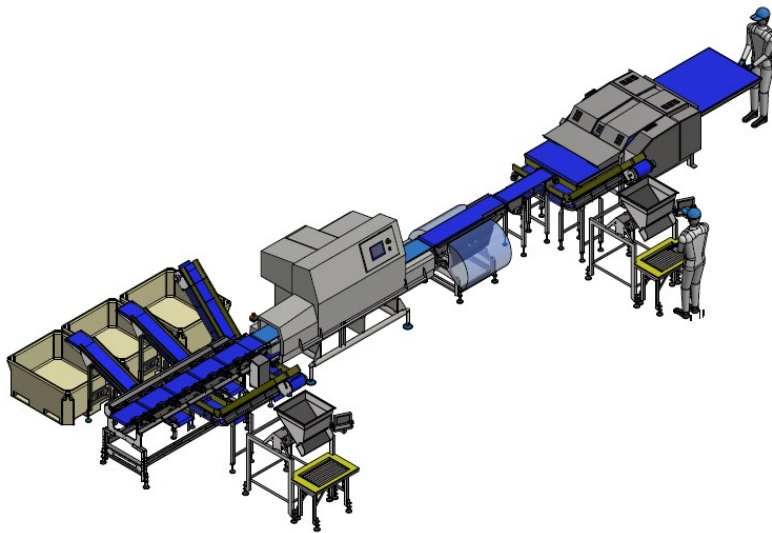


ADVANCING
FOOD PROCESSING



Pre-project: Improved productivity through innovation and proven methods

Project 901535



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1 Summary

The main aim of the project was to assess available technology for industrialized cutting of clipfish, and present various concept production lines with corresponding analyses of benefits and feasibility. This was done throughout the year 2019, through several workshops in collaboration with the reference group from the industry. Cutting of clipfish using various technology was tested. The results are presented in this report, and various concept lines and the discussion if their feasibility is discussed. The main findings is that current mechanical solutions can be commercially viable for cutting of clipfish. It is important to note that even though individual machines or solutions are able to, or assumed able to, handle the production described in this document, it is all concept solutions with estimated performance.

2 Introduction

Clipfish, dried salted cod (or similar species) is one of the oldest cod products traded in the market- and still has a status as high quality, favoured for its mature taste and texture. Like all other consumer markets, the market for this product is moving towards more convenient and sellable products, where consumers like to be able to buy fish pieces, prepacked or in counters, rather than buying the whole fish. Sometimes the product is sold in its dry form but in some cases the product is desalted and sold either chilled or frozen.

As the largest producer of klippfisk, Norway has the potential to create a sustainable competitive advantage in the production of convenient products for the consumer marked. In order to do so we need highly integrated production lines, with large capacity, high level of automization, robotization and production flexibility. To create such a concept is our main objective in this project.

2.1 Available cutting technology

The following technologies are compared and suggestions made based on the assessment.

2.2 Waterjet technology (Flexicut)

The use of high pressure water jet to cut through flesh of fish is well known, with Flexicut becoming an industry standard for cod and related species. This technology has the advantages of being flexible and cutting away pin bones from fish fillets. In clipfish production this technology has potentially many disadvantages, such as the following:

- The products are generally very wide, meaning that machines currently used for fillets will not be wide enough to take the products in. If the machines are made wider this increases mechanical movements of water jet heads and therefore reduces throughput and increases maintenance cost and stops.
- Cutting through the back bones with a waterjet will be very difficult and therefore portioning with this method can be challenging. Using some micro salt or icecrystal additives to improve the cutting power will wear out the waterjet nozzles very quickly as well as it will cut through steel belts or rollers creating problems. This might be solved by introducing traditional knife portion cutting technology into the machine.
- If the product is dry during the cutting it will be less stable on the belts reducing the accuracy significantly
- Waterjet cutting is a costly method to cut fish products and is only justifiable were other methods fail to do the task, or the volume is high enough to sustain a high cost of ownership.

