INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA

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Fish Capture Committee

IQAS FLATFISH PROCESSING ON BOARD BEAMER 2000

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Contents

1. Introduction.

Although the modern Dutch beamtrawlers or so-called beamers have all kind of fish handling equipment, various drawbacks can be mentioned from a point of view of chilled fresh fish handling (quality), crew's safety and working conditions (occupational accidents and workload) and the quality of the marine environment.
In these topics RIVO is carrying out cooperative research; especially:

IQAS:	BEAMER 2000:
• **integrated quality assurance of** chilled fresh fish at sea	• **safety integrated (re)design of** working deck-, bridge- and engineroom layout of a modern beamer: **method Kindunos.**
• EC financed in the frame work of Community Research, programme in Fisheries sector ("FAR"); UP 1-67.	• partly financed by the Ministry of Social Affairs, Dutch Labour Inspectorate (analysis occupational accident) and the Foundation for Dutch Maritime Research (noise control) and Radio Holland Group (bridge electronics).
• 1989 - 1992.	• 1986 - 1992.
• participants: - FF (Fiskeriministeriets Forsøgs-laboratorium, Lyngby, Denmark) - Torrey Station, Aberdeen, UK Scotland. - TNO-CIVO, IJmuiden, The Netherlands. - RIVO, IJmuiden, The Netherlands	• participants: - RIVO, IJmuiden, The Netherlands - Technical University Delft (TUD), Safety Science Group; Maritime Technical Department and Ship Acoustic Department. - Fishing Industry (yards, skippers, crew, manufacturers)

In this paper the research results are given improving the flatfish processing line on board the BEAMER 2000, based on adaptation and extension of existing flatfish handling equipment incorporating the IQAS and Kindunos approach. Without interfering the beamtrawlfisheries (method) too much, the general arrangement (layout and outfit), the quality of the landed fresh fish and quality of the working stations (well-being crew) can be improved considerably, also taking into account the marine environment.

2. Fish handling systems on board Dutch beamers.

Deck layout. The typical layout is a single deck hull having a large whaleback with a fish handling area underneath. The accommodation and wheelhouse area set aft, leaving a large open deck area midships. The winch is housed in the foreward casing underneath the wheelhouse with the whipping drums projecting through the casing sides. A large bi-pod gantry straddles the aft end of the whaleback and carries two heavy derricks from which the 12 m beams are lifted.

The midship section of the main deck is a teakwood covered working deck for fish gear handling, beamtrawl storage and a catch collecting pound with the fishhold underneath. An elevator is sited at the forward end of the main deck and carries the catch from the pounds up and into the whaleback structure to discharge onto a hand-grading conveyor. The conveyor then leeds to a rotary washer, which in turn discharges down into the fishroom.

Deck equipment. To which extent a fish processing line is installed depends on the skipper-owner, crew and stability requirements. However, this lastmentioned aspect hardly gives any design problems for new buildings and the RIVO-TUD beamer 2000 design.
On modern medium-sized beamtrawlers often a fresh fish processing line is used as given in figure 1 (manufacturers, e.g. van Rijn, Katwijk).

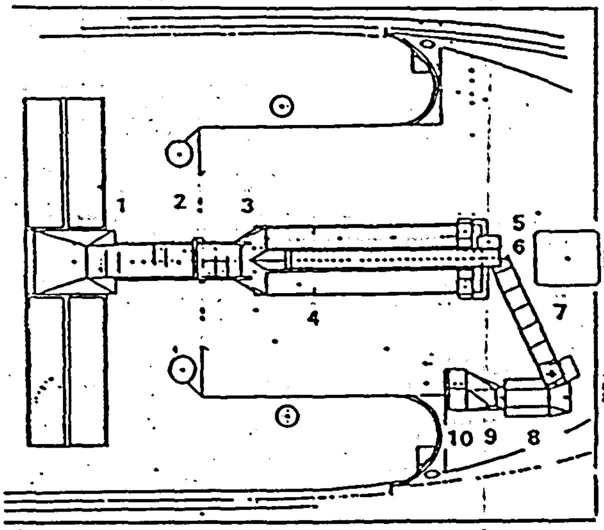


Figure 1 - Beamer fishprocessing line.

1) Deck pounds: typically the Dutch beamers tow for approximately two hours with a speed of about 6 knots. For the hauling procedure the main engine revs are reduced and the winch is set to haul and heaves in the warp until the block on each 12 m beam is up to the derricks. The vessel is stopped and the derricks are heaved up to the 45° position. Then the codend contents will be emptied in the port- and starboardside deck pounds. Having hauled, emptying the codend and shaking out the fish struck in the meshes, the gear is reshot and the vessel built up the towing speed again.Without possibly net repair, the hauling/shooting operation takes around 20 minutes with at either side two men.

Generally a Dutch beamer operate regular weekly trips of 4 - 5 days with two days off. The arrangement of the pounds is to direct the catch into the elevator well. Large diameter water hoses and or pipes are used to flush the flatfish, bycatch, stones and debris into the well. The hoses are connected via a quick release coupling to the seawater pressure main at outlets on either side of the whaleback structure.

2) Elevator (well): starting with one pound the catch is flushed towards the elevator well. By means of a pound board between the pound and the well the catch is prevented from being flushed across the well into the other sound. The foot of the elevator is set into a wellstructure which is let into the bottomplating of the pounds, such that the elevator start down below the level of the catch. A perforated plate with a rubber flap attached is positioned to guide the fish onto the elevator. It is powered by a small motor, often hydraulically driven and with a variable speed control. Water and sand that drains through the perforated plate is collected in the bottom of the well structure and is drained overboard by a large diameter pipe. Large items as stones, rubbish and debris are manually dropped or lifted with the winch overboard.

3) Drip chute: the elevator is set at an angle of approximately 30° leading from the deck well up to the dividing chute, which splits up the catch to the sorting table inside the whaleback. The elevator and drip chute is constructed of stainless steel, the elevator has a mesh belt made out of longitudinal links and carries about 75 mm high flights at about 400 mm centres. The overall length is approximately 5 m and the drip chute has a discharge height of 1.5 m. A rubber flap comprises the front of the trunking to prevent items such as stones from being pitched along the conveyor by the elevator. The rubber causes them to drop down under a controlled manner.

4) Sorting table: one man carries out the flushing operation in the deck pounds, whilst the other three crewmembers arrange some fishboxes and baskets inside the whaleback for the fish to be sorted out manually on size and species. There are rectangular and round sorting tables with one or more belts and sometimes receiving bins on top or underneath.
In figure 1. the sorting table has three conveyors: the outside for handgrading whilst the middle one transports the commercial fish species after gutting to the rotary or drum washer.
Stainless steel mesh with longitudinal links is used for these belts. There are no flights but the sides have flanges to retain the fish on the belting.
Stainless steel is used for the framework and the conveyors are powered by a small motor, hydraulically or electrically driven with speed control. Platforms are fitted on both sides for the crew to stand on to achieve a good working height considering the vessels.sheer.
Once both pounds in turn have been emptied and the catch has been sorted manually, then the fish will be gutted by the four crewmembers.

5) Waste collecting pit with overboard drain: at the end of the outside conveyors of the sorting table is a waste collecting pit or chute with a overboard drain. Stones, other debris, undersized and non-commercial species are left on these conveyors to drop off the end into the overboard discharge flume. Sometimes 20 mm polythene is used to construct the trunking and water jets are used to power the flume Then the fish are gutted by species (plaice, sole, tarbot, crabs (demersal round fish)).

6) Discharge conveyor for gutted fish: taking one species/grade at a time, each box and or basket is tipped out on to the sorting table conveyor belts again. Each fish is gutted manually and is tossed on the discharge conveyor. Guts are simply left on the conveyor belt to be discharged off the end into the overboard flume.

7) Elevator/conveyor belt/chute to feed the washer: depending on the type of washer and the place where it is fitted, a washer chute and/or elevator/conveyor is needed to enter the rotary or drum washer, which is running continously during the gutting operation. The chutes are often made of fibre glass, while the elevator and conveyor are made of the same material as the other conveyors, the framework is stainless steel.

8) Rotating drum washer: when all the fish in the batch has been gutted, the washer is reversed to discharge the fish via a drip chute down into the fishroom hopper, e.g. a washer can consists of a 600 mm diameter drum, approximately 2 m long and is constructed of 10 mm diameter stainless steel round bar hoops welded on longitudinal bars such that a gap of 10 mm is between each hoop. Two rother tracks are fitted on the outside to carry the structure in powered rotters and it is sat in a water trough constructed out of fibre glass. At the discharge end of the drum a section of a spiral in sheet stainless steel lifts the fish over the end flange clear of the water level to slide down a discharge or drip chute into the fishroom hopper.
A hydraulic motor drives the washer with the facility to run in both directions enabling the washer to be reserved to put the spiral section into effect to discharge fish. The water in the trough is fed in, along with the fish, by the inlet chute and the water overflows out of the trough via an exit chute.

9) Washer discharge or drip chute: this connects the outlet of the washer with the fish hold hopper. Material is stainless steel.

10) Hopper in the fishroom: the fishroom of beamers have an oversized capacity for storage of fresh fish in boxes of 40 kg. It is fully insulated and is equipped with overhead tube chilling system, maintaining a fishhold temperature of + 0°C. The main hatch is set in the centre of the fishroom with a second small entrance hatch in the whalebackarea.
Shaped like an inverted 'y' the hopper is mounted on the bulkhead and has a centre trunk with a flap plate which can be positioned one way or the other to direct fish into either of the two lower branch trunks. The two lower trunks each have a door which can be opened to discharge fish into the fishboxes positioned beneath.
On port side, mounted at the top of the forward bulkhead is a fresh water flake ice machine. The output is about 2.5 - 3 tonne per day and continously discharges ices into an ice pound below it.
On the starboard side, set 2 m back from the forward bulkhead to create a working area for the filling of the boxes with fish and ice, are stanchions for fishbox storage. The aft of the fishroom is the main fish storage area, the boxes being stacked in rows across the area and stock up to 4-5 high.

