



TALLINN UNIVERSITY OF TECHNOLOGY
SCHOOL OF ENGINEERING
Department of Mechanical and Industrial Engineering

**IMPLEMENTATION OF THE ENTERPRISE RESOURCE
PLANNING SYSTEM ON THE EXAMPLE OF LIGHTMAKER
OÜ
ÄRIJUHTIMISTARKVARA JUURUTAMINE ETTEVÕTTE
LIGHTMAKER OÜ NÄITEL**

MASTER THESIS

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Tallinn 2023

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THESIS TASK

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(in English) *Analyze different ERP systems, standardize product portfolio to implement ERP in the company Lightmaker OÜ*

(in Estonian) Analüüsida erinevaid ärijuhtimistarkvarasid, standardiseerida tooteportfell ERP juurutuseks ettevõttes Lightmaker OÜ

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2. Research different implementation methods
3. Standardization of products portfolio for ERP configurator integration
4. Optimization of production processes LEAN

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PREFACE

Companies start up small with one or two people and grow over time, some companies grow fast and some slow but all of them have one thing in common. At some point excels and spread sheets just are not sufficient anymore to deal with the data management, order intake, production material needs, employees, and the overall cost of production calculations. If the company reaches the point where the systems that are used to run the system are just not enough, they have to make the decision if they would like to stay at that point where they are or do they want to grow on.

This thesis was initiated by the management board of Lightmaker OÜ and Juhan Terasmaa who is a member of the management board of Lightmaker OÜ and responsible for all operations of the factory. Lightmaker OÜ needs a system to manage all operations of the company to sustain the current growth strategy by 2025.

The author would like to thank Rocksoft OÜ for all the advice and mentoring.

Keywords: ERP implementation, product-, and production standardization,

List of abbreviations and symbols

ERP	Enterprise Resource planning
MDM	Master data management
WIP	Work in progress
PMS	Production monitoring system
CNC	Computer Numerical Control
MIG	Metal Inert Gas
MAG	Metal Active gas
TIG	Tungsten inert gas
BOM	Bill of materials
MRP	Material resource planning
SAP	System, Applications & product in data processing
FIFO	First in first out
ROI	Return on Investment
IRR	Internal rate of return
OEE	Overall Equipment Effectiveness
TCO	Total cost of ownership
CBOM	Configurable bill of materials
ALM	Application lifecycle management
UAT	User acceptance testing

INTRODUCTION

Lightmaker OÜ is a company that was created by two engineers back in 2016. The main products are all types of light signs like front lit letters, lightboxes, flag signs, acrylic boxes and special products for art shows and exhibitions. At the beginning of the company the main customers have been North-Europe Sign companies who don't have production inhouse and they outsource the production from cheaper countries. There are about thirty distinct types of profiles that are used for light signs. The company began in a small shed then moved to a larger garage and from there to their first production plant. In 2020 the factory moved to a new building as the old one could not sustain growth because of lack of space. As the company has developed rapidly through the years from 2 employees and turnover 10K€ (quarter) to twenty-seven employees and turnover over 600K€ (quarterly). The company has strong customers base and has grown naturally about 30% every year. The factory's production processes include CNC milling, MIG/MAG/TIG welding, cutting, bending, grinding/polishing, drilling, and general assembly of the products. As the company has grown from a few employees to over twenty the systems that support the company's management have reached their capacity, now they are covered by google sheets, Pipedrive and Merit. The company's revenue has grown year by year, but EBITA dropped from 20% to 3% last year and it is not sustainable if the company wants to be managed profitably and continue growing. At the moment there is no clear understanding of how much the products cost or what the factories' capacity to produce the orders and what resources are needed to produce them.

The aim of this thesis is to research different ERP systems to better support all processes of the company: sales, sourcing, design, production, quality management, inventory, cost calculations and accounting. Analyze current production processes to find bottlenecks and create a new pricing model for old and new products. Standardization of current product portfolio for ERP implementation and cost model. Choose and implement the ERP system and take the companies to the next level to sustain natural growth and increase profitability for the owners and have the means to invest in new markets and production equipment.

1 Overview of Lightmaker OÜ strategy

Defining why an organization takes new steps and to understand why a company needs to adapt an ERP system first needs the organization to define their strategy and what do they want to achieve. Growing competition in the market and new technologies force us to change and constantly go where they have not gone before. Seek new business opportunities and markets that in the beginning may not have seemed reachable. To account for the increase in production volume and complexity of new products, new systems have to be adopted to support the company. You can run a organization on excel sheets to some point but after the quantities of orders and materials overwhelm those systems you will lose a clear sight on how the organization really is doing. What products are profitable, what are not and what products should be created and what scrapped. To understand the mission and vision statements first need to be explained two different types of business. One is end sales to customers and second is contract manufacturing to other sign companies, they are two completely different business models and this is why we have different mission and vision statements for them.

Lightmaker OÜ sales and project management strategy:

Mission statement: We create modern solutions for the transmission of visual graphic information.

Vision statement: We help businesses to be visible and found. We help our customers find the best solution for their needs and we do it better than anybody else.

Strategic goals 2023-2025:

Increase net sales from 1 million euros to 3 million euros. Net EBITA min 20%

Lightmaker OÜ Factor strategy:

Mission statement: We contractually undertake the production of advertising signs.

Mission statement: We enable modern advertising companies to focus on serving their own clients by working closely with them.

STRATEGIC GOALS 2023-2025:

Increase net sales from 2,5 million euros to 5 million euros. Net EBITA min 10%

To bring this strategy to life the board members decided in 2022 that Lightmaker OÜ has to adopt an ERP system to sustain natural growth and expand.

2 Overview of Enterprise Resource Planning systems

In the beginning there were MRP Material requirements planning the first system was in 1960 at J.I technologies' a manufacturer of tractors and construction machinery. They worked with IBM to develop the first MRP system. After the first one was launched many large companies started developing their own MRP solutions because they saw that there was no possible way to manage the companies with the systems they had used before.

While they were expensive to create, required a team of experts to maintain and took up a lot of space, early MRP systems enabled businesses to track inventory and production. That helped manufacturers manage raw materials procurement and delivery of product to the factory so they could better plan production runs [1]. MRP systems gained traction in the 170s but remained limited to large companies that had the resources and budget for the in-house development because in needed a large team to update and run the system. Eventually large software companies were created like SAP 1972, Oracle 1977, Microsoft Dynamics 2003, Monitor 1974, Sage, Infor 2002, Syspro 1978, Odoo 2005, Katana 2017.

There is a very large variety of different ERPs in the market, choosing the right ERP for your business is critical and maybe one of the most important decisions a business can take.

Some of the criteria's when choosing an ERP system:

- ERP features: Production, Finance, Warehouse, FIFO, Service,
- Business requirements: What you need the ERP to do for you is your company retail, finance, production orientated.
- Implementation: ERP implementation can take anywhere from one month to more than a year depending on whether the system is deployed on-premises, in the cloud or in a hybrid combination
- Support and training: The ERP system will require support for initial implementation, ongoing daily operations, and employee training.
- Vendor industry expertise: long with evaluating the ERP software, it's a good idea to evaluate ERP vendors for their expertise in your industry.

- Technology: Advanced technologies continue to emerge and elevate many of the benefits an ERP system can provide.
- Customization: The need to customize will depend on the complexities of your business processes — and even if you don't need it at the time of ERP selection, it may become important as the business grows

2.1 Brief history of SAP

On April 1, 1972, five former IBM employees started the company in Germany. The Company was named SystemAnalyse Programmentwicklung (System Analysis Program Development). Their idea was to create standard enterprise software that integrated all business processes and enabled data processing in real time. Before that time, all processes were on paper and they had to be inputted in large datacenters so information could be analyzed, this at that time could take days and analyses months. Today, SAP customers generate 87% of total global commerce (\$46 trillion). [2] 99 of the 100 largest companies in the world are SAP customers. 85 of the 100 largest companies in the world are SAP S/4HANA customers. At the moment SAP is one of the best ERP systems for large companies that have a large variety of different business needs. Because the company's continuous innovation strategy approach they help businesses to grow without limits, or, at least without limitations that are often imposed by an ERP system. [2] Used In Estonia in ABB AS, RIMI AS. BLRT

2.2 Brief History of Oracle

American based multinational technology company, they have two main systems on the market at the moment: Oracle Netsuite and oracle E-Business. E-business is mostly used in IT services and Netsuit is specialized in manufacturing, high-tech, professional serviced, project-based and wholesales/logistics operations. Oracle is most often used in United states. Oracle products are most often used by companies with 50-200 employees from 1m-10M€ in revenue. [3]

2.3 Brief History of Monitor

The company was founded in Sweden in 1974. The foudner was Åke Persson and he named the company Verkstadsteknik Persson & Co. In the late 1970 Åke had an idea to create a computer program where he could enter all the data he had collected and

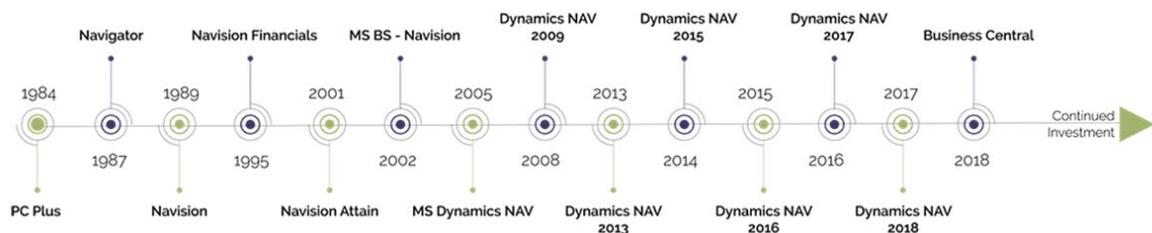
combine it to one spreadsheet, and it would calculate the processing times. The first generation of Monitor ERP was in 1982, at that time they had six employees. For 40 years Monitor has been focused on the manufacturing industry which is unique within the ERP sector. The latest version G5 has built in business intelligence with views for each module that can be used immediately. [4]

2.4 Brief history of Infor

Originally Infor is a multinational SaaS company. Originally, Infor was created as an ERP system for finance and resource planning, supply chain management and customer service. Nowadays, Infor has also developed specific solutions for different industries and an easy-to-use interface. [5]

2.5 Brief history of Microsoft dynamics

The software was first introduced in Denmark in 1984. PC&C released its first accounting package in 1985. It was a single-user application with basic accounting functionality. A few years after that in 1987 the first version of Navision, a client/server-based accounting application that allowed multiple users to access the system simultaneously. The success of the product prompted the company to rename itself to Navision Software A/S in 1995. On July 11, 2002, Microsoft bought Navision A/S to go with its previous acquisition of Great Plains. Navision became a new division at Microsoft, named Microsoft Business Solutions, which also handled Microsoft CRM [6]



Flowchart 1 Different versions of Dynamics NAV [6]

2.6 Cost of Different ERP systems

2.7 Components of ERP

Even if you know that the only way to grow the business is to implement an ERP system and you have a green light from management, you will need to set your budget and justify the costs and returns. Most of these components should be considered when deciding which ERP is right for your business.

- Software licensing fees
- Additional servers and network hardware
- Data conversion and transfer to ERP
- Customization if necessary
- Testing
- Training
- Consultancy support post implementation

2.8 Cost of an ERP system software

There are many reasons businesses want to adopt an ERP system, among the most common are to increase productivity, get a clear understanding of the cost of production, accelerating order to cash cycles and reduction of labor cost. Justifying the ERP cost by choosing the right pricing model for your business as well as being meticulous about exactly which features and modules you need and what you expect your ERP to deliver in financial value. Not all modules will benefit all businesses, so making the decision has to be carefully planned. There are many different modules to choose from:



Figure 1 Modules is Monitor ERP Manufacturing, purchase, and sales. [7]



Figure 2 Modules of ERP Monitor Stock, Time recording and accounting. [8]

automatic runs present this information to you without you having to take any active part in the gathering of information.



Figure 4 Monitor ERP Agent [10]

Extended File Viewer: The Extended File Viewer option provides system support for several different file types when you link external files to records in the database. This option supports frequently used drawing formats, image formats, and different MS Office document formats. Commonly supported file types: DWG, DXF, IPT, IDW, IAM, PRT, PAR, ASM, DFT, PART, ASM, SLDDRW, PDF and so on.

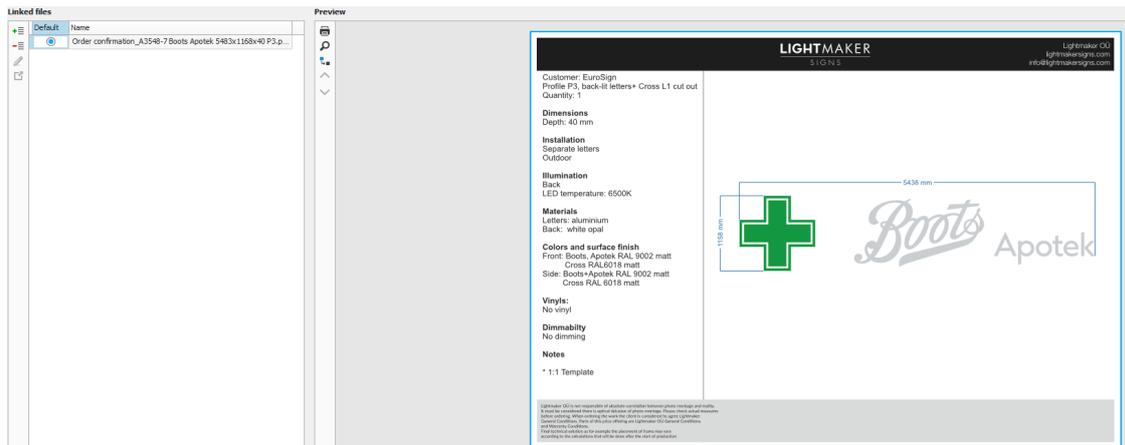


Figure 5 Extended file viewer

Warehouse: The Warehouse option is useful when you have stock and manufacturing units located in different cities, or different stock types on separate premises. In this option, stock orders are used to move parts between different warehouses.

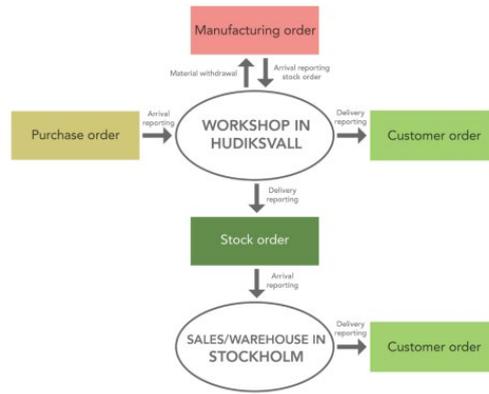


Figure 6 Monitor Warehouse [11]

Web Shop: You can use your Web Shop to reach corporate customers, private customers, and retailers through the same channel. The web shop can be combined with the product configurator. All Configuration data is loaded directly from the Monitor database. If changes are made in the database (material price, routine) the information on the website will also change.

2.9 Deciding which ERP pricing model suits you the best.

There are two readily accepted pricing models for ERP purchase, each with their pros and cons. There are also hybrid options which borrow parts from each model.

2.9.1 Perpetual licensing model

This model allows a business to host the software on their own servers on-premises. It can be a wise choice for large businesses but more difficult to manage for smaller businesses without the infrastructure already being in place to support it. There is the possibility to source the server then you don't need to have the actual server in-house.

