THE PROCUREMENT OF INFORMATION TECHNOLOGY SYSTEMS ACROSS BORDERS

Executive Summary

There exists an image of the well organised procurement process for the acquisition of large and advanced (information) technology systems, requiring some substantial development efforts and transcending national borders. Our basic finding is that though this model is referred to by the parties in the procurement process, it is very often a theoretical construct, at some distance from reality; it might perhaps serve as the basic reference, however.

1. In practice, time is often overdue. Therefore, there is no room for orderly qualification, several competitive bids, etc.

The reason for this may be political pressure; competitive pressure; or an existing IT system that is just too insufficient. Because of the problems involved in substituting it, when, at last, the substitution decision is taken, the system must be changed swiftly and the new system must represent a quantum leap forward.

2. Old personal and commercial relations and trust may weigh heavily in the selection process. Trust might involve the supplier's ability to meet certain requirements, his established image, previous experiences of him, etc.

One company stressed its determination to see to it that the "chemistry" between people, allocated to a specific project, was right. If not, this supplier felt compelled to

substitute one individual for another. The smooth understanding, on the psychological level, was regarded as key to project success.

3. Project teams across the border between purchaser and supplier may form networks and para-organisations that take on equal weight as that of the respective mother organisations. The larger the project the larger the likelihood for the creation of independent units at least at the supplier's side; in one case, we saw the establishment of a new unit in a new location. In such a case the project rather than the firm or organisational unit within the firm might constitute the entity for project managers to identify with.

4. IT companies are more prone to rely upon new IT tools for intra-project communication. So far, changes have not been very dramatic: easy-to-call telephone exchanges, fax machines, sometimes voice teleconferencing, sometimes computer conferencing.

5. One basic point about procurement as something boosting innovation is the fact that specifications should be functional rather than specific about components and details. If the project is innovative enough, there should be some uncertainty as to whether those specifications may be met, at least at the given price or within the established time frame.

But giving the final functional specifications might cause severe problems especially in a complex information technology project, because no one can tell whether it is advancing along a route leading to the final goal. In other words, how can one tell if subsystems are good enough, how may hardware and software be integrated, and how may component parts be adequately tested before integration? – This may actually be a problem assuming particular dimensions in the case of *IT*, because software might be said to be following a different paradigm from hardware.

Why this study?

There are several reasons for this study. Some are related to the development of information technology – *IT* –, some more or less related to the industrial situation of our country, Sweden, and some also to the innovation process.

Information technology spans the very little component – the interconnector, the software program loop, the transistor – and the very large system – the telecommunications network, the telephone exchange, the supercomputer, but also the complex integrated circuit. The small is part of the large, of course.

For a long time, what we have seen is the integration of technologies previously regarded as separate, microlectronics revolutionizing telephone systems, and computers and communications merging in the creation of "telematics" or "compunications".[1]

More and more, such mergers, such integration must take place across corporate and also across company borders. Sometimes but far from always it is the question of procurement. In reality, the borderline between procurement and outright collaboration can be vague and at times artificial.

Another aspect of this is the rapid growth of strategic and technical alliances (cf below). Competitors are entering cooperative arrangements, not just for precompetitive research but also for particular subsystems. Again, we are facing a blurred borderline.

IT is still very much characterised by technology push.[2]

[1] See for example *Telematikens Årsbok 1987*. Teldok, Stockholm, Sweden 1987

[2] Some researchers suggest that the sequence of the Abernathy-Utterback innovation cycle model may, for the first time, be reversed: *process* comes first, giving opportunitites for *products*, i e, process being the *carrier* for services. *SPRU*, Science Policy Research Unit, personal communication, 1988

No invention is turned into an innovation without market success, i e, customers, however. The main road to the successful market introduction of new ideas is through pioneering customers, and the ideal situation is when an early purchaser may specify some new product, system, or service which offers the potential of high value added. And when this customer is interested enough to buy something not yet existing, buying, as it were, expectations.

Therefore, we would expect pioneering efforts to be found in (or *concealed* in) procurement contracts. With the recent emphasis on "globalization" (cf below), such procurement might be expected to take place more and more across national borders.

It is, furthermore, claimed that *IT* development constitutes the forerunner and the model for the research, development, and innovation efforts in other industries.[1] If this is the case, results obtained might be adapted and generalised, given intervening time factors and contingencies.

