GUIDELINES FOR AUTOMATION PROJECT EXECUTION

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2011
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OULU UNIVERSITY OF APPLIED SCIENCES ABSTRACT

Degree programme	Thesis	Number of pages + appendices
Mechanical and Production Engineering	Master's thesis	50 + 5
Line	Date	
Industrial Management	18 February 2011	
Commissioned by	Author	
Sarlin Oy Ab	Heidi Takkinen	

Thesis title
Guidelines for Automation Project Execution

Keywords
Automation, project execution, checklist

The purpose of this Master's thesis was to create instructions for executing an automation project. Sarlin Oy Ab needed directions on how to execute an automation project. Sarlin is starting up a new business area offering total project solutions for customers. Sarlin focuses on small and medium size automation projects on domestic markets.

The thesis represents issues related to project execution starting from the theory of the project to its kick-off and termination. Site work is one important chapter in this thesis. In the end there is an example of how a project customer could order from Sarlin and a description of how the example project could be implemented.

As a conclusion there is a checklist delivered where all significant points according to the automation project are listed. The checklist helps project group members to remember essential issues when participating in the project. As project business gets started, the checklist is meant to be supplemented. It is impossible to make the checklist fully covering as becoming projects are not known yet and Sarlin Oy AB has not executed a project based on the checklist.

PREFACE

The basic idea of this thesis came from my former supervisor Mr. Pasi Haravuori. We have been working together for several years. Since he received a new position as a Director in Automation Department at Sarlin Oy Ab, the need for this kind of thesis arose.

I would like to express my gratitude to him for the possibility and opportunity to make up this thesis and to get acquainted to Sarlin Oy Ab. I also like to show my appreciation to my instructor, Mr. Hannu Päätalo, Principal Lecturer, at Oulu University of Applied Sciences.

Special compliments go to my loving family and friends for helping, supporting and encouraging me in finalising my thesis.

Kempele 18 February 2011

Heidi Takkinen

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DICTIONARY

FAT	Factory Acceptance Test
OEM	Original Equipment Manufacturer
SAT	Site Acceptance Test

1 INTRODUCTION

Automation companies need to be efficient and very competitive because of the changing markets and technologies. It is a huge benefit to be able to specialise in and adapt to new situations by the knowhow of employees. As competition grows, it is wise to check new potential customers on foreign or domestic markets, to learn new technologies and applications or to complement old services with technical solutions. Customers desire for excellence and wider entities that fulfil the demands of quality, delivery time and cost. Huge investments are expensive and long-lasting, which means that many automation companies build up their business on maintenance or modernising their old systems. (3.)

1.1 Sarlin Oy Ab

The company, “Sarlin Oy Ab” (later Sarlin), is planning to increase their knowhow from selling individual automation products to offering complete automation project solutions.

Sarlin Group Oy Ab consists of independent companies which are shown below (Figure 2). This thesis concentrates only on Sarlin Oy Ab.

- Sarlin Oy Ab / Vantaa, Finland
- Sarlin Furnaces Oy Ab / Nurmijärvi, Finland
- Sarlin Furnaces AB / Västerås, Sweden
- Beamex Oy Ab / Pietarsaari, Finland
- Beamex Ltd / UK
- Beamex Inc. / Atlanta, USA (10)

In March 2010 there were 236 employees at Sarlin Group Oy Ab. At Sarlin Oy Ab there were 92 employees and in the automation department 13. The number

of employees in automation department will be increased up to 40 persons by the year 2015.

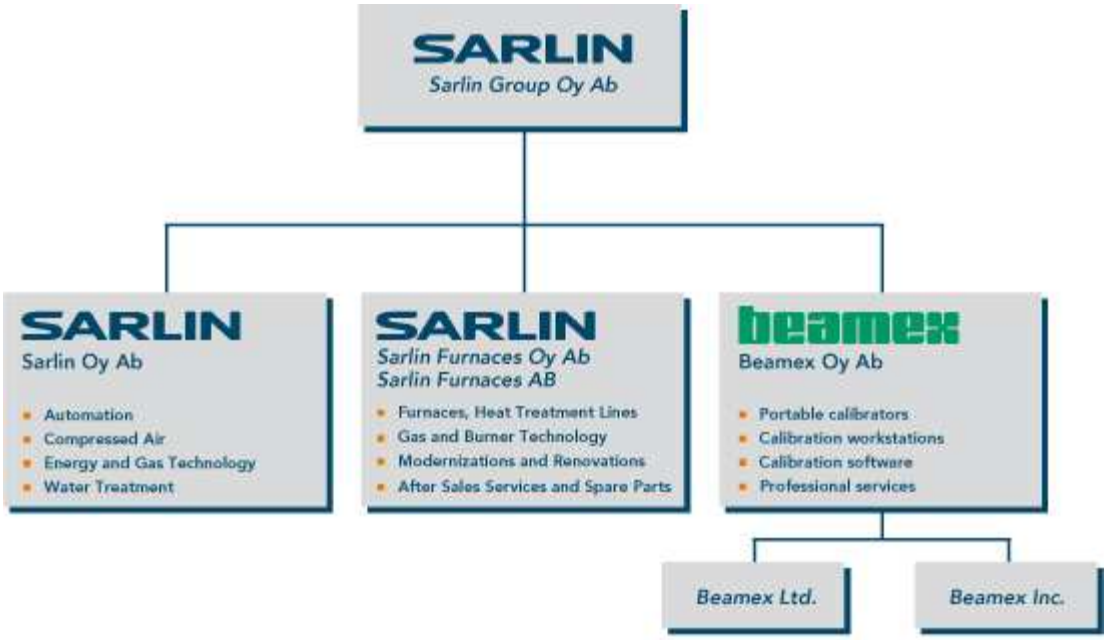

FIGURE 2. Sarlin Group Oy Ab (10).