Advantages:

- Cost of ownership is well defined.
- Allows permanent use of license without ongoing subscription costs.
- TCO lower for larger businesses over time

Disadvantages:

- Upfront costs for onsite infrastructure can be prohibitive for medium and small businesses.
- Can be expensive to scale as a business grows due to the need for further infrastructure upgrades.

2.9.2 The SaaS subscription model (cloud-based)

More suitable for small businesses with the possibility of growth during time. At first you don't need to invest much in infrastructure because the system itself is in the supplier's servers.

Advantages:

- Pricing is according to user number or transaction volume.
- Lower cost of hardware

Disadvantages

- The subscription cost could outweigh the cost of perpetual licenses.
- Sudden increases in demand can increase costs, making cost management more complex.

Tabel 1 Prices of ERP Systems

ERP Name	License Price per user	Company size	Licensing model	Cost of implementation	Price for option
SAP	\$180-220 monthly	Large/very large	PaaS subscription \$840 per month	25-100K\$	
Oracle	\$ 99 monthly	Mid to large	PaaS subscription \$999 per month	25-100K\$	
Infor	\$200 monthly	Small to mid-sized	PaaS subscription \$795 1095 per month	15-500K\$	
Microsoft dynamics	\$210-268 monthly	Mid to large	PaaS subscription \$1650-2000 per month	16-1000K\$	\$1500 per option monthly
Monitor ERP System	€216 per year	Small to mid-sized	Perpetual 22K€	36k€	€1773 one time

3 Implementation methodology and strategies

The methodology of an ERP implementation can be simple or complex, based on factors like size or the company, the project complexity, and whether you're implementing an on-premises or cloud solution. As written before, on-premises solutions have the added steps of hardware (server) infrastructure installations as well as adding an IT department if you don't have it before, for Lightmaker all this is missing. ERP systems are designed to support the organization is just about every aspect of business operations by centralizing data and through automation. [12] A Typical ERP implementation can be divided into six simple stages, each with specific objectives and targets. Largely every business is unique, and every company has its own way of doing business.

ERP implementation stages:

- Discovery and planning

This is the phase where the goal is to develop a detailed understanding of the current issues and requirements for the ERP. This is the phase where the ERP system should be acquired, and a clear understanding of the requirements defined.

- Design

The design phase works from detailed requirements and understandings of the current workflows to develop the new detailed design for the new ERP system.

- Development

This step involves configuring and customizing the software to support the customer processes. If the companies already have a ERP system, here they will choose what data will be migrated, what will be created.

- Support

The project team is still responsible for the ERP during this phase, but its focus will be shifted to listening for user feedback and adjusting the system accordingly.

- Deployment

This is the day every team is afraid of, the day the bandage is torn off and the system goes live. There will the issues and you have to be as prepared as you can. Despite your best efforts to prepare everyone for the transition there will be a lot of moving parts and befuddled employees.

- Testing

Testing and development may occur concurrently. Some parts of the system will work, some in development and some just being created.

- Training

The most important part is to ensure the end-users, the employees, understand how to use the new system. Training has to be comprehensive and available. Very important is how intuitive the user-interface is for the employees. Does the ERP system have a interface similar to the software that they already use. If the interface is similar to the one that they already use or is simple it reduces the training time and improves the employee commitment. As Lightmaker and most of the employees have never used an ERP before it is easy to start from a white sheet but of course complicated because they don't understand the need for it and their "Buy in" is low.

3.1 Microsoft Sure Step methodology

Microsoft Sure Step methodology was introduced in 2007 as a full customer lifecycle methodology which could be applied to all Dynamics solutions. Microsoft believes that every business is in line to create a great customer experience. To achieve a great customer experience, the business has to be more than marketing, back office, supply chain and operations. This is also referred as an agile method

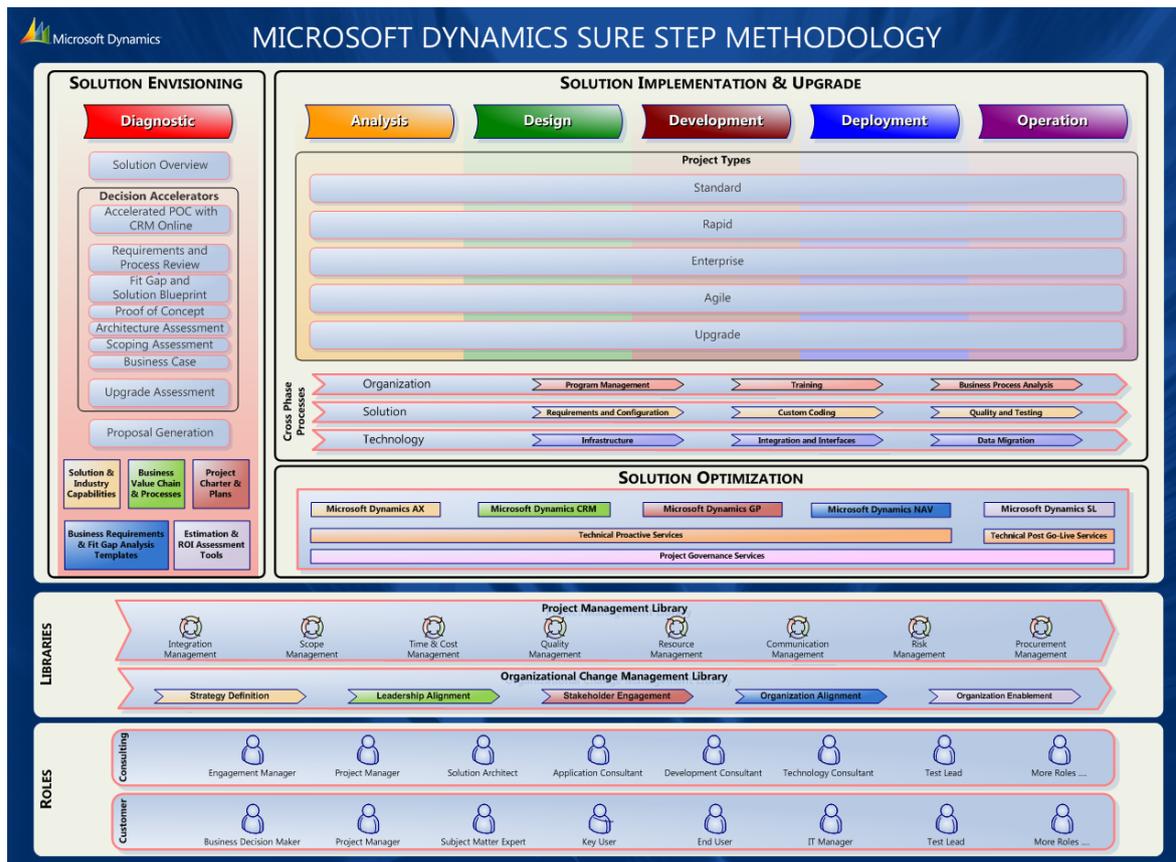


Figure 7 Microsoft sure step methodology [13]

Microsoft Dynamics Sure Step methodology is an end-to-end customer lifecycle which describes the standardized processes and disciplines necessary to implement Dynamics solutions. Sure Step is structured as a general methodology with a product-specific layer for each Dynamics product, providing guidelines and best practices to help successfully implement Microsoft Dynamics solutions. The content in Sure Step consists primarily of prescriptive phase-by-phase and activity-by-activity descriptions for completing each stage of an implementation.

Benefits of using sure step methodology:

- Fast implementation time

Sure Step model provides tools, templates, and best practices which cover all aspects of projects to increase consistency, timeframes, quality, and success of projects

- Repeatable model

flexible and repeatable model which can fit any business or project type, this assures customers you are using the same consistent approach and following correct procedures during a Dynamics implementation.

- Customer satisfaction:

Sure Step allows for faster project completion with minimal risk and a lower total cost of ownership (TCO), leading to increased customer satisfaction. [13]

3.1.1 The six phases of the sure step methodology

- **Diagnostic**

To help the customer determine the right solution to meet their needs and obtain a key understanding of solution requirements.

- **Analysis**

The analysis phase defines the activities required to initiate and effectively plan the whole project.

- **Design**

The design phase includes configuration of the overall Microsoft Dynamics solution and the design of specific customizations needed to satisfy business requirements identified during the analysis phase.

- **Development**

The goal of the development phase is to build and test the system components defined and approved in the design specifications, including developing the customizations, integrations and interfaces and data migration processes.

- **Deployment**

The deployment phase is where all the efforts of the project team come together for a successful transition to the new Microsoft Dynamics solution. Key activities in this

phase include End User Training, User Acceptance Testing, and the actual cutover to the new or upgraded production environment.

- **Operation**

The operation phase defines the activities required to close the project, provide post-production support, and transition the solution and knowledge to the customer.

3.2 Microsoft Success by Design

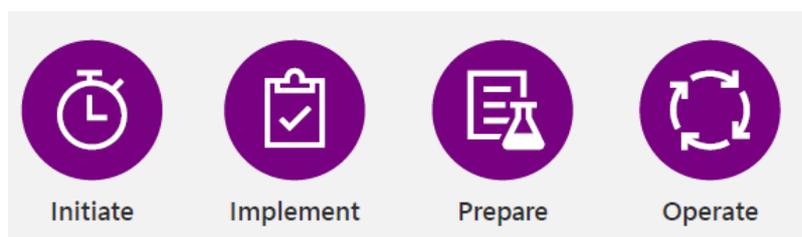
As demand for Dynamics 365 cloud services increased across the enterprise, Microsoft identified the clear need to change the way we thought about evolving our services and our responsibility to customers and partners. They recognized that it wasn't enough to design a platform containing a set of features. They needed to also understand what it takes to deliver a fully functioning, end-to-end solution that runs the mission-critical processes of the customers' businesses. From this need, Success by Design was born.

In Success by Design, reviews are exercises in reflection, discovery (observation), and alignment (matching to known patterns). Project teams can use reviews to assess whether their implementation project is following recommended patterns and practices. Reviews also help project teams to identify (and address) issues and risks that may derail the project.

Benefits using success by design:

- Reduced risk due to early detection of problems
- Alignment to recommended practices

Success by Design maps the Dynamic 365 implementation lifecycle into four methodology-agnostic phases: Initiate, Implement, Prepare, and Operate.



Screenshot 1 Four methodology-agnostic phases [14]

In the **Initiate phase**, the project team is in discovery mode, gathering and validating business requirements, finalizing the high-level solution approach, making inroads to define all in-scope workstreams, and updating the project plan to reflect these updates. When the project team has produced the high-level solution design and the

related project workstreams are defined, Success by Design begins with the Solution Blueprint Review

The Solution Blueprint Review workshop covers the following topics:

- Program strategy
- Application strategy
- Data strategy
- Integration strategy
- Test strategy
- Business process strategy
- Security strategy
- Application lifecycle management strategy
- Environment and capacity strategy
- Intelligence strategy

Initiate	Implement	Prepare	Operate
Get ready to start	Design & Build	Deploy	Live
Requirement Analysis	...	Testing & Acceptance	Solution health
Project Governance	Data Model Design	Go-live planning	Usage
Fit-gap analysis	Integration Design	User readiness	Maintenance
Customer-Kick-off	Solution Performance	Cutover planning	...
...	Security Model Design	...	Post Go-live
Solution Blueprint	Test Strategy	Go-live readiness	
	User Experience Design		
	Application Lifecycle Management Strategy		
	Data Migration Strategy		
	Gap Solution Design		
	Cutover Strategy		
	BI and Analytics Design		

Screenshot 2 Solution Blueprint Review [15]

In the **Implement phase**, the project team is focused on building the solution per the agreed upon solution design and scope. This phase introduces Implementation Reviews that come from the findings and recommendations of the Solution Blueprint Review. Implementation Reviews help you more deeply address questions related to the specific aspects of the solution design (data model, security, and integration) and implementation practices (Application lifecycle management ALM, testing strategy). Implementation Reviews are meant to fully address the risks identified during or after the Solution Blueprint Review but before the solution build is too far along. [16]

By the **Prepare phase**, the solution has been built and tested and the project team is preparing for the final round of user acceptance testing (UAT) and training. Additionally, all necessary customer approvals have been granted, information security reviews completed, the cutover plan defined (including go/no-go criteria), mock go-lives scheduled, the support model ready, and the deployment runbook completed with tasks, owners, durations, and dependencies defined. At this point, the project team uses the Success by Design Go live Readiness Review to identify any remaining gaps or issues.[13]

In the **Operate phase**, the customer solution is live. The goal of this phase is stabilization and a shift in focus towards functionality and enhancements that are earmarked for the next phase of the project.

3.2.1 Success by design outputs

The primary review outputs fall into two related categories: findings and recommendations.

Findings come in three types:

- **Assertions** - Findings that capture noteworthy aspects of the solution or approach. Assertions highlight what the project team is doing right, typically in line with best practices.
- **Risks** - Findings that could potentially influence the implementation negatively if not mitigated.
- **Issues** - Findings that are currently impacting implementation negatively or will do so if not resolved.

The findings and recommendations are based on careful review that calls out the lack of solution performance testing as a risk, which the project team must address to avoid downstream impact on the project.

Success by Design equips project teams with a model for technical and project governance that invites questions and reflection, which leads to critical understanding of risks that might otherwise go unnoticed until too late in the project.

4 Choosing ERP

Deciding which ERP to adopt in Lightmaker was an easy decision because Monitor ERP Systems had a clear advantage over the rest of the options and functionality. Price was moderate, they just adopted the system in one of the largest Signe companies in Estonia and had good references from Lightmaker OÜ suppliers who all were extremely satisfied with the integration process and support from Monitor Systems and Rocksoft OÜ.

4.1.1 Monitor ERP prices:

You cannot find a simple number for cost of implementation, but you can estimate based on factors like business size, number of users or licenses required, training sessions, customizations needed, app and data migrations. One of the largest cost is the time the companies personnel have to invest in to create the data for the ERP

One-time licensing: 29530.-€

User licenses of users:

Complete licensing: 300.-€ per year 11 pcs 3300.-€

Time recording: 200.-€ per user per year 20pcs 4000.-€

Server cost: 5760.-€

Integration price: 35328.-€

Total: 77915.-€

Integration and licensing will be supported by Enterprise Estonian why will cover 45% 32471.-€ of the expenses from first year licensing integration as a part of their Digitalization grants. Initial investment of ERP will be about 45444.-€

4.1.2 Assigning returns

Wavering CRM Piledrive because Monitor has its own CMR 12x50.- monthly -7200.-€ yearly.

Shorten quotation time from 30 min to 10min about 250 pcs per month. 6h-2h.

Saving 4h per day hourly rate to the company about 23€, yearly save 19200.-€. This cost comes from overprocessing of orders to production.

New business we can take on due to free capacity in customer service.

Reduction of overprocessing in manufacturing 19% 81K€. -yearly

Reduction of purchase management operations 6h weekly of automated warehouse replenishment, inventory management. 6hx54 weeks about 7500.- yearly.

