, Lennart Lennerlöf, Christer Marking, Bengt Sandblad, Yngve Sundblad and Peter Ullmark. Also participating in the reference group was Cecilia

Sjöberg, who is now head of VINNOVA's Services and IT Implementation Department.

We would like to thank, first and foremost, the Evaluation Team and the Reference Group for their competent and positive contribution, and also all those who have participated in the work in one way or another, such as taking part in interviewing, making available factual material, reopening their offices to visitors, commenting on the text.

We, at VINNOVA, attach considerable importance to analyses that can throw light on the effects of our work. We welcome any observations relating to these studies. Please pass your comments to Klas Barklöf, analyst in the Strategic Development Division, and Chief Administrator for the project.

VINNOVA in May 2007

Per Eriksson
Director General

Foreword by the authors

This summary presents the main findings of the effects of the collective research and development, supported by VINNOVA and its predecessors from the early 1980s, on the design, implementation, and use of Information and Communications Technology in working life (ITW research).

The programmes on which the evaluation of the effects were based were:

- the Development Programme for New Technology, Organisation and Management (UP)
- Operational Development Systems for the Process Industry (DUP)
- Man, Computer Technology and Working Life (MDA)
- Collaboration and Technology (SAMT)
- programmes related to Information Systems and Cognitive Science
- Man, Technology and Organisation (MTO).

Projects included in KFB's telematics programme, together with a number of ITW projects financed by the Work Environment Fund and the Council for working life research, are also included within the framework of the study.

The project has published the following reports:

- A *final report* (VINNOVA Analysis VA 2007:02), which presents the collected results of the planning and evaluation
- A *feasibility study* that provides the background to the effects evaluation, particularly as regards the selection of methods and limitations
- A *survey report* reviewing programmes and projects relating to important historical developments during the period
- A *report on the effects* identified from the extended studies that were carried out: the effects from two programmes; the effects in the R&D system; three studies on applications/areas; and a study of today's actors in companies and their relationship with operational IT and R&D
- A *workplace report* that describes developments in five workplaces involved in ITW research projects.

The final report, together with other reports, are available at www.VINNOVA.se

Stockholm, May 2007

Per Tengblad & Åke Walldius

Innehåll

Introduction **11**

Programmes studied **12**
Development Programme for New Technology, Organisation and Management (UP) 1982-87 12
Man - Computer Technology - Working Life (MDA) 1987-92 12
Operational Development Systems for the Process Industry (DUP) 1987-96 13
Collaboration and Technology (SAMT) 1993-96 13
Information Systems and Cognitive Science 1993-97 13
Man -Technology - Organisation (MTO) 1997-2001 13
KFB telematics programme 1996-2000 14

Methods and terminology **15**

Long-term effects in working life **17**
Increased capability for adopting new technology 17
Adding behavioural-science competence to technology development 17
From prototype to widespread implementation - a problem for the projects 18
Development of the user organisation 18
From national co-operation between social partners and research to a globally driven development 18

Influence on IT development **20**
IT products to support the business 20
From ITW research to consumer and customer action 21
From in-house to out-sourced development 22

Effects on the R&D system **23**
Institutional development 23
Interdisciplinary approaches and competence centres/centres of excellence 23
Intradisciplinary knowledge creation 24
Effects on availability of training and education, and on skills enhancement 24
ITW-research – a challenging path to interdisciplinary and interactive research 25

Long-term effects of ITW research - an overall assessment **26**
Government ITW research funding as “seed capital” 26
Sound accumulation of knowledge but poor dissemination 26
Augmented utility value 27
Positive spiral of user competence and growth 28
Weak signs of improvement in work environment 28

Lessons learnt and conclusions drawn **29**

Introduction

The revolutionary impact that information technology has had on people's working lives and society at large cannot be overestimated. IT is capable of creating multiple changes, simultaneously and on different levels in the organisations. This applies equally to rationalisation in the production and distribution of existing products and services, and in the development of totally new products, and new ways of using existing ones.