Since the hopper has two separate trunks, the crew can gut three batches of fish without interruption, two in the hopper and one in the washer. After this two men must go down in the fishroom to empty the hopper into the fishboxes, including manually icing by a shovel. Then the batch in the washer is discharged down through the hopper and into the fishboxes leaving the system clear for another three batches to be gutted.
Depending on the skipper crew and the day of the fishing week (fatigue) the fish is more or less handled carefully when boxing and icing. If the fishboxes are well iced. The fishroom chilling system ensures a good quality product, although the opinion differs on this point.

3. Beamer 2000/IQAS.

Beamer 2000. Although the modern beamers (figure 2, enclosure) are hightech fishing vessels, they still suffer three major drawbacks regarding the safety and working conditions:

- wheelhouse layout and - electronics (vision lines)
- noise control (accommodation, engine room)
- occupational accidents (working deck)

Instead of an ad-hoc redesign approach, RIVO and the Technical University Delft (Safety Science Group) introduced the Beamer 2000-concept: safety integrated redesign of a modern beamtrawler, maintaining the catch-effective beamtrawl method/handling as much as possible. This socalled Kindunos method doesn't interfere the beamtrawl fisheries too much. The objectives are to adapt the wheelhouse, working deck- and engineroom layout using the safety problem solving method as developed by the Safety Science Group and the vessel design-spiral techniques (ICES-paper CM 1990/B:17 Fish Capture Committee).

This safety analysis permits structuring of the problem area into a number of manageable subproblems and the setting of priorities by allocating criteria and weighing factors for the potentional solutions.
The basis of this conceptual safety methodology is accident analysis and defining the (re)design requirements (table 1).

Table 1 - Safety (re)design methodology (Kindunos)

Analysis	Results
1) Occupational accident typology and use-scenario's	1) Design identification of dominant factors
2) In depth accident analysis	2) Increased explanatory potentional (retrospective)
3) Human error theory	3) Predictive potentional (prospective)
4) Safety considerations	4) Criteria and programme of (re)design requirements
5) Structured approach of problem solving	5) Integration of problem areas to a level of conceptual (re)designing (innovative potentional)
6) Goodness of solutions	6) Residual risks, reducing bottle necks, costs, foreseeable (mis)use.

Along these lines RIVO and TUD have been studying the safety/working conditions bottlenecks of the working deck, wheelhouse- and engineroom layout (fig. 3; General arrangement safety integrated redesign of a beamer, enclosure).

Within the scope of this paper only the results of the working deck will be considered, particular the redesign solution of exchanging the positions of the winchhouse (a'midships) and the fish processing workstations (forecastle). This solution (fig. 3.) solve a number of problems at one time and have well-thought out advantages, which outweigh possible desadvantages (table 2.).

Table 2 - Goodness of solution (fish processing a'midships).

Advantages	Disadvantages
- vesselmotion less violent midships than in forecastle area	- winch to be equipped with fishing line spooling devices
- warps and lines no longer run across the working deck	- extra investments in case of redesigning
- no interference by crew transit from accommodation to fish processing area	- yet unknown solution in the Dutch fisheries
- operation of gear/codend within clear sight of the skipper	
- improved vision lines	
- noise control	

Integrated Quality Assurance of chilled food at sea (IQAS). For fish preserved by chilling the most important parameter controlling shelf life is temperature. The aim of the IQAS-project (see par. 1.) is to significantly improve the quality of fresh fish landed by Community vessels, to increase the proportion of the fish caught for food purposes and to reduce the heavy workload for the crew.
The Dutch research institutes RIVO (Technical Research) and CIVO-TNO (Fishtechnology) have joined forces for a flatfish integrated system, while the Danish and Scottish participants are working with white fish. The EC-project started in 1989 and the final report will be finished in the second half of 1991.

The objectives of IQAS are specifying and developing a safe, efficient, mechanised on board handling system which will enable the catch to be sorted, graded for length and weight, prepared quickly and correctly for rapid chilling and to be stowed in labelled containers at 0°C until landed and sold. A monitoring, measuring, container labelling and data storage system will be developed to specify the quality and potential yield of the fish

to the buyer at the sale by reference to the actual time/temperature history of the fish prior to the sale and to the measurements of length and weight.
There has never been before developed a system which combines optimal on-board handing of chilled fish with a full declaration of all necessary information of the catch needed in the first hand trade and/or for the following trade or production. At the same time much research emphasis is given to come up with the best ergonomic solutions for the workstations on board and taking fully in account the marine environment aspects.

The RIVO contribution exists of the development of a laboratory computer aided visual fish size sorting and weighing equipment, the so-called FISHEYE and integration of this in an existing beamer fish processing line according the IQAS-philosophy.

Fisheye. The method is based on real time image analysis of the contours of a laser beam cutting the surface of the fish under an angle as seen by a camera perpendicular to a conveyor belt. Integration of the transect areas results in the volume of fish. Because the weight of fish per standard unit of volume is reasonable constant, the weight of the fish can be computed.
Although there are already various fish weighing systems commercial available, RIVO has chosen for "fisheye". On the one hand side the commercial systems are commonly based on the balance concept and for on board purposes they need time to arrive at the equilibrium; on the other hand "fisheye" has the IQAS potentional to sort the various North Sea flatfish and some roundfish in one device.

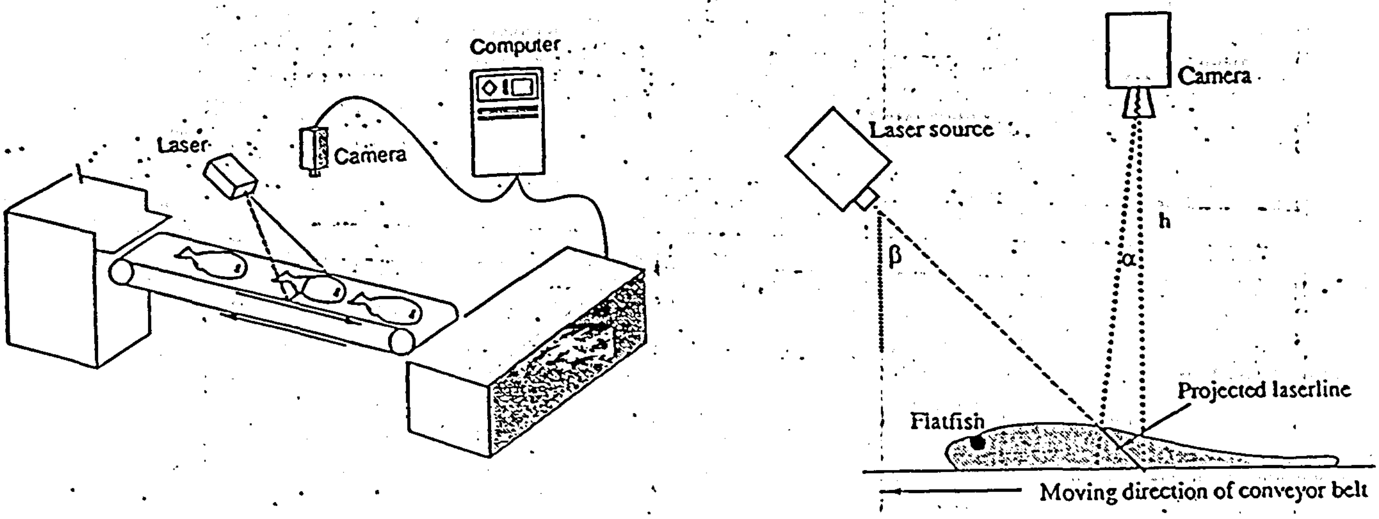


Figure 4 - Profile of the measuring system above the conveyor-belt.

A suitable weighing system for use on board of fishing vessels should carry at least the following characteristics:

- compactness and handiness
- few moving parts
- easy to repair
- cheap

Last year RIVO finished the laboratory experiments and the first sea trials. It is concluded that FISHEYE is feasible to integrate on board of a beamtrawler. The accuracy is sufficient for commerical purposes (error less than 5%).

Integrated IQAS fish handling system. For the beamtrawlers various systems have been investigated to identify the possible and probable options to handle the flatfish and the bycatch in the IQAS-way, from the catching pound to discharge at the quayside, reducing the workload and not effecting the marine environment too much.
One way or the other, to improve the quality of fresh fish or the quality of life, the goal is the same: a safe, efficient, mechanised on board handling system which will enable the catch to be sorted, characterised for length and weight, prepared quickly and correctly for rapid chilling and storage in appropiate, labelled fishboxes or containers at <0°C until landed and sold