1.2 Automation Projects Executed by Sarlin

Price, quality and reliability of deliveries are the common ways to compete on the market. Sarlin has chosen the easiness for the customer to be the way. They offer the customer the whole package: expertise, project engineering, procurement, installations, maintenance, products and systems. The customer only needs to contact one person to get the whole package. The employees of Sarlin need to understand customer's processes on a certain level to be able to offer them required services.

Sarlin focuses on small and medium size automation projects on domestic markets. It means 500-2000 hours of work including installations. At Sarlin selling projects is the task of becoming new automation organisation. The director of the automation department is responsible for it at the moment. The

whole personnel need to be capable of selling projects to customers, at least, on the level of ideas, what kind of projects to sell to what kind of customers. The sales department will assist with selling, if the idea is good enough for implementation. The project flowchart shows an example of a project Sarlin could execute (Figure 1). The structure of this thesis is based on the same flowchart.

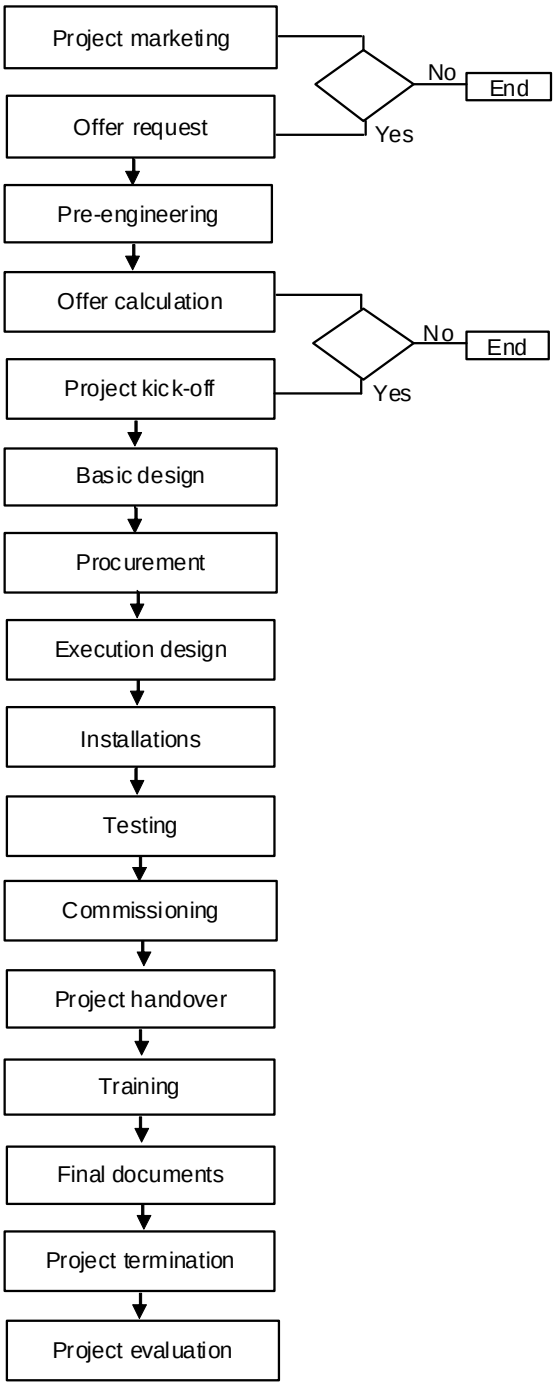

FIGURE 1. Example of project progress.

2 AUTOMATION SYSTEM LIFECYCLE

Project resources are performing the design tasks using different methods and tools. (13, p. 14.) Automation system lifecycle can be divided into phases and they can be defined shortly. (13, p. 16.)

Automation system requirements and functions are defined at *specification phase* for the specific design and execution. (13, p. 16.)

Customer defines the user requirements and makes the preliminary validation plan. In *preliminary design phase* the benefits and costs are evaluated for investment decision. (13, p. 16.)

During *basic design* the customer and the supplier describe the automation system functions for agreement, specific design and execution. (13, p. 16.)

The supplier defines the basic design material for system execution at *system design phase*. In addition to system and execution design, the supplier makes test plans. A milestone at this phase is the execution permission for a system or its part. (13, p. 16.)

The supplier manufactures, assembles and tests the automation system at *execution phase*. Approved FAT-tests (Factory Acceptance Tests) mean delivery permission, where the customer and the supplier are informed the system to be ready for transportation to the installation place. (13, p. 16.)

At *installation phase* the automation system with all its components and software are delivered and installed at the destination. System is tested and checked to make sure it fulfils the design descriptions and requirements. (13, p. 17.)

The supplier shows in *commissioning phase* that the installed system corresponds to the functional description and agreement. According to approved test results the system can be handed over to the customer. (13, p. 17.)

At *operation phase* the validated automation system is used for producing goods. (13, p. 17.) The automation system is purged at the end of its lifecycle.

3 CUSTOMERS

Sarlin is operating in both the private sector and the public sector. The customers want the whole project and the easiness along with it. Most customers do not have resources to commit to the projects, neither small nor large ones. This is why they want someone to do the project on their behalf or advise them how it should be done. (2.)