The growth potential and contribution that information technology has made to increased productivity in the IT sector (hardware manufacturers and software houses) is irrefutable. This, in turn, has led to an increased level of IT investment and capital growth among those businesses that use IT in their work — ranging from the process industry to the public and service sectors. There has been a rise in productivity at work, though the total factor productivity (the real increase in efficiency) is harder to assess.

One of the most important challenges to the use of IT in working life and the research and development programmes we have studied is how businesses actually use the technology in relation to their business idea, how they acquire knowledge, how they organize their work, and how they invest in learning and skills enhance-ment. Studies have shown that successful businesses spend considerably more on learning and organisational development than they do on hardware and software.

Likewise, we can also see that if IT projects are run without learning opportunities or business development there can be adverse consequences for companies and their employees. Poor systems usability can cost businesses dearly. As the use of IT increases, it becomes increasingly important for improvements to be made.

All the ITW programmes that we have studied are linked to the Scandinavian approach to IT-development, which is based on participation and involvement of the users in the design of technology. Such approaches has inspired international R&D as well. However, the influence of the Scandinavian approach was just a drop in the ocean in comparison with the steady stream of standard software programs generated by the growing use of computers in the 1980s and 1990s.

Programmes studied

The majority of programmes and projects in this field were financed from the mid-80s onwards by VINNOVA's predecessors in government research funding — the Work Environment Fund, the Council for Working-Life Research (RALF), the National Board for Technical Development (STU), Swedish Transport and Communications Research Board (KFB), and NUTEK.

The total projects bank comprises some 400 separate projects, which have received *government grants totalling more than SKR 400 million*. In this study, we have confined our analysis, for both strategic and time considerations, to the following programmes.

Development Programme for New Technology, Organisation and Management (UP) 1982-87

In conjunction with the development agreement signed by the parties to the labour market (SAF/LO/PTK) in 1982, the Work Environment Fund and the aforementioned parties concluded an agreement to cooperate on applied research and development. The programme had a budget of SKR65 million and it engaged partners in a number of key sectors and application areas (eg, production planning and design support in the manufacturing industry, health care systems, process control, public administration, etc. Twenty-eight projects were undertaken to try out new technology combined with learning and organisational development, in order to take advantage of the new possibilities.

Man - Computer Technology - Working Life (MDA) 1987-92

The Work Environment Fund and STU established in 1987 fifteen interdisciplinary ITW research locations, which struck a balance between technology and behavioural science, and included widely representative participants from businesses and users. With a total budget of SKR65 million, 18 projects were undertaken, the focus being on production planning, document management, design, robotics and process control. The majority of the projects resulted in practical trials on new work routines and forms of collaboration.

Operational Development Systems for the Process Industry (DUP) 1987-96

Representatives from more than 30 companies in the process industry, together with 20 researchers and a similar number of professionals from the pulp and paper, chemicals, and food industry, gathered together in 1987 at a framework programme on the theme of improving the implementation of IT in process management.

The programme partly included basic work and computer-science studies, and partly interdisciplinary case studies and demonstration projects. Altogether, more than 100 projects were carried out, at a cost of SKR111 million. Both theory and practice were used to clarify the role of the operator in enhancing the efficiency of process management.

Collaboration and Technology (SAMT) 1993-96

In the early 1990s, the Work Environment Fund and NUTEK continued their work on the computer-aided collaboration programme (SAMT). The programme was based on the amalgamation of computer technology and telecommunications, on the new technical support that was available in different collaborative contexts, and what grew out of it — consultations, decision-making and documentation management. A total of 15 projects were carried out at a total budget of SKR 28 million.

Information Systems and Cognitive Science 1993-97

The introduction of the PC into working life and the debate it generated led to NUTEK initiating on the one hand a cognitive-science programme to intensify the studies being made in the Human–Computer-Interaction (HCI), and on the other hand an information-systems programme to study how existing administrative computer systems and organisations could be improved so that the anticipated increase in productivity could be realized. Together, the budget for the projects was SKR40 million, which financed some 37 projects.

Man -Technology - Organisation (MTO) 1997-2001

Based on the SAMT project and the Information Systems and Cognitive Science programme, studies on change were conducted in the news industry, the pharmaceutical industry, the timber trade industry, and in the care and banking sectors. A string of critical challenges were studied, with special emphasis on change processes for combining business development, IT and learning. The programme, which included some 20 projects, was financed by NUTEK with a budget of SKR 57 million.