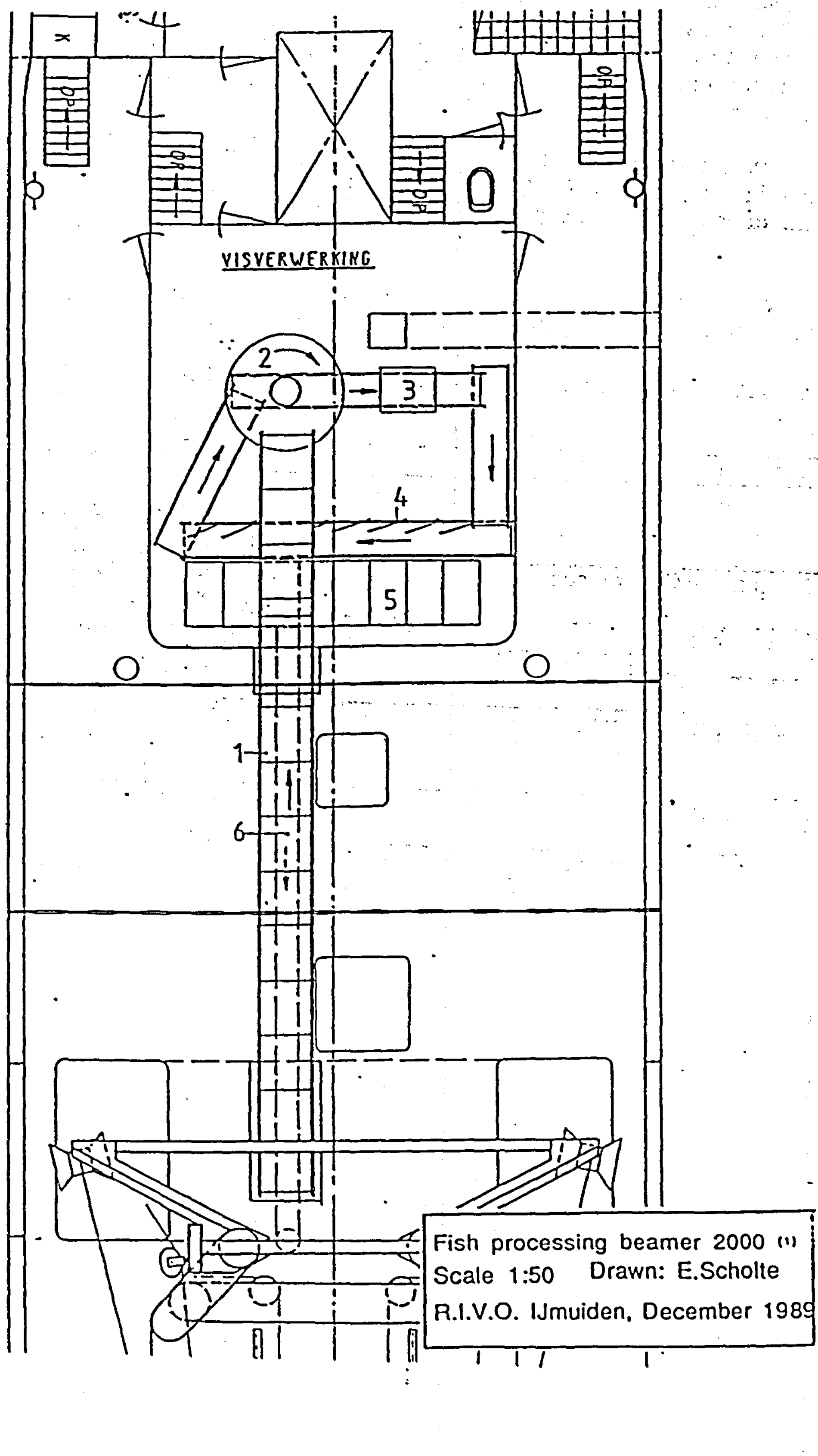
The starting-points for the Dutch beamtrawler is extension of the existing flatfish handling line with the RIVO-developed vision laboratory model for weighing and sorting flatfish on board the Beamer 2000 (fig. 5).

In table 3 the principles of correct on board freshfish handling are given as applied from the point fo view of fish quality.

Table 3 - Principles of correct on board fresh fish handling.

General	Beamtrawlers
1. net/codend: - reduction of handling damage	1. beamtrawlers: - selectivity on species, bycatch and debris
2. rapid handling on deck	2. rapid transfer fish from deckpounds to (rough) sorting tables
3. good gutting	3. manual and/or for machine gutting
4. good washing	4 washing (rotating) drums with CSW buffer tank/container
5. appropriate boxing	5. weight and/or length grader with automatic fish transfer to separate hopper above or below deck
6. appropriate icing	6. (semi)automatic icing of the boxes/containers in the fishhold
7. storage in fishroom (0-2°C)	7. storage in fishroom (0-2°C)

Figure 5 - Flatfish processing on board Beamer 2000 with RIVO vision-module.



Factors which give rise to poor on board quality are:

- too much fish/debris in codend
- delays on deck prior to chilled storage
- poor gutting standards
- poor washing/bleeding standards
- poor hygiene/maintenance of processing machineries
- incorrectly icing of the fishboxes/-containers
- overfilling the fishboxes/-containers
- maintaining correct temperature in the fishhold

For an integrated quality assurance system of chilled flatfish at sea the traditional practices have to be re-examined in the light of existing and new technical developments. Besides the need to lift and carry fishbaskets/boxes for handgutting has to be eliminated. In fig. 5 an auto icing and stowage system isn't incorporated yet, but some commercial available systems (KVA, Meyn) are considered for.

Because nowadays many (wheelhouse) p.c.-computers are already on board, e.g. Macsea plot, Chartnav electronic chart plotter, Odin//Seaplot navigation plotter, Tracor-Marcon ER-monitoring system, Dataship automation, Sperry SR8 2000), the IQAS data-acquisition can be easily realised.

A good beamtrawler monitoring system provides the skipper and (potential) buyer a (quality) data alarming and -storage system, so that any time the actual time-temperature history of the fish prior to the sale is available, including weight, species and length measurements.
Besides the skipper has continuously information about the fishprocessing on board and can react immediately in case of incorrect handling:

- minimize the delays on deck
- correct gutting and washing
- rapid chilling and stowage

Therefore a number of sensors should be installed on crucial places in the flatfishhandling/processing as given in table 4.

Table 4 - Time/temperature control of beamtrawler flatfish handling.

Time/temperature control (fig. 5)	Sensors	Data
1. deck pound	• temperatures • clock • navigation • processing • equipment	• air • seawater (°C) • date/time • fishing grounds • type, line
2. washing drum	• temperature • clock	• air • seawater • date/time
3. CSW buffer tank/container	• temperatures • clock	• seawater • date/time
4. RIVO vision module	• weight • length • species	• kg's • cm • sort
5. receiving hopper	• temperature • clock • contents	• fish • date/time • kg's
6. fishhold	• temperature • clock • icing	• air • date/time • fishbox/container (batch) • dosis

4. Bottlenecks and solutions in beamer fresh fish handling.

Although on the modern beamers much effort is given to mechanize the transport of fish from codend to fishhold and various Dutch manufacturers developed and are delivering grading-, washing equipment and conveyors, still a number of drawbacks can be pointed out especially regarding

- fresh fish quality (time-temperature)
- safety and working conditions (workload)

Safety and working conditions. The beamtrawls are less selective regarding by catches, stones and debris. A typical catch contains a large proportion of rubbish, weed and stones and all except the very large stones or items or debris are flushed to the elevator. Large items are mostly manually dropped overboard, what means heavy workload for the crew and a higher risk of falling, one of the main causes for occupational accidents on the working deck. Back- and jointproblems are the common causes for disablement (ICES-paper CM 1990/B:17 Fish Capture Committee).
As soon as the catch and smaller stones and debris drops off the elevator onto the handgrading table, it then starts to sort it according to size and species. Depending on the layout of the handgrading table more or less commercial interesting fish is temporary stored in receiving bins and/or baskets and fishboxes on the deck. Stones, weed and other debris are left on the conveyor to drop off the end into the overboard flume.

Once both pounds have been emptied the fish are gutted. Taking one species/grade at a time each basket is tipped manually out onto the sorting table, which means an extra load for the crew's back- and joint, especially one's realizes that this workstation is underneath the forecastle deck with often high acceleration levels (>1g).

After each fish is gutted, a monotuous time consuming work, the fish is tossed into the washer chute to enter the rotary washer. Guts are simply left on the conveyor belt to be discharged off the end into the overboard flume. When all the fish in the batch has been gutted, the washer discharges the fish down into the fishroom hopper.

Depending on the type of hopper a limited number of batches of gutted fish can be itemporary stored. After this two man go down into the fishhold to empty the hopper in fishboxes and/or baskets. During half an hour the crew are working in a chilled surrounding (temperature 0° C) to ice and stow the catch appropriate. Again heavy workload, especially to stock up the 40 kg fishboxes up to 4-5 high.

Generally speaking a nowadays beamer fisherman consumes about two times more energy per day than a bricklayer ashore, however, he continous works 4-5 days per week on a moving working platform. The accident rate is about 53 accidents per 1000 workers per year, comparable with the building industry ashore, however, aboard fishing vessels the occupational accidents result in very severe injuries. Disablement of fishermen is a factor 4 higher than ashore, increased in the ages from 40-50 years.

Fresh fish quality. The abovementioned shortcomings with regard to the safety and working conditions do also have a negative effect on the fresh fish quality. The existing processing line is a discontinue process with much manually pull- and liftwork and intermediate storage of fish in a high temperature surrounding.
The handgutting is time-consuming and properly icing and stowing depends on the skipper- and crew's interest (fatigue crew, better quality doesn't pay off yet).

Besides under-utilization of bycatches is a burden regarding the marine environment and the earning capacity of the fishing industry with lower quota's allocated each year and fishing vessel lay-ups during several weeks per year.

Technical solutions. Because the quality of fresh fish after being caught depends on the temperature and storage time, the so-called time temperature history, the IQAS-system, should be introduced, either on board existing vessels (local- and partly redesign solutions) or on board the (drawingboard) fishing vessel Beamer 2000 (new design).
Only in realizing a continous flow in handling and no accumulation of unchilled fish the time-temperature history can become under control, improving the crew's working environment at the same time.

In this paper the Beamer 2000 solutions will be given, because only then the risk of falling can be reduced adequately, combined with the improvements regarding vision lines, hit or crushed by moving objects or gear components. However, the IQAS-philosophy can and will (1991/1993) also easily be adapted on board of an existing beamer as follow-up of the IQAS-EC-project (demonstration project), although without the Beamer 2000 benefits.
To meet the IQAS requirements the existing beamer processing line must be extended with the following equipment above deck (see preliminary IQAS processing sytem fig. 6).

