Peripherals for Electronic Shelf Labels

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Abstract

This master thesis was commissioned by the research and development department of Pricer AB in Stockholm, Sweden. Pricer is currently developing a new locking mechanism that will significantly improve label fastening. However, this mechanism requires new attachments. The initial goal of the thesis was to investigate how the existing peripherals for Electronic Shelf Labels can be improved for use with a new locking mechanism and develop prototypes that prove compatibility.

The initial effort of the project was to investigate current use of both ESLs and conventional paper labels in stores and document all possible label attachment solutions. From these cases the most commonly used were prioritized and highly prioritized cases were included in the project.

Using contemporary product development methods the cases were first researched by viewing patents and competitors' products. Then solutions were iteratively sketched and evaluated until viable solutions were found. Then these solutions were modeled in 3D CAD and evaluated. When the solutions were developed enough for testing, SLA prototypes were produced and evaluated. After evaluating all the solutions produced during the entire process the final solutions were modeled in CAD and simultaneously adjusted for manufacturing and for the latest iteration of the locking mechanism.

The final solutions include products for shelf edge rails, peg hooks, shelf talkers and fruit and vegetable signs. Some new features such as brandable areas in the rails were discovered during the development process. These features add to the value of the new products. All of the products have been greatly simplified compared to its predecessors.
Sammanfattning


Det första steget i projektet var att undersöka hur både ESLer och pappers etiketter används i butiker och dokumentera alla möjliga infästningar. Från dessa infästningslösningar gjordes en prioritering av de vanligaste metoderna och de som ansågs vara högt prioriterade inkluderades i projektet.

Projektet drevs med vedertagna produktutvecklingsmetoder och startade med att de utvalda infästningsmetoderna undersöktes genom att läsa patent och titta på konkurrenters produkter. Sedan skissades iterativt lösningar och utvärderades tills tillräckligt trovärdiga lösningar var framtagna. Dessa lösningar modellerades i 3D CAD och utvärderades. När lösningarna ansågs tillräckligt utvecklade för tester togs SLA modeller fram och utvärderades. Efter utvärdering av samtliga lösningar framtagna under hela produktutvecklingsprocessen modellerades de slutgiltiga lösningarna i CAD och anpassades samtidigt för tillverkning och till den senaste versionen av låsningsmekanismen.

De slutgiltiga lösningarna inkluderar produkter för hyllkantslister, spjut, hyllpratare och frukt- och grönt skyltar. Några nya möjligheter så som utrymme för kundmeddelanden i listerna kom fram under arbetets gång vilket ytterligare ökar värdet av de nya lösningarna. Alla produkter har markant förenklats jämfört med deras föregångare.
Glossary

**Computer-aided design (CAD)** is the use of computer technology for the design of objects. In this project it was used to develop solid models of the concepts.

**Electronic shelf labels (ESL)** are the conventional name of electronic display modules used to display product pricing in stores.

**esp@senet** is search engine for finding international patents.

**HCN** is Pricers ESL with dimensions 70 mm x 35 mm. The N stands for Normal.

**HCS** is Pricers ESL with dimensions 48 mm x 35 mm. The S stands for Small.

**Liquid crystal display (LCD)** is a thin, flat electronic visual display that uses the light modulating properties of liquid crystals (LCs).

**Solid Edge** is a 3D CAD parametric feature solid modeling software.

**Stereolithography (SLA)** is an additive manufacturing technology for producing models, prototypes, patterns, and in some cases, production parts.
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1. Introduction

In the following section the background of the thesis is described. The mission statement and goal is defined and all restrictions and limitations are listed. The project mainly surrounds Electronic shelf labels, hereafter referred to as ESLs.

1.1. About Pricer

Pricer was founded in 1991 in Uppsala, Sweden, logotype in Figure 1. In connection with the formation Pricer acquired Nordic Region license to a patent pertaining electronic price marking from the Swiss company Unigrafic AG. Pricer now offers the most complete and scalable ESL solution on the world market.

“From the position of market leadership, Pricer’s vision is to provide retailers with attractive, innovative and high-quality solutions and tools for real time pricing and communication.”

- Pricer’s vision

Pricer is the largest ESL company with an installed base greater than its competitors’ combined. Pricer today has over 5,000 installations in over 200 different retailers, and about 70 million ESLs installed in 40 countries. Customers include many of the foremost retail chains. Pricer, in co-operation with qualified partners, offers a totally integrated solution together with peripherals, applications and services.

1.2. Background

Pricer AB is currently developing a new label fastening system for their ESL line. This new method of attaching the labels to store interiors requires a redesign of the rails used on shelf edges and other attachment peripherals. To ease market introduction of the new products it is essential to make sure existing peripherals such as shelf talkers, peg hooks etc. are compatible with the new system.
1.3. Mission statement

Identify, investigate and solve possible component incompatibilities in the new product line.

1.4. Project breakdown

The project was divided into five parts

**Part 1**
Identify and categorize pricing scenarios based on real world store examples. Prioritize cases and select the most important for further investigation.