KFB telematics programme 1996-2000

The KFB telematics programme supported both individual projects and the establishment of special research facilities in this field — so-called "themed applications". The areas included were virtual organisations and distance learning, collaboration and coordination, together with transport, societal and citizens' perspectives. A total of SKR40 million per year was made available during the period 1996–2000, some SKR42 million of which was spent over the whole period on ITW-related research.

Methods and terminology

In this report, we studied the effects that ITW research programmes had on socio-political goals in the fields of growth, democracy, competence and work environment. The analysis was divided into a working life, an IT development, and an R&D perspective. We have placed *utility value* at the centre of our research model. This term encompasses the principal aspects of ITW research by expressing the benefits of IT and its implementation in companies and organisations.[2]

> *The utility value is the value that IT, together with business development, changes in work organisation and competence, creates for individuals in their work, for the development of the business, and for society as a whole.*

The utility value arises in an emergent process based on the *involvement of concerned stakeholders*. This provides greater opportunities for the views of all the interested parties to be taken into account throughout the life of the IT support system. It also increases the likelihood that the IT project will have sufficient *breadth in its competence*, with all the areas of competence and skills represented. With teamwork being the watchword in the development process, this also increases the chances of the results being distinguished by a holistic view, where a *high quality of IT support* helps in the development of the business, its activities, and the competence of the employees.

Conversely, there is often a need to *develop the user organisation* to enable the technology to be better implemented. Thus, the utility value can be seen both as a common point of departure and as a long-term goal for the ITW research. The study's selection of methods and practices were derived from this concept.

One of the method-related challenges was to find a common benchmark or criterion for the three principal perspectives: *working life, IT development, and the R&D system*s. During the planning phase we identified a wide spectrum of indicators for the three perspectives, which we divided further into utility value components, creating the following matrix:

[2] We have used the term "utility" and not the concepts of "usability" or "usefulness" which are more centred on the technology itself than on its general use.

Indicators / Effect-area	Stakeholder participation	Breadth of competence	Quality of IT-support	Development of user organisation
Working-life effect indicators: Influence on IT strategies / investments / methods of introduction, key personnel, career paths, influence on bipartite cooperation, trade agreements, official publications and actors, changes in competence **IT-development effect indicators:** Influence on development work & methods, career paths, sales/distribution of products and services, establishment & growth of IT suppliers, patents development, production of standards **R&D system effect indicators:** Citation index, citation impact, merit index, recognition & honours, influence on methods development, institutional changes, supply of individuals with ITW competence, theses/treatises				

The thinking behind setting up a relatively detailed number of indicators was our wish to be open to a wide range of long-term effects. The descriptive and quantitative reports on funding levels, the number of programmes and projects, collaborating research establishments, companies, researchers, and gender issues dealt with in *the survey phase of the study* also served as the foundation for *in-depth-study searches* on the effects, and on the effect chains, in five different orientations:

- *Programmes*: in which findings and long-term effects were studied with reference to two ITW research programmes (DUP and MDA).
- *Institutions*: in which the focus is on the technical research institutions and universities (particularly those in Gothenburg and Linköping).
- *Applications*: in which systems/programs that have been assessed in a standardized way as having a high utility value can be related to ITW research.
- *Actors*: in which a number of interviews have been made, and a questionnaire has been sent out to procurers, design engineers, and usability experts, in order to highlight their experience and appraisal of the ITW research.
- The *Workplace*: in which five case stories from workplaces involved in different ITW projects are presented.

Long-term effects in working life

Increased capability for adopting new technology

One clear effect was that the active contribution made by businesses and users gave rise to an *increased capability for adopting new technology* in offices and workplaces. The researchers have underlined the importance of user involvement and competence in the introduction of new technology. In a wider perspective, we can regard ITW research as *an element in the Swedish tradition of accepting technology-driven rationalisation* and innovation and an accompanying high level of operational skill in order to reinforce the country's competitiveness and to promote continued growth. ITW research succeeded, particularly in industry, in elevating professionalism among workers, and adding to the agenda the need to learn more about their own activities. The support that the researchers gave to the users by making it possible to create models of the processes and to assist training on a given IT platform, had a greater impact than did the subsequent development of a technical support function.