- gutting machine flatfish (4)
- RIVO-fisheye (7)
- bycatch handgutting station (12)
- transferstation gutted and sorted fish in fishhold (9),

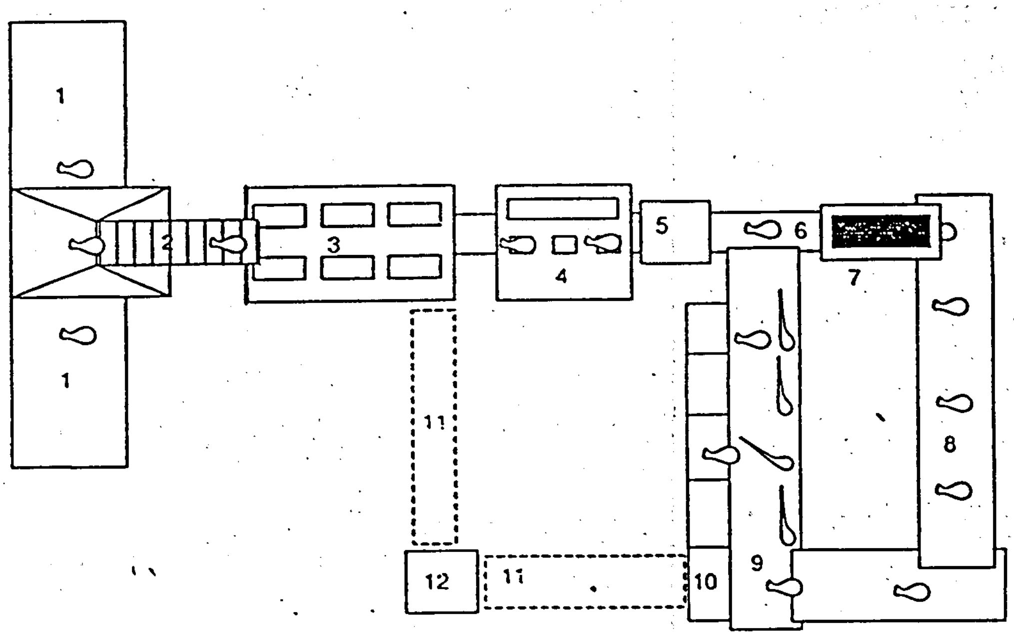


Fig. 6 - IQAS fish processing system (preliminary).

and below deck:

- ice-dosing system
- fishbox/-container fill- and transport system.

Except the RIVO vision modules, the other equipment exists already but either not in accordance with the IQAS processing line or the commercial version has not been installed on a broader scale (too much 'growing pains'). Before introducing this processing line on board the Beamer 2000, two important design/engineerings consequences must be checked profoundly:

1) changing of the winchhouse (midships) with the extended processing line (forecastle) with regard to the beamer stability requirements (Dutch Shipping Inspectorate, Beamer 2000).
2) extending the fish handling line with extra equipment with regard to throughput of the fish (waiting line system) and the workload of the crew (work-sleep cycle).

5. Design consequences and costs.

Stability requirements. In table 5 the calculated stability parameters for Beamer 2000 (fig. 7) and the required criteria according the Dutch Shipping Inspectorate are given. In enclosure I more naval architectural background information is given for the worst loading condition (arrival at home port with 10% fuel, stores atc. and 20% full catch).

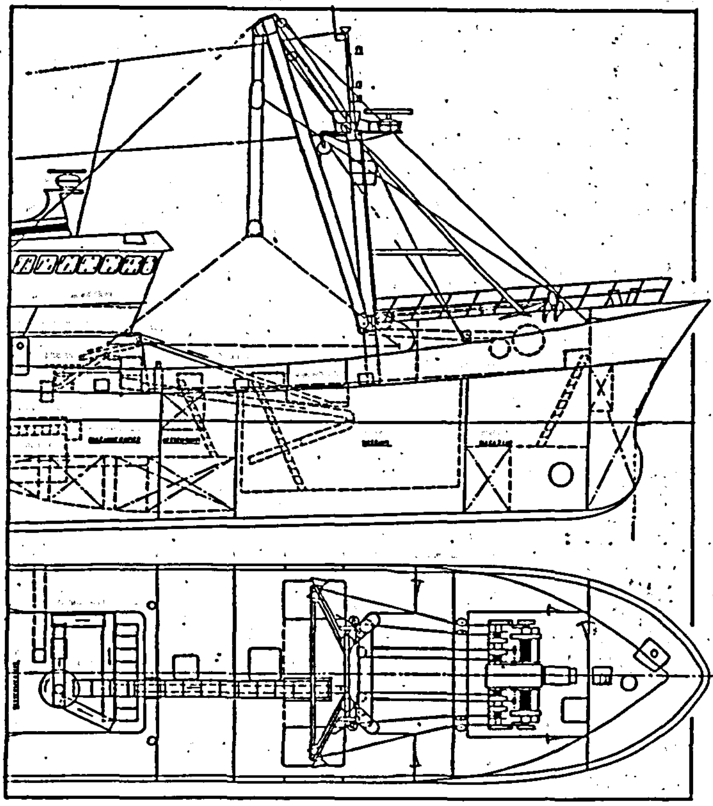


Fig. 7 - Beamer 2000

Table 5 - Stability criteria Beamer 2000.

Criteria	Dutch Shipping Inspectorate	Beamer 2000 (condition 4)
1) metacenter height (GM)	GM ≥ 0.50	0.71 m
2) righting lever arm (GZ) ≥30°	GZ ≥ 24 x q (≥ 0.33)	0.39 m
3) φ (GZ max)	φ ≥ 30°	38.8°
4) area under the GZ curve (0.30°)	A ≥ 0.090 (≥ 6.6xq)	0.098 mrad.
5) area under the curve (0.40°)	A ≥ 0.148 (≥ 10.8 x q)	0.165 mrad
6) area under the curve (30°, 40°)	A ≥ 0.049 (≥ 3.6 x q)	0.067 mrad
7) static angle due to wind inclining moment (-10°, ...)	≤ 40°	39.6°

$q = apkl/0.9\, L^2 = 1.37$
$L = 1.12 \times Lperp. = 40.25\ m$
$apk = 2000\ hp$

According to table 5 Beamer 2000 fulfill the Dutch beamer criteria sufficiently, even there is some reserve stability for future new processing equipment.

Although it was necessary to increase the beamer intact stability requirements in the seventies due to capsizings, this implies for the relatively short vessels a worse seakeeping performance in the North Seas. Since the seventies the design of the Dutch beamtrawler has changed in some ways. Nowadays the vessels are larger, some of them are equipped with a bulbous bow and afterward supersturcture instead of a deckhouse. Because falling is one of the main causes for occupational accidents, RIVO has been wondering if the seaperformance can be improved by either reducing the stability criteria (developed in the seventies) for the closed stern modern beamer or retrofitting a bulbous bow. The influence of the superstructure and bulbous bow has been checked by using the computer program SHIPMO of Marin (Maritime Research Institute Netherlands, Wageningen). Only preliminary calculations have been made to get an idea about the influences.
Regarding the results as given in Enclosure II, the following conclusions may be drawn.

1) the influence of the superstructure on the static stability data is negligible, so there is no need to reduce the metacentric height when a superstructure is applied.
2) at an average wave period of 7 seconds, which is significant for the North Sea, the reduction of the pitch value and the vertical acceleration with a retrofit bulbous is negligible with the SHIPMO programme. However, one should keep in mind that the bulbous bow friction is not considered here. Meanwhile the experiences with some bulbous bow beamers are showing a better working condition at the forecastle during fishing (6 knots).

From the abovementioned one may conclude that reducing the stability criteria for the modern beamer doesn't effect the seaperformance considerably and retrofit bulbous does reduce the vertical acceleration at the forecastle deck a bit. The only technical solution to improve the seaperformance is to change the winchhouse with the fishprocessing area in the forecastle as redesigned in Beamer 2000 (reduction of accelerations with 50%). Besides only with model tanktests and full scale acceleration measurements the hullform can be optimized appropriate.

IQAS throughput, waiting line, work-sleep cycle. The process of filling a boat with fish at sea can also be described as a queueing.phenomenon or waiting line system. For the beamtrawlers it is rather well-known at which moment a batch of fish with bycatch, debris etc. comes on board. In setting up a processing line it is important that the throughput and processing capacity must be matching otherwise the fresh fish detoriates fast and instead of reducing the crew's workload it increases considerably. When the throughput is too small for the size of the vessel and processing line the beamer will be too expensive to operate and the income will not exceed the costs, preconceived the earnings for landed fresh fish will increase considerably, what is not yet the case in the Dutch fishauctions.
After discussions with the Shipping Inspectorate the original IQAS layout (figure 8) was adapted, resulting in the IQAS line as given in figure 9. One of the reasons is that in transferring the gutted and weighed fish into the fishhold, the chute must not pass the engineroom (construction, quality loss).
Regarding to the conventional processingline the new IQAS-lines does improve the:

• fresh fish throughput (no discontinuities or intermediate chilled storage is foreseen).
• ergonomics (no heavy pulling and lifting).

Sorting table: the two crewmembers sorts the fish in bycatch and flatfish. The flatfish and bycatch are tossedon a different conveyor transfering the fish into a buffertank filled with cold water. This method of fish sorting gives a great advantage to the conventional system; the fish quality don't change due to the cold water and the crew's workload has reduced (no fish in temporary boxes/baskets on deck).

Buffertank flatfish: the buffertank is filled with cold water to keep the temperature low A vertical elevator transports the flat fish to the top of the tank (better working condition for the crewmember at the gutting machine).

Automatic gutting machine: the machine (developed in 1983 Leba) guts the fish automatically. The fish is placed by one crewmember under a clip. The machine drills two holes in the belly of the fish, then with water under pressure the intestines are flushed out.
After a promising and state aided start on board half a dozen beamers, the crews were not so happy with this plaice gutting machine:

- growing pains
- too much maintenance
- too much wear and bear of some components
- retailers and customers did not like the drilled holes in the plaice.

However, in the IQAS philosophy a good working (semi)automatic gutting machine does relieve the crew's workload considerably. Before reintroducing this gutting machine, it should be improved and extended with also sole gutting (RIVO investigates now the shortcomings).