Obviously, *IT* companies are pioneers in the utilization of some new *IT* tools. Since such tools are essential to communication, they might be expected to figure in development projects across corporate and national borders. Thus, one aspect of our study would be to look upon *IT* companies' use of *IT* tools in the research and development process.

Finally, Sweden and Swedish industry. Several researchers, comparing different economic structures in different countries, have concluded that Sweden had a large part of its economy depending upon "mature industries" which have been successful in the early utilisation of advanced new technologies to boost productivity and competi-

[1] Larry Sumney, president of the Semiconductor Research Corporation, made this claim at the international conference on "*Changing global patterns of industrial research and development*" in June, 1989. This conference will here be referred to as CGPIRD, for short.

tiveness in general.[1]

The technology currently offering the most general tools and the broadest areas of application is, of course, information technology. This general statement may find several empirical underpinnings: Swedish corporations as well as public undertakings have procured a comparatively large number of pioneering *IT* systems in the past. Swedish banks were pioneers in the use of cash registers; Swedish hospitals and local communities can also be cited as forerunners; as can industry.

At present, the Swedish level of *IT* utilization is number one, two, or three in the world depending upon measure. The countries to challenge a claim to leadership, in particular areas, would be the US and Japan. Thus, the "*IT* soil should be fertile"; not least in the public administration, a Swede would be tempted to add. The argument that *IT* is one important element in the dynamic competition[2] that decides the future of the Swedish economy is well founded.

Be that cause or result, Sweden has some major information technology based corporations, foremost Ericsson but also the Televerket (the national telecommunications administration), as well as smaller but still important concerns.

This list of reasons for the project may seem to prove just too much. Finally, however, the most general proposition, of course, would be that *IT* plays a central role in corporate and organizational life. A bank procuring a computer system crucial to its service delivery; an airline using computers and communications as its strategic base; a distribution company in the pharmaceuticals business completely recreating its foundation; the examples abound.

[1] E g, Henry Ergas, at a conference of the National Academy of Engineering, documented in Guile, Bruce R, and Brooks, Harvey (eds.): *Technology and Global Industry*. National Academy Press, Washington, D C 1987

[2] Andersson, Åke E, and Strömquist, Ulf: *K-samhällets framtid*. Regionplanekontoret, Stockholm 1988

If, therefore, a company or an organization undertakes to order a custom made system, that is bound to be important. The development process is far from without problems, since those establishing the specifications are not those end users that will, finally, use the system; and very often, there are no patterns to follow. The smooth development, and the smooth running of the communication and cooperation process with the supplier, might therefore seem to be of prime importance.

Our project

The proposal for this project suggested the study of one large project – a historical one – to get to grips with the various problems and issues involved. Furthermore, literature studies and discussions would be needed to structure the problem area.

The case study thus was intended to be exploratory, getting to know whether our description of the procurement and project process was accurate enough, what aspects were judged crucial, etc.

In fact, we have studied three different processes, three cases. Two of those three constitute two seaparate, specific procurement projects, the third a more general description oofthe way along which one information technology company sets out to meet its customers' needs.

The opportunity to compare between different types of projects would seem beneficial in generating insights as to what research problems to focus on. The broad diversity between the three objects of study may also serve as the foundation for a discussion on the need for limitations to the area of study.

Our various observations may help to illustrate some of the features gained from the more general discussions. At the same time, we have to be alert to the fact that there is far more even in our limited universe than we have encountered so far.

The process as anticipated

Before suggesting this project, we discussed the project idea in broad terms with several buyers and sellers of large IT systems, sometimes involved in projects with a development and innovation content. They suggested an ideal procurement process:

1. Formulate the project intentions in broad terms, ask suppliers for comments, ideas, and other input, including information on new developments under way but perhaps not yet official.

2. Write a project outline and invite all potential bidders to tender preliminary offers, which are only provisional and the basis for further discussions, demonstrations, references, and tradeoff analyses.

3. After a review of new ideas, developments under way, references, etc, a smaller number of companies are shortlisted. They are equipped with specifications for the project and invited to tender offers. Specifications may include one set of targets and another of project execution outlines. They may also contain rules as to the evaluation of different offers.

