NETWORKED ENGINEERING GROUPS BY 2002 – A RESULT OF CURRENT STRATEGICAL DECISIONS

Lars Line, Assistant Professor Agder College. Affiliated to Program on Applied Coordination Technology at the Norwegian University of Science and Technology in Trondheim

ABSTRACT

Based on three years of research on distributed Engineering groups in a Norwegian consultant company, this paper attempts to convey the link between current strategic decisions and a possible work situation for an engineer by the year 2002. The focus is on the interplay among engineers in a distributed organisation and how this interplay is supported by technology. IT strategy is an important aspect. Strategy is discussed in general and an extension to the classic strategy terms is proposed. A first level IT strategy for the actual case is presented. The conclusions from the scenario is that the most important competitive advantage is the ability to develop and offer high quality services that otherwise would have been impossible. The single most important enabler is competence. This points in turn to a strategy focused on continuously developing new competence among the employees (lifelong learning).

Keywords, Networked engineering groups, distributed work, IT strategy, learning

Introduction

How will my work day be in two to five years ?

The author has over the last three years worked with research on distributed engineering groups in a Norwegian consulting company [Line96], [Line97], [Line98], [Line98-1]. The question quoted above is often raised by employees during interviews or conversations. The management is also interested in possible implications of the rapid development of information and communication technology. However, their questions normally go in the direction of:

What strategic decisions should we take to meet these changes?

The future is ultimately not knowable to anyone. The first question is whether an answer based on research in use of current technology and extrapolation of current trends will have higher probability than qualified guesswork. The second question is whether such a foresight or scenario is of interest and have practical implications on decisions that are to be made today. This paper describes the authors' effort to answer both the above questions, and the answer is probably yes.

The focus of the present paper is how an engineer in a distributed organisation is supported by technology in his interplay with colleagues and customers. Four years is selected as the foresight horizon of two reasons:

- It will allow several technologies that are known today to become mature and penetrate the market to a level where it can be included in a standard working environment.
- Four years is a short enough horizon to experience the implications of decisions that are made today.

It is difficult to convey an understanding of how technology can influence existing work processes and open up for new forms of interplay. Most people must experience and experiment with the technology and then create new ways of working or changing old ones

[Line98]. It is even more difficult to imagine and convey prerequisites and conditions for exploitation of future technologies. The main reason for choosing the scenario form was to meet the above objective. The present paper is structured in four main sections:

Methodology and focus: A general discussion of foresight methods, the approach selected for this paper and a presentation of the focus of the paper.

IT strategy: A general discussion of IT strategy and a proposed strategy for the actual case.

Technology: A foresight for technologies found to be important for the actual case.

Scenario: A workday by year 2002 for a water & sanitation engineer working in a distributed organisation.

Methodology and information sources

This section presents methods for technology forecast and refers to general examples. The approach and focus for this paper is also presented and discussed in more detail here.

Methods for Technology forecast

This discussion is mainly based on [Walker&Betts97], assessments and methods from [Philips97] and [Laubacher&Malone97] are also considered.

Walker and Betts [Walker&Betts97], identify four major categories of technology forecasting methods: Surveillance, Projective, Normative and Integrative

The three first categories of technology forecasting methodologies involve the projection of development in a single technology (like Moore's law for integrated circuits) or in a small group of technologies. Technical development takes place in an interactive environment. Development in one technology can trigger or accelerate advances in other technologies. Martin and Betts advocate integrative techniques where these relations are taken into consideration. They identify three types of integrative techniques: Cross-Impact analysis, Mathematical Models and Scenarios.

Method 1 and 2 are suited when dependencies between ruling parameters are known and can be expressed in mathematical relations. System dynamics is an example of such a method. Powersim [http://www.powersim.com] is a versatile simulation tool based on system dynamic principles. Scenario planning is a more qualitative method suited when mathematical relations between important parameters are not established.