Waterjet cutting is therefore not chosen as the primary method in this project, long as other methods are available to do the same task.

2.3 Bandsaws

This method is traditionally used. It is very manual, dangerous and accurate weight portioning is not possible. This method is therefore rejected for this project.

2.4 Mechanical knives and portion cutting with knives

When improving the efficiency of product lines it is always the best option to use proven methods as much as possible and then apply innovation to what is missing. Mechanical knives (Stripcutter) and portion cutters with computer vision systems (I-cuts) have been used in the salted fish industry for a long time and the method works well for cutting. The benefits are as following:

- The capacity is very high (20 fish pr minute at minimum) - and if the lines are configured correctly, use of labour is minimal.
- The cuts are very straight.
- Cutting through the back bone has been done.
- The basic technology is proven; only adjustment needed in combination of several machines.
- This is a low cost cutting technology in terms of cost of ownership.

This method is therefore suggested as the base technology for the process.

2.5 New Innovation

By combining the use of proven technology with new equipment to be developed this offers a chance to make a new cutting concept.

- Size grading of raw material to make sure 1st cut settings give optimum cutting pattern.
- Vision quality control unit to look for defects and location of membranes and possibly grade product by color of raw material.
- Dual line portion cutter, making it possible to cut to exact weight or length.

3 Objectives

Main objective for Marel in the project was to assess and describe several cutting methods, and present concept lines for industrialized and dynamic cutting into fixed weight portions.

The sub objectives in the project was to use both proven solutions and innovation to secure the best possible outcome. Through workshops with the industry group there was a feedback loop to guide the project. To effectively show and discuss the results some concept layouts should be made, with descriptions and analyses of feasibility as well as profitability.

4 Project execution

The project was mainly driven by a series of workshops with Marel and the reference group throughout 2019. In the meetings Marel presented various concepts, technologies and specifications, and feedback from reference group was noted. In middle of 2019 clipfish from several species was tested by Marel on mechanical portion cutters, as well as x-ray and waterjet machine. These test led to the finalized concept layouts that is included in this report.

5 Findings, discussion and conclusion

The call from FHF specified a flexible, automatic solution for the dynamic cutting of split clipfish and salted fish into portions of identical weight. Based on this, Marel has taken a broad approach, and presented various solutions that aims to solve this. The document also discusses various methods for packing of end-product, both raw and desalted portions.

5.1 Mechanical cutting

Infeed of pre-graded clipfish into StripCutter. Fish is cut in middle, or belly out. Automatic transfer to dynamic weighing scale for weighing of each piece. Portion cutter scans fish and cuts portions according to specified order. As seen below after the portion cutter, there is an option to have a drop-down grader, for effective grading and distribution of individual pieces into the right packing station or tub.