Returns: $7200+19200+81000+7500=114900€$

4.1.3 Calculating ERP ROI

When investing in an ERP system you have to understand the value of ERP, how it will help you manage your business, grow it and earn you money. ROI is easily the most common method used in business to measure project returns and to compare these with other potential investments. This is a simple metric on the surface; it is calculated by adding up the expected return from an ERP system and then subtracting the expected costs of the ERP. ROI can provide you with a flexible metric to measure the ERP project success. Adding a temporal element to the ROI calculation using a payback period which looks to see how many months it takes to pay back the initial investment. Another more sophisticated metric that captures the value of time is the internal rate of return (IRR). Costs in the next month are more expensive than costs in a future period. Gains that begin sooner are more valuable than a gain later. IRR provides a percentage value that looks like the quotient in ERP ROI.

$$ROI = \frac{\text{Net Return on Investment}}{\text{Cost of investment}} \times 100\% \quad [17]$$

$$ROI = \frac{114900}{45444} \times 100\% = 252\%$$

Typical ROI from investing in an ERP [18]

- 19% reduction in operating costs
- 15% reduction in administrative costs
- 19% reduction in inventory costs
- 18% reduction in obsolete inventory

5 Standardization of products

As Lightmaker OÜ has grown rapidly from the company of a few employees to little under 30 in just a few years there has been little product standardization. The market is constantly changing and highly competitive. Monitor G5 ERP was chosen for Lightmaker because it is an ERP made for companies who produce products. One of the features that made Monitor ERP stand out was the product configurator option. With the product configurator you can manage and combine several variants and models of one product and calculate the price and create manufacturing order from the information. Using the product configurator streamlines the registration and quotes of an order and with it you get the accurate cost for sales instantly. This option eliminates order specific BOM preparations, secures compatibility and ensures a correct BOM and routing for standard products. Follow up on configuration is easy, and you can get sales statistics on option and materials.

One of the biggest challenges was that there was no standardization done and customer needs for design is different. Designers chose themselves what they thought suited the customer best at that moment but often they were not the best options because they do not know the end location of the product, the wall type where the product would go is it concrete, wood, sandwich panel etc.

ERP configurator needed the design factors to be standardized so they could be precalculated on option lists by variables and chosen by the client. This would give the customer better knowledge of what they were ordering, designers need less time to think what would suit the client. Offering faster and more precise because the design would be decided during the offering not design phase.

5.1 Standardization of main profiles

Standard solutions are the most widely spread sign solutions in Europe. They are easy and quick to produce and can be rather accurately priced. It is always possible to combine standard solutions and use a variety of materials to give them a more personal touch. As there are many standard solutions, it is very likely there is a solution that fits 90% of the signage needs. [19]. Product main profiles are shown in appendix 1

5.2 Standardization for mounting systems

The installation is always considered before starting to design or calculate the price for products. Lightmaker believes that the installation is one of the most technically challenging parts of the project because every building is different in size and material. Every sign has a different size and mounting method that can be applied. Standardisation of mounting methods had to be done so customers could easily choose which one suited their needs the best and we could calculate the price for them most accurately.

For different product groups different mounting methods were created: Mounting systems are shown in appendix 2.

5.2.1 Standard mounting systems for letters:

➤ **MM01 Signe on aluminum U profiles**

- * Most cost-efficient mounting system
- * Makes sense in some cases when the installer has no info on how the sign will be installed.
- * May need some drilling and adjusting on site
- * Could need two people for convenient installation (measuring, marking, drilling).

➤ **MM02 Sign on aluminum U profiles and hooks**

- * No drilling needed into the frame.
- * This solution brings signs 30mm off from the wall thus is good for walls with some restrictions on the surface (like metal sandwich panel walls).

➤ **MM03 Sign on U profiles + distances with hooks**

- * Same as MM02 but allows hook to be positioned also behind the letters thus making the hooks less visible and easier to place on the wall.

➤ **MM04 Sign on U profiles + hooks and plates**

- * Same as solution with hooks but the plates behind them allow stronger adhesion to the wall surface.
- * Possible to reinforce with either glue or several screws.

➤ **MM05 Sign on U profiles + Hooks + Plates + Distances**

- * Same as solution MM04 but has distances between frame and letters to allow better hook placement to the wall and hiding hooks behind letters.

➤ **MM06 Sign on U profiles with mounting ears**

- * Takes more than one person usually for installation.
- * No need for drilling into the frame.
- * Depending on viewing angle mounting ears are more visible than hidden wall installation profiles but less visible than hooks.
- * Depending on fasteners type may allow easier installation to uneven walls.

➤ **MM07 Sign on U profiles with mounting ears + L profiles**

- * Easy to install alone - first install L profile, then just lift on the sign
- * Wall profile is light and possible to install by one person
- * Does not work if there are some restrictions on the wall surface and sign needs to be away from wall
- * Rather cost-efficient mounting system.

➤ **MM08 Sign on U profiles with mounting ears + L profiles**

- * Easy to install alone - first install light profile, then just lift on the sign
- * Wall profile is light and possible to install by one person
- * Does not work if there are some restrictions on the wall surface and sign needs to be away from wall
- * It has advantage over same solution without mounting ears because no need to make holes in bottom frame to fix to the wall.

➤ **MM09 Sign on U profiles with suspended wires**

- * Good solution if sign is placed indoors and fixed to the ceiling
- * Would move if some force is applied to it
- * Thin and quite invisible hanging system

➤ **MM10 Sign on L profiles+ L profiles**

- * Alternative version for U profiles as back frame of the sign
- * Easy installation with two separate L profiles for the wall
- * Measuring two wall side L profiles need precision

➤ **MM11 Sign on acrylic frames**

- * Letters on acrylic frame to make most transparent and less visible frame as possible
- * Frame is least visible and sign itself is in focus
- * It is not so strong as a metal frame and then does not work on bigger signs.

➤ **MM12 Sign on Frame with telescopic mounting**

- * Strong and rigid solution to suspend sign from ceiling
- * Legs can have telescopic or fixed mounting plates

➤ **RM01 Roof mounting with horizontal frames**

- * Sign with horizontal frames behind is positioned on triangular frame
- * Frame can be fixed to the roof with weights or directly to the roof construction
- * Stones, plywood, and foam that may be needed for fixing the frame are not usually included with a sign.

➤ **RM02 Roof mounting letter by letter**

- * Same as triangular frame but without having letters pre-mounted on horizontal frames
- * Every letter has its own triangular frame
- * Cleaner look.

➤ **SPMM01: Sign directly against wall**

- * Simple and clean look
- * For fixing to wall can be used either pins, double sided tape, glue or inner fitting inserts.

➤ **SPMM02: Sign with distance pins behind it**

- * Gives a different look compared to letters directly on the wall
- * Can look cluttered and be difficult to install when letters are smaller
- * Distance normally varies from 15mm to 50mm.

5.2.1.1 Standard Mounting systems for Lightboxes

➤ **LM01 Lightbox directly against wall**

- * Cost efficient
- * Clean look where sign is installed directly against the wall with no distance
- * Sign needs to be opened and closed on the site
- * May need two people for measuring, marking drilling

➤ **LM02: Lightbox on L profiles + frame**

- * Fast installation
- * Expensive

➤ **LM03: Lightbox on U profiles and U profiles**

- * Especially good for heavy lightboxes

➤ **LM05: Lightbox on Z profiles with frame**

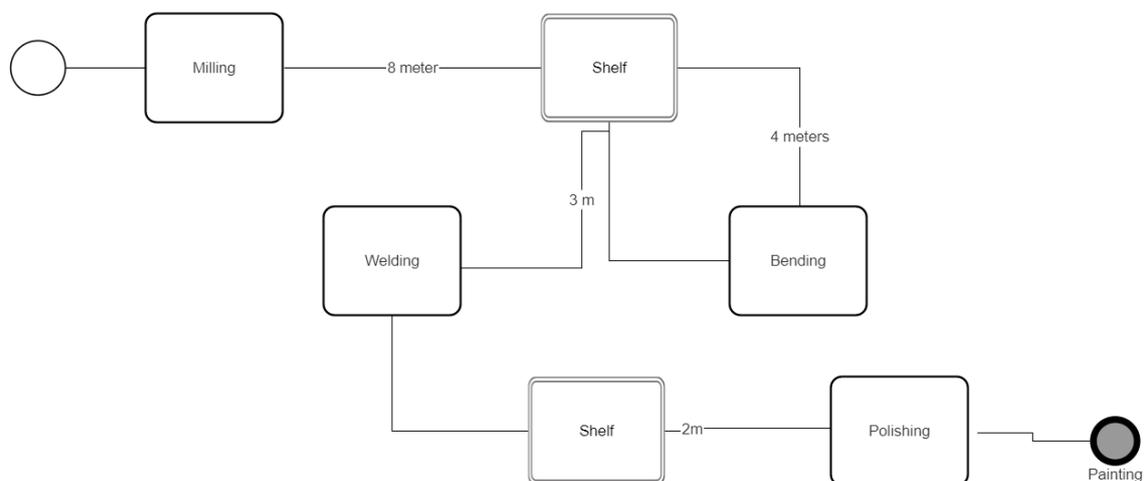
5.3.1 Welding department layout

Taiichi Ohno categorized seven main wastes in production.

- Defects
- Over production
- Waiting
- Transporting
- Movement
- Inappropriate processing
- Inventory

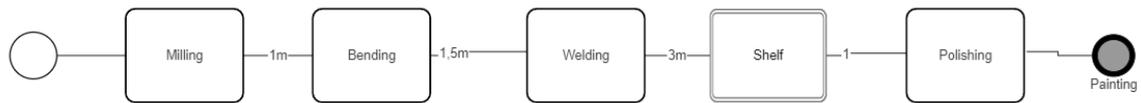
As a part of this thesis, we are concentrating on the topic of transportation. Every time you have to touch or move something from one corner to another is categorized as a waste. Production has to be smooth and operation sequences made to move the subassembly as little as possible and unnecessary moves not possible.

Production process before layout modification: Aluminum sheet is milled in the router type 3 axis milling machine. After it is stacked on a shelf that is 8 meters from the milling machine, from the shelf it is moved to the bending machine that is the farthest corner of the room. After bending the sheets is moved back to the shelf where the welder takes them when he gets an order from the foreman because the shelf is far away he does not see them.



Flowchart 3 L1 front and back production process

As seen from the flowchart the material is touched and moved many times, for some smaller parts the time it takes to move the part is even longer then the actual part work operation.



Flowchart 4 L1 production flowchart

Welding department layout after modification. LEAN principles were used to decrease lift and space needed to keep excessive WIP in production. Milled first bended part is lifted straight on the bending machine and rest on the overhead shelf next to the bending machine. Bended parts are therefore stacked next to the welding table where the welder sees them and are about 0,5 meters from the workstation. After welding they are moved to the polishing workstation and from there to subcontracted painting facilities in a straight line. Never has to be subassembly have to be moved backwards in the production facility.

5.3.2 5S implementation in assembly department

5S philosophy is that everything has its place and when the work is done the thing is put back in its place. Everyone knows where the place is where the thing has to be, so it does not have to be searched and time spent searching the thing. You may think is understandable for everyone that if it takes you 30 minutes to find the tool that is needed to carry out the 5-minute operation it is waste but it is not. There are five pillars to 5S: Sort, set in order, shine, standardize, and sustain. When measuring assembly times for ERP adaptation it was noted that over 60% of complete assembly time was spent searching for tools and parts.



Photo 1 Tools box before 5S



Photo 2 Tool stands next to all assembly workstation after 5S implementation.

6 Product configurator

In the configuration, the different components are combined to become the finished product. The configuration is made in connection with order registering, pre-calculations, quoting, etc.



Photo 3 Product configurator [20]

P6P configurator:

Component	Option/Value	Value/Quantity	More info
Pindala	PINDALA =	m ²	>>
Übermõõt	Übermõõt =	jm	>>
Tähekõrgus	Tähekõrgus =	mm	>>
Tähtede arv	Tähtede arv =	pcs	>>
Reklaami kogupikkus	Reklaami kogupik...	mm	>>
Reklaami kogu kõrgus	Reklaami kogu k...	mm	>>
Materjalpindala	Materjalpindala =	m ²	>>
Täheposti laius	Täheposti laius =	mm	>>
Hõlvujad elemendid	Hõlvujad elemen...	pcs	>>

Photo 4 P6P Configurator measurements

Component	Option/Value	Part number	Value/Quantity	More info
(x) Sign name	Sign name = Juhani suusad		Juhani suusad	>>
Difficulty level	1 level	1-LEVEL	1,00 pcs	>>
Frontside material	WN770 - 31% 5x3050x2050mm	SMWN7705	2,00 m ²	>>
Backside material	Leht materjal, AW 1050A 1x1500x...	SMAW1050 1MM	2,00 m ²	>>
Side material	1,2x70 AW 1050A rull	1,2X70SERV	21,00 jm	>>
LED	KM-P2-W (0.72W) 6500K	KAISEN KM-P2 W WH	92,00 pcs	>>
(x) LED Kogus	LED Kogus = 92		92 pcs	>>
Power supply	XLG-75-12-A IP67	XLG-75-12-A	1,00 pcs	>>
(x) Dimmable	Dimmable = No		No	>>
Kiletamine	NO	NO	1,00 pcs	>>
NCS Värvimine	NO	NO	1,00 pcs	>>
(x) Kas tagapind on vaja v...	Tagapinna värv = Yes		Yes	>>
(x) Arvesta värvimise min ...	Arvesta värvimise min hinda = Yes		Yes	>>

Photo 5 P6P Configurator options

Order details

Component	Option/Value	Part number	Value/Quantity	More info
(x) Outdoor	Outdoor = Yes		Yes X ▾	»»
🔍 Mounting element	On U30x30x3 profiles	MM01	1,00 pcs	»»
🔍 Letter Side color	Beige	RAL 1001 GLOSSY	2,90 m ²	»»
🔍 Profile color	Signal yellow	RAL 1003 MATT X ▾	1,62 m ²	»»
(x) Estimated power suppl...	Estimated power supply output W...		66 W	»»

Photo 6 Order Details in configurator

There are unusually two to three parts of the configurator because some information must be shown on the order confirmation document to the customer. The two first sheets are for measurements and details on what material is used to manufacture the product but that information is not relevant to the customer. Information on the last sheet named "details" is the information shown on the customer order confirmation.

6.1 Variables for standard Solutions

Variables are a part of the product configurator; they are numbers or calculations based on data you have input.

Variables are used in different formulas such as rule formulas in configuration groups, time formulas and quantity formulas in BOM and routing, and price formulas for parts. Variables can also be created directly in the procedure Configuration groups, for example in connection with when you create a configuration group or when you create its structure. Those variables are also saved in this variable register.