Inventing the Organisations of the 21st Century is a large research initiative at the Centre for Coordination Science, MIT Sloan School of Management. The first working paper from this initiative is Scenario based. *Two Scenarios for 21st Century Organizations: Shifting Networks of Small Firms or All-Encompassing "Virtual Countries"?* [Laubacher&Malone97]

> *Scenario planning begins with the assumption that the future ultimately cannot be knowable with any certainty. Starting from this point, scenario planners set out to think deeply about the various potential futures which might emerge. The scenario process employs a range of techniques-research, brainstorming, story telling-and attempts to sketch a series of narrative accounts which delineate the boundaries of what could conceivably occur going forward.* [Laubacher&Malone97]

The research questions raised by this initiative are very complex. Laubacher and Malone chose to focus on one major uncertainty; the size of the individual company. To contrast advantages and disadvantages, they chose two extreme scenarios, very small or very large companies. The scenarios are assessed through an extensive review process.

Vision of the future [Philips97] is another example of a large scenario-based research program. The aim of this program is to imagine what kind of products Philips should offer in the year 2005. This is a relatively "clean" technology forecast. Extensive research in socio-cultural trends and developments in technology forms the basis of the scenarios. The extensive use of social scientists and "futurologists" in both the creative process and the assessments illustrates the fact that "What could people possibly need or want?" is as difficult a question to answer as "What products are we able to make?"

Approach and focus

The objective is to give a credible portrait of the near future (four year) work situation for a water and sanitation (W&S) engineer working in a distributed organisation (Asplan Viak, AV). Through this picture I wish to illustrate probable consequences of strategic decisions taken today. Experiences and principles described in [Line98] "*Distributed engineering groups, practise and principles*" form a basis.

The focus is on how an engineer in a distributed organisation is supported by technology in his interplay with colleagues and customers. The focus is indicated in figure 1.

Market penetration of new technologies and establishment of standards is important factors. Relevant technological development are considered and discussed in the Technologies section

It is a basic assumption for the scenario that the company has a strategy for building a distributed organisation. I will not discuss aspects of the formal organisation. *Virtual engineering backbone - Coordination by design* [Line97], presents and discusses a feasible concept. The principles presented in [Line98] underpin that social interaction and cooperative action for mutual benefit, are vital elements for a distributed organisation.

> *The emerging knowledge economy is not only changing existing industries and companies, it is also creating entirely new business opportunities which are purely knowledge based.*
>
> *This process will dramatically change the way we communicate and coordinate.* [Schiefloe&Syvertsen97]

We are currently observing profound changes of the society and economy as a whole, a process that is speeded up by digital information and communication technologies. The process characterised by IT support for communication and coordination, poses new demands on the way we think about IT strategy. For this reason, reflections about IT strategies and a proposed "first level" strategy is given in the next section.

The scenario was reviewed and commented by several W&S (water & sanitation) engineers from AV (Asplan VIAK)

IT Strategy

A common interpretation of the term "strategy" is: "*A plan for how to change an unwanted situation into a desired situation*". I find Stacey's [Stacey97] metaphor of a continously changing fitness landscape as a meaningful background for a deeper understanding of the complexity connected to organisational strategies.

> *Fitness landscape is a conceptual ram for thinking about the evolutionary journey of a system. Strategies that make the system fitter for survival represent movement up a hill, whereas disadvantageous strategies represent movement down into a valley. Each system's landscape is determined by the strategies of the other systems it interact with. Evolution is therefore a journey across a heaving landscape.* [Stacey97]

In this picture a strategy is judged by its effect and therefor seen as the sum of idea, plan, implementation and effect. Since we are talking about a system of human beings, an organisation, the total effect may not be apparent and not easy to measure. A seemingly successful strategy, measured against the original goal, may turn out to be a dead end. (A local fitness peak that suddenly disappears). The opposite may just as well be the case. A seemingly unsuccessful strategy may for instance contain a learning process necessary to identify and reach a higher fitness peak.

I do not reject the classical strategy chain of "goal-idea-plan-implementation-goal attainment". I merely open for a broader interpretation of strategy as a continuous change and improvement process. In this perspective a strategy may contain elements that are not directly targeted at an overall goal and elements that are not directly measurable. Economic life often emphasises infrastructure, education and stable external conditions as vital for economic growth. Studies [Orlikowski96], [Forrester97-1] and strategic actions taken by companies [Statoil97], indicates that this strategy perspective is gaining momentum and underpins the proposed strategy perspective.