4. The offers received are reviewed and evaluated. There may be the requirement for a threshold to be superseded, and above that, a point system is established. That is why also the evaluation stage involves negotiations and discussions. The initial specifications need to be clarified; there will be some risks and benefits involved in a true development project; there will always be tradeoffs, making different offers qualitatively different; and there will most certainly be questions on the time schedule. Since there might be a separate document specifying how buyer and supplier would work together, there must also be mechanisms to resolve "interfacing" problems, e g, who is responsible for delays, who should decide on costly deviations from plans, etc. The formulation of liability paragraphs is important. In fact, there will, in a sense, be

two contracts in one: legal and technical. There may also be the difference between the goals or specifications, and, possibly, an equally specified process whereby these should be achieved; if technology transfer is one objective, this may even be very important.

5. Finally, one contractor is selected. Now all the "theoretical" problems as to formulating the contract are practical. The main point here is that though innovation is an inherently uncertain process, this uncertainty has now been encapsulated in a contract. How does it address the uncertainty versus reality problem, and how would the innovation process be affected?

6. Furthermore, we have concentrated on projects transcending national borders. What language should have precedence? Very often, the buyer's language. That would mean, for example, that a Swedish company might acquire something from an American corporation, based upon a Swedish description and its English translation, the Swedish version having legal priority. But those people involved in the technical – as distinct from the legal – interpretation of the contract live in different countries, different cultures, master different languages, experience different corporate cultures, and have to communicate over long distances, at least sometimes.

7. How, then, to evaluate the outcome of the project? One way would be to compare contract with outcome. Given the idea of innovating, this might not be relevant unless the uncertainty component is taken into account, and then what's the use of the contract? If part of the project fails, it might be because it was truly impossible and thus the goals too ambitious. But when is a project too venturesome, and when is it too little venturesome – seen ex ante, not in retrospect? Another way would be to ask the people involved; they most often have a perception as to if the project was successful or not. But then the question is whom to ask. It might not only be that buyer and supplier have different opinions, but different actors within these two organisations may also diverge. Yet

another proposal would be to make a formal cost-benefit-study, ex post. This is sometimes feasible, but, given the innovative component, not always.

8. Another proposition would be to evaluate the development process. Only in theory, people would be prepared to be unaffected by the perceived outcome of the project, but then, in theory, we would be given perceptions as to whether the actual planning and execution of the project was good, and how it might have been improved.

Case 1: An electronic PBX

The emergence of electronics made telephone switch manufacturers and telephone service providers experience a major shift in their worldview. This development, and its repercussions on employment, decision making, etc, has been described in a number of case studies and consequent analyses.

In brief, though the advent of the transistor, developed by the world's largest telephone company, Bell, was foreseen to impact on telephone exchange design and the whole telephone system "sooner or later", the swiftness in the changeover from electromechanical to electronic systems turned out to be unexpected and unprecedented. Actually, customers *did* want the latest technology, even if it was "uneconomic", which very often was another way to express the feeling that the new technology offered entirely new qualities, new performance dimensions.

What would become PBX 345 is a case in in point. Back in the 70's, the Swedish telecommunications administration Televerket was, like so many of its counterparts around the world, a de facto monopoly. By the mid-70s there was, in Sweden, a widespread unhappiness with available subscriber exchanges, which where electromechanical. These bulky systems required a large space, a high ceiling, very often a separate building or at least a room of their own. They took about half a year to install and much longer to order before actual installation started.

To balance the national telephone monopoly and to act as a pressure group, Swedish business had formd The Business Telephony Committee, Näringslivets Telekommitté, or NTK for short. Their important mission was to press for something better, including better subscriber exchanges. As a stopgap, an electronically controlled relay station was developed, but it was seriously hampered by the fact that it could handle only small organizations, up to some five hundred connections.

The pressure from the NTK, in conjunction with new signals about market orientation, changing ground rules for telephone businesses all over the world, etc, created strong impetus to do something, and to do it quickly. All internal development resources, including those of Ellemtel, the joint development company with Eicsson, were already occupied, so procurement from the outside was necessary.

Another pressure came from abroad and called for free trade, i e, the close links between the Televerket and Ericsson might be questioned in the future. Therefore, it was judged important to make the procurement process almost demonstratively free of any bias.

The project was in a hurry already from the start. In 1974–75 specifications were designed, and the documentation for the request for offers was formulated in parallel while specifications were established.

Several consultants were egaged in this process, not least in the cumbersome evaluation of the different offers. These concultants often came from Teleplan, a joint and independent consultancy set up and owned by Sweden's largest electronics corporations. One of the main consultants had also worked for Northern Telecom.