**Part 2**
Generate and evaluate concept solutions for selected cases.

**Part 3**
Develop and evaluate Proof-of-concept prototypes of the concepts.

**Part 4**
Develop final solutions complete with manufacturing documentation.

**Part 5**
Summarize project results in documentation and presentation.

1.5. Goal

The goal of this project was to investigate how the existing peripherals can be improved for use with the new system and develop prototypes to prove compatibility.
1.6. **Restrictions and limitations**

The following segment describes the restrictions and limitations that were determined before the project began.

- The geometry of the locking mechanism is not to be changed in vertical offset.
- Since the locking mechanism is under development it is subject to change during this project.
- Horizontal placements and dimensions of the locking mechanism can be modified as long as the function does not suffer from the modifications.
- The rail can be modified as long as the modifications do not affect the locking mechanisms function of the manufacturability of the rail.
- Shelf talkers can be modified to a certain extent, but not as drastically that it requires new manufacturing methods.
- Other client-produced products are not to be modified. Changes to these components can be suggested but cannot be critical to final solutions.
- Fruit and vegetables signs can be modified as long as the same manufacturing methods can be applied.
2. **Context**

This segment describes the context and background around which the project were carried out. It also clarifies the terminology used in the project.

2.1. **Electronic shelf labels**

Electronic shelf labels or ESLs are the conventional name of electronic display modules used to display product pricing in stores. The modules usually use a Liquid Crystal Display (LCD) or other similar technologies to display the price to the customer. The ESLs are linked in a network either via radio, infrared or visible light to allow them to be updated remotely. Automated ESL systems main benefits are decreasing pricing management labor while increasing pricing accuracy.

2.2. **Pricer’s current ESLs**

Pricer’s current Continuum line consists of a number of ESLs with different dimensions to support specific client needs, see Figure 2. Pricer offers a two-way system that allows to labels to respond with critical information to the system such as display failure or similar issues. Another possibility with a two-way system is to have the ESLs display alternative information such as current stock balance or sales statistics.

![Figure 2. Pricer continuum ESL line](image-url)

For this project the display features are of little importance. The context that will influence the project is instead the outer dimensions and geometry of the labels and the fastening mechanism used in the current products. The Pricer ESLs have plastics lips on the top and bottom of the labels that allow them to be snapped in to grooves in rails and single attachments. While these lips make mounting easy they require force to be removed and does not lock the labels from being pushed horizontally in the attachments.
2.3. Future ESLs

Pricer is currently developing a new locking mechanism for the ESLs that will require no added force to detach the labels from the attachments. Instead a special tool will be used. The mechanism is patent pending. The new locking system will also fasten the labels so they are secured from horizontal movement in the attachments. The new system is based on spring-loaded magnetized metal blocks that lock the labels in place and require a special tool with powerful magnets to release the labels from the attachments.

A basic sketch of the mechanism used with a rail can be seen in Figure 3. The metal blocks are pushed into the ESL when the hooks are placed in the rail. Once the hooks are properly placed, the blocks springs back to fill the gap above the hook, thereby hindering it from being removed. The use of magnetized metal allows a strong magnet to be placed in front of the ESL releasing it without the use of force.

![Figure 3. Patent pending ESL locking mechanism](image)

2.4. Store visits

To gain knowledge about price labeling in general, several visits to stores in different markets and geographical locations where performed. The goal of the visits was to document as many different pricing attachment solutions as possible and how commonly they were used. Since most stores in Sweden have yet to adopt a ESL systems the majority of the visits where to stores with traditional pricing labels.
2.4.1. Shelf edge rails

The vast majority of labels in stores are attached to shelf edge rails. These rails come in various profiles depending on the manufacturer and some provide additional features such as color options. Most rails also provide the ability to attach extra peripherals such as shelf talkers and promotion indicators. In stores with Pricer ESLs the attachments were poorly used and not in unison with the ESLs as intended. In one example the shelf talker was actually taped in front of the ESL. One observation worth considering was the spice shelves, which had a curved profile that seemed to prohibit the use of ESLs, examples in Figure 4.

Figure 4. Examples of shelf edge labels and attachments
2.4.2. **Peg hooks**

The second most common product display is peg hooks. Peg hooks are used where the products are not fit to stand on shelves, for example candy bags or batteries. This method uses at least one peg hook per product and requires price labels either below or, more commonly, above each product. One common workaround is to place a shelf edge rail above the peg hooks to support the labels. This is pleasing since it unifies the appearance of the whole store interior. Two other methods commonly used are peg hooks with hangers for rocker labels or metal plates with adhesive labels, examples in Figure 5.

![Figure 5. Examples of Peg hooks labeling](image)

2.4.3. **Fruit and vegetable signs**

The fruit and vegetable section of grocery stores often has its own kind of signs that shows photos of the products along with the name. They often display further information such as where the products were produced and classes, or other similar facts. The thing that stands out about these signs is their modular structure. There actually are signs that are specially designed for the Pricer labels already, as seen in Figure 6.