In this perspective a strategy may contain some general and maybe intangible elements and some unique and targeted goals. General and intangible can be interpreted as rubber bands. It may therefore be necessary to define economical borders and evaluate the situation by qualitative approaches. Organisational size and complexity are important factors regarding the suitable form and level of detailing. Based on my experience with AV [Line96], [Line98] I advocate focusing on understandable and identifiable targets, empowerment and coordination of efforts as main elements in an IT strategy for this type of organisation. A suitable form can be a short top level document, followed by concrete action plans.

In the following, I will propose a first level IT strategy for AV. In order not to loose the focus of this paper, the relations to the overall company strategy is not discussed in more detail (see approach and focus).

As a background for the strategy, an overview, or holistic picture of IT use in AV is given. The main areas are briefly presented.

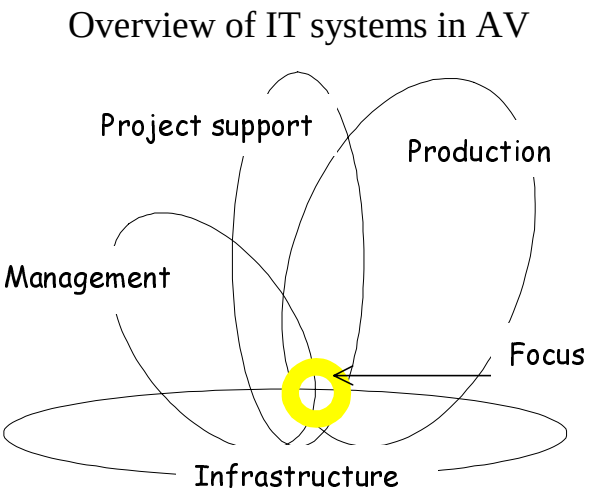

Figure 1: Main areas of IT use in AV

Figure 1 illustrates the main areas for use of IT in AV, which coincides with the main internal and external responsibilities, where overlaps indicate the need for coordination.

Infrastructure

The infrastructure covers all the basic services that the active components (Management, Project support and Production) depends on. In relation to the discussion of technology in the next section, it is common to include the responsibility for all layers except domain specific user applications and customised collaborative services into the infrastructure. The infrastructure therefore counts for most of the direct IT costs. It is important that it is professionally operated, and focused on the needs of its customers, the active components.

Management

Management has traditionally been an important area for IT use in most organisation. Typical systems are Accounting, Invoice, Payroll and Personnel administration. I will not cover this area in more detail, just emphasis that there is a tight coupling between invoice and project support.

Project support

More than 90% of the work carried out in AV is organised in projects and the company has approximately 1500 active projects at any time. Support for general project procedures and customisation of the work environment to reflect this organisation is therefor imperative. Support for communication and coordination is also included in this area, as will be elaborated under the proposed strategy.

Production

The production in a knowledge company like AV includes a very wide use of IT. Even if several employees still use their PC as an advanced calculator and typing machine, new forms of digital production are rapidly increasing. Ideally, each group or profession is responsible for their own production system. There are, however, many dependencies among the groups, both with respect to flow of information and exchange of tool competence [Line96].

Proposed strategy

The following issues are considered to be crucial for an IT strategy of a distributed engineering company like Asplan Viak:

1. Efficient support for project work. The solutions must be flexible and span from small informal projects to relatively large multidiscipline projects involving employees from several subsidiaries, customers and partners.
2. Efficient management of a distributed organisation.
3. General acceptance of the need for good domain tools and production methods. Advanced use of technology as a means to achieve competitive advantages must be clearly argued and based on internal competence.
4. Continuous and systematic efforts to improve general IT competence.
5. Encourage, support, coordinate and disseminate ad-hoc and creative use of IT to improve work processes.

Currently the IT budgets for AV is approximately 6% of the revenue. Substantial increase of this figure must be triggered by concrete projects with short term, tangible profitability, or a radically changed view of the importance of information and communication technology. The

objective of the above statement is to serve as a boundary for generally accepted investments and efforts, and to debunk the hype that IT is a major overhead.