RIVO fish eye system and transfer station: after the fisheye system a transferring station is located.The computer controls the shifting station; the visual measured fish is sent by clatters to a box filled with cold water. There are five shoppers situated in the shifting station, four for the different kinds of plaices and one for sole. In the system of the shifting station a return conveyor is placed to return incorrectly measured plaice and sole to the system. Fisheye weights incorrectly when a fish stirs too much when measured.
In the shifting station there are also shoppers for the different kinds of bycatch species After the bycatch is sorted a conveyor transports the fish into a buffertank filled with cold water. Then crewmember guts the fish manually and put the fish in a buffer filled with cold water situated in the shifting station.
When the hoppers are full the fish can be transferred into the fishhold after batch-washing in a rotary washer or because the buffers are prechilled, this can be done after finishing all the caught fish. To reduce the workload in the fishhold, an already commercial available fish storage system can be installed, e.g. the Swedish KVA-system (enclosure III).

Figure 8 - 1st IQAS line.

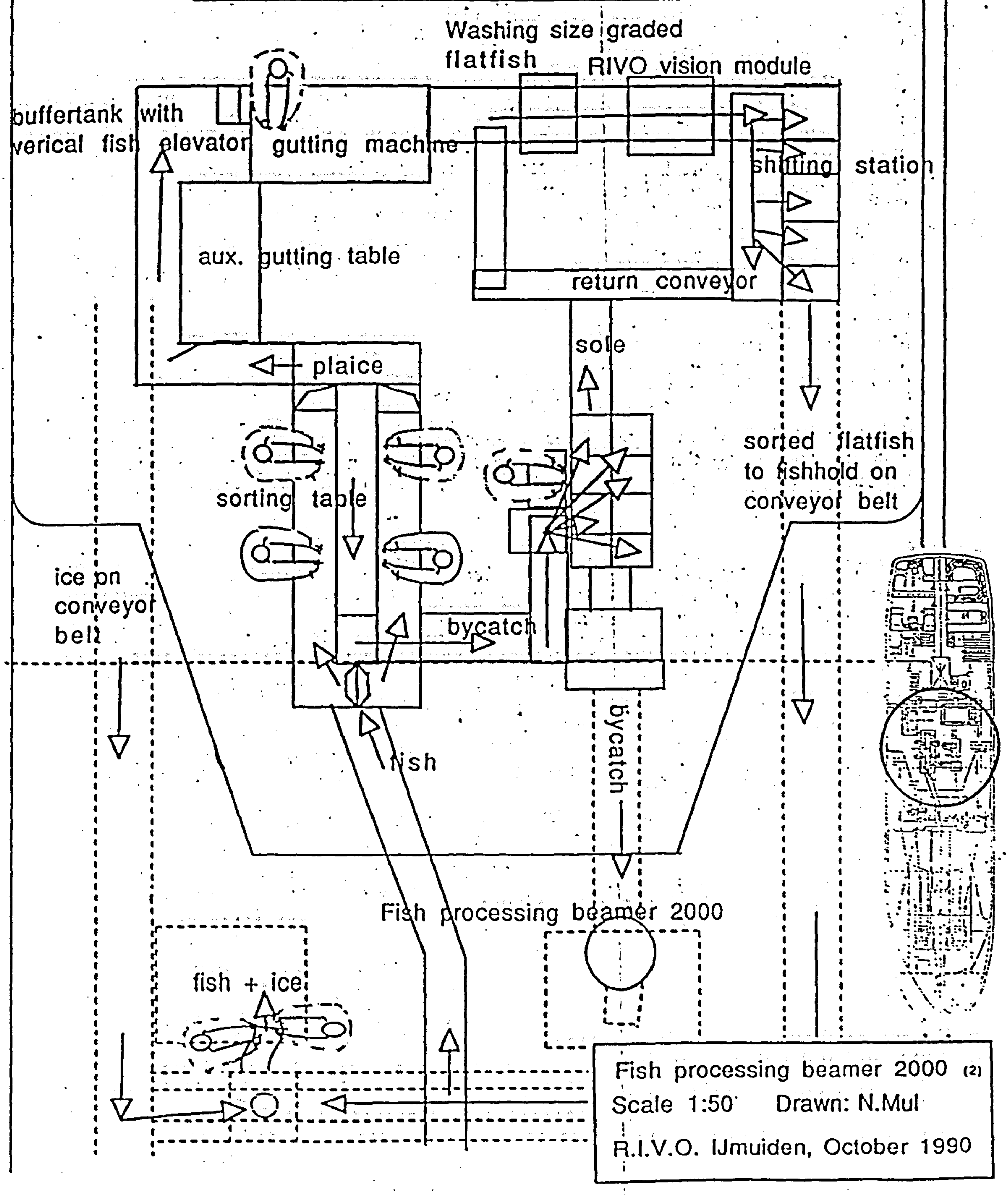
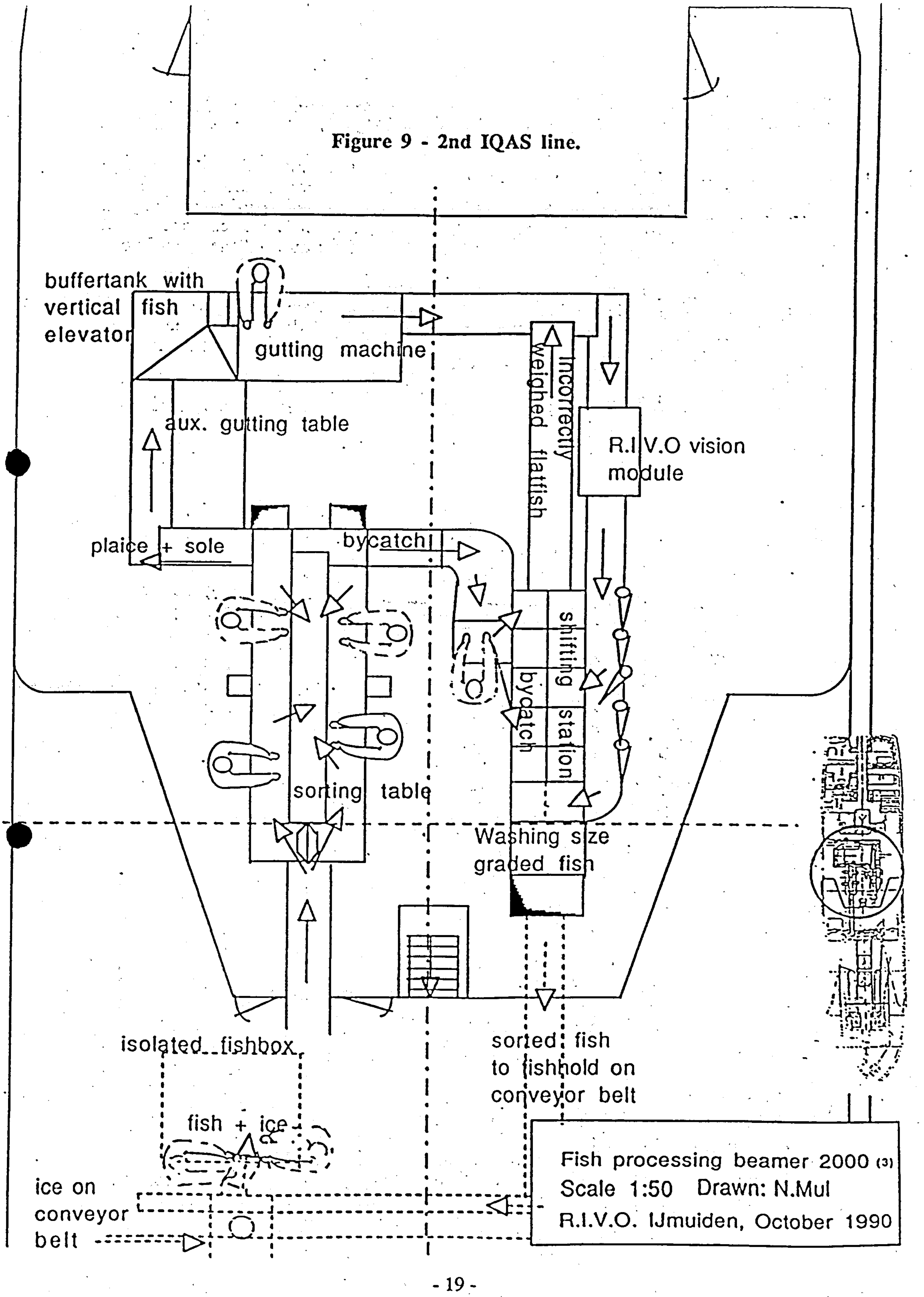
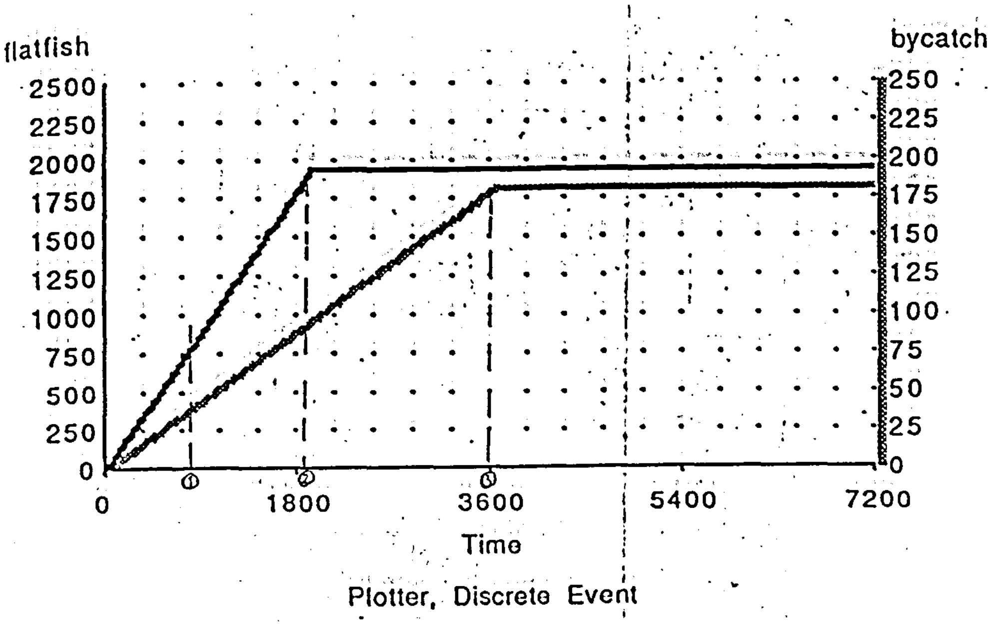


Figure 9 - 2nd IQAS line.