A vital aspect here was how the interface between the researchers and the organisation functioned. The key to ITW research lay in its traditional interactive approach. When this approach is successful, particularly in a long-term research venture, *the findings generated can be applied immediately in working life*. A recurrent problem in many projects was that the difference in time horizons between the actors tended to increase over the years. Companies were faced with accelerating change, whilst the tempo of research had to follow a more drawn-out process, in which the findings had to undergo critical scrutiny.

Adding behavioural-science competence to technology development

Many practitioners asserted that having access to behavioural-science specialists to supplement technical competence in development processes was the most important contribution that the researchers made. On the other hand the need for economical perspectives were underestimated. *The lack of economic expertise in many projects* lead to problems in linking the project to the company's strategy, thereby obstructing implementation. All necessary investments were not calculated (like training and organisational change). Therefore, it was not possible to clarify the cost of flawed implementation.

From prototype to widespread implementation - a problem for the projects

Participants in many projects were aware of the problem of going from demand specifications, prototypes and demonstrations to local operations or, even more challenging, to commercial implementation. In many cases, the necessary technology was simply not yet available for the intended organisational solution. In innovations based on local development work, problems arose either because of negative attitudes of the management (or the IT department), or because of conflicting priorities. Implementation on a wider scale was often hampered by a reluctance to adopt solutions developed elsewhere - because of the competitive situation, or for political reasons. Standard systems, developed in other contexts and for other types of activities, were not adapted to the business and work practices of the organisations. *The suppliers were, to a large extent, not sufficiently involved.*

Yet there are *individual examples of how systems and products can be developed* that generate healthy profits for the organisation and achieve wide coverage through commoditisation and spin-off companies.

Development of the user organisation

Examples from the workplace studies have revealed long-term work in developing competence internally within the organisation, as well as a need for information support. By building systems on the basis of professional know-how it was possible to create conditions for *long-term development work within the user organisation* with a focus on competence and learning. DUP's focus on the development of the operator's work is an example of how operators progressed from the job of machine minder to a position of responsibility for the process. This was also regarded in the business as a pre-requisite and an important component in the rationalisation and rise in productivity within the pulp-and-paper industry in the 1990s.

Yet, in contrast, we found very few direct effects of the projects and in the programmes on work environment. This area was one of the goals specified in both MDA and UP, and it was also highlighted both in the 1980s and again at the beginning of the new millennium. However, The Swedish Work Environment Authority made considerable use of ITW research, such as in their drawing up of work environment guidelines for work with computer display units.

From national co-operation between social partners and research to a globally driven development

As regards implementation in working life, it is clear that ITW research from its emergence in the 1970s through to its establishment in the 1980s played a crucial

supportive role in the adoption of the new technology into working life. This was done in the framework of the multilateral cooperation then existing both between research and active trade union organisations and collaboration between the social partners. In the later phases, dramatic changes took place both in the expansion of IT (personal computers and the Internet) and in the diminishing involvement of, and between, the social parners. During this period, ITW research moved on with practical development work and industrial collaboration at the company level, often focussing on new kinds of usability problems. In this change, the projects had to relate to ever stronger suppliers and consultancy firms driving both system development and management strategies.

Influence on IT development

Developing IT support for an organisation involves a wide spectrum of actors - from the suppliers of hardware and software to those responsible for the final tuning of systems and applications for the business.

From the early phases of IT development most of the work was carried out internally by the companies and in their own IT departments. Now the work is, to a large extent, in the hands of a variety of suppliers and consultants, many of them on a global scale. It is now the suppliers that largely set the conditions for creating the utility value, within a framework of increasing standardisation (both existing and newly created standards). There is obviously limited scope now for Swedish research and IT-companies to remain at the forefront. However, added value is being created in the implementation processes, where technology and organisational consultants are taking on a more decisive role. In pace with this development, specifying programme needs, managing suppliers, and directing consultants have become increasingly important functions for the user companies. There is now a longer distance between IT developers and the users, but those in control of purchasing (seldom the end user) often have a stronger focus on costs and results.