![Figure 6. Examples of Peg hooks labeling](image)
2.4.4. Other attachments

Pricing labels located on larger signs are also quite common but since the price is displayed in large prints in these situations the ESLs relatively small form factor makes it unsuitable as an alternative. Other less common label locations are wire baskets and on-product tags. These sometimes have a price size close to the ESLs displays which makes them an applicable alternative. Some examples of all these different scenarios are shown in Figure 7. Most of these scenarios can be solved with a single attachment that allows the ESLs to be fastened on any flat surface.

![Figure 7. Examples of other attachments](image)

2.4.5. Other observations

What happens if the clients wants to turn the ESLs vertical? It might be worth looking into if this is possible with the available products and if it can be improved without compromising the horizontal positions readability, see Figure 8.

![Figure 8. Vertical label placement](image)
Many products in electronics stores have specially made displays, see Figure 9. Developing a few concepts for such displays can show some very appealing uses of ESLs that are more visually pleasing than the usual shelf edge solutions.

Figure 9. Custom display in electronics store

Shelf talkers are used to communicate messages to the customers about the products such as special sales, which products are ecological or even if the products are out of stock, see Figure 10. These shelf talkers are often unattractive and poorly fitted. Developing visually appealing attachments can increase clients willingness to switch to Pricer's ESL system.

Figure 10. Shelf talkers to communicate message to customers
In home improvement stores, on-product labels are often used when the customers are intended to try out the products with their hands, see Figure 11. It might be worth trying to see if it is possible to use Pricer ESLs on such labels.

Figure 11. On-product labels

Can you use Pricer ESLs on curved shelves (see Figure 12)? If not, how can we make that possible. This can create possibilities for the clients to be more creative in store interiors and still use ESLs.

Figure 12. Curved shelves
2.5. **Important cases**

After studying the material gathered during the store visits a prioritized case list was developed. This lists the highly prioritized cases that were to be part of this project. The medium prioritized cases were to be included if time allowed and the low priority cases were discarded.

*High priority*

- Shelf edge rails
- Shelf talkers
- Peg hooks
- Fruit & Vegetable signs

*Medium priority*

- Baskets
- Flat surfaces

*Low priority*

- Custom displays
- Large signs
2.6. Existing solutions

After listing the important cases further research of these cases were done. Information was gathered from other ESL manufacturers, Pricer promotion material and international patents from esp@senet.

2.6.1. Shelf edge rails

Shelf edge rails come in many different shapes varying from flat beams to curved aluminum profiles, see Figure 13. The protection the ESLs require from the rails varies depending on the situation. ESLs mounted close to the floor run the risk of being hit by shopping carts or accidentally kicked on. In these scenarios the rails are often fitted with a clear plastic cover to completely enclose and protect the ESLs. When the labels are mounted higher above the floor less protection is needed. In the case with curved profiles the rails has no fastening abilities for the ESLs and require a single attachment for each individual label.

Figure 13. Examples of shelf edge rails

2.6.2. Shelf talkers

The most common way of attaching shelf talkers is placing them inside the transparent rail housing the paper price labels. The new locking mechanism introduces a more complex rail and does not support this placement of shelf talkers. Other solutions found are grooves on the ESLs that allow shelf talkers to be dropped in front of the labels. Examples of these shelf talkers are shown in Figure 14.

Figure 14. Examples of shelf talker solutions
2.6.3. Peg hooks

Peg hooks are almost exclusively made of bent steel wire, see Figure 15, with the odd exception of plastic peg hooks slowly emerging. Fastening labels to peg hooks is a challenging task since each manufacturer uses its own shape and diameter of the steel wire. This is not such a big issue when dealing with large manufacturers that are supplying both the peg hooks and single attachments for the labels as they can be custom made.

2.6.4. Fruit and vegetable signs

One surprising fact realized after researching Fruit and vegetable signs further was that one of the major cost of the signs actually was the printed labels used. This meant that to make a successful predecessor to the current signs the labels needs to remain simple in form and easy to produce. Another improvement necessary was to incorporate the ESL better to make it blend in with the sign and not stick out and ruin the esthetics of the sign. Examples of an existing solutions is shown in Figure 16.

Figure 15. Examples of peg hooks

Figure 16. Examples of fruit and vegetable signs
3. Project outlines

This chapter covers the initial planning of the project and continuous revising of that plan as well as documentation of the project.

3.1. Initial project plan

The first effort of the project was to develop a project plan. Since this was done before the beginning of the project the knowledge of the problem was scarce. This meant the plan did not align properly with what the company was looking for. However the effort was not in vain since the project plan raised a lot of questions, which helped further understanding and defining of the problem.

Part of the project plan was a Gantt chart listing the efforts required during the project, see Figure 17. As mentioned earlier the time plan was revised as the project progressed and the initial time plan in form of a Gantt chart turned out to be unsuitable for this specific project.