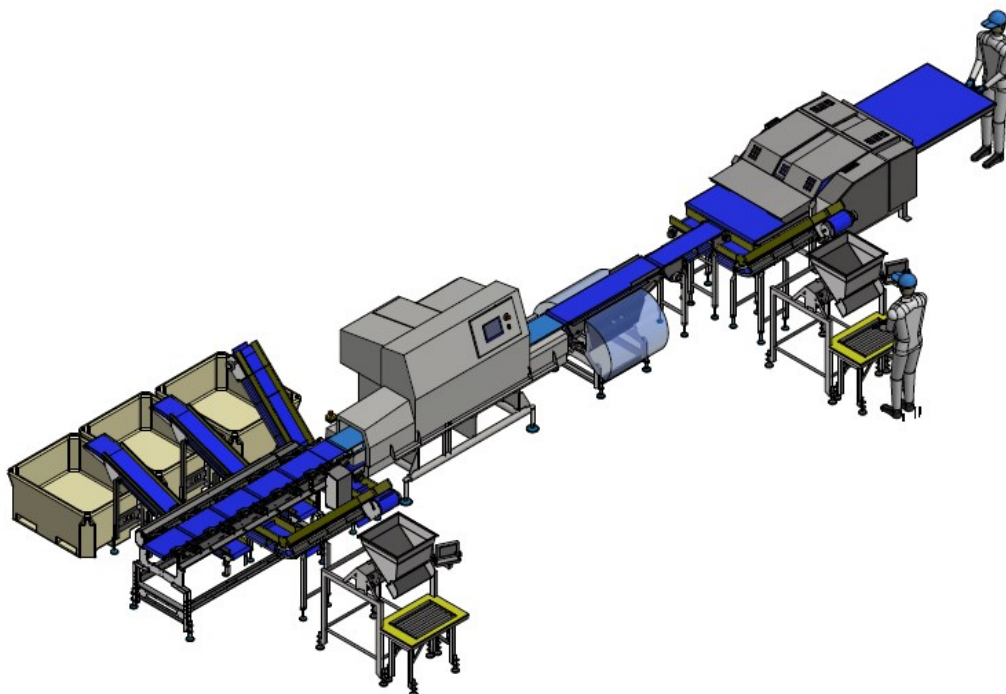


Figure 1

5.1.1 Possible cutting patterns



5.1.2 Specifications

Accomodate different sizes of split clipfish and salted cod (<i>Gadus morhua</i>).	Yes
Optimise cutting to maximise the utilisation of each individual fish	Somewhat
Dynamic portioning of fixed weight clipfish	Yes
Cut all bones (backbones, pinbone, collarbones, etc)	Yes
Have a minimum capacity of 15 fish/min	Yes
Produce cleanly cut surfaces	Yes
Be test run, error corrected and ready for implementation	No
It must meet all necessary HMS criteria.	Yes

5.1.3 Advantages

- Highest accuracy of all available technology
- Fulfills of project goals at lowest cost
- Is very flexible with regards to end product and next process