The first three issues define the focus and balance of efforts within three major IT application areas. Infrastructure is not set forth as a separate issue even if it covers most of the direct expenses. The reason is that selection and quality of the services must be governed by the needs of the three active areas. The natural next step is to follow up these issues with detailing of goals and action plans. These activities must be coordinated and consequences for the infrastructure must be considered simultaneously.

Issue number one is, as I define it here, the most challenging, as will be argued for in the next section.

Issue number two is included because a well functioning bureaucracy is regarded as an important foundation for a distributed organisation of knowledge workers.

Issue number three is included because good production systems still are of major importance and require attention. The statement indicates, however, that we in this area will have reasonable level of control regarding potential and effects.

Issue number four is considered a prerequisite to accomplish the continuous change process that the "IT revolution" seems to be. This is underpinned by an internal survey in AV [DU1]. Almost all the suggestions from the employees stressed the need for more systematic coaching. I see no standard or general solutions to this learning need, but some ideas and experiences are outlined in [Line96]. The Norwegian oil company Statoil recently launched the IT-Step, offering all employees a PC with ISDN internet connection at home, including a training program in basic IT skills. Initiatives like this signal new corporate thinking in the area of lifelong learning [Statoil97].

Issue number five pinpoints that the strategy is more than just focused and planned initiatives. Many of the modern tools and services are open ended and highly customisable. Users and groups will evolve new use patterns and local applications. Experience from AV [Line96], [Line98] and studies like [Orlikowski96] suggest that such initiatives should be encouraged and considered an important part of the change process. One possible solution could be to allocate resources to encourage creative local solutions, followed by dissemination of ideas and the results to the rest of the organisation.

Project support

Asplan Viak has more than 1500 active projects at any time. The projects span from small informal projects to relatively large multidiscipline projects involving employees from several subsidiaries, customers and partners. Above 90% of all workload are related to projects. Of this reason, procedures and routines that increase quality or reduce cost or time spent to solve typical project task have a large potential.

There is no panacea or turn key solutions to this. Any technological solution can do more harm than good if it is not in line with the existing coordination mechanisms [Schieflo&Syvertsen97], [Line97], [Gillet96]. Modern open-ended cooperative technology may be used to extensively automate existing procedures and control of how the procedures are performed. This may lead to rigid bureaucratic processes that hinders new forms of interplay. We need automation and adoption of the technology to reflect typical structures of the work processes. The principle about organisational and technological compatibility [Line97] and that the technology is used to support open processes is advocated as vital success criteria’s.

It is beyond the scope of this paper to go in detail on actual services. Some principles and solutions are presented in earlier papers [Line96], [Line97]. The scenario presented in this paper also illustrates how services implemented by the above principles are intended to work.

Success in the transition to digitally supported work procedures calls for strategic focus and organisational maturation, accomplished as a part of a holistic strategy. Expensive IT investments may not be necessary.

Technologies

The objective of this section is to identify development in information and communication technologies that:

- Is likely to penetrate the marked within four years.
- Is important to distributed engineering work

A foresight of relevant technologies (Telecommunication, basic net services, hardware, cooperative services and user applications) was carried out. [L97n1].

> *We concluded that the most far-reaching changes in the next decade are not likely to be the result of dramatic new innovation. Rather, they will almost certainly result from the focusing, refining and merging of existing technologies and their extension to more areas of our lives.* [Philips97]

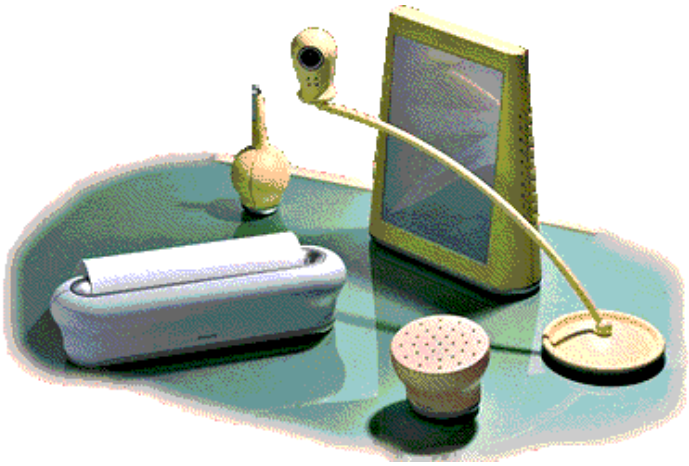

Figure 3:Office "PC" in year 2005 [Philips97]

The conclusion in the foresight is inline with the conclusion drawn by Philips. In all areas we will experience a more or less continuous development that will enhance the possibility for distributed and digitally supported cooperation. I will point to three technological changes that are very likely to occur within the next four years.