Variables created for profile letter product configurations P00, P01, P3, P4, P5, P6, P8, P9, L1, L10, FL1R, FL1R:

- Area m²
- Material Area m²
- Count of letters pcs
- Overall length mm
- Overall height mm
- Letter post width mm
- Perimeter of letters m
- Dimmable Yes/no
- Vinyl Yes/NO

- NCS color Yes/NO
- Difficulty level 1,2 and 3
- Account for minimal quantity price for painting
- Backside has to be painted
- LED Quantity

Formula: $\text{Round}(1.1 * ((\text{if}([T\ddot{a}heposti\ laius] < [LED\ Samm], [\ddot{U}mberm\ddot{o}ot] * 1000 / 2 / [LED\ Samm], (([\ddot{U}mberm\ddot{o}ot] * 1000) / 2) / [LED\ Samm] * ([T\ddot{a}heposti\ laius] / [LED\ Samm]))) , 0)$

- Estimated power supply output:

Formula: $[LED\ Kogus] * [LED\ v\ddot{o}imsus]$

- Milling speed aluminum
- Milling speed plexi glass
- Applying Vinyl
- Painting cost for white color
- Painting cost for two colored parts
- LED Step, every LED has its own usage from letter depth. The step variable is given by an option list and value

Code	Part number	Name	Value
LED	EPILED_LUNO-WH	Luno-WH 0,72W 6500K	120,0000 mm
LED	EPILEDLUNO-RDW	LUNO- (0,72W) RD W	120,0000 mm
LED	EPILEDLYPSO 1...	Elypso 1.5W - WH, modul do semaforów, IP67	100,0000 mm
LED	EPILEDPIQ-NW	EPIQ 0,24W 4000K NW	40,0000 mm
LED	EPILEDOPTICOR...	OPTICOR1- 0,5W WH	70,0000 mm
LED	EPILEDFLAGA 1...	FLAGA 1.0W WH 6500K	90,0000 mm
LED	TRIGLO-WH	TRIGLO - (1,5W) WH	220,0000 mm
LED	KAISEN MINI3 0...	KAISEN MINI3 0.7W WH 6500K	60,0000 mm
LED	KAISEN MINI 3 0...	KAISEN MINI3 0.4W WH 6500K	60,0000 mm
LED	KAISEN KM-T2-2	KM-T2-W 6500K	220,0000 mm

Photo 7 LED Step

- LED power output

Code	Part number	Name	Value
LED	EPILED_LUNO-WH	Luno-WH 0,72W 6500K	0,70
LED	EPILEDLUNO-RDW	LUNO- (0,72W) RD W	0,72
LED	EPILEDLYPSO 1...	Elypso 1.5W - WH, modul do semaforów, IP67	1,50
LED	EPILEDPIQ-NW	EPIQ 0,24W 4000K NW	0,24
LED	EPILEDOPTICOR...	OPTICOR1- 0,5W WH	0,50
LED	EPILEDFLAGA 1...	FLAGA 1.0W WH 6500K	1,00
LED	TRIGLO-WH	TRIGLO - (1,5W) WH	1,50
LED	KAISEN MINI3 0...	KAISEN MINI3 0.7W WH 6500K	0,70
LED	KAISEN MINI 3 0...	KAISEN MINI3 0.4W WH 6500K	0,40

Photo 8 LED Power output

- Power supply output

Code	Part number	Name	Value
POWER SUPPLY	PWM-40-12	PWM-40-12 IP67 Dimmerdatav	40 W
POWER SUPPLY	PWM-60-12	PWM-60-12 IP67 Dimmerdatav	60 W
POWER SUPPLY	PWM-90-12	PWM-90-12 IP67 Dimmerdatav	90 W
POWER SUPPLY	PWM-120-12	PWM-120-12 IP67 Dimmerdatav	120 W
POWER SUPPLY	PWM-200-12	PWM-200-12 IP67 Dimmerdatav	200 W
POWER SUPPLY	XLG-75-12-A	XLG-75-12-A IP67	75 W
POWER SUPPLY	XLG-100-12-A	XLG-100-12-A IP67	100 W
POWER SUPPLY	XLG-150-12-A	XLG-150-12-A IP67	150 W
POWER SUPPLY	ELG-200-12B-3Y	ELG-200-12B-3Y IP67	200 W

Photo 9 Power supply output

- Edge material height

Code	Part number	Name	Value
SIDE MATERIAL	1,2X150SERV	1,2x150 AW 1050A rull	0,150
SIDE MATERIAL	1,2X120SERV	1,2x120 AW 1050A rull	0,120
SIDE MATERIAL	1,2X100SERV	1,2x100 AW 1050A rull	0,100
SIDE MATERIAL	1,2X80SERV	1,2x80 AW 1050A Rull	0,080
SIDE MATERIAL	1,2X70SERV	1,2x70 AW 1050A rull	0,070
SIDE MATERIAL	1,2X50SERV	1,2x50 AW 1050A rull	0,050
SIDE MATERIAL	1,2X40SERV	1,2x40 AW 1050A rull	0,040
SIDE MATERIAL	1,2X20MM	1,2x20 AW 1050A rull	0,020
SIDE MATERIAL	1,2X30 AW 1050A	1,2x30 AW 1050A rull	0,030
SIDE MATERIAL	0,6X120 SERV	Roostevaha 0,6mm 120mm servamaterjal (harja)	

Photo 10 Edge material height

6.2 Rules for product configurators

Rules set boundaries and take away or choose options that you have defined previously.

Rule number	Description	Rule definition	Logical formulation
1002	Serva kõrguse valk		(([Tähepostilaisus] <= 64) and ([Tähepostilaisus] >= 30))
1003	Serva kõrguse valk		(([Tähepostilaisus] >= 64)
1004	Serva kõrguse valk		(([Tähepostilaisus] >= 94) and ([Tähepostilaisus] < 140))
1005	Serva kõrguse valk		([Tähepostilaisus] >= 140)
1008	LED valk 30mm <= 30		([IsSelected(SIDE MATERIAL 1,2X30 AW 1050A)] and ([Tähepostilaisus] <= 30))
1009	LED valk 50mm < 100 > 25		(([Tähepostilaisus] < 100) and [IsSelected(SIDE MATERIAL 1,2X50SERV) a...])
1010	LED valk 50mm > 100		([IsSelected(SIDE MATERIAL 1,2X50SERV)] and ([Tähepostilaisus] > 100))
1017	Kile valk		[IsSelected(KILETAMINE NO)]
1013	LED valk 70mm <= 50		([IsSelected(SIDE MATERIAL 1,2X70SERV)] and ([Tähepostilaisus] <= 50))
1014	LED valk 70mm		([IsSelected(SIDE MATERIAL 1,2X70SERV)] and ([Tähepostilaisus] > 50))
1015	LED valk 100mm		([IsSelected(SIDE MATERIAL 1,2X100SERV)] and ([Tähepostilaisus] < 150))
1016	LED valk 120mm		([IsSelected(SIDE MATERIAL 1,2X120SERV)] and ([Tähepostilaisus] < 180))
1018	Dimmeri nupp		([Dimmable])
1018	Dimmeri nupp		not([Dimmable])
1019	NCS Toon		not([NCS Color])
1020	PWM trafo yes < 40		(([Dimmable]) and ([Estimated power supply output W] < 40))
1020	PWM trafo yes > 40 < 60		(([Dimmable]) and ([Estimated power supply output W] > 40) and ([Estim...
1020	PWM trafo yes > 60 < 90		(([Dimmable]) and ([Estimated power supply output W] > 60) and ([Estim...
1020	PWM trafo yes > 90 < 120		(([Dimmable]) and ([Estimated power supply output W] > 90) and ([Estim...
1020	PWM trafo yes > 60 < 90		(([Dimmable]) and ([Estimated power supply output W] >= 120))
1021	NO dimming <= 75		([not([Dimmable])] and ([Estimated power supply output W] <= 75))
1021	NO Dimming > 75 > 100		([not([Dimmable])] and ([Estimated power supply output W] > 75) and ([...
1021	NO > 100 <= 150		([not([Dimmable])] and ([Estimated power supply output W] >= 100) and [...])
1021	NO dimming > 150		([not([Dimmable])] and ([Estimated power supply output W] > 150))
1022	RAL dissappear		[IsSelected(NCS VÄRVMINE YES)]
1023	RAL Akryl		([IsSelected(MOUNTING METHOD MM12)] or [IsSelected(MOUNTING METH...

Photo 11 Rules for P6P Configurator

One of the rule sequences is to choose the edge height of the letter, it is dependent on the width of the letter. If the letter is narrower than 30mm the height of the letter will be 30 mm. The second rule is to command the LED. If the letter height is 30 and the width is under 25 mm then the configurator chooses LED: Kaisen Mini 3 but if the width is wider than 25 mm LED will be Kaisen P0. Rules control edge height, LED types, power supplies, NCS painting, acrylic plex glass painting, laser cutting, Dimming.

6.3 Parts

The part register is the most important and fundamental register in any ERP system.

A part can for example be purchased, sold, manufactured, requirement planned, stock counted, stock valued, product calculated, linked to price lists, used for statistical purposes or fictitious.

In other words, many of the functions have to do with parts. The part register consists of a great deal of different types of information that supports all the different functions. The primary information for a part is its part number, part name, unit, part type, and standard price. In addition to this, there are different prices, planning settings, locations, grouping terms, order information etc. which can be entered for a part. The basic principle is that it should be sufficient to only enter the primary information for it to be possible to use the most common functions in the system, for example to manage orders. All other information that can be entered for a part is intended for more advanced functions, and to use the system at a more advanced level.

A part has units that can be pcs, meters, running meters, kg, letter, Watts, bags. For most aluminum profiles that are ordered they are ordered in bars, withdrawn to production orders in running meters and we pay the supplier in euro per kilogram. Kilograms are used to calculate the end weight of the product as well. All parts have standard prices, this is the price we sell the material to the customer. There is a different location where we define from where and for what price we buy the material. For price calculations we use FIFO (first in first out) settings. FIFO is calculated via the old stock log records existing in the system. All records have a price which is saved during the arrival reporting. However, for a purchase order the price will be updated when the supplier invoice becomes linked to the arrival reported items. This means that the FIFO value can change even though no stock transaction has taken place after the most recent inventory value list was created. Stock count and direct stock reporting will have the standard price as value. Other transactions such as negative

reporting of material via manufacturing order, gets the standard price and also affect the FIFO. When FIFO is to be calculated, the part's balance is first checked. Then the program will find as many (positive) transactions as needed to be able to evaluate these parts. The most recent transactions will then be used first. Example: If you have a balance of 100 units and the most recent transactions are: first a purchase of 80 units for €10 each and then a purchase of 80 units for £20 each, then the FIFO will be: $80 \times €20 + 20 \times €10 = €1800$, that is €18 per unit [21].

Planning of parts is crucial in production, when are you going to run out and when do you have to order or produce new parts. For that there is the planning window of parts there you can define is the Control methodology stock driven of order orientated. Dependent on what type the part is you can define safety stock quantities, lead times for ordering, minimal and rounding quantities etc.

6.4 Option lists for product configurator

An option list defines different parts that can be selected in the configuration. The parts will in the normal case be used as included/incorporated parts in a manufacturing order and be added to the basic BOM and routing. For options that do not have the function that they should be included in the structure on the manufacturing order, then fictitious parts are often used.

Option lists created to be added to basic BOM's:

MOUNTING METHOD for Letter configurations:

Pos.	Part number	Selection	Name	Part type	LSR	For op.	Def
			Default values. It is possible to enter ...				10
	MM01		On U30x30x3 profiles	⊙	Lot-for-lot		
	MM02		U30x30x3+Hooks	⊙	Lot-for-lot		
	MM03		U30x30x3+hooks+distances	⊙	Lot-for-lot		
	MM04		U30x30x3+Hooks and plates	⊙	Lot-for-lot		
	MM05		U profiles+H+P+D	⊙	Lot-for-lot		
	MM06		U30x30x3+Mounting ears	⊙	Lot-for-lot		
	MM07		U30x30x3+L25x25x2	⊙	Lot-for-lot		
	MM08		U30x30x3+L25x25x2+Mounting ears	⊙	Lot-for-lot		
	MM09		U30x30x3+Suspended with wires	⊙	Lot-for-lot		
	MM10		L40x40x3	⊙	Lot-for-lot		
	MM10/2		L50x50x3	⊙	Lot-for-lot		
	MM10/3		L30x30x3	⊙	Lot-for-lot		
	MM11		Acrylic frames	⊙	Lot-for-lot		
	MM12		Acrylic frames+suspended with wires	⊙	Lot-for-lot		
	MM13		Frame with telescop mounting	⊙	Lot-for-lot		
	MM14		U50x50x3 Al profiles	⊙	Lot-for-lot		
	MM15		U50x50x3 1xAl profile	⊙	Lot-for-lot		
	HAT PROFILE		Hat profile for mounting	⊙	Lot-for-lot		

Photo 12 Option list for configuration of Letters

For this option list most of the options are fictious BOMs. As the upper level BOM is all the same but the materials and operations needed to manufacture the part are different. The fictious level is therefore uploaded to the correct Level of the basic BOM.

Some Option lists like Vinyl are materials, the material quantity is defined in the product configurator when creating a quote or customer order.

Pos.	Part number	Selection	Name	Part type	LSR	For op.	Default qty	f(x)	Minimum qty	Maximum qty	Unit	M
			Default values. It is possible to enter ...			55	1,00	√x	0,10	100,00		
	3M 2330 SERIES VINYL		3M 2330-xxxx			Lot-for-lot		√x			jm	
	3M 3630 SERIES VINYL		3M 3630-XXX			Lot-for-lot		√x			jm	
	3M 3635-222		3M 3635-222 Perforated black			Lot-for-lot		√x			jm	
	3M 3630-236		SC 3630-236 Turquoise			Lot-for-lot		√x			jm	
	PRINTVINYL2X		Printed Vinyl 2x			Lot-for-lot		√x			m²	
	3M 3635-0171		3635-0171 lumehall, Day/Night			Lot-for-lot		√x			jm	
	3M 3635-100		valgust võmendav			Lot-for-lot		√x			jm	
	3M 3635-208		3635-208 valge matt blokeeriv 1,22x...			Lot-for-lot		√x			jm	
	3M 3635-30		3635-30 valgust hajutav, LT 30%			Lot-for-lot		√x			jm	
	3M 3635-70		3635-70 valgust hajutav, LT 60%			Lot-for-lot		√x			jm	
	3M 3635-91		3635-91 suitsuhall, Day/Night			Lot-for-lot		√x			jm	
	ORACAL 8800-XXX		PVC Termovormitav valkule valguska...			Lot-for-lot		√x			jm	
	ORACAL 8500 SERIES V		Oracal 8500-xxxx			Lot-for-lot		√x			jm	
	3M 7755-420		SC 7755-420 Hõbe			Lot-for-lot		√x			jm	
	3M 7755-431		SC 7755-431 Kuld			Lot-for-lot		√x			jm	
	3M 2080-M211		3M 2080-M211 Charcoal Metallic 1,52...			Lot-for-lot		√x			jm	
	3M 2330-82		3M 2330-82 Light blue 1,22x50m			Lot-for-lot		√x			jm	
	3M 2330-84		3M 2330-84 Azura blue 1,22x50m			Lot-for-lot		√x			jm	
	3M 2330-87		3M 2330-87 koobalsinine 1,22x50m			Lot-for-lot		√x			jm	
	3M 3630-015		3M 3630-015 Yellow 1,22x50m			Lot-for-lot		√x			jm	
	3M 3630-106		3M 3630-106 briliant-roheline 1,22x2...			Lot-for-lot		√x			jm	
	3M 3630-115		3M 3630-115 hele sidrunikollane 1,22...			Lot-for-lot		√x			jm	
	3M 3630-116		3M 3630-116 Bright Jade Green 1,22...			Lot-for-lot		√x			jm	
	3M 3630-125		3M 3630-125 kuldikollane 1,22x50m			Lot-for-lot		√x			jm	

Photo 13 Vinyl option list

Quantities are calculated by formulas.

6.5 CBOM-s for product configurator

BOM (bill of material) or product structure is a list of the raw materials, sub-assemblies, intermediate assemblies, sub-components, parts, and the quantities of each needed to manufacture an end product.

A BOM can define products as they are designed (engineering bill of materials), as they are ordered (sales bill of materials), as they are built (manufacturing bill of materials), or as they are maintained (service bill of materials). The different types depend on the business need and use for which they are intended. In process industries, the BOM is also known as the formula, recipe, or ingredients list. The phrase "bill of material" (or "BOM") is frequently used by engineers attributively to refer not to the literal bill, but to the current production configuration of a product, to distinguish it from modified or improved versions under study or in test [22]

BOMs are of hierarchical nature, with the top level representing the finished product which may be a sub-assembly or a completed item. BOMs that describe the sub-assemblies are referred to as modular BOMs. The first hierarchical databases were developed for automating bills of materials for manufacturing organizations in the

early 1960s. At present, this BOM is used as a database to identify the many parts and their codes in manufacturing companies. We are using a CBOM configurable bill of materials that are used when you have multiple options.