Sarlin Oy Ab has 650 customers of which 20 % makes 80 % of the contribution margin. The customers are divided into segments of metal industry, investigation and welfare, after-sales, energy, chemistry, forest, and food and beverages industries. (Figure 3). (2.)

The target project customers of Sarlin are small and middle-sized factories. The majority of Sarlin's customers (90 %) are OEM-clients (Original Equipment Manufacturer). It means the clients are manufacturing components for Sarlin to combine them. "An original equipment manufacturer, or OEM, manufactures products or components which are purchased by a company and which are retailed under the purchasing company's brand name. OEM refers to the company that originally manufactured the product. OEM may also refer to a company or a manufacturer which supplies to another manufacture or company for use in the components of their own products."(5) Rest 20 % of Sarlin customers are end-users.

Sarlin offers four different types of product packages;

- device deliveries to OEM-client, final customer or retailer
- total deliveries to OEM-client, final customer or retailer
- service sales that can be total delivery, sourcing or installation services
- consulting which is selling knowhow or training services

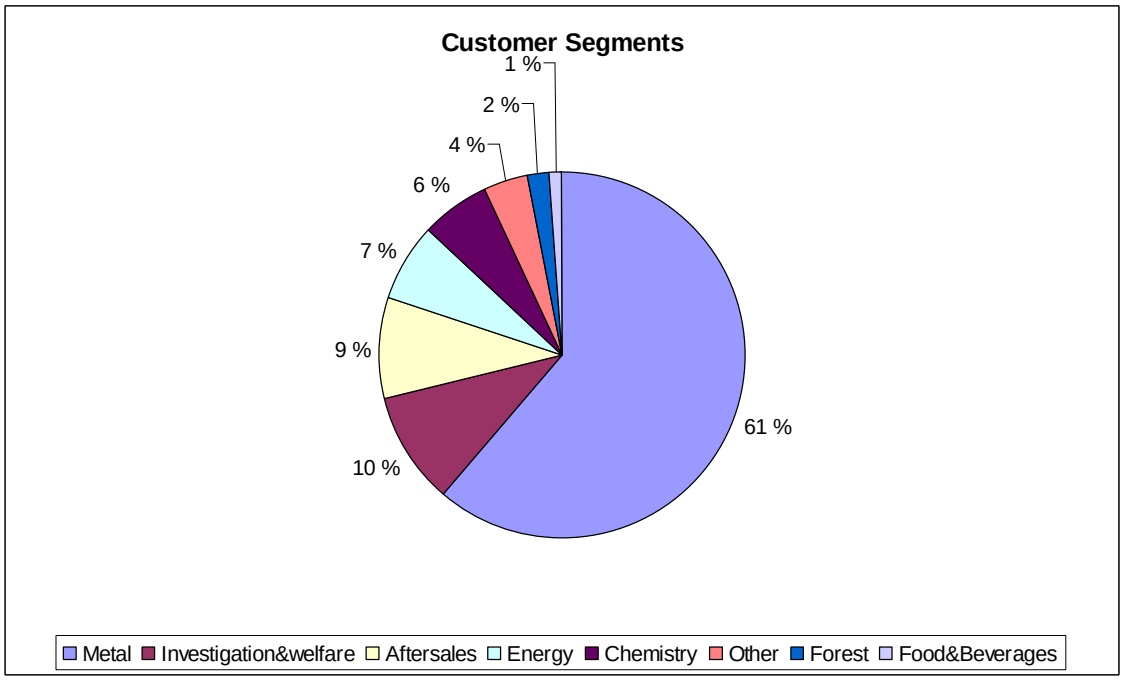

FIGURE 3. Customer segments in different industries.

3.1 Customer Segments

The metal Industry made 61 % of the sales in 2009. It is still going to be the number one segment in the future.

Chemistry had 6 % of the sales. It will be growing and is a very important segment. The future of chemistry industry may lie in biomaterials. VTT, forest companies and petro chemistry are investigating different possibilities and would be very important partners. The research is done in Finland and the execution elsewhere.

The food and beverages industries, like bakeries, had small deals for 1% of the sales in 2009. Hand-made bakery products are becoming more rare due to the increased automation level in bakeries. Hygienic regulations must be taken into account when automated processes are designed for the food and beverage industry.

Maintenance reliability in the energy, water and waste industry covered 7 % of the customers. This includes small district heating plants in sizes 500 kW to 30 MW. 500 kW could represent for example an industrial estate and 30 MW could be heating up the whole residential area. There could be several district heating plants that are controlled from a centralised control room. Sarlin Oy Ab plans to take care of their process automation devices and the remote use of a process.

The forest industry covered 2 % of the customers. The pulp and paper industries in Finland are in crisis at the moment. The forest industry is sufficient although it is on a breaking point. Researchers are focusing on how to utilise forests in the future. The traditional forest industry is turning to the chemical industry. One example is producing diesel from pine tree. The forest industry is growing more than ever.

Investigation and welfare covered 10% of the customers, which are schools, universities, hospitals, culture technology and institutes, eg. VTT, the Technical Research Centre of Finland.

After-sales had 9% of the sales. It actually means spare part sales for devices bought by customers earlier.

4 SUPPLIERS AND SUBCONTRACTORS

4.1 Suppliers

Suppliers' business is to provide goods or services for vendors in return for the agreed compensation. Suppliers do not normally interact with consumers directly but vendors do. Suppliers may provide volume discounts for vendors when they sign long-term contracts or place orders for large quantities. (14.)