5.1.4 Disadvantages

- Does not dynamically cut whole fish
- Only straight cuts

5.2 Waterjet cutting

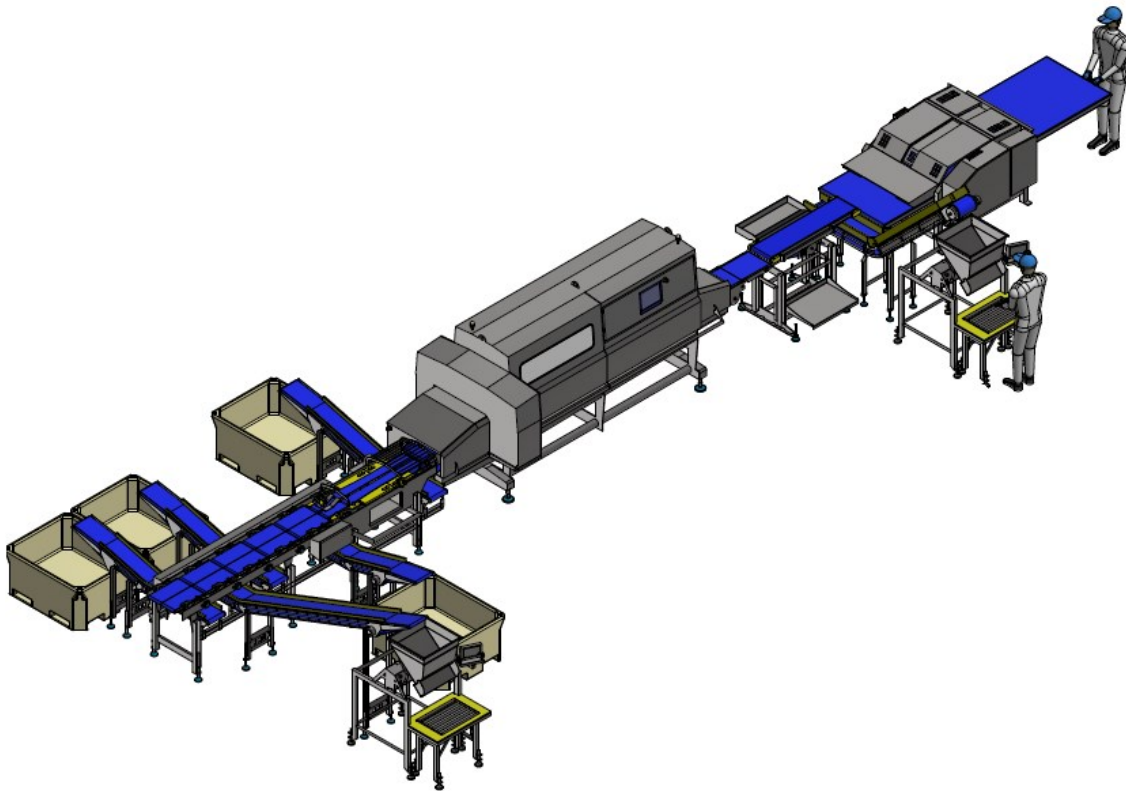
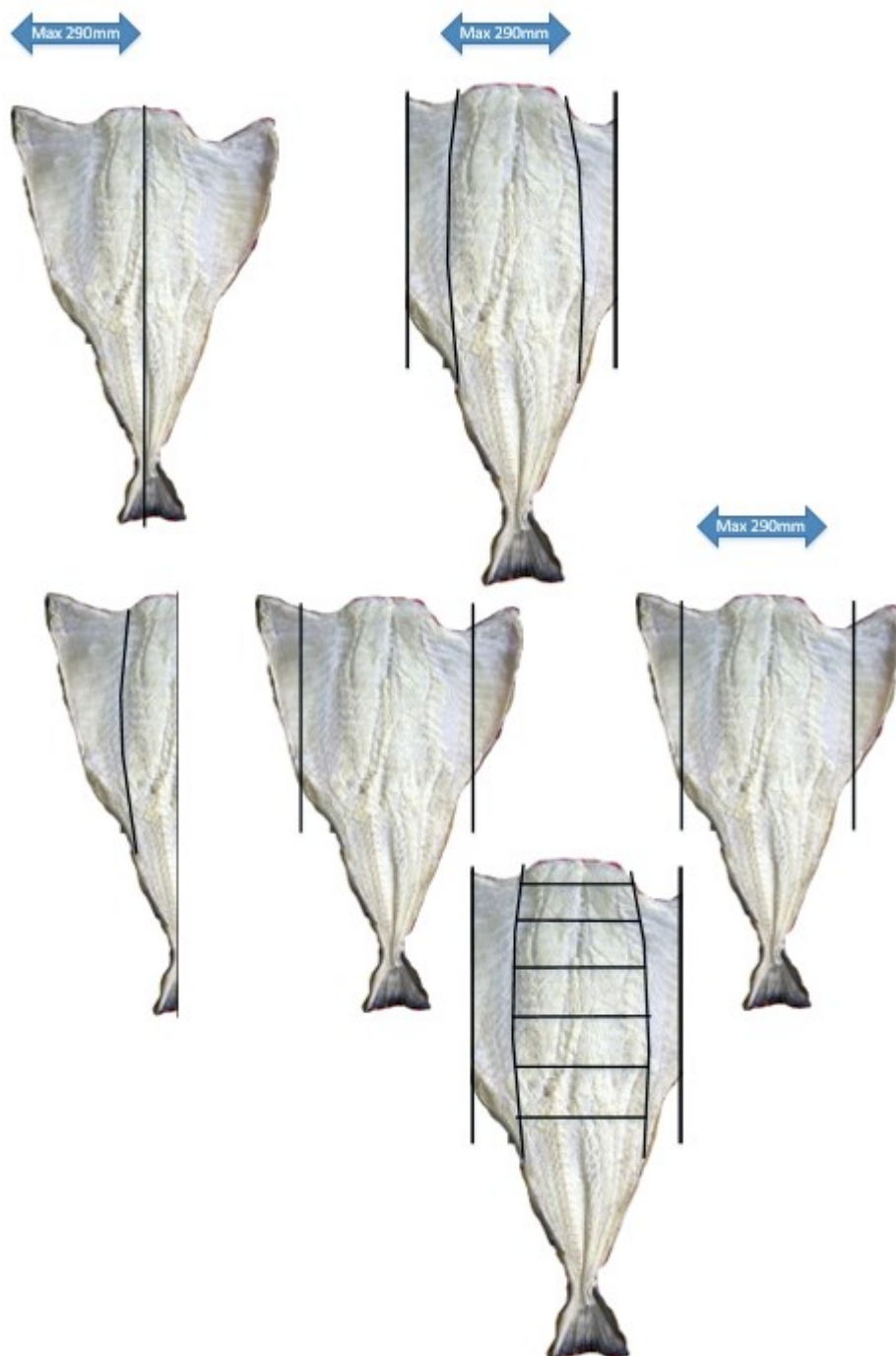