![Figure 17. Initial Gantt chart](image)

3.2. Revised time plan

For this project a block level time plan turned out to be more fitting as the task was clearly divided from each other. Each block represents a clear task with a separate goal and get individually adapted amount of the project time, see Figure 18. In this revised time plan there is also checkpoints (cp) to make sure that the project proceeds as intended and nothing gets overlooked. The complete time plan with listed block names and checkpoints can be seen in Appendix A.

![Figure 18. Revised time plan](image)
### 3.3. Continuous documentation

During the entire project each effort was documented and filed for reference in future time blocks and for this report. Each of the major blocks were initiated with an individual block report planning the efforts necessary and concluded with a report documenting the results of the block. In some cases miniature time plans or completion charts were used to keep track of the several concepts that were developed continuously. One example of a completion chart is shown in Figure 19. The concepts and prototypes were sequentially named as seen in the chart. The names are of no importance to this part of the report as the figure is only shown to illustrate the documentation produced during the project.

![Concept completion chart](image)

<table>
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<tr>
<th>CONCEPT</th>
<th>APPROVED</th>
<th>DRAWINGS</th>
<th>ORDERED/PLANED</th>
<th>prototype</th>
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<td>✓</td>
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<tr>
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<td>✓  ✓  ✓</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

Figure 19. Concept completion chart
4. Concepts

This section describes the main creative part of the project, the iterative process of concept development. This might result in some repetitive reading but that was intended to truly portrait the iterative nature of product development. To ease this a little this section is broken down by the individual products instead of the process steps. This means that the report is not chronologically true but it makes it possible to easily follow each product thru the process.

4.1. Rails

The first step was to take the information gathered from the context section and develop solutions for the cases listed. As mentioned the most common solution to price labeling is shelf edge rails and therefore this case is covered first.

4.1.1. Initial sketches

Initially the rail was not part of the project since a concept was already developed together with the locking mechanism. As the project progressed new ideas that would affect and improve the rails emerged. During sketching of other concepts the rail were continuously simplified and this lead to new rail profiles, see Figure 20.
4.1.2. First concepts

This simplified rail was then modeled in Solid Edge to better illustrate the true proportions of the concept. In Figure 21 the concept profile is displayed next to the original rail profile to illustrate its simplified appearance.

![Initial solid model of rails](image)

Figure 21. Initial solid model of rails

4.1.3. Refined solution

While discussing the simplified rail concept it was discovered that the concept had possibilities beyond just a profile. By adding grooves to the large void between the hooks, see Figure 22, the profile allows a printed paper strip to be inserted in the rail. This form of branding was not unheard of as the original rail allowed a 10 mm adhesive band to be attached to the rail. The new concept however gives new opportunities of branding since the strip can now be printed paper or plastic thanks to the height of the strip being enlarged to 23 mm. This also allows messages or logos to be printed on the strip.

![Refined rail solution with branded strip](image)

Figure 22. Refined rail solution with branded strip
4.1.4. Prototype

When preparing for the production of a rail prototype, the profile was redrawn with a uniform thickness of 1.25 mm to ensure a perfect fit with the ESLs locking mechanism. All other dimensions were also adjusted to give the necessary tolerances. The holes in the rail, added in the refined solution, are used to lock the ESL from horizontal movement. A plastic pin in the back of the ESL body fits in these holes fixating it in the position it has been attached to the rail. The prototype was then produced as a rapid prototype using the SLA method. The resulting prototype is shown in Figure 23. The rail is also showed with and without the larger paper strip.

Figure 23. Rail prototype
4.2. Shelf talkers

The redesigned rails pose new challenges when it comes to attaching shelf talkers. The more complicated geometry of the rails makes attaching the shelf talkers directly to them impractical so a solution incorporating the ESLs was needed.

4.2.1. Initial sketches

The initial sketches shows (in Figure 24) a few plausible methods beginning with grooves in the labels or rails that allows bent plastic to be attached and then removed with force. A more innovative method would be to introduce magnetic powder in the rails during extrusion allowing magnetic shelf talkers to be attached. These would not hold firm in the though environment grocery stores actually are. Then there are a few examples of cutting the shelf talkers to allow the to grip behind the ESL in different ways.
4.2.2. First concepts

It was decided early in the process that attaching the shelf talkers behind the labels was the most beneficial solution. During a brainstorming session alternatives solutions were sketched and later verified with CAD mock-ups. A few of these are shown in Figure 25. To be able to attach the shelf talkers on a label that is already placed in the rail version three was selected for further refinement.

![Figure 25. Versions of shelf talker solutions](image)

4.2.3. Prototypes

To further improve the concept and test its plausibility a number of mock-ups with slightly different dimensions were produced, one of the test chart is available in Appendix B and a single example is shown in Figure 26. By varying the dimensions incrementally the hole in the shelf talker surrounding the ESL could be optimized to ease mounting and maximize grip.

![Figure 26. Shelf talker prototype with printed dimensions](image)
To make the prototypes as true to reality as possible a special synthetic paper called PicoFilm from Papyrus was used. This paper is made of a polyester foil and has a thickness of 0.3 mm, similar to common shelf talkers. A few variations in the shape and color of the shelf talkers were made to visualize the possibilities for potential clients, see Figure 27.