4.2 Subcontractors

A subcontractor is a person or a company hired by a general contractor to do part of the work, e.g., to install electrical systems needed in a construction job. Generally the subcontractor is able to do work at a lower expense or at a greater skill level than the general contractor could do. (16.)

5 PROJECT

A project is an entity of tasks where the goals are clearly defined and scheduled. A project organisation is responsible for project execution with the help of resources defined beforehand. (12, p. 21.) A project is done once and has limited duration. It has its own organisation and there is external financing involved. (12, p. 21.)

5.1 Feasibility Study

A feasibility study clarifies if a project idea is rational. Based on the study, a business unit director or a sales manager decides if the idea is taken forward. A project manager will be chosen and nominated if a project is carried out.

5.2 Project Organisation

The structure of a project organisation is usually lighter in the beginning, wider when the project goes on, and it becomes lighter when heading towards the end. A project organisation usually has an executive board, a project manager and a project secretary. (7, p. 126-127.) One person alone can also form a project, where he/she performs all the tasks. The project organisation takes care of work distribution and personnel training. It also makes the agreements of different areas.

5.3 Project Manager

The project manager is responsible for project execution. He/she is responsible for the design and the budget, and that the project schedule follows the project plan. The project manager shares the tasks and follows that the project and

sub-projects are done on schedule. He/she also takes care of briefing, sharing information as well as keeping and updating the data. He/she prepares weekly follow-up meetings with the project group. Documentation and archiving are also on the project manager's responsibility. After the project is terminated he/she writes the final report and finishes the project.

5.4 Project Plan

A project plan is made based on decision making and project execution. The objectives of the project plan are the control of the resources and their efficient use. Schedules and cost estimates are kept. The project can be executed after the project plan has been approved. Written agreements are made concerning roles, tasks and resourcing.

5.5 Project Agreement

The purpose of a project agreement is to ensure the project execution and desired results. Project requirements and due to that workloads and schedules can change during the project but the project agreement is signed and bound before the project even starts. A well made agreement can help project execution, even if goals are changed. This means that project scope, workload and schedule changes are taken into consideration by writing down the possibility to update the contents of the agreement or by agreeing beforehand the exceeding amount of work and charging it. The project progress is usually described in the project plan (attached to the project agreement). (11, p. 11).

The project agreement defines all significant issues of a project such as project scope, responsibilities, rights, risks, schedules and price. The responsibilities of the customer and the supplier are bound by a project agreement. The project agreement is agreed by signatures of the both parties. The agreement needs to be so unambiguous that both parties understand their duties and

responsibilities. Sanctions can be agreed upon in case of breach of the contract. (1, p. 89).

The project agreement may include parts of how payments shall be made based on the project progress, e.g.:

- Agreement signed 10 %
- Design completed 30 %
- Installations done 20 %
- Tests executed 10 %
- Commissioning approved 10 %
- As-built drawings delivered 10 %
- Warranty of guarantee 10 %.

The unclear issues which are not agreed upon in the project agreement can be solved according to NLM 10, “The general terms and conditions for supplying equipment within and between the Nordic countries” (4). It is possible that payment arrangements are not agreed upon in the project agreement. In that case NLM 10 is taken in use and payments shall be executed as described in chapters 24-27.

5.6 Project Phasing

A project is usually phased in a chronological order. The purpose of project phasing is to divide a project into clear entities and sub-projects. Those entities can be independently designed and implemented. There is an example of an investment project in figure 3. The phases are partly overlapping. At the end of each phase a clear measurable result is presented. The result can be a research, definition, prototype, etc. (2, p. 190.)