Figure 2

5.2.1 Description

Infeed of pre-graded clipfish into StripCutter. Fish is cut through middle, or belly out. Automatic transfer to waterjet cutter. Cutter scans fish with X-ray, and cuts dynamically into portions according to specified order. Bone is cut using the built-in mechanical knife. As proposed above, there is an option to have drop-down grader after the waterjet cutter, for grading and distribution of individual pieces to the designated packing station or tub.

5.3 Cutting patterns



5.3.1 Specifications

Accomodate different sizes of split clipfish and salted cod (<i>Gadus morhua</i>).	Yes
Optimise cutting to maximise the utilisation of each individual fish	Somewhat
Dynamic portioning of fixed weight clipfish	Yes
Cut all bones (backbones, pinbone, collarbones, etc)	Yes
Have a minimum capacity of 15 fish/min	Yes
Produce cleanly cut surfaces	Yes
Be test run, error corrected and ready for implementation	No
It must meet all necessary HMS criteria.	Yes

5.3.2 Advantages

- Flexible cutting (curved cuts)
- Possibility to cut along pin-bones
- Both water and mechanic knife cutting

5.3.3 Disadvantages

- Expensive process
- Still not fully dynamic
- Significant innovation needed
- Less accuracy in weighing when using x-ray compared to portion cutter with scale