A multi-level bill of materials (BOM), referred to as an indented BOM, is a bill of materials that lists the assemblies, components, and parts required to make a product in a parent-child, top-down method. It provides a display of all items that are in parent-children relationships. When an item is a sub-component, of a (parent) component, it can in turn have its own child components, and so on. The resulting top-level BOM (item number) would include children; a mix of finished sub-assemblies, various parts, and raw materials. A multi-level structure can be illustrated by a tree with several levels. In contrast, a single-level structure only consists of one level of children in components, assemblies, and material [22].

BOM and routing is one of the most important and fundamental functions in an ERP system. BOMs are then linked with certain Configurators no fill the lower levels of the main BOM from Option lists and operation times from the measurement tables.

Material quantities and routine times are normally calculated by formulas of they have a certain amount of time needed to manufacture a sublevel.

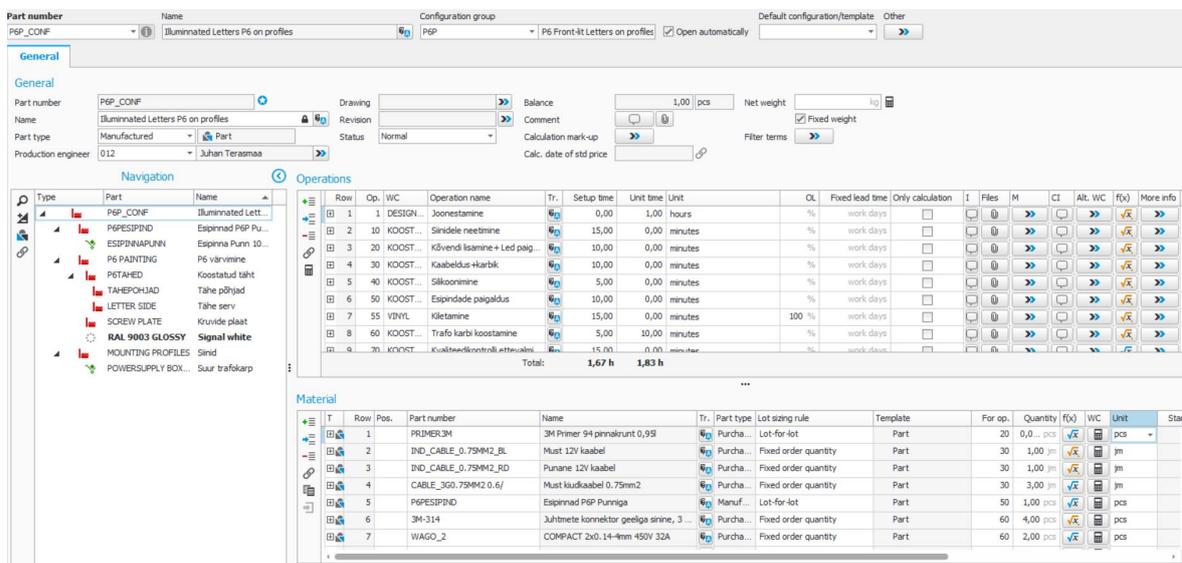


Photo 14 Top level BOM for P6P

The BOM Tree Parts view, though similar in navigational structure to the BOM Tree view, provides more details on the individual parts within a BOM and includes

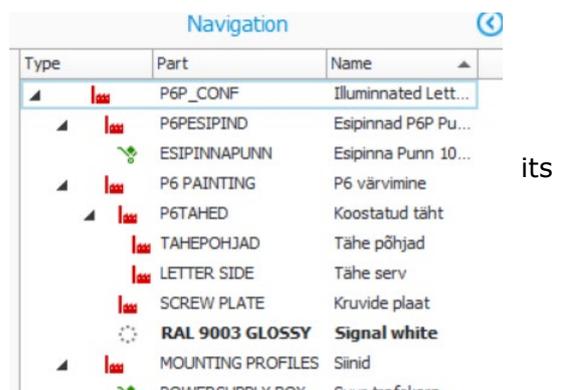


Photo 15 Navigation tree

parts-related options.

Operations can be added and deleted by variant code. For example, "kiletamine" applying vinyl is governed by a variant code KILE. When the product BOM is configured, a variant is chosen by an option list. If the variant ___KILE is triggered the operations is added or removed. The problem with the variant code is its method of use. The First variant is NCS. When NCS coloring is applied the operation will be added. The next variant code is ___Kile and the third _____LAS. Is used for laser cutting.

Operations

Row	Op.	WC	Operation name	Tr.	Setup time	Unit time	Unit	OL	Fixed lead time	Only calculation	I	Files	M	CI	Alt. WC	f(x)	More info
1	1	DESIGN...	Joonestamine		0,00	1,00	hours	%	work days	<input type="checkbox"/>			>>		>>	✓	>>
2	10	KOOST...	Siridele neetmine		15,00	0,00	minutes	%	work days	<input type="checkbox"/>			>>		>>	✓	>>
3	20	KOOST...	Kõvendi lisamine+ Led paig...		10,00	0,00	minutes	%	work days	<input type="checkbox"/>			>>		>>	✓	>>
4	30	KOOST...	Kaabeldus+karbik		10,00	0,00	minutes	%	work days	<input type="checkbox"/>			>>		>>	✓	>>
5	40	KOOST...	Silkoonimine		5,00	0,00	minutes	%	work days	<input type="checkbox"/>			>>		>>	✓	>>
6	50	KOOST...	Espindade paigaldus		10,00	0,00	minutes	%	work days	<input type="checkbox"/>			>>		>>	✓	>>
7	55	VINYL	Kiletamine		15,00	0,00	minutes	100 %	work days	<input type="checkbox"/>			>>		>>	✓	>>
8	60	KOOST...	Trafo karbi koostamine		5,00	10,00	minutes	%	work days	<input type="checkbox"/>			>>		>>	✓	>>
9	70	KOOST...	Kvaliteedikontrolli ettevalmi...		15,00	0,00	minutes	%	work days	<input type="checkbox"/>			>>		>>	✓	>>
10	80	QUALIT...	Kvaliteedikontroll		5,00	10,00	minutes	%	work days	<input type="checkbox"/>			>>		>>	✓	>>
11	90	PACKING	Pakkimine		10,00	30,00	minutes	%	work days	<input type="checkbox"/>			>>		>>	✓	>>
Total:					1,67 h	1,83 h											

Photo 16 Operation list for product

Measurements were taken during actual production of over 20 different orders and the median was chosen.

Examples of formulas used in BOM:

Calculating painting price for letters: if ([Tagapinna värv] = "true", if (([PINDALA] + [Übermõõt] * [Servamaterjali kõrgus]) < 3.34 and [Arvesta värvimise min hinda] = "true", 40 + ([PINDALA] + [Servamaterjali kõrgus] * [Übermõõt]) * [Kahevärviliste tähtede hind], 2 * ([PINDALA] + [Übermõõt] * [Servamaterjali kõrgus]) * [Kahevärviliste tähtede hind]), if ([Übermõõt] * [Servamaterjali kõrgus] < 3.34 and [Arvesta värvimise min hinda] = "true", 40 + (([PINDALA] + [Servamaterjali kõrgus] * [Übermõõt]) * [Kahevärviliste tähtede hind]), ((([Übermõõt] * [Servamaterjali kõrgus]) + ([PINDALA]) + ([Übermõõt] * [Servamaterjali kõrgus]))) * [Kahevärviliste tähtede hind]))))

Welding time of letters: ([Übermõõt] / 8 * 30) * [Difficulty level].

6.6 Pre and post calculation for manufacturing order

Production process monitoring can be divided into three main groups – Product tracking, Process parameters, and Process efficiency. Process monitoring is a very

valuable input for Decision Support Systems (DSS). The phrase DSS is an umbrella term used to describe computer applications that enhance the user's ability to make decisions, more specifically, the term usually refers to IS, which facilitates decision-making activities. [23]

6.6.1 Pre-Calculation

The main purpose of this procedure is to perform a financial calculation of manufacturing cost, cost price and sales price for product structures. Costs consisting of material, sub-contracted work, and own work are added together to the total manufacturing cost. You can create pre-calculations after you have created BOM and routings for the parts. Many of the options are suggested by rules in the system so you do not need to choose them. Measurements inputted in the Monitor configurator are generated from customer drawings and with macros written in CoreIDRAW.

Example:

Profile: P6B Profile 6 front lit letters on backplate:

Area: 3,54m²

Perimeter of letters: 38 meters

Letter height: 898 mm

Numbers of letters: 13 pcs

Overall length of sign: 3954 mm

Overall length of sign: 898 mm

Material area: 4,422 m²

Letter width: 102 mm

Backplate length: 4000 mm

Backplate height: 983 mm

Depth of Backplate: 45mm

Number of backplates: 2 pcs

Mõõdud

Component	Option/Value	Part number	Lock	Value/Quantity	OC	More info
(x) Pindala	PINDALA = 3,540			3,540 m ²		»
(x) Übermõõt	Übermõõt = 38			38 jm		»
(x) Tähekõrgus	Tähekõrgus = 898			898 mm		»
(x) Tähtede arv	Tähtede arv = 1			1 pcs		»
(x) Reklaami kogupikkus	Reklaami kogupik...			3 954 mm		»
(x) Reklaami kogu kõrgus	Reklaami kogu k...			898 mm		»
(x) Materjalpindala	Materjalpindala ...			4,422 m ²		»
(x) Täheposti laius	Täheposti laius ...			102 mm		»
(x) Taustaplaadi laius	Taustaplaadi lai...			200 mm		»
(x) Taustaplaadi kõrgus	Taustaplaadi kõr...			943 mm		»
(x) Taustaplaadi sügavus	Taustaplaadi süg...			45 mm		»
(x) Taustaplaatide arv	Taustaplaatide a...			2		»

Screenshot 3 Configurator P6B measurements

Options:

Frontside material: 5 mm WN770 opal plexi class

Backside material: 2mm AW1050 aluminum

Letter side material height: 70mm

Dimmable: yes

Vinyl: Oracle 8500-034

Letter color: RAL 9005 Matt

Materjal

Component	Option/Value	Part number	Lock	Value/Quantity
(x) Sign name	Sign name = Hy...			Hydroscant Entr...
Difficulty level	1 level	1-LEVEL		1,00 pcs
Frontside material	WN770 - 31% 5...	SMWN7705		4,422 m ²
Backside material	Leht materjal, A...	SMAW1050 1MM		4,422 m ²
Side material	1,2x70 AW1050...	1,2X70SERV		45,00 jm
Taustaplaadi materjal	2*2000*3000 A...	SMAW1050 2MM...		0,60 m ²
LED	KM-P2-W (0.72...	KAISEN KM-P2...		174,00 pcs
(x) LED Kogus	LED Kogus = 174			174 pcs
(x) Dimmable	Dimmable = Yes		Yes	x
Power supply	PWM-200-12 IP6...	PWM-200-12		1,00 pcs
Kletamine	Yes	YES		1,00 pcs
(x) Vinyl m2 (diletamise aja...	Vinyl m2 = 0,10			0,10 jm
NCS Värvimine	NO	NO		1,00 pcs
(x) NCS Color	NCS Color = No		No	x
(x) Kas tagapind on vaja v...	Tagapinna värv ...		Yes	x
(x) Arvesta värvimise min ...	Arvesta värvimis...		Yes	x

Screenshot 4 P6B Options

Backplate color: RAL 9005 Matt

Recalculation for quote: 902€ this is without markup and indirect overheads. After the order is won the BOM moves to engineering where the drawings are made and BOM corrected. After the order moves from customer order to engineering the BOM is corrected, this means current materials and parts are ordered. 90% of standard BOMs are correct but in some cases the LEDs of base materials have to be modified. BOM update after engineering and creation of production drawings: price 1036€.

6.6.2 Post-Calculation

The purpose of this procedure is to be able to perform a financial follow-up after a part/an order has been manufactured/reported. Here you compare planned costs with actual costs. You can calculate the price and see all allocations of costs during production.

Post calculation after production of example product: 1067€ Difference -3%

Goes to part	Reporting items	Part number	Name	Pl. qty	Rep. qty	Rejected qty	Remain. qty	Pl. material cost excl. SO
...		TÖMBENEET AL ...	Tömbeneet AL 4,8x12	4,00 pcs	123,00 pcs	0,00 pcs	0,00 pcs	0,12 EUR
BACKPLATE M...		L30X30X3	AW6060 30x30x3 6m L profil	4,00 jlm	10,00 jlm	0,00 jlm	0,00 jlm	17,14 EUR
BACKPLATE M...		U30X30X3	AW6060 30x30x3 6m U profil	4,00 jlm	16,00 jlm	0,00 jlm	0,00 jlm	17,14 EUR
BACKPLATE P...		SMAW1050 2MM...	2*2000*3000 AW1050A H24 32,6kg	5,00 m ²	6,00 m ²	0,00 m ²	0,00 m ²	138,55 EUR
LETTER SIDE		1,2X50SERV	1,2x50 AW1050A rull	46,00 jlm	45,00 jlm	0,00 jlm	0,00 jlm	44,28 EUR
P6B_CONF		3M-314	Juhtmete konnektor geeliga sinine, 3 kont. 0.5-...	4,00 pcs	4,00 pcs	0,00 pcs	0,00 pcs	1,06 EUR
P6B_CONF		3M_UR2_CONN...	Juhtmete konnektor geeliga, 3 kont. 0.4-0.9mm ²	2,00 pcs	2,00 pcs	0,00 pcs	0,00 pcs	0,17 EUR
P6B_CONF		CABLE_3G0.75M...	Must kiudkaabel 0.75mm ²	3,00 jlm	3,00 jlm	0,00 jlm	0,00 jlm	1,37 EUR
P6B_CONF		DIN75044,2X19...	DIN 750-4N Zn 4,2x19 Drilling screw RAL 9005	30,00 pcs	30,00 pcs	0,00 pcs	0,00 pcs	1,46 EUR
P6B_CONF		ELG-200-12DA-3Y	ELG-200-12DA-3Y IP67 DALI	1,00 pcs	1,00 pcs	0,00 pcs	0,00 pcs	43,42 EUR
P6B_CONF		IND_CABLE_0.7...	Must 12V kaabel	5,00 jlm	5,00 jlm	0,00 jlm	0,00 jlm	0,50 EUR
P6B_CONF		IND_CABLE_0.7...	Punane 12V kaabel	5,00 jlm	5,00 jlm	0,00 jlm	0,00 jlm	0,50 EUR
P6B_CONF		KAISEN KM-P1-...	KM-P1-W (0.5W HE) 6500K	328,00 pcs	328,00 pcs	0,00 pcs	0,00 pcs	75,44 EUR
P6B_CONF		LIIM+TIHENDMA...	LIIM+TIHENDMASS 600ML VALGE	174,00 g	174,00 g	0,00 g	0,00 g	1,86 EUR
P6B_CONF		ORACAL 8500 S...	Oracal 8500-xxxx	1,00 jlm	1,00 jlm	0,00 jlm	0,00 jlm	5,54 EUR
P6B_CONF		PEF312100	PE FOAM 1,2x100m 3mm	9,00 jlm	9,00 jlm	0,00 jlm	0,00 jlm	2,10 EUR
P6B_CONF		PRIMER3M	3M Primer 94 pinnakrunt 0,95l	0,0001 pcs	0,0001 pcs	0,00 pcs	0,00 pcs	0,00 EUR
P6B_CONF		WAGO_2	COMPACT 2x0.14-4mm 450V 32A	2,00 pcs	2,00 pcs	0,00 pcs	0,00 pcs	0,46 EUR
P6PESIPIND		SMWN7704	WN770 - 37% 4x3050x2050mm	0,60 m ²	0,492323 m ²	0,00 m ²	0,00 m ²	9,77 EUR
P6PESIPIND		SMWN7705	WN770 - 31% 5x3050x2050mm	4,00 m ²		0,00 m ²	0,00 m ²	81,40 EUR
TAHEPOHJAD		SMAW1050 1.5MM	Lehtmaterjal, AW1050A 1,5x1500x3000mm	1,20 m ²	1,50 m ²	0,00 m ²	0,00 m ²	28,28 EUR
TAHEPOHJAD		SMAW1050 1MM	Lehtmaterjal, AW1050A 1x1500x3000mm	4,422 m ²	4,259204 m ²	0,00 m ²	0,00 m ²	63,87 EUR