![Figure 27. Shelf talker prototypes with different shapes and color](image)

### 4.3. Peg hooks

As mentioned in the context section peg hook labels are most often divided into two methods of attachment. These are hanging rocker labels, that swing upward as products are removed from the peg hooks, or fixed metal plates located above the products.

#### 4.3.1. Initial sketches

Some initial sketches, seen in Figure 28, show solutions such as punching holes in the metal plates or use snap fits or similar solutions to fasten single attachments. Since the metal plates are flat surfaces, developing a single attachment that allows the ESLs to be mounted on any flat surface with one product was a possible solution. The last of the concepts was to remove the adhesive component and only use plastic snaps to hold the ESL on the metal plates.

![Figure 28. Initial sketches for peg hooks with metal plates](image)
The rocker labels are attached to a horizontal steel peg and the initial sketches tried to mimic that behavior while allowing the ESLs to be attached to the rocker. During the brainstorming of these ideas another concept of an attachment that enables the labels to be angled emerged, see Figure 29. The sketches of this concept simply illustrate the behavior and were by no means working solutions.

4.3.2. First concepts

The concept of punching holes in the metal plates was quickly abandoned since this required custom-made peg hooks with specific dimensions and thickness of the plates. The CAD models instead developed the idea of a single attachment that with the help of adhesives can be attached to any flat surface, see Figure 30.
The first concepts for the rocker labels featured a round grip looping the steel peg and a lower part allowing the ESL to be attached, see Figure 31. The second concept tried to minimize the profile of the attachment by only keeping the parts necessary for the locking mechanism to work.

![Figure 31. Concepts for peg hook rocker](image1)

The angled attachment was initially modeled in CAD to investigate whether the concept was even possible. At this state the model is still not functional since the label would simply fall down if positioned in the lower angle. In Figure 32 the attachment is shown in this position.

![Figure 32. Concept for angled peg hook attachment](image2)

4.3.3. **Refined solutions**

Among the concepts for the metal plate peg hooks the initial sketch with plastic snaps was selected for further development. It was redrawn in CAD using a uniform thickness of 1.25 mm and was modified to fit the locking mechanism, see Figure 33. A single hole was added to lock the ESL in place.

![Figure 33. Refined concept for metal plate peg hooks](image3)
When refining the peg hook rocker the simpler profile was selected for further development. The initial concern with the profile, v1 in Figure 34, was that the peg was not centered over the center of mass of the ESL causing it to be angled down when hanging in a relaxed position. This was solved by moving the loop attaching to the peg, v2 in Figure 34. The second concern was if the ESL was subjected to a bending force it would attack at the lip securing the ESL by surrounding the metal blocks. This would cause the attachment to bend and open up so the Locking mechanism would fail, illustrated by the red arrows. This was solved by redesigning the profile so the force would attack a harmless intersection instead, v3 in Figure 34.

![Figure 34. Iterations of profiles for peg hook rocker](image)

The final concern with the peg hook rocker attachment was the fact that the minimal profile would not protect against rotation. This meant that the ESL could be rotated enough to slip out of the attachment. To prevent this the rocker was finalized with en extending wall down from the top hook. The final concept is shown in Figure 35.

![Figure 35. Refined concept for peg hook rocker](image)

The angled peg hook attachment was refined to provide a more functional proof of concept. To hold the ESL in different angles a disc with small bumps is placed on each side of the steel wire leading up to the ESL, see Figure 36. These prevent the label from rotating down to its relaxed position. The bumps are small enough to allow the angle to be adjusted and are intended to release the ESL if any sudden force is added. This prevents the attachment from breaking, if someone accidently hits it. To stabilize the construction a rib was added to each disc. The complex shape of the attachment prevents it from being extruded but to keep costs down it was designed to be injection molded. The challenge was to get the desired geometries with a two-part mold and no moving parts. With this design that is possible.
4.3.4. Prototypes

The SLA prototype of the metal plate peg hook attachment worked as intended. However, the material used in the SLA process does not have the same mechanical properties as extruded thermal plastics. This meant that the snaps holding the attachment to the plate did not give the desired force and the ESL was easily removed from the plate. This could be solved by adding a lip to the bottom of the attachment but instead it was decided to go back to the adhesive version for the final solution. The prototype is shown in Figure 37.
The prototype of the peg hook rocker worked flawlessly. It even solved issues that were not considered before it was produced. Most existing rocker attachments allow the label to be rotated too far causing it to stay over the peg hook and not fall back. The dimensions of the cut-out in the prototype allows the label to be rotated more than enough to enable products to be removed from the peg hook while always falling back to its intended position. The prototype is shown in Figure 38.

Figure 38. Peg hook rocker prototype
The angled peg hook attachment was produced as more of a proof of concept prototype than a final prototype. Its main function was to investigate whether the idea was even possible in reality. The prototype did function as intended however the brittle plastics used in the SLA process started to break when the label was angled. The poor mechanical properties of the material also had a hard time keeping the label in the desired angle. The prototype, shown in *Figure 39*, showed a lot of promise and gave indications on what needed to be improved in the final solution.