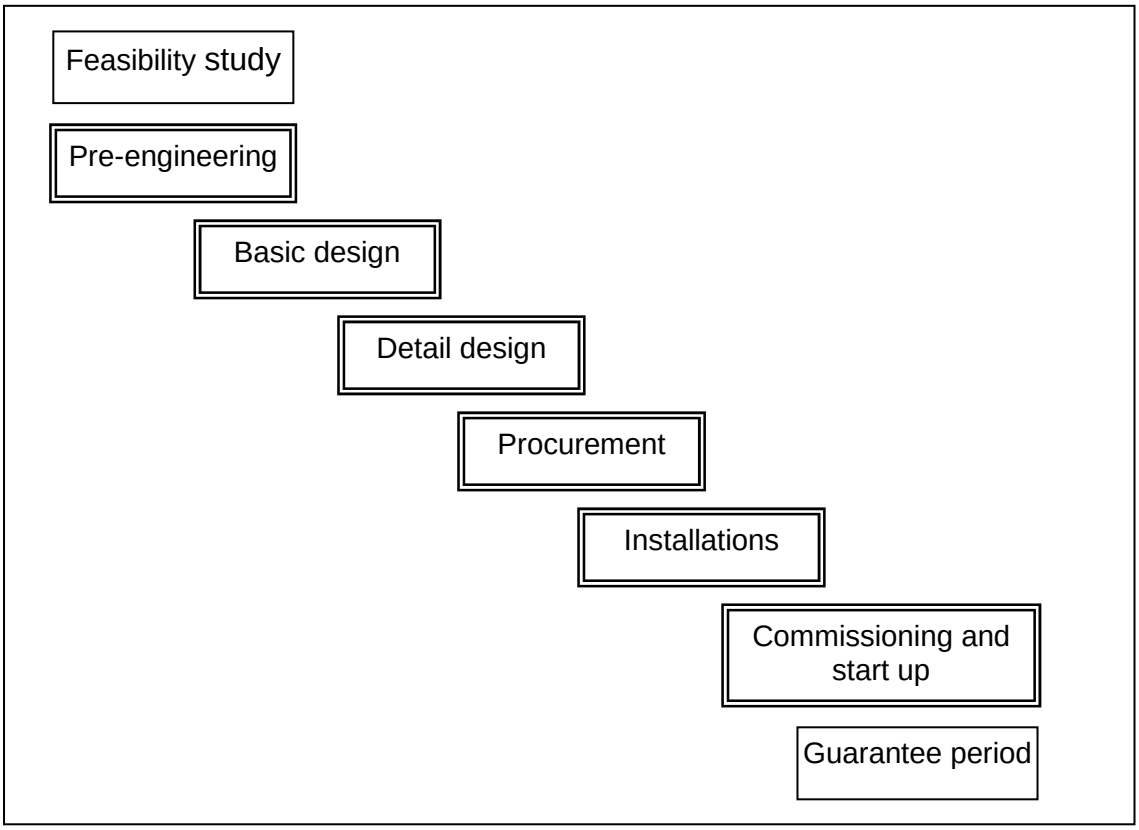

FIGURE 3. Investment project phases (6, p. 103).

5.7 Project Execution and Control

Project execution includes project task execution phase by phase according to the project plan. Control and supervision also belong to the project execution. Design and project meetings are important, because the progress of the project in addition to tasks and budget execution are discussed. Existing problems are processed and solved in those meetings in co-operation of other project members and specialists.

5.8 Documentation

Administrative documents of the project are saved in the project folder, which can be on the server. The project manager is responsible for establishing and upkeeping the project folder. (13.)

6 PROJECT MARKETING AND SELLING

Project marketing and selling differs from other means of marketing in many ways. Project marketing and selling can be characterised as a strong change and discontinuity as to demands, uniqueness and complexity of the projects. One customer may need only one project. One specific marketing segment may be addressed to only one interested customer. That makes developing customer relationships and sustaining them challenging. (1, p. 53.)

Every project is unique at least in some part. Because of that the project supplier should utilise the good solutions created in previous projects. This helps meeting the needs of the customer of the new project. During project marketing and sales the customer needs are found out. The purpose is to produce a project offer and an agreement, where the project is an independent entity from the customer’s point of view. At the same time it is a profitable and interesting business source from the project supplier’s viewpoint. (1, p. 53.)

7 CHANNELS FOR FINDING PROJECTS

Taking care of customer relationship, from the business point of view, is even more important in the beginning and at the end of a project than during execution. The most significant asset of customer relationship arises when there is hardly any work needed when new projects or services are sold to the same customer. (1, p. 395.) If the relationship satisfies the both parties, the customer most likely uses the same supplier in several projects and shares good experiences with other potential customers. (1, p. 396.)

Co-operation with subcontractors may affect projects and business by the publicity it brings. New project opportunities and information may be found through the subcontractor. (1, p. 399.)

Advertisements on television, in newspapers and commercial publications may help to get new customers and projects. Exhibition stands bring people to get acquainted to your company. It is a convenient place to introduce them your company and the services it offers.

Contacts gained during previous jobs may be worth one's weight in gold. Contacting them and telling about the solutions and services your company offers may lead to a project.

8 PRELIMINARY DESIGN

In the preliminary (pre-) designing phase it is ensured that the product can be manufactured and delivered to the customer in time according to the request of quotation (9). The most important initial data and requirements are usually coming up in the pre-design phase in which information is produced for investment decision. (13, p. 20.) The design department creates the required drawings, cost calculation basis and rough scheduling. With these documents and information the sales engineer is able to make an offer. (9.) Pre-design data must include the possibilities to execute the project, risks, security issues and instruction of how to control them. A preliminary estimate of costs is also included in the pre-designing plan. There are no common instructions or models for the pre-design phase. (13, p. 20.)

9 OFFER CALCULATION

To be able to calculate project costs, some principles need to be taken into consideration. One must estimate how many hours of work are required in each phase of the project and how many people each phase requires. The following issues also affect the project price:

- budget
- personnel needed (internal and external)
- machinery and devices
- materials
- schedules and deadlines
- travelling
- management
- sales and marketing
- general expenses
- profit
- other resources (6, p. 152.)

Cost estimates are the basics of project profitability. Cost estimates need to be made with an adequate accuracy. (6, p. 174.) They can be divided into preliminary cost estimate, basic cost estimate and final cost estimate. The accuracy level of the preliminary cost estimate can vary between -20 % - +40 %. It is made rather quickly and with a small experienced specialist group. (6, p. 175.)

The basic cost estimate is calculated with actual prices and charges of the day. Taxes and other expenses are separated. Information of previous corresponding deliveries can be taken as the initiative of the basic cost estimate. (6, p. 175.)

The final cost estimate is made when the design is almost complete. Most of the equipment is ordered and important installation agreements are signed. The accuracy shall be 3-8 %. (6, p. 175.)

When a total delivery is sold, the cost estimate needs to be divided into clear entities such as:

- Wages
    - design
    - test
    - installation
- Material costs
    - tools and devices
    - automation system
    - test equipment

10 BASIC DESIGN

The basic design continues when the pre-design is complete. The targets are to produce precise functional specifications and system execution principles. The pre-design of the project is considered from the customer's point of view. On the other hand the basic design is explored from the automation designer's viewpoint. (13, p. 20.)