5.4 Automatic batching and packing

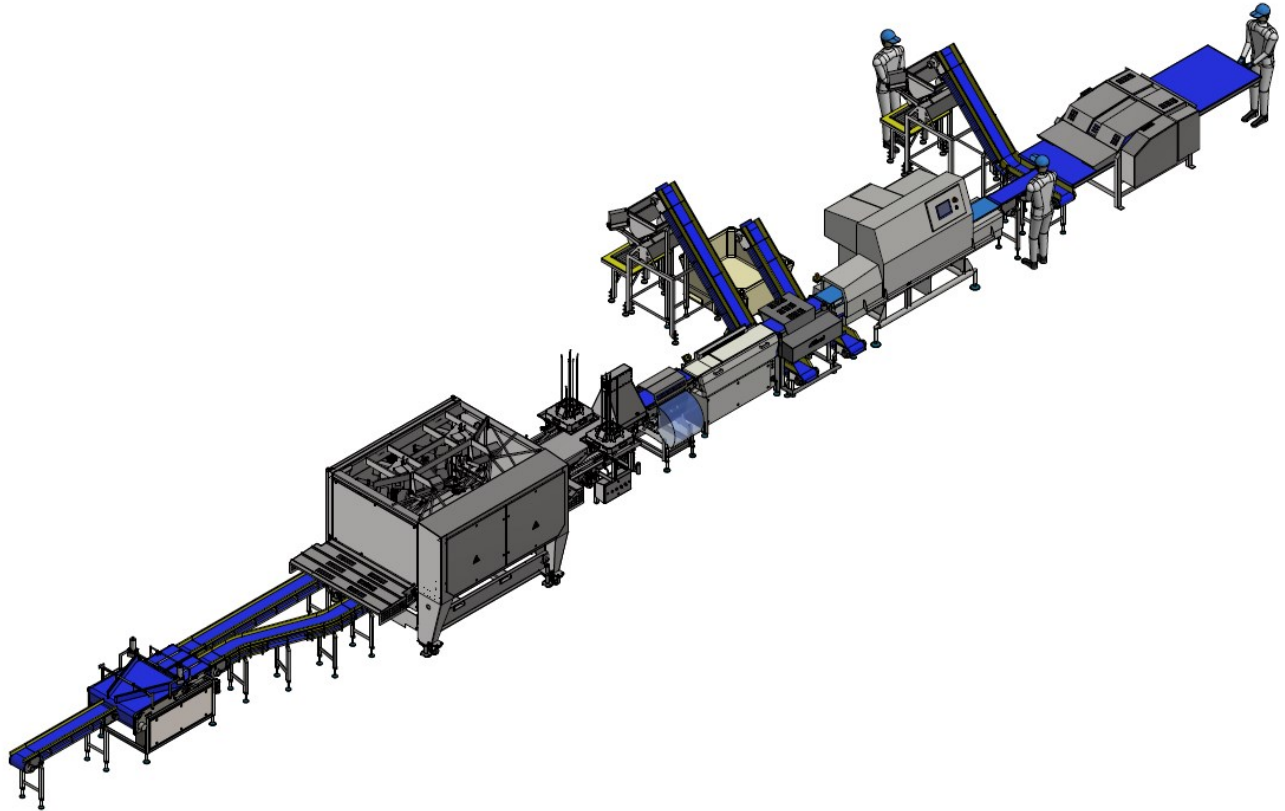


Figure 3

5.4.1 Description

Cutting process same as for section 5.1. After portioning, all pieces go into an aligner that creates spacing between portions going into the robot. Portions are weighed individually on a dynamic weighing scale, as well as scanned for maximized accuracy. A robot automatically places pieces according to order in retail trays, and creates minimal give-away using batching calculations.

5.4.2 Specifications

Accomodate different sizes of split clipfish and salted cod (<i>Gadus morhua</i>).	Yes
Optimise cutting to maximise the utilisation of each individual fish	Yes, for portions
Dynamic portioning of fixed weight clipfish	Yes
Cut all bones (backbones, pinbone, collarbones, etc)	Yes
Have a minimum capacity of 15 fish/min	Yes
Produce cleanly cut surfaces	Yes
Be test run, error corrected and ready for implementation	No
It must meet all necessary HMS criteria.	Yes

5.4.3 Advantages

- Very labor effective packing process
- Very low give-away in end product'
- Easily adaptable to include de-salting and bulk packing

5.4.4 Disadvantages

- Investment requires relatively high volumes of retail packing to show profitability