Screenshot 5 Direct materials on order

Part number	Reporting items	Op.	Name	Work center	Pl. qty	Rep. qty	Remaining quantity	Pl. time	Rep. time	Planned cost	Rep. cost
P6B_CONF		1	Joonesta...	DESIGN/E	1,00 pcs	1,00 pcs	0,00 pcs	2,00 hrs	1,27 hrs	44,00 EUR	27,94 EUR
P6B_CONF		5	Taustapa...	KOOSTAM	1,00 pcs	1,00 pcs	0,00 pcs	0,28 hrs	0,57 hrs	4,92 EUR	9,92 EUR
P6B_CONF		10	Kõvendit...	KOOSTAM	1,00 pcs	1,00 pcs	0,00 pcs	0,72 hrs	4,03 hrs	12,56 EUR	70,58 EUR
P6B_CONF		30	Kaabeldus	KOOSTAM	1,00 pcs	1,00 pcs	0,00 pcs	0,30 hrs	4,02 hrs	5,25 EUR	70,29 EUR
P6B_CONF		40	Silikooni...	KOOSTAM	1,00 pcs	1,00 pcs	0,00 pcs	0,63 hrs		11,10 EUR	
P6B_CONF		50	Espandad...	KOOSTAM	1,00 pcs	1,00 pcs	0,00 pcs	0,37 hrs		6,42 EUR	
P6B_CONF		55	Kleitamine	VINYL	1,00 pcs	1,00 pcs	0,00 pcs	0,03 hrs		0,50 EUR	
P6B_CONF		60	Trafo kar...	KOOSTAM	1,00 pcs	1,00 pcs	0,00 pcs	0,25 hrs		4,38 EUR	
P6B_CONF		70	Kvaliteedi...	KOOSTAM	1,00 pcs	1,00 pcs	0,00 pcs	0,50 hrs		8,75 EUR	
P6B_CONF		80	Kvaliteeti...	QUALITY	1,00 pcs	1,00 pcs	0,00 pcs	0,25 hrs		4,38 EUR	
P6B_CONF		90	Pakkimine	PACKING	1,00 pcs	1,00 pcs	0,00 pcs	1,17 hrs	0,12 hrs	17,50 EUR	1,75 EUR
P6 PAINTING		5	Joonesta...	DESIGN/E	1,00 pcs	1,00 pcs	0,00 pcs	0,17 hrs		3,67 EUR	
P6 PAINTING		20	Tähtede ...	PAINT 1	1,00 pcs	1,00 pcs	0,00 pcs			148,80 EUR	24,00 EUR
P6TAHED		10	Joonesta...	DESIGN/E	1,00 pcs	1,00 pcs	0,00 pcs	0,03 hrs	0,01 hrs	0,73 EUR	0,23 EUR
P6TAHED		15	Painutus...	BENDING	1,00 pcs	1,00 pcs	0,00 pcs	0,00 hrs	1,18 hrs	0,00 EUR	20,71 EUR
P6TAHED		20	Keevitus...	WELDING	1,00 pcs	1,00 pcs	0,00 pcs	2,63 hrs	2,73 hrs	50,40 EUR	52,48 EUR
TAHEPÕHJAD		10	Joonesta...	DESIGN/E	1,00 pcs	1,00 pcs	0,00 pcs	0,03 hrs	0,01 hrs	0,73 EUR	0,23 EUR
TAHEPÕHJAD		30	Freemine	MILLING	1,00 pcs	1,00 pcs	0,00 pcs	0,57 hrs	0,72 hrs	24,37 EUR	30,82 EUR
TAHEPÕHJAD		40	Freemine	MILLING	1,00 pcs	1,00 pcs	0,00 pcs	0,00 hrs		0,00 EUR	
LETTER SIDE		5	Joonesta...	DESIGN/E	1,00 pcs	1,00 pcs	0,00 pcs	0,02 hrs		0,37 EUR	
LETTER SIDE		10	Letter be...	TAHESERV	1,00 pcs	1,00 pcs	0,00 pcs	0,80 hrs	4,87 hrs	16,00 EUR	97,33 EUR
BACKPLATE PAL...		5	Joonesta...	DESIGN/E	1,00 pcs	1,00 pcs	0,00 pcs	0,05 hrs	0,02 hrs	1,10 EUR	0,47 EUR
BACKPLATE PAL...		10	Freemine	MILLING	1,00 pcs	1,00 pcs	0,00 pcs	0,38 hrs	0,68 hrs	16,23 EUR	29,26 EUR
BACKPLATE PAL...		20	Painutus...	BENDING	1,00 pcs	1,00 pcs	0,00 pcs	0,62 hrs		10,79 EUR	
BACKPLATE PAL...		25	Keevitus	WELDING	1,00 pcs	1,00 pcs	0,00 pcs	0,17 hrs	0,02 hrs	3,20 EUR	0,32 EUR
BACKPLATE PAL...		40	Värvimine	PAINT 1	1,00 pcs	1,00 pcs	0,00 pcs			41,00 EUR	34,00 EUR
PPESPIND		10	Joonesta...	DESIGN/E	1,00 pcs	1,00 pcs	0,00 pcs	0,03 hrs	0,01 hrs	0,73 EUR	0,23 EUR
PPESPIND		30	Freemine	MILLING	1,00 pcs	1,00 pcs	0,00 pcs	0,61 hrs	0,78 hrs	26,05 EUR	33,55 EUR
PPESPIND		35	Freemine	MILLING	1,00 pcs	1,00 pcs	0,00 pcs	0,00 hrs		0,00 EUR	
PPESPIND		40	Purnside II...	GLUEING	1,00 pcs	1,00 pcs	0,00 pcs	0,20 hrs	3,68 hrs	3,50 EUR	64,46 EUR
BACKPLATE MO...		10	Joonesta...	DESIGN/E	1,00 pcs	1,00 pcs	0,00 pcs	0,02 hrs		0,37 EUR	
BACKPLATE MO...		20	Sinide pu...	SAWDRILL	1,00 pcs	1,00 pcs	0,00 pcs	0,54 hrs	1,35 hrs	8,15 EUR	20,25 EUR

Screenshot 6 Direct materials reporter on order

6.6.3 Results of ERP implementation

Parts, routines, workstations, operations, and calculations of material quantities are calculated into product configurators that build up BOM's for productions and sales. Before Lightmaker OÜ did not have a clear understanding of the actual work hours and quantities of materials that are to be used to produce a product. Even if the calculations for materials were precise there was no calculations backed by concrete data for different operations milling, welding and general assembly hours were predicted by sales managers though gut feeling and there was no feedback from production back to sales after the production process. The biggest value of the ERP system is the feedback as everything now works on the same system calculations can be corrected to ensure that the customer is given the fairest price for their products from Lightmaker OÜ.

Pre-calculation of example P6B from sales: 902€

Pre-calculations of example P6B after engineering: 1032€

Post calculation of example P6B after production: 1067€

As you can see from the calculations already, after engineering the price of the product went up 13% and after production 16%. This means the initial offering was false, this means the profit earned from the transaction is 16% less than expected. This information is invaluable to Lightmaker OÜ to change the calculation formulas or find more optional designs for the product portfolio.

SUMMARY

The aim of this master's thesis was to find the best possible enterprises resource planning systems and implement it to Lightmaker OÜ. Implementation of the enterprise resource planning systems is part of Lightmaker OÜ 2025-year financial goals set by the management board of the company.

Many different ERP systems were researched to find out the main players in the field, their history and how they started and how they developed during that period. Comparison on abilities and descriptions were noted in this thesis of the fields where each ERP system was mainly used. Various components of different ERP systems were studied to understand the nature and complexity of the systems to choose the right software for the company.

Different cost models were researched, and ERP system Monitor ERP Systems was chosen as the ERP for Lightmaker OÜ

Two implementation methodologies and strategies were studied for the integration of the system to Lightmaker OÜ. Both methodologies were created by Microsoft Sure step was the first and second Success by design. Both methodologies are briefly described in this thesis to give the reader insight on the integration ways.

Vast standardization of products and mounting methods were created during the thesis. As the company had grown rapidly this part was always in the field of view but had not been done for different purposes. Design meeting with Engineers and sales managers took place for many months to create names and standard part lists for different designs and options. New product names and descriptions were created together with catalogs that were forwarded to customers so they could give Lightmaker OÜ simpler, faster, and more precise quotes and orders of the products. This strongly strengthens Lightmaker OÜ market position to serve their customers quickly, accurately and in proper manner.

Gathering the data of operations, routines, and worktimes to create flowcharts of routines brought out clear shortcomings in production where layout modification to LEAN manufacturing and 5S to organize workplaces was applied to improve overall productivity and reduce production cycle times.

Product bill of material configurators with parts, option lists, rules and calculations were created in Monitor ERP systems according to operations, routines, and cycle times. Standardized product prices for sales and configured BOMs could now be created during minutes. The cost of the product, from sales to production could be created and monitored and post calculated in minutes. Material sourcing, warehouse management, stock materials and parts ordered with clear understanding of allocations to production workstations and quality related costs.

In conclusion, it can be said that based on these result Lightmaker OÜ has chosen and implemented the best ERP for their needs. Monitor ERP Systems will serve as a gateway to new business and to achieve its goals set by the management board.

KOKKUVÕTE

Käesoleva magistritöö eesmärgiks oli leida parim võimalik ärijuhtimistarkvara ja juurutada see Lightmaker OÜ-sse. Ettevõtte ressursside planeerimise süsteemide juurutamine on osa Lightmaker OÜ 2025. aasta finantseesmärkidest, mille on püstitanud ettevõtte juhatus.

Uuriti paljusid erinevaid ERP süsteeme, et selgitada välja valdkonna peamised tegijad, nende ajalugu ning kuidas need alguse said ja kuidas sel perioodil arenesid. Selles lõputöös märgiti ära võimete võrdlus ja kirjeldused valdkondadest, kus iga ERP-süsteemi põhiliselt kasutati. Uuriti erinevate ERP süsteemide erinevaid komponente, et mõista süsteemide olemust ja keerukust, et valida ettevõttele sobiv tarkvara.

Uuriti erinevaid kulumudeleid ning Lightmaker OÜ ERP-ks valiti ERP süsteem Monitor ERP Systems.

Süsteemi Lightmaker OÜ-ga integreerimiseks uuriti kahte rakendusmetoodikat ja strateegiat. Mõlemad meetodikad lõi Microsoft Sure samm oli esimene ja teine edu disaini järgi. Mõlemat meetodikat kirjeldatakse selles lõputöös lühidalt, et anda lugejale ülevaade integratsiooniviisidest.

Lõputöö käigus loodi ulatuslik toodete ja paigaldusviiside standardiseerimine. Kuna ettevõtte oli kiiresti kasvanud, oli see osa alati vaateväljas, kuid seda polnud tehtud erinevatel põhjustel. Kohtumised inseneride ja müügijuhtidega vahel toimusid mitu kuud, et luua nimed ja standardsete osade loendid erinevatele disainilahendustele ja võimalustele. Koostati uued tootenimed ja -kirjeldused koos kataloogidega, mis edastati klientidele, et nad saaksid Lightmaker OÜ-le teha lihtsamaid, kiiremaid ja täpsemaid toodete hinnapakumisi ja tellimusi. See tugevdab tugevalt Lightmaker OÜ turupositsiooni, et teenindada oma kliente kiiresti, täpselt ja korrektselt.

Toimingute, rutiinide ja tööaegade andmete kogumine rutiinide vooskeemide koostamiseks tõi esile selged puudujäägid tootmises, mille puhul rakendati asendiplaani muutmist LEAN tootmiseks ja 5S-i töökohtade korraldamiseks, et parandada üldist tootlikkust ja vähendada tootmistsükli aega.

Monitori ERP-süsteemis loodi vastavalt toimingutele, rutiinidele ja tsüklaegadele tootearvestuse materjali konfiguraatorid koos osade, valikuloendite, reeglite ja arvutustega. Standardiseeritud tootehindu müügi- ja konfigureeritud spetsifikatsiooni

saab nüüd luua minutite jooksul. Toote maksumust alates müügist kuni tootmiseni saab luua ja jälgida ning järelarvestada minutitega. Materjalide hankimine, laohaldus, laomaterjalid ja osad tellitud, mõistes selgelt tootmistöökohtade jaotust ja kvaliteediga seotud kulusid.

Kokkuvõtteks võib öelda, et nende tulemuste põhjal on Lightmaker OÜ valinud ja juurutanud enda vajadustele parima ERP. Monitor ERP Systems on värv uuele ärile ja juhatuse seatud eesmärkide saavutamisele.