*Figure 39. Peg hook angled prototype*
4.4. Fruit and vegetable signs

Fruit and vegetable signs are usually a sign built by a number of interchangeable paper labels showing information about the product such as photos, price, country of production, etc.

4.4.1. Initial sketches

As discussed in the context section the main issue was to integrate the ESL in the sign. This caused the initial sketches to deal with this issue. A few different methods of attaching the ESL were developed. In Figure 40 the three main versions are shown. The first uses rails to allow the ESL to slide into the sign. The second sketch uses the ESLs shape to snap it in the sign with holes to allow the hooks to penetrate the back of the sign. The last version uses the hooks from the locking mechanism together with holes in the back of the sign to attach it.

![Figure 40. Initial sketches of fruit and vegetable signs](image)

4.4.2. First concept

The initial effort was to improve the visual appearance of the fruit and vegetable signs. One of the first ideas was to bend the paper labels used to create slightly curved surface, see Figure 41. This allows the entire sign to appear thinner than the actual depth of the ESLs body. This curved surface was achieved by again using an extruded profile with grooves that hold the paper labels in place.

![Figure 41. First concept of fruit and vegetable signs](image)
The second concern was the fact that the locking mechanism required the ESL to be mounted from the top and pushed down, leaving a gap to the top edge. To unify the entire sign this behavior had to be avoided. The solution was to use a group of holes that allow the ESL to be attached from the front and slid horizontally to lock in place, see Figure 42. This leaves no gap between the top of the ESL and the profile.

![Figure 42. Holes for locking mechanism](image)

### 4.4.3. Refined solution

For the refined solution the profile of the sign was redrawn with a uniform thickness of 1.25 mm, see Figure 43. After some discussion it was realized that just placing paper labels in the profile would not create the curved surface, with a radius of 250 mm, intended. Also the gap between the paper label and the profile would mean that a slight push on the labels would cause it to instead form a concave surface or even fall out of the sign. To prevent this behavior additional supports was added to the profile. These ribs not only helps to support the paper labels but also ensures a perfect curved surface.

![Figure 43. Refined concept of fruit and vegetable signs](image)
4.4.4. Prototype

The SLA prototype of the fruit and vegetable sign showed great promise. The ESL integrates beautifully with the sign and the curved profile and paper labels gives it a lean but solid appearance, see Figure 44. The locking mechanism worked perfect with the holes in the sign. The only issue was that the supporting ribs behind the paper labels were not tall enough to create a perfect curved surface.

![Figure 44. Fruit and vegetable sign prototype](image)

4.5. Manufacturing

In an average store there is around four km of shelf-meters holding four shelves on either side. This adds up to 32 km of shelf edge rails in each store. One can easily understand that these products will be produced in vast quantities and that influences the manufacturing methods and materials more than fixed costs and labor.

4.5.1. Manufacturing methods

Due to the vast production series of these products there are only three viable manufacturing methods. Injection molding, sand casting or die stamping. Due to the material being thermoplastics the only method left is injection molding. Since this was the obvious choice all products where developed with this method in mind. To further increase manufacturing speeds the products where developed to allow the use of extrusion rather than traditional injection molding. All products, except for angled peg hook attachment, follow this restriction. The angled peg hook attachment requires injection molding due to its complicated geometry but has been developed so that a two-part mold with no moving parts can be used.
4.5.2. Materials

The choice of material where initially thermoplastics to aid the manufacturing methods. For all the single attachments this is still true but for the shelf edge rails aluminum is another viable option. Most thermoplastics are possible choices for the single attachments. The final choice comes down to the plastic with the lowest material cost that still has the mechanical properties to support the labels. This final choice has to be made with the help of experienced thermoplastic professionals.

The shelf edge rails production volumes means that the final cost will be very similar to the material costs. The differences in tooling costs will be broken down over such a vast number of products that it will virtually disappear. This makes aluminum a possible option, since the material costs are very similar to most thermoplastics, Ulrich et al. (2008), as shown in Figure 45.

![Figure 45. Raw material costs](image-url)
5. Results

The results of this project are shown in this section as the final solutions for the new locking mechanism peripherals. It discusses some generic solutions to ease development of alternative peripherals and summarizes the entire creative process.

5.1. Final solutions

The peripherals developed are described and illustrated here. The final solutions have all been adapted to the latest iteration of the locking mechanism. This system has the hooks on the back of the ESL pointing upwards to decrease the chance of dirt gathering in the rail profile. The magnetic metal blocks have been changed to rectangular magnets due to some interior mechanics changes.

5.1.1. Basic rail

The first rail solution is a basic rail that gives a solid appearance and incorporates the necessary features to allow the ESLs to be securely attached, see Figure 46. The profile follows the locking mechanism of the ESLs and has a hole pattern on the bottom lip that locks the labels from horizontal movement, visible in mechanical drawing in Appendix C. This rail is designed for extrusion in thermal plastics or aluminum and the holes are placed on the bottom lip to ease punching after extrusion.