By means of the RIVO Mac-Extend programme the throughput of an average catch of fresh fish for a socalled North-beamer (fishing grounds above 54° Latitude), has been simulated.
In first instance to check if, regarding the time-temperature history of the throughput there are no bottlenecks and secondly to investigate if the IQAS mechanisation improves the work-sleep cycle of the crew. Due to the aim of this drawing board study, only an average catch was simulated: 2000 fishes (90% flatfish and 10% is bycatch) for a typical Northern beamer (less bycatch than in the South). In Enclosure IV the Mac-Extend results are given.

From each workstation in the processing line, the necessary throughput time is estimated in consultation with the RIVO skippers and/or technical details as given by the manufacturers, e.g. the gutting machine throughput is 1800 flatfishes per hour (1 per 2 sec.) and the average transfer speed of conveyors is 0.2 m/s.
For the catch the possibly bottlenecks are the intermediate storage before the gutting machine (ca. 20 min.), where the flatfish will be kept in a seawater filled buffertank, as



1 = 4 crew, ready with handsorting
2 = 1 crew, ready with handgutting bycatch
3 = 1 crew, ready with gutting machine

Fig. 10 - Fish processing time sequence

well as in the buffertank for the bycatch (7 min.) and the intermediate storage of gutted fish in the transferstation buffers (90 min.) before transferring it into the fishhold. This means that the temporary on deck stored fish must be pre-chilled adequately to prevent quality loss as much as possible. An other bottleneck can be, where the incorrect weighed flatfish coincide with the not yet weighed flatfish before the RIVO vision module; an extra task for the fisherman at the gutting machine. In figure 10 the workcycle for the

four crewmembers (the same number as with the conventional line) is plotted, starting at the sorting table. After 15 minutes the fish has been handgraded. One man starts working at the gutting machine and a second one starts the bycatch handgutting, while the other two starts cleaning the deckpounds, elevatorconveyor or start to prepare the fishhandling in the fishhold (icing and stowage), depending on the chosen system. After 30 minutes the bycatch has been gutted and this man can go to the accommodation for rest/sleep till the next catch comes on board (± 1 hour 15 min.). After 1 hour the man at the gutting machine has finished his batch of flatfish and can go for rest or starts cleaning the gutting machine; vision module and the transfer station.
After circ. 1 1/2 hour the whole catch has been processed and stowed in the fishhold. This means that there is not much time left before the next codends comes on board. In time sequence the IQAS line doesn't yet improve the work-sleep cycle of the crew, but the routine has been mechanised in such a way that e.g. at night time two men can do the processing, while the other can go back for sleep after the beamtrawls are be towed again. The advantages of this system is that with various temperature sensors the time-temperature of each individual fish can be controlled and with fisheye registered as defined by EC Regulation 3166/82 in terms of the weight of a single fish.
The hard labour of the crew decreased considerably, although not much time gain has been realized so far regarding the existing system due to the beamtrawl fishing method (tows of 2 hours, 24 hours a day, 5 days per week). Further mechanisation/automation as no men in the fishhold can bring relief here and/or at nighttime 2 men shift of 6 hours. Of course to improve the workcycle considerable, the best solution is to increase the number of crew from 4 to 6 persons, something already in use on baord of a few beamers!

The extra investments for the gutting machine, computer vision module and transfer station is about Hfl. 200,000.--. Only if better quality fresh fish gets a better price of the retailers and the auction costs are lower, the payback time of this IQAS line above deck is about four years. The social costs will be also lower due to less disablement and sickleaf.

6. Conclusions and recommendations.

Although the Dutch beamers do have various processing equipment, still the fish isn't handled quality appropriate from the codends, catching pounds to discharge at the quayside. Besides much heavy pull- and liftwork must be done by the crew and much bycatches goes useless and dead overboard again..
Only by introducing an integrated fishhandling system (IQAS), abovementioned shortcomings can be solved, as showed by the studies carried out partly in the framework of the EC-Community Research Proramme (FAR-UP1-67) and Safety integrated redesign of beamtrawlers (RIVO/TU Delft, Beamer 2000).
In this drawingboard study the design consequences have been given and the costs/benefits are considered of the extension of a beamer processing line with a flatfish gutting machine, the RIVO developed computer vision module and the transfer station for gutted fish.
Only by changing the winchhouse (a'midships) with the workstations (forecastle): the Beamer 2000 concept, a considerably improvement in working environment can be realized. This means that in combining the IQAS and KINDUNOS philosophy an enormous step forward can be made to improve both the quality of the landed fresh fish and the quality of the working environment. The design calculations are learning that there are no negative stability consequences and only by model tanktesting the seaperformance can be optimized to reduce the vertical accelerations (hullform, bulbous bow) and falling of the crew.

The first attempt in computer-modelling of the beamer catch throughput (Mac-Extend) gives more insight in the queueing phenomenon. Before the gutting machine, the handgutting of the bycatch and buffers in the transferstation a pre-chilled intermediate storage is necessary, while the working cycle for the crew doesn't improve much or further mechanization is inevitable (no men in the fishhold) and the crew's working pattern is changed, e.g. 6 hours shift. An other easily reaching solution is to increase the fish processing crew from 4 to 6 members, however, not in favour of the skipper-owner. Anyhow with the IQAS beamer 2000 line the crew's working condition improves considerably and minimise the quality loss of the landed fish. At the same time more bycatch species can be processed preventing caught fish goes useless and deadly overboard. To reduce the environmental load as well, more emphasis must be given to the selectivity of beamtrawls (length, species and debris).
However, can this line also be installed on an existing beamer? The answer is yes, but then nothing is done to reduce the vertical accelerations and some assumptions must be tested in practice firstly:

1) The shortcomings of the already existing Leba plaice gutting machine has to be solved and extended with sole gutting..
2) The RIVO laboratory computer vision module Fisheye becomes an acceptable seaworthy prototype for the industry and can measure also the length acceptable and/or a combination with the TNO-infrared length measurement can be realized.
3) Existing gutted fish transferstations can be adapted for beamer purposes.
4) Existing auto-icing and stowage system can be installed in the beamer fishhold.

As follow up of IQAS phase I, this can be done due to the EC granted IQAS phase II: performing on board the experimental work to connect unit operations equipment as developed in the earlier phase of the project. The aim is establishing a production line according to the principles of quality assurance. RIVO and CIVO-TNO will do this on board the beamtrawlers, while the participants of IQAS/phase I are concentrating on Danish and Scottish white fish trawlers.
The financial EC contributions (FAR-programme) doesn't foresee the building costs for changing the winchhouse with the processing area in the foreship, the Beamer 2000 concept. For this a newbuilding vessel is necessary, what is nowadays out of common practice due to overcatching capacity!
If fishing gear technicians are also successfull in improving the debris and species selectivity of beamtrawls, a positive spin off is given to the marine environment as well.

Only on board of the **BEAMER 2000**, the objective of integrated quality assurance can be realised to the maximum extent:

Q1: quality assurance of fresh fish handling.
Q2: quality of the crews working environment.
Q3: quality of the marine environment.

In this paper it is showed that it is more a matter of reconsidering/streamlining already existing techniques than reinventing the wheel, however, from the **IQAS** and **KINDUNOS point of view**. The noticed (nowadays) shortcomings can technically be solved without too high extra investments.

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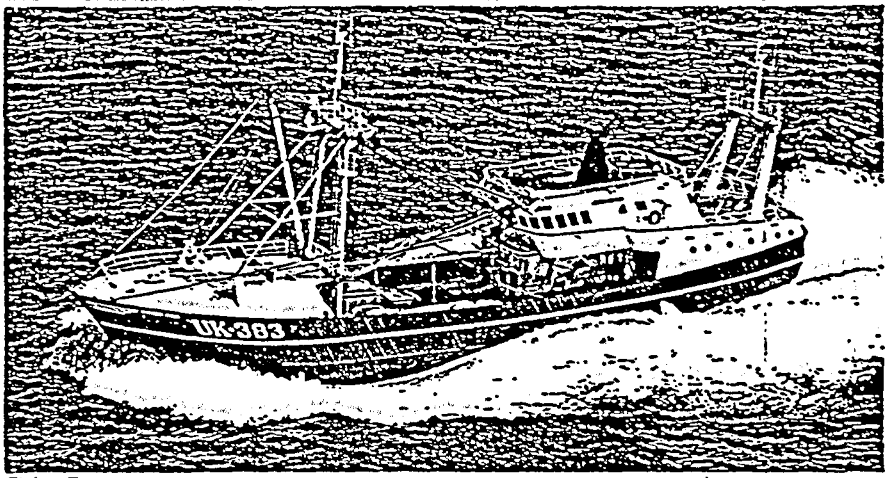
BEAMTRAWLER