Real time communication: Penetration of standards and equipment for data- and multimedia conferences.

Internet capacity: General (and affordable) availability of high and predictable Internet capacity.

Security and authentication: Directory standards and security mechanisms will be as accepted as smtp and http are today.

These changes will in sum enable a new level of digitally supported distributed cooperation.

Scenario

The past has caught up with me. A quick count of the task list reveals 15 red and 10 green points. Then comes the project manager for the purification plant. His request for a start of activity glare in my face. He has used the highest priority and is thus at the top of my list. I remember clearly that we gave an offer for designing the purification plant and I accepted the responsibility for design of the machines. We were jubilant when we got the contract, but that was before my activities should start, and I thought only of the tasks that should be finished before Christmas. I have known about it and seen that the hours are in my schedule. From next month they expect full workload and the tender must be ready in half a year. I shall have to make a list of all my jobs and discuss with the group leader whether others can take over some of my minor tasks.

Now I have to make a battle plan for the day and the week. Monday is the big day for coordinating the work. The project manager is a bulldog. He can even be unpleasant if I have not done what I have promised to do. I have to start the kick off procedures to show that I am on my way. The important things first, I must have a cup of coffee and sum up the situation after Saturdays bar crawl. Then I will be mentally ready to start shuffling tasks.

I start with something simple and pleasant. Johnny in Molde asks for tips about how to design sand-filters. I was an updated specialist in the field some years ago and have relevant literature and know of many examples. I search a bit in the archives and compile a fine list of references. I give a few hints about grading of the sand. I also mention the problems of clogging that occurred after a while in one of the plants. I wish him luck and say that he is welcome back with more queries. I am assigned the responsibility as training coordinator in plant design for the junior engineers. Three questions await answering. I had better answer them at once. The first question is simple. It is just a question of finding the relevant code. The second question is not complicated, but does not lend itself to a simple answer in writing. The answer sits in the fingers but not in the head. I contact the questioner over the net and show her how to use the program. We chat a bit about sensible use of roughness coefficients and clear up a misunderstanding. The last question is not that simple. Halvor has only been employed for a year. He spent the first six months in Trondheim together with some very skilled senior engineers. He then moved to Steinkjer. The group leader in Steinkjer travels a lot and I think that Halvor is given too many tasks that are beyond his present competence. I don’t know where to begin and do not have time for a thorough explanation. I ask Halvor to let the task wait a bit and go to see my group leader to discuss the problem. The situation is somewhat delicate.

Luckily the group leader understands the situation. He says that he had an inkling about the problem and is glad to be able to attach it to a case. He takes over the search for a solution.

Time to make up a status of my own projects. The pump station runs smoothly. Tom has not started calculating the shock waves. He is tidy and experienced so I don’t yet start to urge him to hurry. The costs are according to plan and can all be invoiced to the client. Then comes the upgrading of the monitoring system for the purification plant in Arendal. I have not quite got the hang of it yet. There are so many new solutions and the computer people have their own tribal language. Oops! There was a red line. Has Tore been working on the project? He is not part of the team. I remember that Geir who shares office with Tore was to make a little technical note. Can he have left it to Tore without notifying me? He has not given any comments. I must find out about this at once. Tore is of course not available. There is no message saying where he is and when he will be back. That man is less accessible than the king. I tag the manhours that he has charged my project as “unresolved” and ask for an

explanation. I might as well be a bit sharp so that they learn to clarify before they juggle the tasks.