Figure 46. Basic rail
5.1.2. Brandable rail

The second rail also features a simple profile to ease manufacturing. The major difference from the basic rail is the brandable area included in this rail, see Figure 47. The profile features grooves which allow a 23 mm printed strip to be inserted in the rail. These strips can be solid colors to differentiate store sections or printed messages to communicate current promotions. This rail is also intended to be extruded in either thermal plastics or aluminum. A technical drawing of the rail is available in Appendix C.

Figure 47. Brandable rail
5.1.3. Curved transparent rail

The final rail solution has a curved profile to enhance the aesthetics of the rail. The curved profile actually reduces the visible edges from the front of the rail, simplifying its appearance, see Figure 48. Behind the curved surface the rail has grooves similar to the brandable rail that allows for the same printed strips to be attached. Since the strips in this rail are located behind the profile they are completely protected from dirt and other destructive forces. The rail has a uniform profile to allow extrusion but the material is limited to thermal plastics since a transparent material is required to keep the brandable strips visible. Technical drawing in Appendix C.

Figure 48. Curved transparent rail
5.1.4. Rail attachment

To attach the rails to shelf edges the best solution is to use a two-part system where the back rail contains the features necessary for different shelves. The back can also be produced with different angles to enable the rails to be tilted differently according to the shelf heights. In Figure 49 this system is displayed on the Curved transparent rail with two different angled backs. The front rail snaps on to the back part, and are locked horizontally either by its adjacent rail or single stops attached to the end of the aisle. The front rail has been modified with additional profile elements to allow it to be attached to the back.

Figure 49. Two-part rail system
5.1.5. Shelf Talkers

The final solution for the shelf talkers are attached same way as the prototypes, with two tabs that fits between the hooks on the back of the ESL. This enables the shelf talker to be attached when the ESL is mounted in the rail. Once fitted the shelf talker sits firmly in its place and require knowledge of its geometry or very strong force to be removed. The solution is not so much the design of the entire shelf talker, but the cut-out that allows it to be attached, since each company will want to make their custom shelf talkers regarding shape and form. To illustrate the creative possibilities two different shapes are shown in Figure 50. A technical drawing with measurements to show the required tabs is available in Appendix C.

Figure 50. Examples of shelf talkers
5.1.6. Metal plate peg hook attachment

For the metal plate peg hooks the initial concept of an adhesive attachment was selected despite the fact that the prototype was based on the snap concept. The profile was redrawn for the latest locking mechanism with a uniform thickness of 1,25 mm. A lip in the top of the profile was added to prevent it from being pried of the peg hook. This lip can be removed to provide an attachment that works on any flat surface. In Figure 51 the attachment is shown by itself and mounted on a peg hook. The attachment can be extruded in transparent plastic to allow it to blend in with the environment but in the image it is rendered in white to improve visibility. The technical drawing of the attachment is available in Appendix C.

![Figure 51. Metal plate peg hook attachment](image-url)
5.1.7. Peg hook rocker attachment

The peg hook rocker solution was also redrawn for the latest locking mechanism and with uniform thickness. The profile was extended to lock between two hooks and the metal blocks lock the ESL sideways. The attachment allows the ESL to swing up when a product is removed from the peg hook. The profile can easily be adapted to fit peg hooks with different wire diameters. It does not prevent the entire assembly to be removed from the peg hook but to achieve this would require additional parts which would remove the benefits of this simple design. The peg hook rocker is shown in Figure 52 and a mechanical drawing is available in Appendix C.
5.1.8. Angled peg hook attachment

To called the angled peg hook attachment a final solution would be an exaggeration. The concept have been improved significantly but requires further development. The attachment has been fitted with additional ribs to strengthen the grip around the steel wire. It has also been adapted to the latest locking mechanism, in Figure 53 it is used with the HCS label. It is still possible to produce this attachment with a two part mold. This is not considered a final solution and needs some additional improvements to reduce the tooling costs. Therefore, no mechanical drawing is available. The ESL can be angled down - 20 degrees and up + 20, + 50 and + 90 degrees.

Figure 53. Angled peg hook attachment
5.1.9. Fruit and vegetable sign

The final fruit and vegetable sign has been adapted to the latest locking mechanism which now only requires six rectangular holes and not the previous more complicated slider holes. The supporting ribs have been raised to ensure the paper labels form a perfect curved surface. The sign is shown, in Figure 54, in dark plastic to decrease the visibility of the hollow interior and to not steal interest from the text and symbols on the labels. This choice was made, since the raised ribs secures the paper labels enough, to eliminate the need for any stop mechanism on the edges of the sign. A mechanical drawing of the sign skeleton is available in Appendix C.

Figure 54. Fruit and vegetable sign
5.2. **Generic solutions**

The new locking mechanism requires certain geometries to be able to attach to rails or single attachments. To ease development of additional peripherals not covered in this project sketches of the generic solutions were made.