In our study of the actors, we found that usability often had to come second for reasons of time or economy. We also noted that, apparently, the link to ITW research in the methods used by the developers was often weak - despite the fact that a large proportion of the project work involved different forms of "participatory design" in accordance with the Scandinavian model. Instead the processes are dominated by the individual consultancy firms, whose methods were often developed in an anglo-american business environment.

It has not been possible to evaluate the role that the ITW programmes have played in comparison to, for example, the high visibility of customer needs recently generated by commercial and governmental e-services. However, it became clear in our study of the actors that usability was allowed to influence the development work when it constituted a vital competitive element in relation to the customers - in other words, when the customers themselves were the end user.

IT products to support the business

The level of ambition in the programmes to produce specific IT products and services varied. In the DUP project, which had a stronger focus on development, we found more specific IT products than in the more research-orientated MDA. But even in MDA we

found products that had been generated by the project - thanks in no small part to sustained research efforts and collaboration with industry. There are examples of a few spin-off development companies with commoditised technical solutions to which ITW research contributed in one way or another. By maintaining their contacts with their original institution, the development companies were able to manage improvements and to come up with new product ideas.

However, we found in the application and actor studies that there was relatively little contact between the Swedish IT suppliers/professionals and Swedish ITW research. American research and method development seems to be a more important source of inspiration for the Swedish IT-suppliers.

More and more, IT development is being characterized by standardized platforms and components. Standard systems are growing in importance. Among the 35 finalists in the Users Prise 2000-2006, organized by the Swedish Confederation of Trade Unions (LO) and UsersAward Ltd, was ABB Control and KLIV-film (both of which were influenced by ITW programmes), two of only a handful of examples that could be described as developed "in-house". In other words, a small, local development team, working in close cooperation with the users, built the system. What stood out among all the finalists was the highly active role that the users played in all phases of the design, development, and deployment work.

From ITW research to consumer and customer action

In order to influence the product development of the suppliers towards being able to create a higher utility value, the trade union organisations TCO and LO, in parallel with and inspired by ITW research, designed instruments for certification of computer hardware (the TCO´92 and ´95 labels) and software (the LO User Certified label). The latter certification was combined with an annual quality contest, an initiative that came directly from the area of ITW research (ITQ/UsersAward project).

This joint trade union initiative is unique to Sweden and, particularly because of the TCO certification program, has generated considerable international interest.

When the trade unions adopted the point of view of the consumer, they put their finger not only on the mutual interest within companies to secure functioning IT support, but also showed that implementation can be looked upon from the customer's or consumer's perspective, and not just from a strict work environment viewpoint. VERVA (the Swedish Administrative Development Agency) has also used parts of the ITC research in the context of highlighting usability aspects in public procurement.

From in-house to out-sourced development

In the earlier programmes, the companies themselves managed a large proportion of the systems development work, and the necessary adaptation through access to their own IT resources. Later on, however, the situation changed through the outsourcing of IT resources, predominantly to global IT companies such as Microsoft and SAP. This made it difficult for ITW research to remain in touch with these new developments and new supplier structures. However, in a number of individual research projects, development-minded researchers achieved successful results both through collaboration with industry and through the establishment of spin-off IT companies.

Effects on the R&D system

Institutional development

It is clear that ITW research today has a wide coverage over the country's universities, both within and between institutions, and with a natural concentration to the main university centres. The success of Linköping University is quite extraordinary, bearing in mind its modest size. It is, of course, the computer science institutions that dominate. Computer science is a young discipline that became established in the majority of universities during the studied period. During the 1990s, a number of interdisciplinary centres started to spring up as a result of the institutional collaboration that was supported by different ITW programmes. Continued financing was made in the form of faculty grants from research foundations established in the 90s.

Since the budget for individual projects seldom amounted to more than about a million kronor per year, the ITW programmes for the respective institutions are all relatively small, serving as supplementary and supportive financing. The projects could only afford two or three senior researchers from different disciplines for supervising PhD candidates in their respective fields.