Our assistance for running the purification plant in Silvan municipality is about to end. The job just waits for my final tidying, classification and commenting before it is in the archive. It is important to remove trash, but straightforward, informal comments have proved to be useful when gathering information from past projects. I shall have to find time for going through the project. It would have been nice to do it. Maybe, for once, I could avoid being nagged by the project controller. Luckily it was a relatively tidy project. I manage to straighten it up myself. Tender, contract and correspondence are tidy and in accordance with standard procedure. I can concentrate on separating the final product from the intermediate stages in design A few of the memos from Tore were instructive and would make good background information when working with similar project in the future. Other memos are of little interest for a new project. They had better be kept out of the index. Final calculation shows a 5% loss. We won the job in a sharp competition with other consultants. I think we were aware of this possibility already from the outset. I must check with the original internal budget. Yes, there it is. That can be used as an explanation for the loss.

I attach a comment to the contract. There were a few clauses that proved to be unfortunate. There, that is the end of the project. It goes to the eternal indexes as a part of our spiritual ballast.

Time to sign on for the purification plant. I report myself as active for the project so that the project leader can see that I have started. Simultaneously I acquire write access to my activities. I put myself on the list to get general information and updating from the project leader. The project pops into my message filter with its own folder and subfolders. The project leader likes tidiness so he has made an elaborate structure. According to my taste it is a bit overdone, but I get what I need and adjust myself to the regime.

I see that the municipality is strongly represented in the project. They have access and can comment on most documents. They are also in on many activities, specially the running of the plant. It was not so simple when we starting to let the customers see the project documents. We had to consider things more carefully and get to know those who sat on the other side. Where the new regime works the gain is great. Effective exchange of information, useful initiatives based on experience and early sorting out of conflicts. At best we avoid the game of passing the blame and cooperate to solve problems. I must get the feel of the situation and find how the tone is in this project.

First I look at the description of the various activities. Then I read the documents pertaining to the various activities. The list of documents looks straightforward and well structured. It is possible that we shall need a few more drawings, but they can be added when we see what we need. The inside of the documents is empty. There is neither structure nor content. I collect the preliminary papers from the last purification plant and start at the beginning.

By the way, we are in the middle of getting the last purification plant started. The PLS people have worked for a few weeks trying to get the plant running. Last Friday they had got reasonable control and we could start a trial run of the chemical cleaning. John took his sleeping bag and went out there on Friday. I must contact him and ask how things have been running. John is tired after a more or less continuos surveying of the process, but is in a very good mood. He has just received the tests of the first purified water. They are just as we wanted them to be. He has done some practical adjustments, but the process has run just as we have prescribed. That is our reward for the extensive pilot experiments. This experience will contribute considerably to the current project and be a good reference for future projects. John is exhausted and needs to sleep. He asks if I can monitor the process for the next 24 hours. It

is especially important to follow the process at 6 p.m. Then they start running the plant at full capacity. In my present mood it goes without saying that I don't mind, but I ask him to see to it that I get full access so I can follow the processes from my home. Security is of course strict. We discussed at length if we dared to attach the plant to the net. To run the municipal sewage plant would be a perfect Internet game. Many dirty tricks are available. One is to open the emergency overrun. The effect would be very unpopular, especially in the bathing season. No, this must get to the mail. I must have a cup coffee and talk to Anders and Henrik. They worked on the project. The Monday mood is gone. A cigar would be nice. We should be allowed to bask in the glory of our own successes. They are not many.

Now there is no way of avoiding starting work on the new purification plant. There has been a delay, but shit happens. The first item is the functional specification of the purification process. This is a preliminary and relatively relaxing task. I have a week to do it. It consists of cutting and gluing from the preliminary project, looking at other projects and making a report in prose that is a snitable mix of know-how experience and common sense. I must see to it that it fits the functional specification for the intake pump station.

I establish a dependency and check the status for the document. It is finished so I might as well check out and state that my activity shall start tomorrow. I see that the project manager shall approve the report and that the municipal staff for running the plant wants to comment on it.

It would be nice to have references back from the detail design to the functional specifications. I must define suitable anchors to make it easy to create links. Functional specifications for mechanical components and material specifications are tasks of similar type. I check them out and adjust them to the schedule.