11 PROCUREMENT

After investment decision is made, it is important to order some devices immediately because of the long delivery time. (13, p. 23.) Suppliers are chosen according to quality, price and ability to deliver. Usually the efficient lifetime of the final product is quite long. In addition to the procurement price, annual maintenance costs, software support and development costs must be taken into consideration. The same thing is valid when the offers of system suppliers are compared. The cheapest procurement price may not be the cheapest one when maintenance costs are added to the life cycle of the product. (7, p. 186.)

12 LABOUR

The project organisation is disposable. Organisation delegates defined tasks for the project organisation to perform. The project is responsible for carrying out the tasks with the resources available. The project organisation is demolished when the mission is completed. The size of a project organisation can vary depending on the project phase. (7, p. 21.)

A project group consists of specialists, who are responsible for their own special areas. The project manager is their supervisor. (7, p. 21.) The project should have the most competent people to perform each task. They should possess team work skills and their motivation should be at the right level. (7, p. 47.)

13 DATA MANAGEMENT AND COMMUNICATION

Designing means producing new information based on existing initial data and data given by others. A remarkable part of design work is gaining data, adopting old solutions and co-operation with other designers. Producing new innovative solutions has become rare. Design functions have become global, which makes it challenging. Companies may have many offices around the country or even around the world. Data management is a significant element in design function and needs to be supported in the best possible ways. (13, p. 25.)

Traditionally communication is based on changing documents. Parties have different customs and policies for data management. The documents need to be edited to fulfil the needs of other parties. This is very time consuming work. Issues concerning project execution are shared in the minutes of a meeting and in agreements. A huge amount of information is shared in meetings, corridors and phone conversations and also via emails and text messages, in addition to official data and documents. Note boards, telephone, web and video negotiations are also used. Usually informal information is not saved in the data management system and disappears when designing goes on. (13, p. 25.)

During the project lifecycle communication is emphasised in different situations. The following chapters include topics handled in different phases of the project. (6.)

13.1 Kick-off

The contact persons on the customer’s side and project group specialists participate in the kick-off meeting. The kick-off meeting is a great place to share opinions and expectations concerning the project and to discuss about the following issues:

- Project scope

- Responsibilities and project organisation
- Project plan
- Instructions, standards and methods
- Communication and meetings (6, p. 297.)

The kick-off meeting could be ended with a social evening, where project participants would have an opportunity to get acquainted with each other (13, p. 97-98.)

13.2 Project Execution

Weekly meetings with the project group are important to have the project situation updated. The project manager has an essential role as an information sharer. All the information may not be relevant to the project group, but it increases the motivation to have a good view of the project as a whole. The project manager informs the project group about changes in the project plan and organisation, forthcoming inspections and approvals among many other vital issues. (6, p. 294, 297.)

Technical solutions and project handling issues are discussed during the project execution. The customer and the supplier have meetings in which technical and commercial entities can ne involved. That is why one must know exactly what has been agreed upon and one must be alert all the time. The project agreement must be known well to avoid the risk of extra costs.

13.3 End of Project

At the end of the project the following issues are handled:

- Project results
- Practical arrangements
- Final report
- Documentation and archiving

- Project after-sales service. (6, p. 297.)

14 MATERIALS

Many times technical selections are forced to be done in early stages. This means the general alignments such as the selection between the field bus and traditional cabling and choosing the components and the equipment used. During the pre-design phase the customer may require specific technology because of the earlier good experiences. The customer may even want a certain supplier because of the availability of spare parts. The designer's knowhow and experience also affect technical choices. (13, p. 23.)

Based on what is written above, the designer generates the technical execution description of the system. It means the parts and connections of equipment and software, factory layout, etc. (13, p. 19-20.)

The design basis of instrumentation is to control the whole plant from a central control room. Machinery and equipment located off-site are also operated and monitored from the central control room. Local operating cabinets and panels may be used if local control is necessary. The instrument cabinets and panels need to have at least 20 % enlargement capacity for future extension.

High quality industrial instruments should be used. All field instruments need to be moisture and dust-proof. The protection class of the field instruments is decided according to customer demands and regulations. In their installation, easy accessibility for calibration and maintenance under normal operating conditions must be taken into account and they must not be exposed to excessive heat and vibration.

15 PROJECT EXECUTION AT SITE

Each project has a person who is responsible for the material arriving to the site. He/she receives and signs for the incoming material and also shows where it shall be stored. All the material taken off the warehouse shall be marked in the list and reduced from the material list. The material shall have numeric codes and bar codes for traceability.

The customer takes care of installation supervision. He/she can hire the third party representative to do the job on their behalf. The customer is responsible for acquiring the works passes for their employees and contractors. Safety at site is the customer’s duty in addition to giving proper protection equipment to contractors. Project members working at the site during installations usually have their protection equipment provided by their employer.

It needs to be agreed upon in the project agreement whether the customer offers the employees and contractors social premises and dining possibility. The power supply, water and pneumatic posts required for installations are delivered by the customer.

16 LOGISTICS

Logistics is the delivery of required goods, at required place, at required time, in required state and to the person required (15.)

Supply chain parties need to co-operate efficiently to get the right information in the right form at the right time. The delivery notice must arrive before the actual goods. Supply chain parties have different kinds of views for the same delivery process, which is the biggest challenge. The information produced should be in line, simple and automatically transferrable between the different parties. (8.)

Sarlin has three different types of logistics (Figure 4);

- Sarlin orders products from manufacturer for customers' use (green arrows).
- Sarlin delivers products customer ordered from Sarlin's warehouse. Some of them are spare parts (red arrows).
- Sarlin orders special products (non-warehouse products) for specific project (blue arrows).