Institutions in both Linköping and Gothenburg established sustainable collaboration with each other on the basis of the ITW theme. An enduring outcome in Linköping was the establishment of four institutions that together created a 10-year centre of excellence. New institutes and business networks were also set up in Gothenburg, focusing to a large extent on ITW issues.

The industrial research institutes also provided a bridging role. Six such institutes together participated in 34 projects during the period.[3] Similar knowledge-bridging roles were played by a host of consulting firms, trade unions and public authorities.

Interdisciplinary approaches and competence centres/centres of excellence

The MDA programme was the first to be organised on an interdisciplinary basis and, in the view of all those researchers interviewed, it provided a decisive contribution in the ambition to cross over disciplines in the field of IT implementation. Both the SAMT

[3] The Swedish Institute of Computer Science (SICS); the Industrial Research and Development Corporation (IVF); the Swedish IT Institute (SITI); the Swedish Pulp, Paper & Packaging Research Institute (STFI); the Swedish Institute for Food and Biotechnology (SIK); and SP Trätek (the Swedish Institute for Wood Technology Research)

and the MTO programmes continued along these lines. Evidence of the interest from the universities for this *additional financial support for the interdisciplinary IT research* was clearly evident in the fact that all 10 major universities during the period were involved in five or more ITW projects.

It was also about this time that the first interdisciplinary centres appeared at the universities, such as the Centre for the Study of Man and Computers (CMD) at Uppsala University. This was followed later by CMTO (and later HELIX) in Linköping, Change@Work in Lund, and CORE at Chalmers. In Stockholm, NADA at KTH, one of the most active institutions in the ITW field, hosted a centre for user-orientated IT design (CID) between 1995 and 2005, and in 2000, the computer-science institution in Uppsala acted as host for the interdisciplinary-focused National IT User Centre (NITA).

Intradisciplinary knowledge creation

The programme provided additional finance for licentiate and doctoral degrees to such an extent that the ITW approach still makes a central contribution to the universities' computer-science institutions.

In summary, in Linköping and Gothenburg, the ITW-researchers have published their work in internationally refereed journals and conferences. In both cases, contributions have been made which have been quoted extensively in the international computer science community. However, in both of these learning establishments a higher rate of production was evident in the technology faculties of the host institutions than in the social sciences. There was also little evidence of co-operative interdisciplinary publications.

Effects on availability of training and education, and on skills enhancement

The increased professionalism in the IT sector has to a high degree influenced the design and content of degree courses in both the specific computer-science courses and in related courses in other disciplines. Of particular interest in the field of ITW is the cognitive-science programme. Since its start, 30 to 50 undergraduates a year have graduated (Linköping), and there is strong evidence that these graduates are highly sought-after in industry, the public sector, and consultancy firms focusing on interactive design and usability issues.

We also have an example from an individual project under the MDA programme, which formed the basis of a new course in Karlskrona-Ronneby. A survey of the involved institutions in Linköping reveals that training programmes have become attached to local competence centres, not only at the CMTO but also at the new Helix

centre of excellence. In a similar way, the Victoria Institute and the University in Gothenburg also made significant contributions through training programmes.

A clear indication of the need for broad competence in industry in the interaction between IT and the requirements of the business was the setting up the Graduate School for Human-Computer Interaction. This can be seen as a part of the MDA–SAMT chain of programmes run between 1997 and 2003 in cooperation with the departments of computer-science at Stockholm and Linköping.

ITW-research – a challenging path to interdisciplinary and interactive research

The ITW programmes largely influenced the interdisciplinary nature of the research, and cooperation between researchers, companies and the public sector. Interdisciplinary centres were set up in close collaboration with industry. The level of publication from ITW research was in line with other directions within the studied institutions. However, the interactive nature of ITW research is seen as a problem. The demands from the academies to provide scientific reports come into conflict with the need for direct reporting and development by companies. However, the institutions in Linköping and Gothenburg that were studied more closely have nonetheless managed to overcome this problem. The growth of the institutions in terms of the number of licentiate and doctoral degrees awarded, together with the national and international collaboration with which they are involved, confirms the sustainability of their methodological development.