So I have to start the detail design. Coarse sieve hall, sand trap, fine sieve hall and engine room. This concerns a lot of people. The structural engineers need to know our demand for floor space and the loads from the equipment. The electrical engineers must know what signals must be accommodated and the need for power. The HVAC must have their design basis and the cost controller will nag about all changes. In other words, many groups will ask for information. Whenever I put in machines and components they will demand to be informed about revisions. Most of them will want information on revision and manually estimate the consequences. Electro might attach to the model and ask for information on any point of contact. I do not know if I like having them that close. It leads to noise and storms of messages. I must keep some information to myself until the design stop changing too often.

The rest of the day I am allowed to work in relative peace. There were just a few telephones and some queries that could be answered quickly. By the way, Tom sent the address of a Belgian rag and waste dealer that has specialised in Ariel spare parts. Tom and I share the passion for old bicycles. He knew that I need some spare parts in order to get my bicycles on the road in the spring. I find just what I need and the price is reasonable. I take the chance and buy right away. The firm does probably not have the highest credit rating, but people with interest in cycles with a soul can not possibly be crooks.

At 5.20 p.m. my dinner nap is interrupted by the man running the purification plant. They have capacity problems. The flow through the filters might be insufficient. He is not comfortable with this situation just before we get the full load on the chemical process. I go to my attic and log in. I can see that the flow through the fine sieves is too small but I am not certain what to do. Tore is a specialist on the mechanical process. I would have liked to have an opinion from him. Luckily he is at home and we look at the problem together. He thinks that we should shut down the valves and blow the fine sieves clean. Then we tighten the coarse sieves before we open the valves. We choose that procedure and hope it will do the

trick. I thank for the help and check out. I promise the operator on the plant to come back and check on the situation before the eight o'clock news.

During the afternoon cup of coffee I reflect over the situation and the technology. During the day I have been in contact with suppliers, colleagues and customers from all over the country. From the attic a colleague and I have run a purification plant 400 kilometres away from us both. The technology is in many ways fantastic, but what have we really achieved? I remember when the surveyor Jonas was about to retire. When he was tidying up his office he came across a 15 years old tender for a mapping job. His pay was a tenth of what it is today. Still he could have done the job for the same price today. New electronic laser instuments, GPS, 3D terrain models and computer programs have reduced the time needed to one tenth.

In a few projects and operations we have improved our efficiency to the same degree. Improved efficiency in such highly repetitive tasks is not much in focus. The running of the purification plant from the attic shows that we can provide services that were not possible before. We can make quick decisions of high quality utilising resources from the whole department. The technology joins us together. I feel strongly that the network of knowledge plays a decisive part in improving top expertise and training junior engineers. The network is an enormous support for those that are in direct contact with the customers. Wherever they are, when things happen specialists are available who can help in solving the problems of the customer. It is difficult to measure the increase in efficiency when the tasks are constantly changing. We could have become extremely efficient at planing the purification plants and the control systems of the 90ties. But that might not help much if nobody wanted our products anymore.

Things are ”achanging”. The technology becomes simpler and cheaper. New possibilities pop up all the time. I wonder if I ever shall get rid of the feeling that, really, we have only just started.

Conclusions

From the review of the scenario by W&S engineers in AV, the general comment is that the picture is realistic and illustrates interesting possibilities.

> *We could have done the most of this already today. We must continue the effort to improve this way of working and our use of the technology.*
>
> *Maybe it is still early days to work this way, but the technology will catch up. FAH-[Line98]*
>
> *It's realistic. My workday is however more chaotic with more interrupts. Much would be achieved if the technology could help us in structuring requests.*

The above quotes show that the objective to convey the importance of current strategic decisions is achieved.

The main conclusion is embedded in the reflections at the end of the scenario:

The important competitive advantage offered by being part of a distributed network of knowledge workers is the ability to develop and offer high quality services that otherwise would have been impossible.

We live in a period characterised with high change rates, and we see no signs that the changes will slow down. We must prepare for continuous adaptation to new and rapidly changing external conditions. Professional networks and close interplay with others is necessary to keep up with this change process. Existing communication and information technology enables

closely coupled work among distributed group members [Line96], [Line98]. The improvements in these technologies throughout the next four years will significantly improve this possibility. Competence is necessary to be able to exploit this opportunity. Competence in use of technology, competence in human interplay and competence in how technology can support and coordinate human interplay.

A strategy focused on building this competence among the employee's is probably the single most important enabler for a creative and competitive distributed organisation.

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