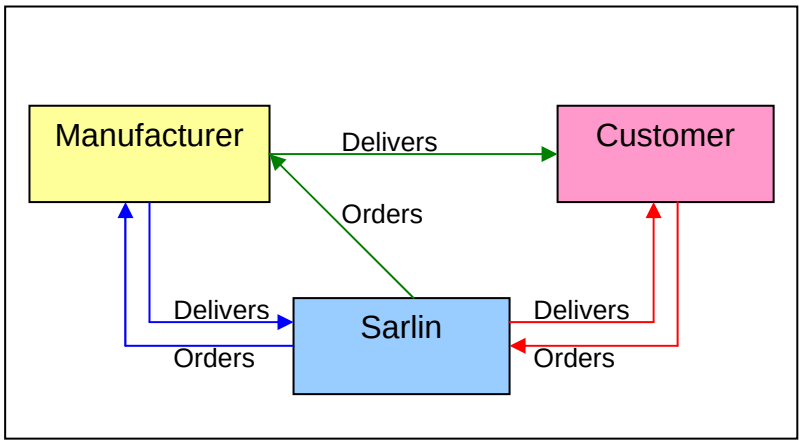

FIGURE 4. Logistics of Sarlin.

17 TESTING

Test phases are normally performed before commissioning. Definition and design outputs need to be tested before the next phase begins. It can be executed by comment rounds, cross-checks or test sessions in which several specialists participate. (7, p. 244.)

The test procedure needs to be planned and prepared with care because fixing design mistakes is the more expensive the later they are found and corrected. Any changes needed to be made during the design phase usually have reflection to the other parts of the project. Design portions should be performed in logical entities but preferably in small parts. In small projects design parts are tested by one person. It is possible to perform execution phase and final product tests faster and more fluently, if the previous phases are tested and checked properly. (7, p. 244-245.) Approved test results may be a driver for the project executer to invoice the customer.

Factory Acceptance Test (FAT) ensures that the system is working as designed. The system shall be thoroughly checked and the functioning shall be verified before delivery. Testing shall be carried out in co-operation with the supplier and the purchaser's representatives. It is convenient to perform Factory Acceptance Test in the supplier’s premises, where sufficient personnel and equipment are available rapidly if any changes for connections need to be made.

When the system has been installed at the site, the system is “cold tested”. In this case it means that all internal connections of the system and the functionality of the system are checked by using a few sample loops. The loops are connected to the process stations. This is done in co-operation with the purchaser. The remaining process connections are carried out by the purchaser before pre-commissioning of the plant. The purchaser also performs the cold

testing of the process I/O connections and the tuning of the control loops. The supplier’s presence is not necessary in this stage.

It is essential for the users and the maintenance people to participate in the functional testing. In accordance with the functional test the instruction manual is composed. (13, p. 24.)

18 COMMISSIONING AND HANDOVER

The commissioning stage is usually at the end of the project. From the executer's point of view it can be called a handover and during that time the customer receives the project. The distribution of liabilities (who does what in what kind of circumstances) regarding commissioning is mentioned in the project agreement. The project supplier usually participates in and supports the commissioning stage and the usage at the start. The actual productive use starts after the commissioning phase and the responsibility is transferred from the project to the customer. (1, p. 346.)

The customer is co-operating with the project group and the users to ensure the product or service ordered fulfils the project agreement. All the features and functions are checked systematically to make sure the execution has been done according to specifications. Handover minutes are composed according to the acceptance-test, where all the flaws and faults are listed. A list of corrective actions is done with the person responsible. (7, p. 266.)

A test-run of two months at the minimum is recommended when all the parts of the final product are used under production circumstances. Existing faults are fixed by the named person of the project, who spends, for example, a day a week for the old project tasks. The final approval is done after the failure-free session. (7, p. 266-267.)

In commercial projects it can be agreed that, for example, the last five percent of the purchase price is paid after the approved test-run. Approval procedure and criteria need to be defined precisely in the beginning of a project in the project agreement to avoid misunderstandings. Extra tasks which are not included in the agreement affect the schedule and decrease the supplier's contribution margin. New ideas that come up after the project is finished are

listed to an improvement target list. The list is handled in a final meeting where further actions are agreed upon. (7, p. 267.)

19 TRAINING

Training can be divided into three different categories: operator, engineering (configuration) and maintenance training. The operator training gives the operating personnel the ability to use the system in its full extent. The engineering training gives the design engineers capability to make modifications and additions to the configuration. The maintenance training advises maintenance personnel to trace and identify faults. Every part of training is with a written form and training is given in a required language.

20 GUARANTEE

Commercial projects usually include a guarantee time e.g. one year, and during that time the supplier is responsible for the correction of its mistakes free of charge. (7, p. 267). The guarantee time ensures that performance and usability of the product fulfils the project requirements. It also certifies that the project supplier does his/her share of the project. (6, p. 247.)

There are two types of guarantees; full guarantee or limited guarantee. The full guarantee covers fixing all mistakes and problems with no charge. The limited guarantee only covers the issues that have been predetermined to be under guarantee. The extent and duration of the guarantee in addition to the distribution of responsibilities are an important part of the project agreement. (6, p. 247.)

The guarantee period can vary from a few months to several years. Devices have a guarantee of minimum 12 months up to five years. The guarantee period can be replaced by, e.g., first year extensive maintenance agreement with no charge. (6, p. 247.)