5.2.1. **Generic rails**

One way of allowing Pricer ESLs to be attached is derived from the shelf edge rails. These geometries can be used in additional rails or single attachments. The required geometries are shown with dimensions in *Figure 55*. Note that the profile connecting the required black edges can be designed freely as long as it does not intersect with the ESL geometry. To achieve horizontal locking one of the lips can be changed to holes or alternatively holes surrounding the magnets can be implemented.

5.2.2. **Generic flat surface**

To attach a Pricer ESL to a flat surface or single attachment of similar geometry six holes are required to lock the ESL in all directions. These holes are shown with dimensions in *Figure 55*. Note that the lower holes can be substituted to a single lip similar to the one found on the generic rail geometries. Additional Generic sketches can be found in *Appendix D*.

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**Figure 55. Required geometries, HCN**
5.3. The creative process

Because of the nature of the products in this project there was no need for mathematical calculations or other technical endeavors. As mentioned before, the focus of this project was the creative product development process. In conventional definitions of product design, Ullman (2003), this would fall under the conceptual design step of the mechanical design process.

To further illustrate the iterative nature of the process, and how the products evolve, a breakdown of all the stages for the peg hook rocker is shown in, Figure 56. The process started with research of existing products. In this case Trion’s Flip Scan paper label attachment. From here brainstorming and discussions led to a few sketches (only the ones who led to further concepts is shown here). When we get to the CAD models we really start to see the iterative process. Between each stage the concept was evaluated and discussed. The profile of the peg hook rocker went thru many stages until a satisfactory solution was found.

Then the process moved to prototype development. After the concept was adapted for manufacturing, and a prototype produced, it was tested and evaluated. All of the earlier stages together with the prototype were then finally evaluated again and the outcome was the final solution.

In some of the other products the latest concepts was sometimes dropped and older concepts were picked up again later in the process. This means the design process is not as linear as illustrated in Figure 56. For a better view of the illustration a larger version is available in Appendix E.

The next step in the process would be to adapt the final solutions for manufacturing and develop new prototypes. In testing of these prototypes an end user survey and user tests should be performed to see how the products actually functions in real world situation. Discussions with attachment manufacturers would also provide valuable input and experience to further improve the products.

Figure 56. Creative process for peg hook rocker
6. **Recommendations and discussion**

One continuous goal during the entire project was not to just redesign the peripherals for the new locking mechanism but to improve and simplify them. Most existing single attachments are assemblies of several injection-molded parts. By redesigning them using single extrudable parts will greatly increase production speeds and reduce costs.

One input missing in this project is really the end users feedback. Since the locking mechanism is still in development discussion with manufacturers and store personnel have been limited. Their input would surely have helped the development process and improved the outcome of the project. That is why this is the next step of the process. Pricer has initiated discussions with attachment suppliers and will continue this project.

Since Pricer does not manufacture any of the products involved in the project some areas such as manufacturing and material choices have not been given the amount of time it would usually get in a product development project. The solutions developed will be used to illustrate viable solutions to attachment manufacturers and ease market introduction of the new ESL locking mechanism.

Some would argue that the production speeds would be decreased and tooling cost would be much higher with aluminum. All these facts are controllable by for instance making five dies in one tool increasing the tooling cost by less than 5 times but the production speed increases 5 times. This makes such considerations uncontrollable as parameters for calculations and I would once again argue that the vast numbers virtually eliminates these cost anyway.

The next step in this project would be, as mentioned earlier, to get feedback from potential end users on the developed solutions and also if any solutions are missing. Then there are also the cases from chapter 2 that were prioritized as medium cases and did not get any time in this project. These might still be interesting to include in further development.

The resulting solutions have exceeded our expectations as we discovered new features during the process. The branding possibilities in the shelf edge rails are an example of these great new features. All of the products have been greatly simplified from its predecessors.
7. References

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Appendix A - Time plan

Blocks
1. Project outlines and time planning
2. Store visits and case documentation
3. Case prioritizing and selection
4. Concept generation and development
5. Prototype development
6. Finalize solutions and develop manufacturing documentation
7. Documentation and presentation completion

Checkpoints
cp1. Present result from store visits
cp2. Present initial concepts and choose future candidates
cp3. Present concepts and choose candidates for prototype development
cp4. Present prototypes
cp5. Present final solutions

Jonas Käck
Design & Product development
Industrial Design
Royal Institute of technology

Master Thesis 30 hp
Company: Pricer AB
Fitting for ESL line
Start date: 26/1 2010
Appendix B - Shelf talker dimension chart

r = 5 mm

r = 1 mm

r = 10 mm

h = 70 mm

w = 90 mm

8 mm

67 mm

18.5 mm

20.5 mm

22.5 mm

24.5 mm

33.5 mm

EKOLOGISK

EKOLOGISK
# Appendix C - Final solution drawings

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Appendix D - Generic solutions

REQUIRED GEOMETRIES

HCS

REQUIRED GEOMETRIES

HCN
Appendix E - Product development process