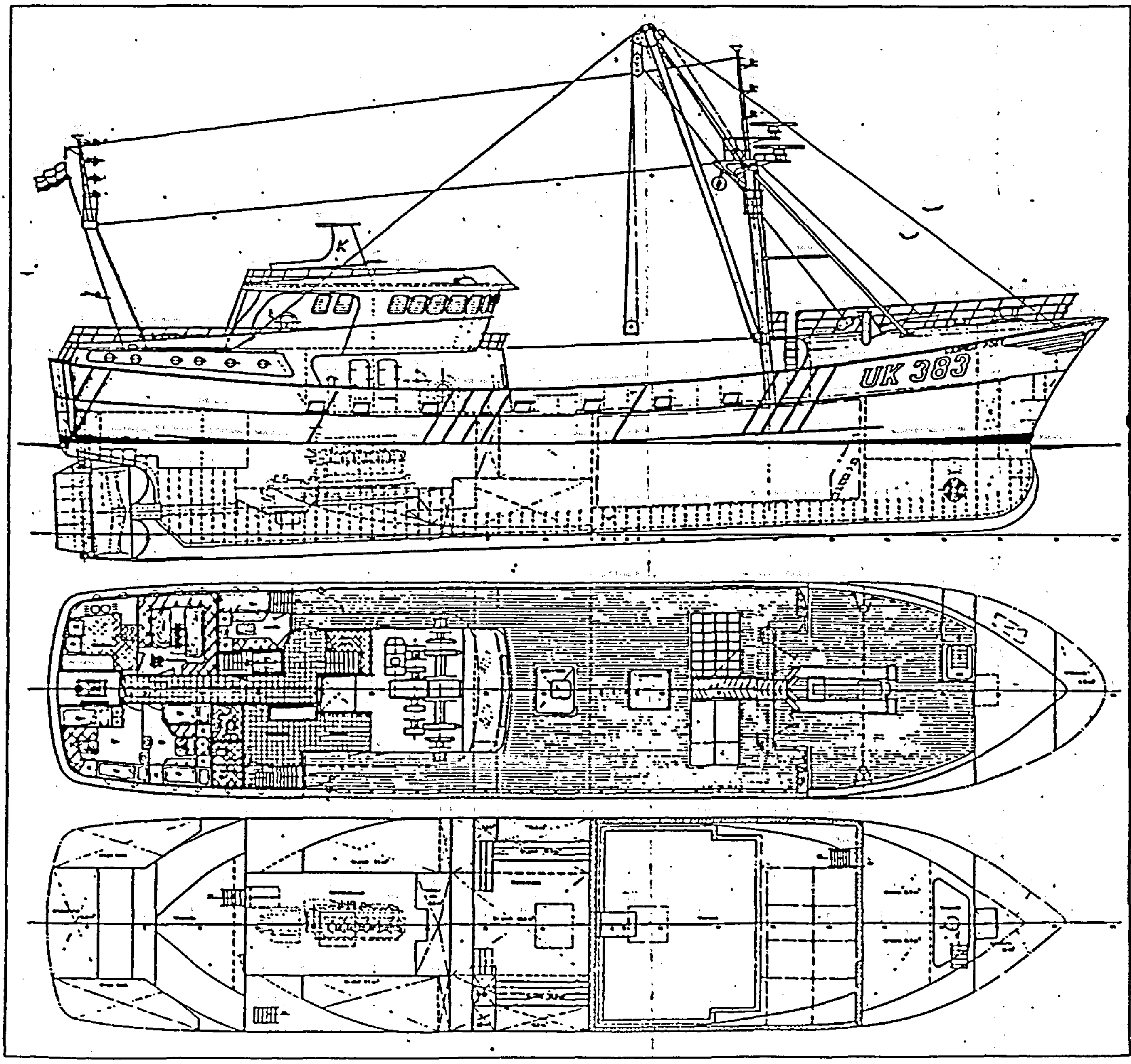
M.V. UK 383 'Harmen Post'
Owner: Rederij Geertruida B.V.
Urk, The Netherlands
Builder: Scheepswerf Metz B.V.

Figure 2



Flying Focus

Principal Particulars	
Length over all	41.90 m
Breadth mld.	8.50 m
Depth	4.70 m
Draught mld. ½ l	3.50 m
Deadweight	135 ton
Gross tonnage	435 GT
Fuel oil cap.	120 m³
Fresh water cap.	27 m³
Main engine	2000 HP
Speed	13,5 KN



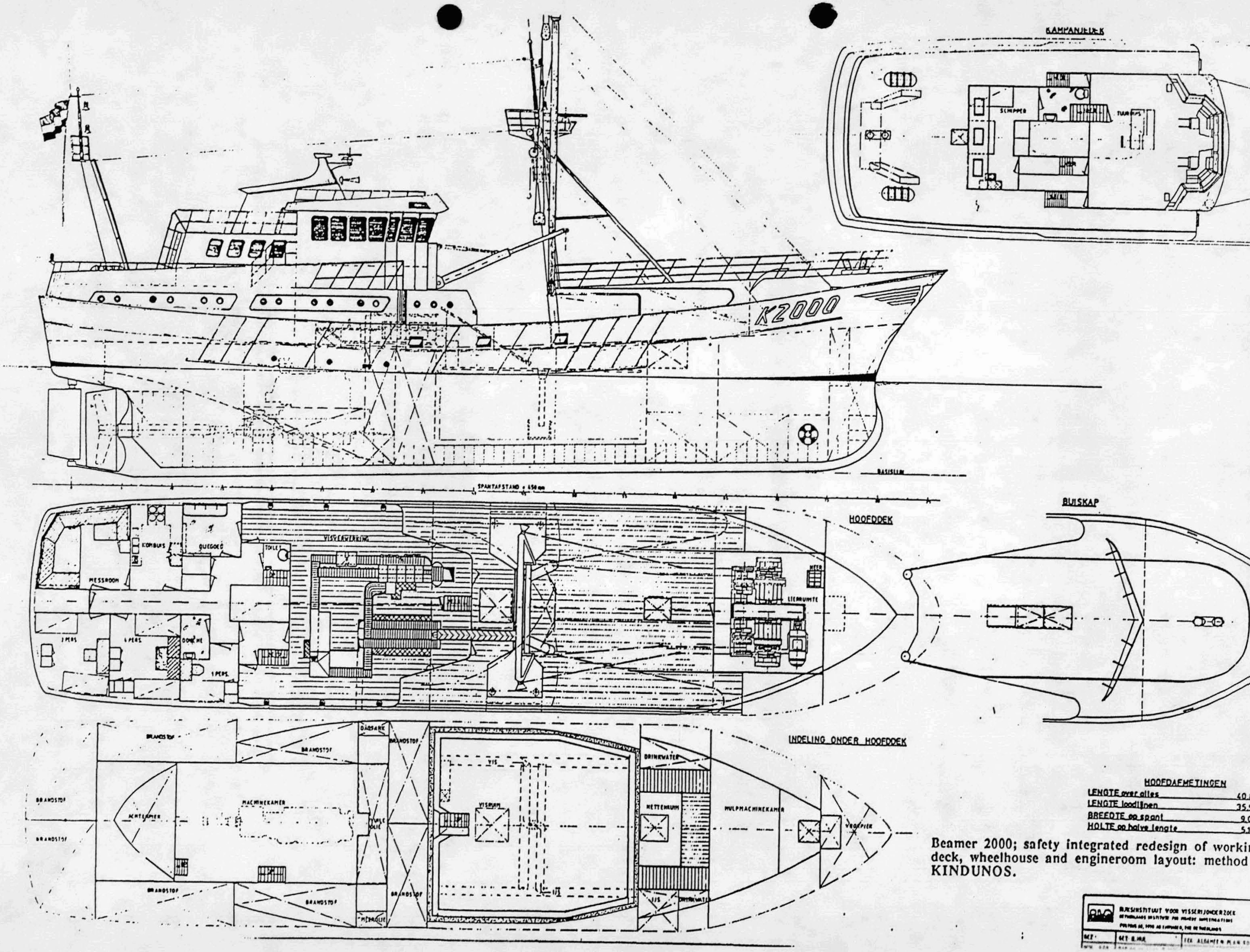


Figure 3

Beamer 2000; safety integrated redesign of working deck, wheelhouse and engineroom layout: method KINDUNOS.

	IMO Res. A168 1968	Bekendmaking aan de scheepvaart 55/1968 visserijvaartuigen			IMO Torremolinos 1977	bekendmaking aan de scheepvaart 124/1977 ** visserijvaartuigen			aanvulling op bekendmaking brief S.I. dd 27-02-1980	
		div. visserij-methoden	boomkorvisserij apk ≤ 0.8L^2	boomkorvisserij apk > 0.8L^2 q = apk/0.8L^2		div. visserij-methoden	boomkorvisserij apk ≤ 0.8L^2	boomkorvisserij apk > 0.8L^2 q = apk/0.8L^2	boomkorvisserij L < 35 m apk > 0.8L^2	boomkorvisserij L ≥ 37 m apk > 0.9L^2 q' = apk/0.9L^2
	1	2	3	4	5	6	7	8	9	10
stab. arm Ø = 30° [cm]	≥ 20	≥ 20	≥ 24	≥ 24*q	≥ 20	≥ 20	≥ 24	≥ 24*q	zie kolom 8	≥ 24*q'
dyn. weg tot Ø = 30° [cmrad]	≥ 5.5	≥ 5.5	≥ 6.6	≥ 6.6*q	≥ 5.5	≥ 5.5	≥ 6.6	≥ 6.6*q	zie kolom 8	≥ 6.6*q'
dyn. weg tot Ø = 40° [cmrad]	≥ 9 (Ø = 40° of Øf)	≥ 9 ...	≥10.8 ...	≥10.8*q ...	≥ 9 (Ø = 40° of Øf)	≥ 9 (Ø = 40° of Øf)	≥10.8	≥10.8*q	zie kolom 8	≥10.8*q'
toename dyn weg Ø = 30° - Ø = 40 [cmrad]	≥ 3 (Ø = 40° of Øf)	≥ 3 ...	≥ 3.6 ...	≥ 3.6*q ...	≥ 3 (ø = 40° of øf)	≥ 3 (Ø = 40° of Øf)	≥3.6 (Ø = 40° of Øf)	≥ 3.6*q (Ø = 40° of Øf)	zie kolom 8	≥ 3.6*q' (Ø = 40° of Øf)
stab. arm max. bij Ø= Øm	advies ≥ 30° zeker > 25°	idem	idem	idem	idem	idem	idem	idem	idem	idem
MG [cm]	≥ 35	≥ 35	≥ 35	≥ 35	≥ 35	≥ 35 (gec. voor vrij vl. opp.)	≥ 50 (gec. voor vrij vl. opp.)	≥ 50 (gec. voor vrij vl. opp.)	≥ 50 (gec. voor vrij vl. opp.)	≥ 50 (gec. voor vrij vl. opp.)
windmoment	....	.....	.....	.....	ja	ja	ja	ja	ja	ja

* Øf is de hoek waarbij openingen te water komen.
* Bij boomkorvisserij wordt onder L verstaan de kleinste waarde van:
  Loa in meters volgens de meetbrief
  1.12*Lll in meters
* zie kolom 9 en 10; voor schepen met een lengte tussen 35 en 37 meter wordt de factor q' gevonden door rechtlijnige interpolatie.