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APPENDICES 1 Standardization of main production products

- **P00 - Letters and plates cut out from solid material.**



Photo 17 P00 Letters or plates

- **P01 - Letters or plates with attached sides**



Photo 18 P01 Letters with attached sides

- **P01 - Old style neon letters**

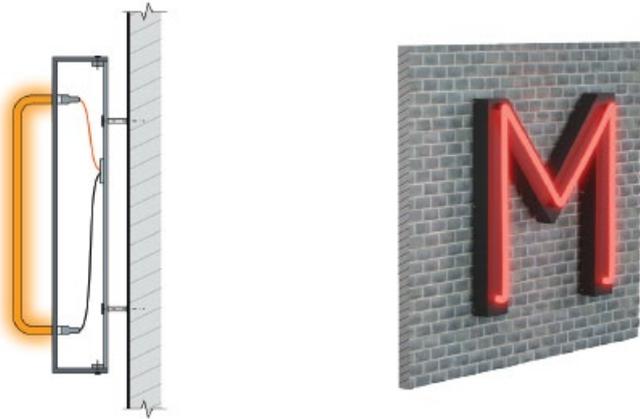


Photo 19 P1 Neon letters

➤ **P1FN - Fake neon letters extruded acrylic tube imitation**



Photo 20 P1FN Fake neon letters

➤ **P1FN and P2FN**



Photo 21 P1FN and P2FN

➤ **P1BS and P2BS - Bulb sign**

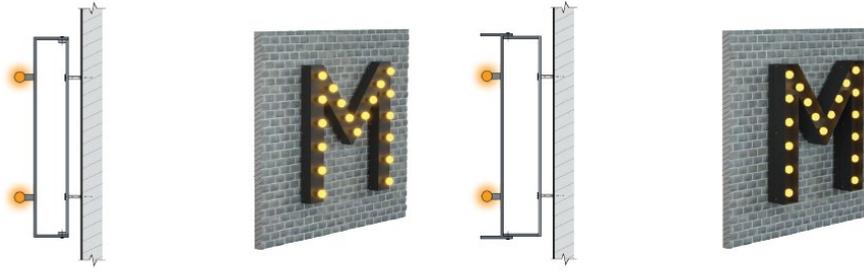


Photo 22 P1BS and P2BS

➤ **P3 – Back-lit channeled letters**

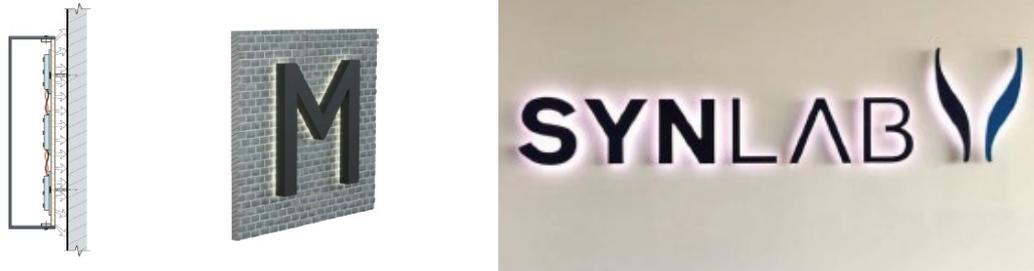


Photo 23 P3 Back-lit letters

➤ **P4 – Front lit letters with metal trim**



Photo 24 P4 Front-lit letters with metal trim

➤ **P5 – front lit letters with a plastic trim**



Photo 25 P5 Front-lit letters with plastic trim

➤ **P6 – Front lit letters**



Photo 26 P6 Front lit letters

➤ **P8 – Front and/or side-lit letters**



Photo 27 P8 Front and/or side lit letters

➤ **PP30 Full acrylic letters**

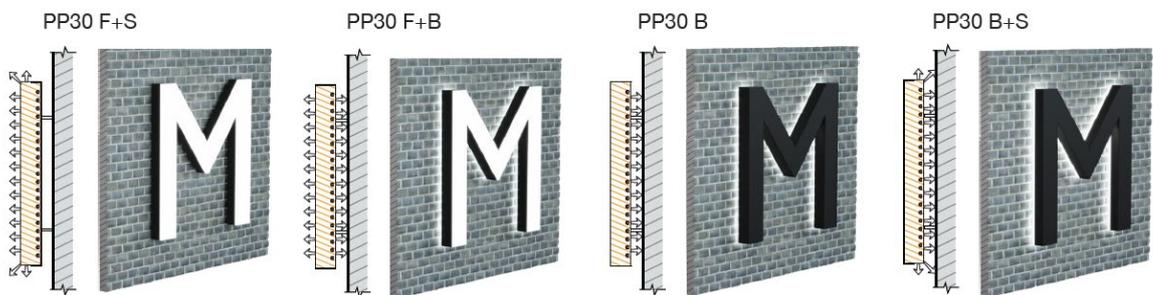


Photo 28 PP30 Full acrylic letters

➤ **L1 Lightbox with only cut out design**



Photo 29 L1 lightbox with cutout design

➤ **L4 - Lightbox with full front illumination**

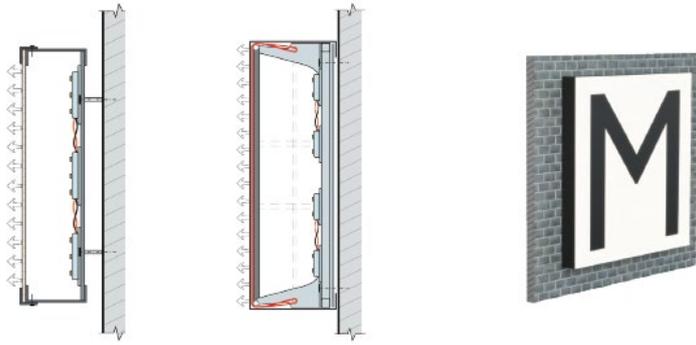


Photo 30 L4 Lightbox with full front illumination

➤ **L8 – front and side lit box**



Photo 31 L8 Front and side lit box

➤ **L10 – Lightbox with extruded cut out**



Photo 32 Extruded cut out design lightbox

➤ **FL00, FL01, FL1m FL4, FL6, FL8m FL10 Flagsigns**

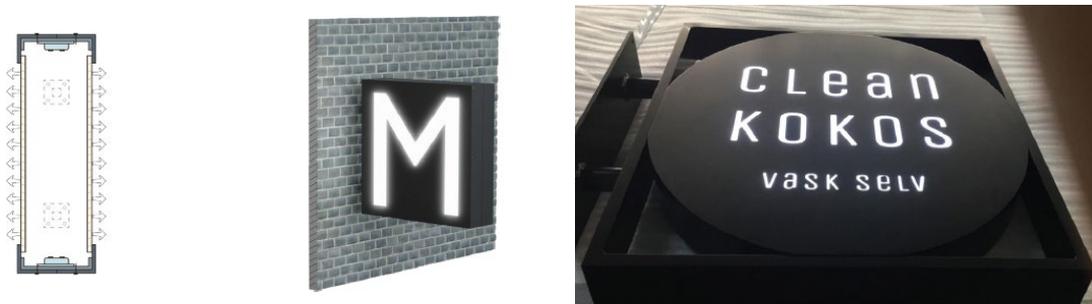


Photo 33 FL1 front lits cut out flagsing

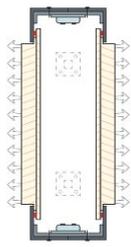


Photo 34 FL10 Extruded front flagging

➤ Pylon/totem – freestanding sign



Photo 35 Pylon/Totem

APPENDICES 2 Standardization of main mounting methods

- **MM01 Signe on aluminium U profiles**

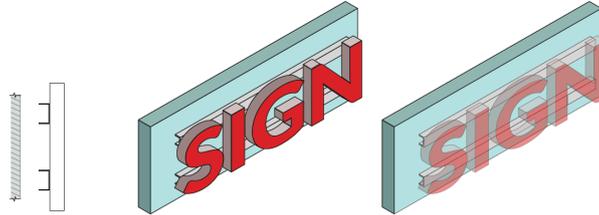


Photo 36 MM01 mounting method

- **MM02 Sign on aluminium U profiles and hooks**

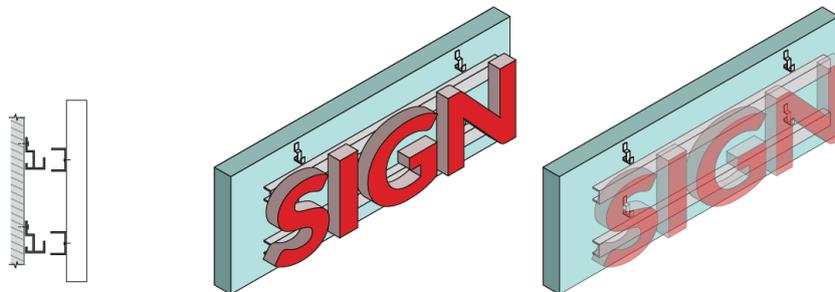


Photo 37 MM02

- **MM03 Sign on U profiles + distances with hooks**

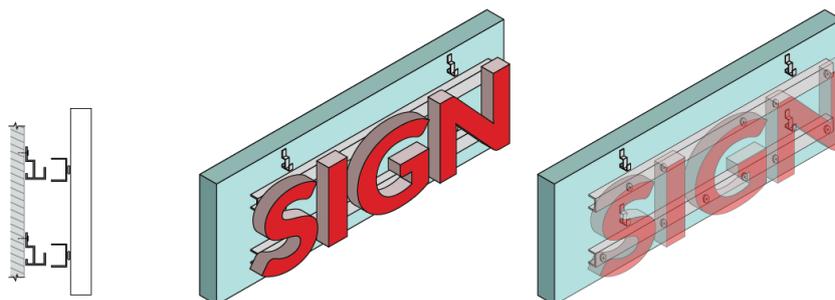


Photo 38 MM03

- **MM04 Sign on U profiles+hooks and plates**

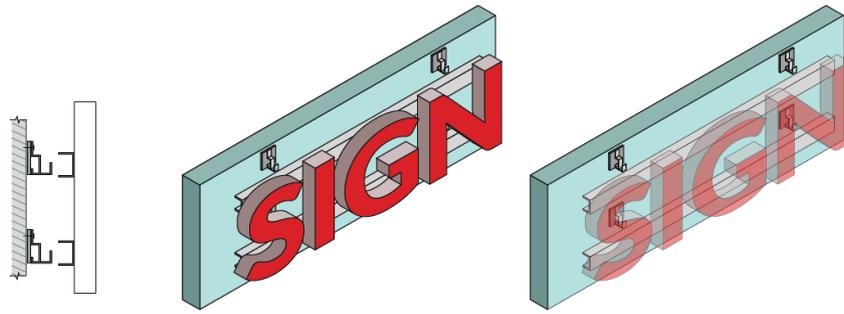


Photo 39 MM04