5.5 Manual batching and packing

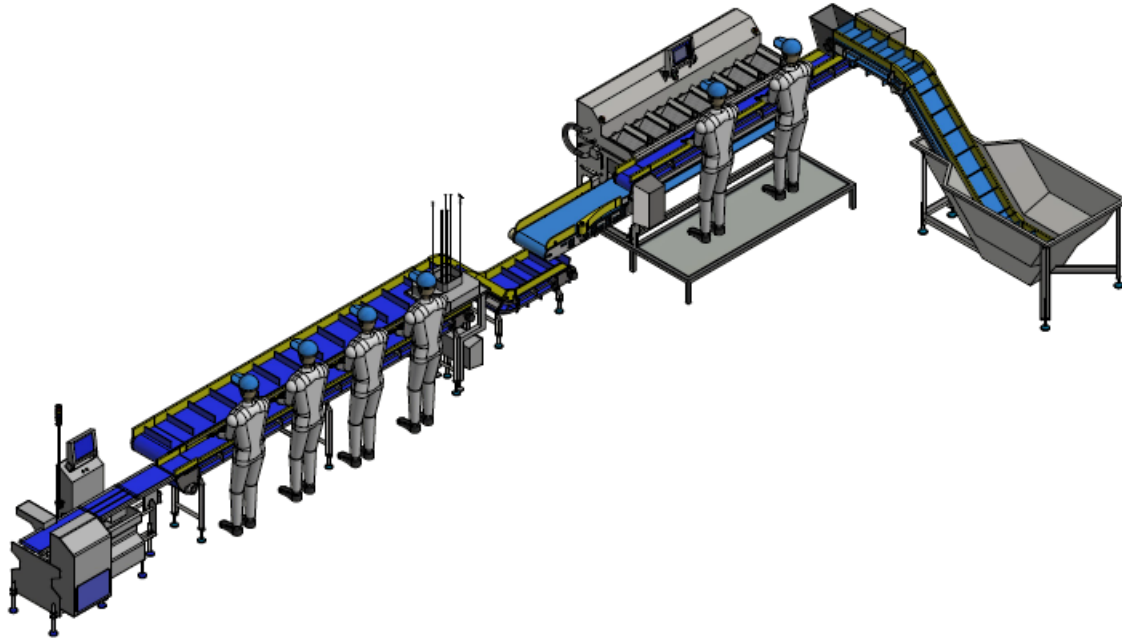


Figure 4

5.5.1 Description

Can be utilized regardless of upstream cutting process. This manual retail packing process is known, and gives a very high throughput and accuracy. The line can be used for both raw and de-salted portions, as well as IQF raw material.

5.5.2 Advantages and disadvantages

- High throughput
- Very low give-away in end product
- Flexible with regards to raw-material input
- Labor intensive

6 Findings and summary

The project has shown that there is many opportunities to innovate on existing technology to achieve flexible, accurate and high volume cutting of clipfish. A prerequisite for a good result in all concept lines is pre-graded raw-material suitable for the process or end product specification.

Mechanical cutting using both static knives and portion cutter is a solution that can provide high accuracy, high productivity at the lowest cost and risk. The line could be implemented with a de-salting process, or with direct distribution to packing process.

Waterjet cutting of clipfish was tested during the project, and revealed challenges of using X-ray for weight estimation and bone identification. Significant innovation is needed to achieve good result. Waterjet cutting is considered possible, but more testing and tuning of equipment is needed. A cutting process involving waterjets will give more flexibility, as well as more investment and cost of operation compared to mechanical solutions.

Most known batching and packing technologies can be adapted to clipfish portions, and some of those are discussed in this document. To achieve best possible yield, cutting and batching should be considered in close relationship to each other.

Available and know technology will fulfill most of the current requirements from the industry as this document has discussed. However, a fully dynamic cutting process that will cut each portions optimally from any given raw-material would still need significant innovation or improvement on current technology.

Main findings:

- Many opportunities to elaborate on existing solutions to achieve dynamic cutting
- Mechanical cutting using stripcutter and portioncutter is feasible and cost effective
- There are significant challenges with using x-ray and waterjet for portioning
- To have a fully flexible portioning line that optimally cuts each fish needs innovation

7 Deliverables

7.1 Presentations:

Clipfish presentation Jan 19:
FHF – future of clipfish:
FHF – future of clipfish part 2:

Start-up meeting January 19
Workshop Oct 19
Workshop Dec 19

7.2 Layouts

NO144976L02:
NO144976L03:
NO144976L04:
NO144976L05:

Oct 18
Nov 19
Nov 19
Nov 18

7.3 Documents:

Description of layout NO144976L02:

Oct 18