The specifically Swedish specification contained many problematic points. In a Swedish local exchange, for example, to get to the switchboard, you should always dial

0, not, as in some other countries, 9. This was a "must". And of course interfacing with the Swedish telephone system was another requirement, as was the Swedish numbering plan.

Then the product chosen should be produced within the Televerket in Sweden; what was called for was, first, a development project, at least in the sense that adaptation to the Swedish system took place; and, then, a technology transfer project.

By this time, trade unions within the Televerket were quite concerned over future employment prospects, threatened by the electronics development. A commission judged it necessary to close down the factory in Vänersborg, and then another commission, sponsored by the trade union, said to keep it open. The outcome would be that Vänersborg should produce part of the new exchange.

The evaluation team knew quite a lot about the six bidders and their products, already from the beginning. Thus this list was easily reduced to a shorter one, with three companies remaining. There was never the request for more specified offers, the usual second round, partly for time, partly for factual reasons.

The three remaining offers were very different, qualitatively. One company had an exchange that was already on the market and that functioned well. They were rejected for a reason typical of the rapid development in electronics: it was already out of date. With the pressure building up from Swedish business, and with the partnership with Ericsson to take into account, the Televerket could not imagine buying a product that could not be justified as modern enough.

Another worldwide company was only very early in their development process. "They had a dream and a vision, but the only thing they could show was overhead transparencies." It seemed too risky, and also too long term, to opt for this system.

So, in reality, the Televerket were left with just one possibility, Northern Telecom (NT). Their suggested solu-

tion was a very advanced telephone exchange, which was in the latter stages of field trials in Canada (where the company is based). A few early products were in use, but series production had not been started.

Northern Telecom was a new acquaintance to the Televerket. In fact, it was only at this time that NT started to become one of the few major international players in the market for telephone systems, in a shakeout that started in the early 70s, triggered by the electronics development, a shakeout continuing to this day. The springboard for NT's expansion was pioneering efforts in digital switching – they were the first to use this in a consequent way – and the brain drain from the US, by well educated Vietnam war protesters.

We have seen that the timing of the PBX project in all probability was the most important feature in the Televerket choice of supplier. The main reason for going abroad, and so swiftly, for this product might be said to have been some political or public pressure on what was then perceived as a government monopoly. And we have also seen that another pressure, from trade unions to keep employment opportunities, played a role.

The contract had two different parts. It was a development contract, requiring the joint development of the exchange that would become called *345*, and it was a licence agreement to allow for production in Sweden.

The development included the redesign and partial substitution of hardware parts. Furthermore, the software had to be rewritten. Everything should be adapted to Swedish and European standards.

The problem, seen from NT's side, was to assess the ability of the Swedish production plant to adapt to and then to introduce the new production processes that came with a completely new type of product. The story is not unusual: it turned out that machinery, equipment, plant, training, personnel, organization, were all geared towards the old electromechanical production. Experiences from NT itself, if nothing else, demonstrated what difficult and demanding investments, not just in machinery but also in attitudes and knowledge, that would be required.

To get the Swedish order was of course pleasant enough to NT. Only that it caused problems also. The expanding development department was already more than tied up with other major projects, and here came yet a large one. It seemed impossible to recruit enough people of the right caliber in all of Canada!

Silicon Valley would be an option, however. Competition for people is tough, but there is labor available there. And Northern Telecom had already toyed with the idea of establishing a development unit down there; it would be well placed to follow at close range important new developments in the electronics industry. The *345* project became the triggering factor for the establishing of what had only been on the wishing list in Toronto.

The Swedish project gave the initial backbone for this establishment. This was a well defined project, with clear goals, and with funding: an ideal situation.

By the end of 1976, a formal contract was signed. The development part contained the large uncertainties in the the most straightforward way, the Televerket paying for actual time spent, but with certain ceilings. The licensing part was rather standard too, a basic payment and then a royalty. Prices on key components that were to be delivered from NT were specified in the contract (e g, codecs, A-D converters). The project plan was very detailed and thoroughly thought through. A joint reference group was established.

During 1977 and 1978, about ten Swedes, from the Televerket, were constantly in Palo Alto – not the same Swedes always, so there was a larger group that participated in the project both in California and in Sweden. They were needed to tell first-hand – written directives were not enough – about Swedish requirements, standards, and specifications, and they were there to acquire knowledge that should then be transplanted. Swedes were planning their stays in Palo Alto in accordance with tax

regulations, which meant that no one who was more than a visitor stayed less than half a year or much more than a year.