➤ **MM05 Sign on U profiles + Hooks + Plates + Distances**

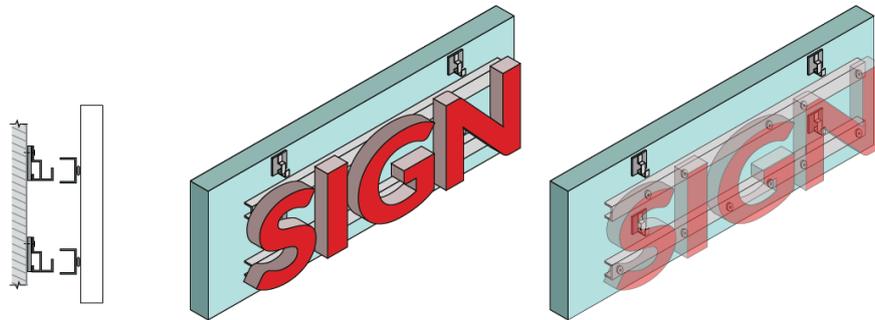


Photo 40 MM05

➤ **MM06 Sign on U profiles with mounting ears**

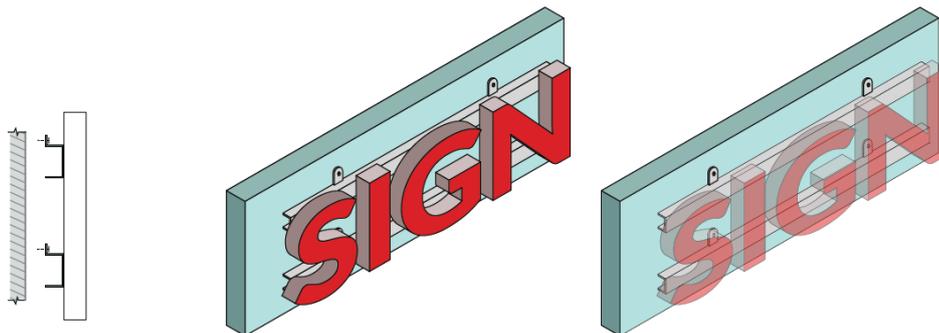


Photo 41 MM06

➤ **MM07 Sign on U profiles with mounting ears + L profiles**

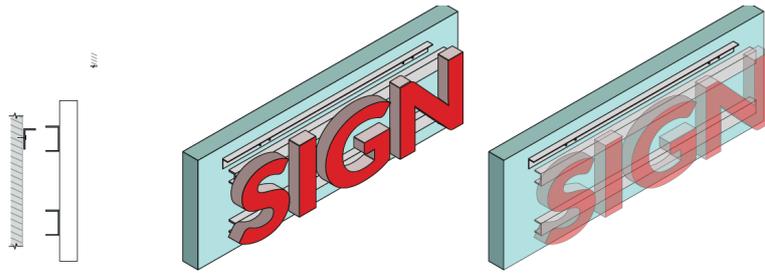


Photo 42 MM07

➤ **MM08 Sign on U profiles with mounting ears+L**

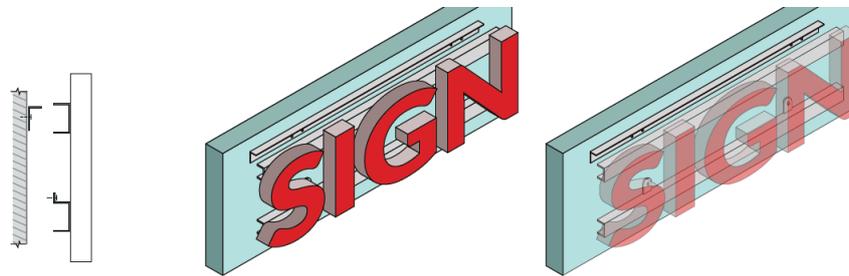


Photo 43 MM08

➤ **MM09 Sign on U profiles with suspended wires**

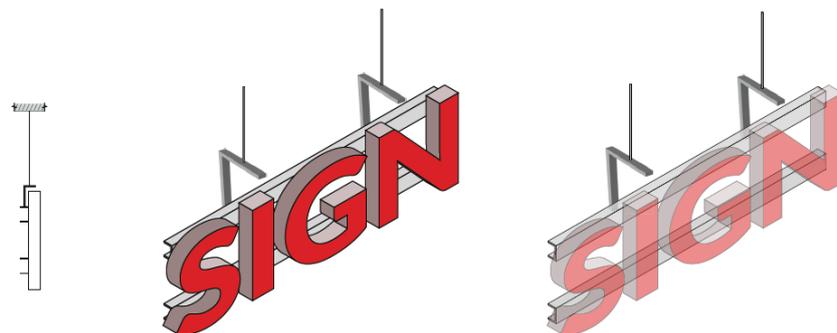


Photo 44 MM09

➤ **MM10 Sign on L profiles+ L profiles**

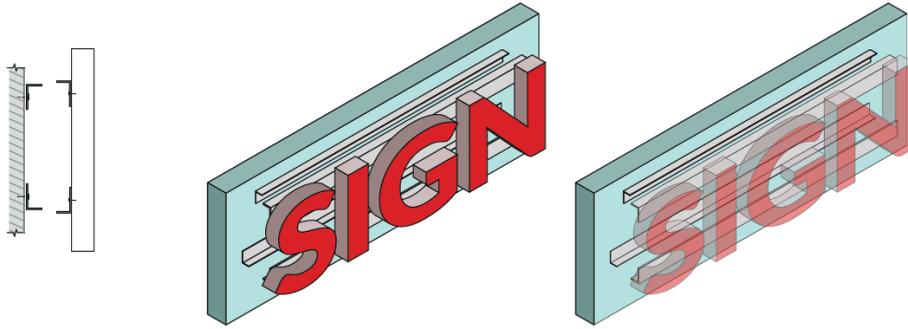


Photo 45 MM10

➤ **MM11 Signe on acrylic frames**

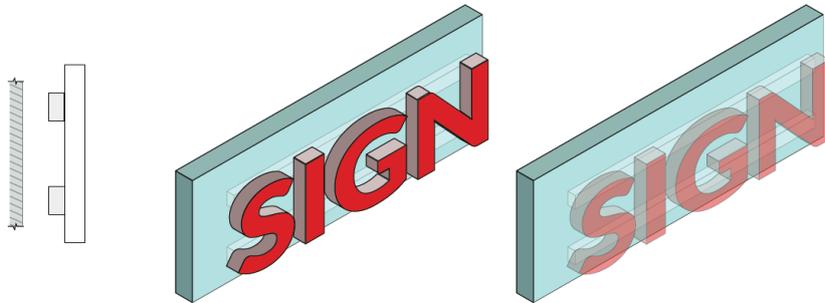


Photo 46 MM11

➤ **MM12 Sign on Frame with telescopic mounting**

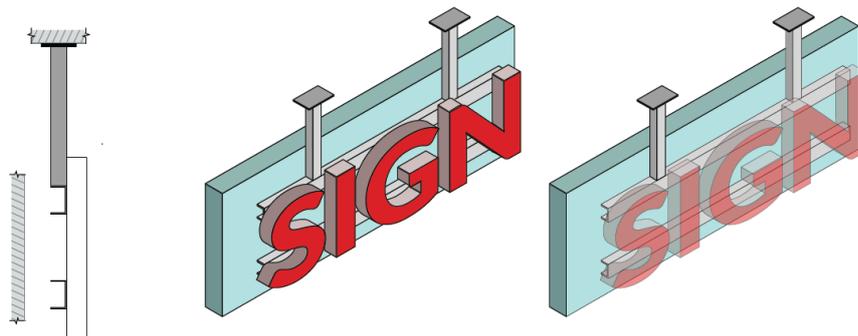


Photo 47 MM12

➤ **RM01 Roof mounting with horizontal frames**

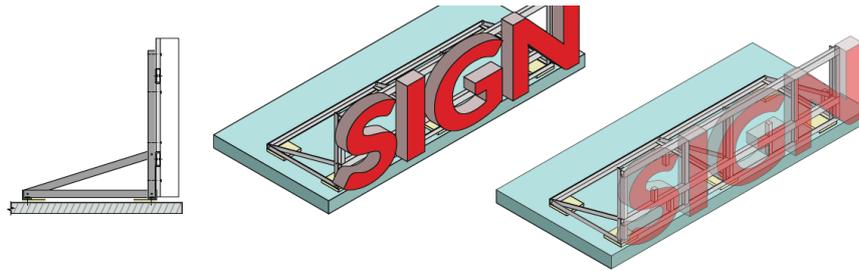


Photo 48 RM01

➤ **RM02 Roof mounting letter by letter**

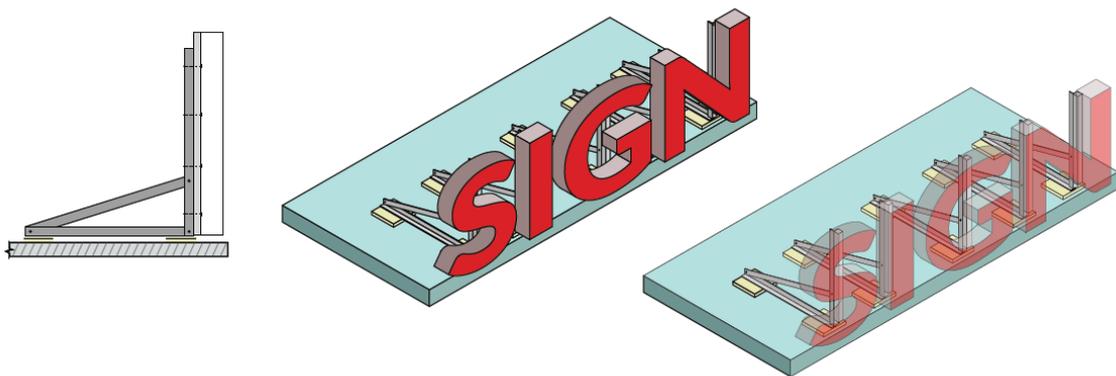


Photo 49 RM02

➤ **SPMM01: Sign directly against wall**

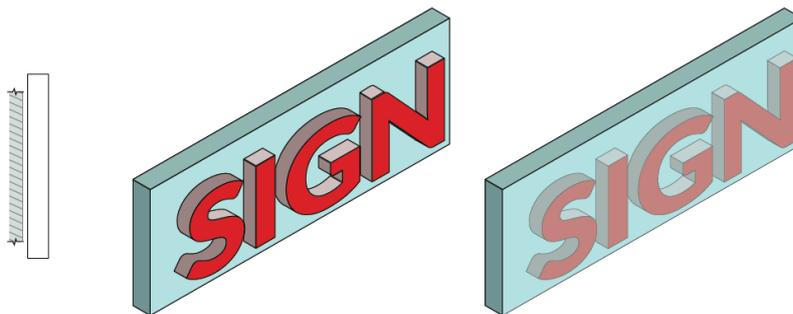


Photo 50 SPMM01

➤ **SPMM02: Sign with distance pins behind it**

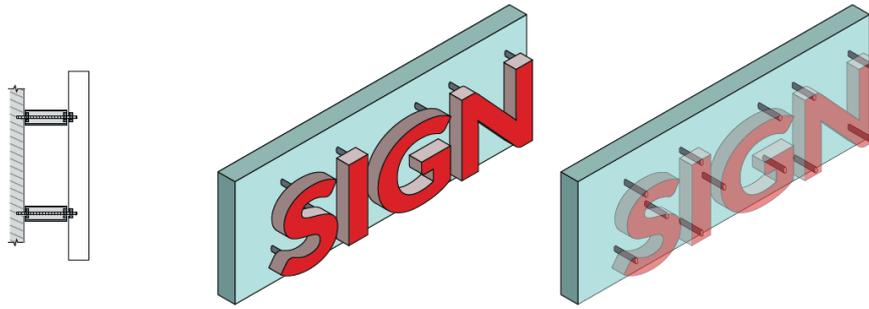


Photo 51 SPMM02

Standard Mounting systems for Lightboxes

- **LM01 Lightbox directly against wall**

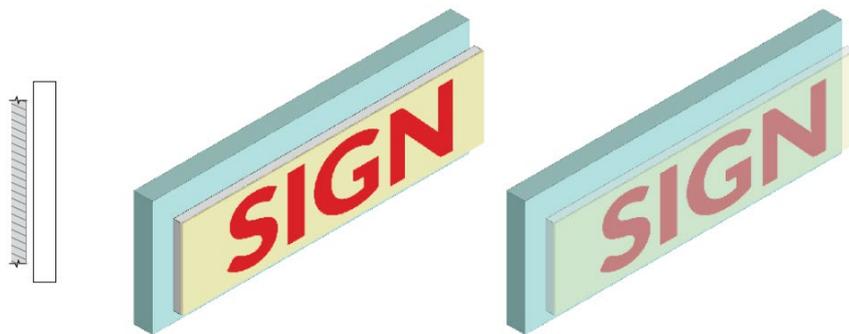


Photo 52 LM01

- **LM02: Lightbox on L profiles + frame**

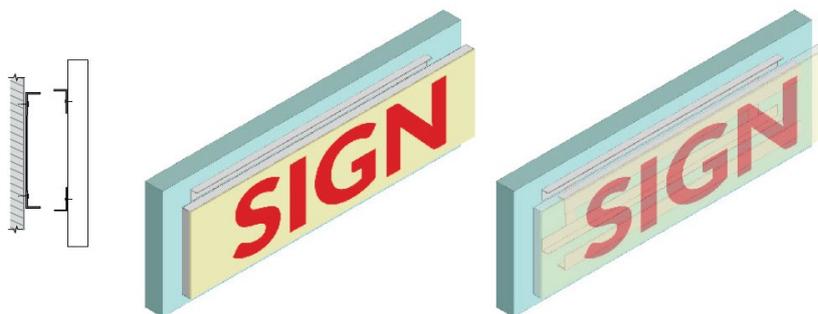


Photo 53 LM02

- **LM03: Lightbox on U profiles and U profiles**

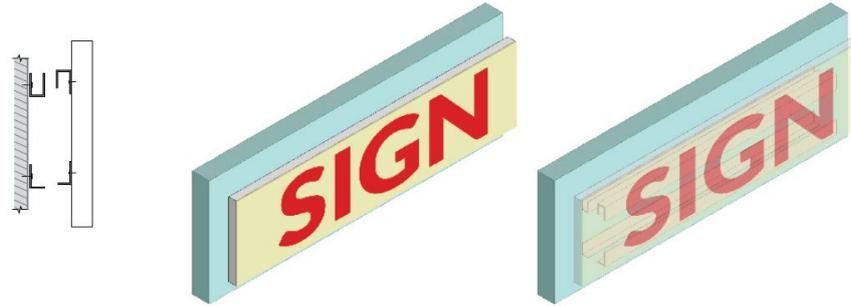


Photo 54 LM03

➤ **LM05: Lightbox on Z profiles with frame**

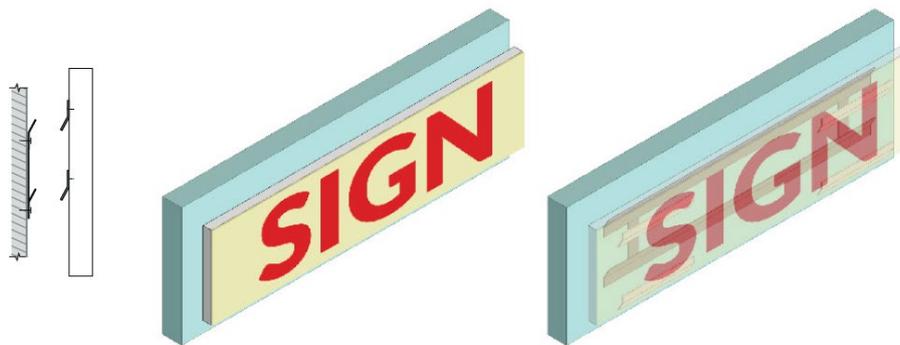


Photo 55 LM05

➤ **LM06: Lightbox with telescope mounting**

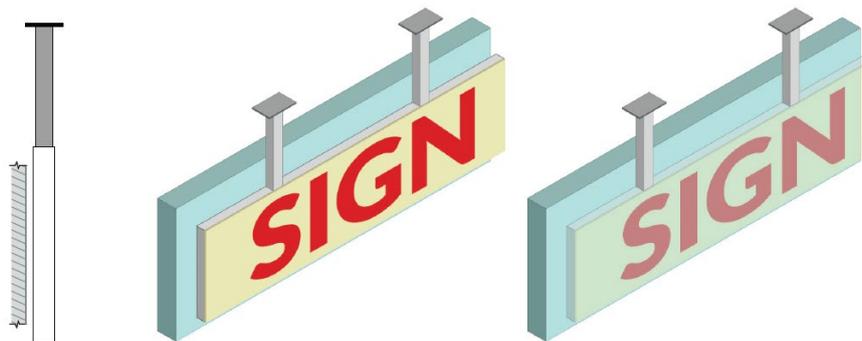


Photo 56 LM06

➤ **LM07: Lightbox suspended with wires**

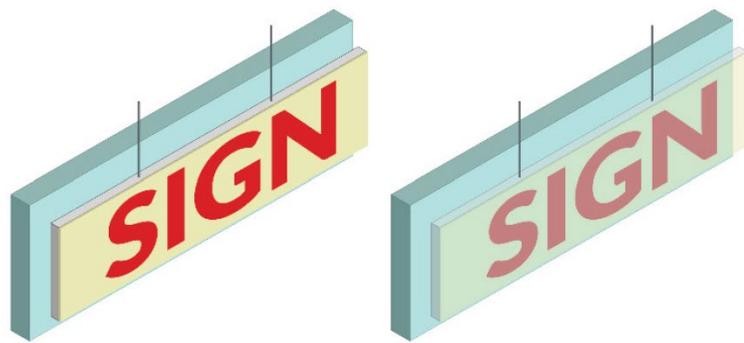


Photo 57 LM07

➤ **Hat profiles**

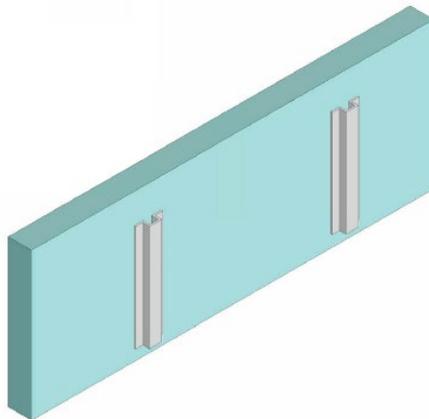


Photo 58 Hat profiles

Flag sign Mounting systems.

➤ **FM01: Open one leg**

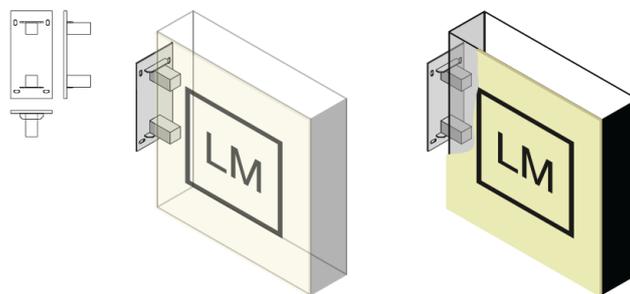


Photo 59 FM01

➤ **FM02: Covered one leg**

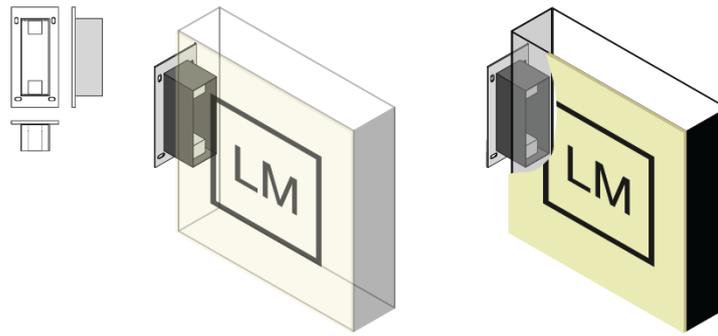


Photo 60 FM02

➤ **FM03: Open two leg**

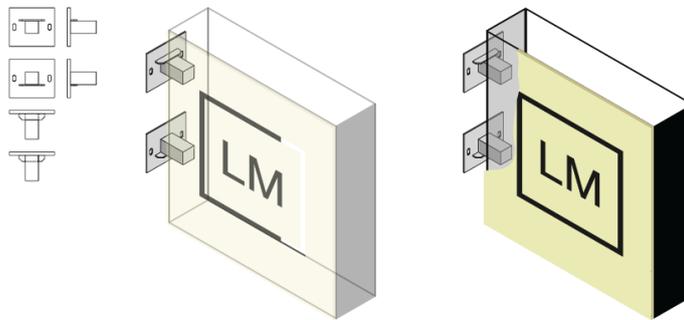


Photo 61 FM03

➤ **FM05: Hidden leg**

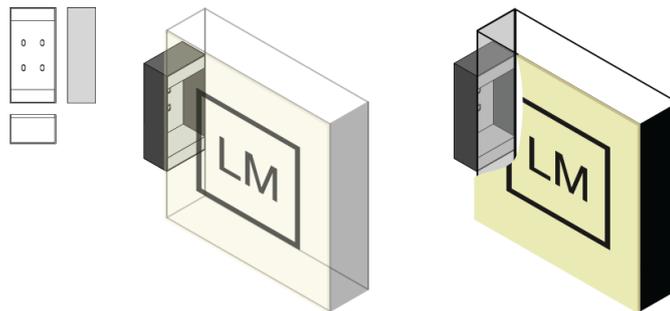


Photo 62 FM05

➤ **FM06: Open two round leg**



Photo 63 FM06