21 PROJECT TERMINATION

A project is always a learning process. There are no two similar projects. All project experiences are valuable and they should be documented accordingly for future project needs. Project participants learn new issues and strengthen their knowhow which should be transferred for the use of the whole organisation. (7, p. 271-272.)

Project is over when all defined tasks have been executed. The project manager writes a short memo about it. It informs what and why, to whom was done and what happens next. It also shows who are responsible for final product maintenance, technical support and further development. (7, p. 268.)

Problems and improvement proposals are brought up in the final report. The final report is a summary from the completed project for the next ones. The report highlights what was learnt, what worked well and what should be done differently next time. The final report is written by the project manager right after the project is finished. Commonly it is seen as an extra task, but it is valuable for the development of the organisation. Final report should be written as its own and included in a project plan. There should be enough time to write a detailed report. In the final report the goals set in the beginning are compared to outcomes and the project is evaluated as a whole. (7, p. 271-272.)

The final report and the memo about the project execution are archived into the project folder. The project is terminated during the final meeting where the whole project and its results are evaluated, the final report and the actualised cost estimate are approved. Actions in the future are also discussed in the meeting. (16.)

When the project is finalised, the project manager should invite all the project participants over for a closing ceremony. It is time for boasting each other,

remembering happenings during the project and learning from the success. (7, p. 271.)

22 PROJECT EVALUATION

It is not so simple to define and evaluate a project successfully as one may assume. Projects have several different goals such as

- goals in contents and quality
- executive goals
- financial goals
- schedule goals (7, p. 274.)

The priority of goals mentioned above varies depending on whose point of view the results are seen. The schedule and the cost are the most important issues for the customer. Users are interested in final results and their features. Technical solutions mean a lot to the project group. The project is successful when the set goals are achieved according to the schedule and costs agreed upon. The results and success of the project need also be evaluated with the project plan. (7, p. 274-275.)

Success has an alternative, project can also fail. The project failure means that the project expectations are not fulfilled. As mentioned above, different people value different issues. The order of the most important criteria in the project execution varies depending on the people involved in it. The result looks like in Figure 5. (7, p. 281.) The opposite expectations can affect the same result to be both successful and a failure. (7, p. 279.) The project can be successful in one area and fail in another. (7, p. 282.) Usually a project failure is caused by incompetent project control and inappropriate methods. (7, p. 285.)

Priority	Customer	User	Project
1	budget	quality	schedule
2	schedule	schedule	quality
3	quality	budget	budget

FIGURE 5. Expectations towards project.

23 EXAMPLE OF PROJECT

One example of what kind of project Sarlin could execute for a customer is shown below. There can be several different kinds of projects, but they are not handled in this thesis.

A comprehensive solution of measuring oil and gas flow will be designed for a Finnish burner equipment manufacturer. The customer gives the maximum size of the installation and XYZ-coordinates of the flanges of inlet and outlet pipes. A flow measurement system is composed to the customer. The installation includes piping with its support, flanges, gaskets, control and relief valves, flow indicator, heating, pressure and differential pressure measurements and monitors to represent the measurement information. In addition I/O is needed to gather the information and communication to the burner and house control systems. Duplicate piping gives challenge to the project. There is burning gas or oil in the inner pipe and nitrogen in the interspaces of the pipes.

The customer sends Sarlin a request for quotation and Sarlin decides to make an offer. The customer approves the offer and the project can be kicked off. (Appendix 1/2.) One of the first tasks is to visit the plant to get acquainted with it. Seeing sizes and scales in reality makes designing easier. The design work of piping and control system should begin as soon as possible.

The customer and Sarlin sign the project agreement (Appendix 1/2) where details of project execution are agreed:

- What and when to be done
- Social premises at site
- Locked storage for tools and other equipment
- Water, electricity, compressed air, etc.
- Material orders, delivery times → schedules
- Resources: designers and project manager

Site work (Appendix 1/4) may begin when the design work is complete. Materials arriving to the site need to be controlled and forwarded to the right place at the right time. Project members contact the customer to be able to operate at the site and contractors can start the installations.

The project termination is getting closer. Required tests and commissioning are performed and approved. The minutes of them are signed. As-built drawings and other final documents are delivered to the customer (Appendix 1/5). Project can be terminated and the customer will be invoiced.

This kind of project requires special knowhow of piping. The use of a subcontractor may be necessary if Sarlin does not have adequate piping expertise. Sarlin needs to be very precise and careful when selecting a suitable subcontractor (Appendix 1/3).

The authorities may require certificates and documents regarding gases, electricity and safety. It may have an affect on schedules and has to be agreed upon with the project manager. Sarlin is responsible for delivering the required documents. After the project is handed over to the customer, final calculations are done to check whether the project was successful or not. Furthermore the experiences of the project group are shared (Appendix 1/5).

24 SUMMARY

The purpose of this Master's thesis was to create guidelines for automation project execution. The company is about to start a new way of business; offering customers total project solutions. A created checklist gives the company a basis how to execute a project.

The progress of this writing process was more or less time consuming. The commissioner of the thesis was very busy with his daily work so the comment rounds took quite a long time. The thesis was implemented by remote work which was demanding. Uncertainty of what kind of upcoming projects would be made the work challenging. The theory is based on project literature and practices from the earlier work experience in different projects.

The checklist was done several times to find out the most satisfying and appealing result. It is impossible to create a fully covering list because every project is unique. The appearance of the latest version was explicit enough to follow. Checklist users at Sarlin will complete it as soon as their project operations take place and they see which parts are essential and which are less needed.

APPENDICES

Appendix 1. Checklist for automation project execution.

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