When the hardware was documented, all documentation had to be transferred to a new documentation standard. During 1977–78 production technology was transferred. Some test procedures were unchanged, but most of them had to be adapted, some only later, in Sweden.

It turned out that the share of the hardware that had to bcome uniquely "Swedish" was very large. By the spring of 1978, specifications for circuit boards were ready, and early production started.

While development work continued, now not least for software, field trials started (in the Uppsala "tele district"). It was a small exchange, 500 lines. It required not just handholding but even "artificial animation", and a couple of Californians had to spend Christmas there.

In the spring of 1979, another subscriber exchange was delivered. This was installed at the Televerket plant Teli in Nynäshamn, which meant that it was very close both to the producing divisions of the Televerket, and to its corporate headquarters as well.

Previously, production plants – such as the one in Nynäshamn – had been just that. Now, testing and other tasks required much more skilled people, and the need to recruit various experts to work permanently there emerged. This change has been judged "traumatic" – together with the intense requirements for retraining. One important conclusion was that from now on, production units must become much more autonomous, no longer just lines of machinery, controlled from somewhere else.

During the heyday of the project in Palo Alto, there were at times ten Swedes among 60–80 people. In 1981 the buildup had resulted in a staff of 200 at NT/Palo Alto Labs, and the *345* was no longer the dominating project.

The *345* had its share of hickups. It was conceived, initally and for a long time, as a stopgap only. Soon Ericsson and Televerket would come up to speed with another exchange, and the *345* was expected to be produced in a series of 30 to 50, representing perhaps 30 000 subscriber lines. Up til now (1989), however, 500 exchanges have been installed, representing some 0.5 million lines.

The reason for this deviation from "plans" is that it is a good product, and the product that was designed to substitute it, the MD 110/A 335 (MD 110 is the Ericsson denomination) was delayed.

But delays were something hampering the *345* development too. When the A 335 had been specified in 1976–77, and development had been going on for about a year, a consequent decision was flouted, "let us kill the 345 project, money is just pouring out". While the A 335 was more ambitious, more powerful – and expected to be ready by 1980...

So there were a number of fights internally, and Ericsson applied some pressure, asking valid questions about the value and ethics of thc longstanding collaboration and relations between itself and the Televerket. Still, the *345* project was kept alive, and if it had been delayed, the same happened to the A 335 too.

Some ten *345* exchanges were installed in 1979, and they were still problematic. But while the A 335 was still delayed – it would eventually reach the market between four and five years after the *345* – the *345* could be said to function impeccably from the end of 1980. (Actually, A 335 and *345* turned out to be rather complementary, the latter for larger switchboards, the former for smaller.)

Personal contacts are judged of prime importance in a project like this. The idea flow tended to stream in the reverse direction too; NT had never given a licence before, so they were in a learning process, totally "innocent as they were". By contrast, the Televerket was a very experienced licencee. One thing that they tought their supplier was better order in the documentation (NT had had half a dozen different subcomponent numbering systems at the same time!).

Case 2: Custom design integrated circuits

The semiconductor industry has two standard bearers when it comes to products: microprocessors and memory circuits.

The microprocessors have come into the spotlight because new generations of them herald new generations of microcomputers too. Two competing producers of microprocessors are supplying the main competitors in the field of microcomputers, Intel supplying IBM with consecutive central processors called 286, 386, and alike, Motorola catering for the 68 000 series and others, central to the Apple Macintosh. There are other producers as well: National Semiconductor, Texas Instruments, Zilog.

But what about the Japanese? Answer: they have become renowned, feared, and bashed for their low priced volume production of memory chips. Each new generation here is named for and marked by a multiple of two as much memory capacity: 16 kbit, 64 kbit, etc.

Apart from these volume products, however, there are other volume products, for the telecommunications industry, for example. And apart from all these volume products, there are specialized circuits, for special purposes – in computers, telecommunications, but also for inherently low volume applications such as space and defense.

The quality features of an integrated circuit are determined by its technology. By this we mean the basic design of the various components, from silicon substrate over different insulation methods, integrated into that substrate, to the creation of islands equally integrated into the substrate, and to the actual interconnecting of components and islands and electrodes on the surface of the substrate. The basic material is always silicon, but that basic material might be doped differently, making for different families, and the insulation might be oxide or nitride or perhaps etched grooves, making for further combinations, thus