Long-term effects of ITW research - an overall assessment

Government ITW research funding as “seed capital”

Altogether, it is clear that ITW research funded by government money can, to a large extent, be regarded as strategic funding to promote or to influence both research institutions and companies. ITW research funding amounting to some SKR20 million per year can be compared with VINNOVA’s support for "Services and IT implementation" amounting to more than SKR250 million (2005). Because of this limited funding, the programme and project funding has largely served as a lubricant to smooth the actors’ networking and collaboration activities, but also to support PhD candidates and to disseminate knowledge.

Sound accumulation of knowledge but poor dissemination

The majority of the programmes were keen to generate both greater and wider effects than those that could be documented directly upon programme conclusion.

We have seen a number of cases of a functioning *knowledge-accumulation system* operating over a long period of time in many *companies* — not least when the project could be linked to obvious needs and where it was well established among the strategic actors in the companies. Two examples, Långasjönäs and ABB Control, demonstrate the importance not just of senior management (many of whom will be replaced in the context of long-term development work) but also of continuity in functions lower down in the hierarchy.

The accumulation of knowledge and the greater intensity in ITW research is even clearer in the universities - through developments in the respective institutions, between institutions, and via the setting up of learning centres. Although ITW research appears to be well established, today’s researchers bear witness to the uncertainty inherent in the funding system. In truth, ITW research has arrived at the crossroads. Hitherto, the financing bodies of the research have supported the institutional development, which is where the ITW research has been given room. But the future is seen to be more uncertain due to time restraints in the financing.

The endeavour to *disseminate the programmes* more widely in working life and among the suppliers (and similar actors) achieved only limited success. The aspiration to spread knowledge from the programmes more widely did not match the information and knowledge needs from potential recipients in working life - managers, HR specialists and union representatives, suppliers and consultants. This is also a strong reminder of the strict requirement for relevant research in this field, and of the need for the knowledge produced to be accessible. The importance of the mobility of the actors, often in the same role but also in new positions, should not be underestimated. We have encountered a number of successful researchers who were recruited direct from working life, but really there were far too few. What is more common is the movement of researchers to companies and administrative jobs. But the movement of researchers from one research group to another or into a different field is also important - regardless of whether they were in a training capacity, providing motivation, proffering advice and acting as consultants or merely carrying out the traditional work of a researcher.

Dissemination of research findings also takes place through the educational system, particularly from the growth of the special ITW schools and the cognitive science courses that are now available in a number of educational establishments.

Augmented utility value

The *participation of concerned stakeholders, specifically end-users,* and the methods for attaining this participation, were at the forefront in the majority of programmes. ITW research has, above all, contributed to the understanding of the need for involvement on the part of all concerned stakeholders. As regards the more specific methods in systems development and adaptation, a great deal has been done, but the work of disseminating the research findings has had to compete with more technology-based, and consultancy based, methods.

It was possible to establish a *breadth of competence* in the development process, and an interdisciplinary approach to research in a number of institutions, led by the MDA programme. This can be seen as an important positive development in relation to the increasing professional specialisation in this area.

To a large extent, ITW research focused on applied research - even in the more research-orientated programmes such as the MDA - and therefore contributed to the development of both prototypes and products. The main problem facing further development and the dissemination of research findings has been in the lack of involvement on the part of suppliers and/or of making the findings known in wider circles. Where knowledge dissemination is particularly important is in the development of the earlier menitioned consumer/customer instruments for usability.

The most conspicuous impact of ITW research can be seen in the field of *work organisation*. It is clear from a number of examples from companies and the field in general that ITW researchers have improved competence in work processes, and have increased awareness of the opportunities offered by IT among a wide range of employee groups, thanks to its commitment to employee participation in the work.

This has led not only to sustainable processes in the workplace but also to increasing competence within companies and in the field in general.

Positive spiral of user competence and growth

In the assessment of the contribution made by ITW research to the overriding goals - growth, democracy, competence, and a sound working environment - a picture unwinds in which we can see clear signs of a *positive spiral of competence and growth*, where the programmes and projects have contributed to increased involvement and development in the user organisation. We have seen many examples in the field, at the corporate level, and in the workplace of how a developing work can be linked to effectiveness and lean production. The link with growth applies particularly to the IT using sectors. On the other hand, as we have already asserted, direct links between ITW research and Swedish IT suppliers are weak, which means that this is probably the principal challenge facing this field of research in the future.

Weak signs of improvement in work environment

The programmes and projects have had only a limited beneficial effect on the *working environment*. The importance of the MDA programme to the Work Environment Authority’s guidelines for work with display units is relevant here. Work environment was also included in the earlier programmes, such as UP, DUP and MDA, primarily as a concept but also, to a lesser extent, in its findings as well. In the later programmes, we could say that the terms "usability" and "sound work environment" were beginning to be used interchangeably. We can also state that the ITW programmes were unable to break the trend towards the increasing cost of poor quality, resulting from flaws in usability of IT support.

Lessons learnt and conclusions drawn

Sweden is still at the leading edge in IT development and use of IT in companies and the public sector. Although ITW research has contributed to this, today it has to adapt to a very different world compared with that in the 1980s and 1990s:

- An integrated and increasingly mobile information and communications technology
- A rapid pace of technological development with shorter technological generations
- A general increase in IT penetration and IT competence among the population
- A more developed knowledge and services oriented society, with customers becoming important new users
- A new division of roles and work among users, buyers and developers, where global suppliers are now making a serious impact

It is our view that increased, long-term investment in innovative solutions for IT in working life should be based on more intensive collaboration among the actors in what we call socio-technological innovation networks. IT innovations do not only boost productivity in a technical sense but also have a social impact - work organisation, competence and education - that is decisive for the benefits and added value that the new technology can bring. It is also important that socio-technological innovation is grounded in an economic and commercial context. Innovations lacking long-term economic benefits for the user will simply never be implemented. Shortcomings in this respect were found in the evaluation of earlier ITW research.

The conspicuous interdisciplinary approach in ITW research, together with the interactive forms of work manifested in the knowledge centres and in long-term collaboration, are clearly in need of further development. It is probably here, in the socio-technological innovation networks, that the support from research has its greatest potential. The processes must instil competence in *both the buyer and the user* and, at the same time, the *suppliers* must be involved in a way that gives them ample scope for learning. Indeed, the involvement of the suppliers, the program developers and consultancy firms, is of growing critical importance. The procurers, working closely with senior management, have an important job to do in interpreting and articulating the operational and business interests, as do the employees and the users of the technology.

A large part of the ITW research can be regarded as entrepreneurial, either by being closely linked to actual development processes and technological develop-ment (evaluation and documentation), or by actually being involved in the processes. Even though the main focus of the ITW research is on interactivity, and of researchers working closely with the company and in the workplace, we find that it is still not without its problems. The interaction should be based on *long-term collaboration between the researchers and the company*. This implies that the parties must find a way to manage the different time frames in which they are working, based on the different assignments they have. Likewise, it follows that the *financing bodies* need to develop models that enable longer-term funding.

The experience from projects and programmes in which *personnel change roles* has been positive, which opens the door to new future development opportunities. This rotation of staff helps to achieve wider distribution of the knowledge gained - which is because direct communication is the principal and best way of spreading knowledge, and also because dissemination through education, written matter and other channels is often far too slow to achieve a lasting effect.

The social partners in the labour market, who were the first - the pioneers - to legitimise ITW research and utility value, have gradually reduced their activities. However, the outlook for growth, particularly the ability to limit work environment and operational costs incurred as a result of inadequate usability, now provides a strong incentive for the parties to resume their long-term involvement in ITW research.

The successes and setbacks in ITW research provide valuable lessons for future involvement in the development of what we have called socio-technological innovation networks.

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03 Sammanfattning - Användningsdriven utveckling av IT i arbetslivet - Effektvärdering av tjugo års forskning och utveckling kring arbetslivets användning av IT. *Brief version of VA 2007:02, for brief version in English see VA 2007:13*

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VINNOVA´s mission is to promote sustainable growth
by funding needs-driven research
and developing effective innovation systems

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