Trim-en stabiliteitsberekening 13-12-1989 9:52:41
Conditie : aankomst haven (misse reis: 8t vis, 10% voorr., 70% d.w.)

Omschrijving	Gewicht ton	Zhoogte m	Mhoogte tonm	Zlengte m	Mlengte tonm	Zbreedte m	Mbreedte tonm	VrVlstof tonm
Leeg schip	626.500	3.970	2487.205	18.580	11640.371	0.000	0.000	0.000
ijs	8.000	1.600	12.800	28.900	231.200	0.000	0.000	0.000
proviand	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
vis	8.000	2.100	16.800	24.100	192.800	0.000	0.000	0.000
dw bb	9.797	1.931	18.920	30.752	301.281	-1.181	-11.571	0.000
dw sb	9.797	1.931	18.920	30.752	301.281	1.181	11.571	0.000
dw sba	2.188	1.018	2.228	14.071	30.786	2.934	6.420	1.073
dw bba	2.188	1.018	2.228	14.071	30.786	-2.934	-6.420	1.068
fo sb	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
fo bb	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
fo sbe	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
fo [illegible]a	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
fo [illegible]a	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
fo bba	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
fo sbak	2.655	3.106	8.246	7.409	19.673	2.857	7.587	1.240
fo bbak	6.549	3.503	22.940	6.735	44.113	-2.995	-19.616	2.817
vuile olie	3.453	1.964	6.782	11.261	38.885	-2.917	-10.070	0.000
vuil water	3.837	1.964	7.536	11.261	43.205	2.917	11.189	0.000
lo	0.358	2.631	0.942	18.198	6.518	-4.057	-1.453	0.095
dagtank	3.582	3.811	13.649	18.200	65.191	4.053	14.517	0.000
vp- tank	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Totaal	686.904	3.813	2619.197	18.847	12946.091	0.003	2.153	6.293

Carenewaarden

Volume = 666.816 m³ ETM = 6.457 tonm/cm
Wl zwaartepunt = 17.229 m Ton/cm inzinking = 2.825 ton/cm
Lengte loodlijnen = 35.930 m

Dwarsstabiliteit

KM dwars = 4.533 m
Gewichtszwaartepunt KG = 3.813 m

GM vast = 0.720 m
GG' correctie = 6.293 / 686.904 = 0.009 m

Metacentrum G'M gecorrigeerd = 0.711 m

Trimligging en diepgangen

Diepgang = 3.658 m Diepgang achter = 3.974 m
Totale trim -0.631 m Diepgang voor = 3.343 m

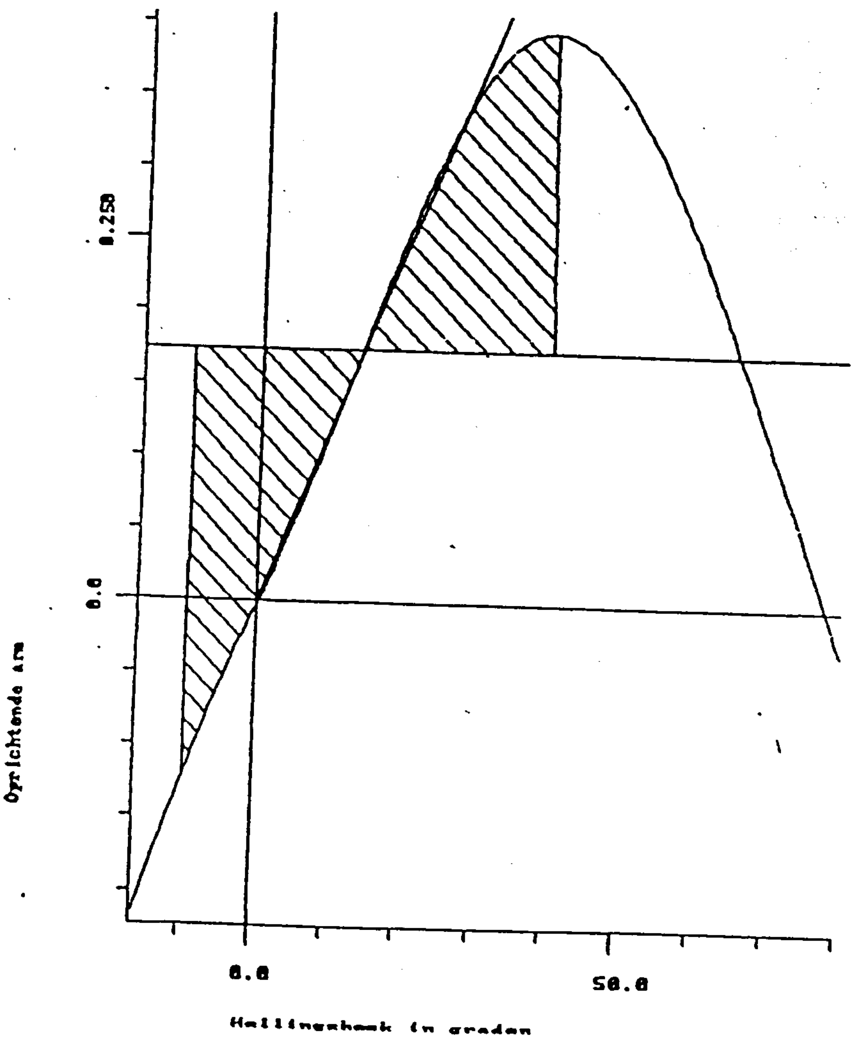
De stabiliteitswaarden gelden voor de opgegeven trimligging.

Trim-en stabiliteitsberekening 13-12-1989 9:53:45
Conditie : aankomst haven (misse reis: 8t vis, 10% voorr., 70% d.w.)

Statische arm dynamische weg, berekend met vrije vertrimming :

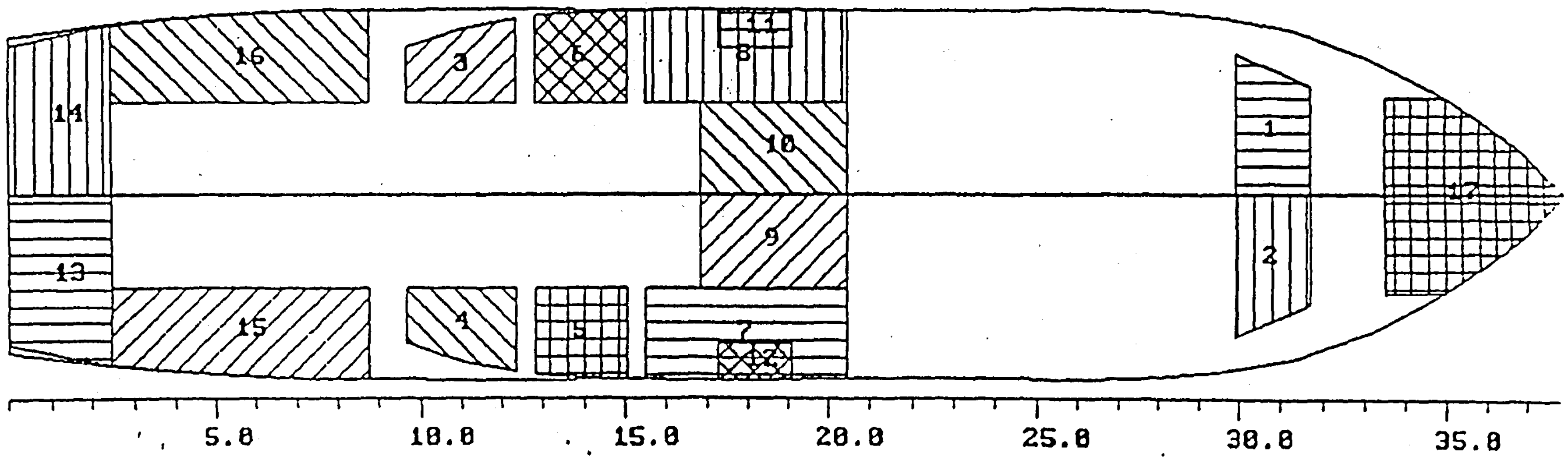
Hoek (@) graden	KN sin@ m	KG'sin@ m	GB cos@ m	G'N sin@ m	Dyn.weg mrad
0.00	0.000	0.000	0.003	-0.003	0.000
10.00	0.788	0.664	0.003	0.121	0.010
20.00	1.567	1.307	0.003	0.256	0.043
30.00	2.277	1.911	0.003	0.363	0.098
40.00	2.853	2.457	0.002	0.393	0.165
50.00	3.279	2.928	0.002	0.349	0.231
60.00	3.557	3.310	0.002	0.245	0.283
70.00	3.706	3.592	0.001	0.113	0.315
80.00	3.734	3.764	0.001	-0.031	0.322

Maximum G'N sin(@) is 0.394 m bij 38.80 graden.
Statische hellingshoek naar lij 9.67 graden
Hellingshoek naar lij, vanuit 10 graden naar loef is 39.60 graden

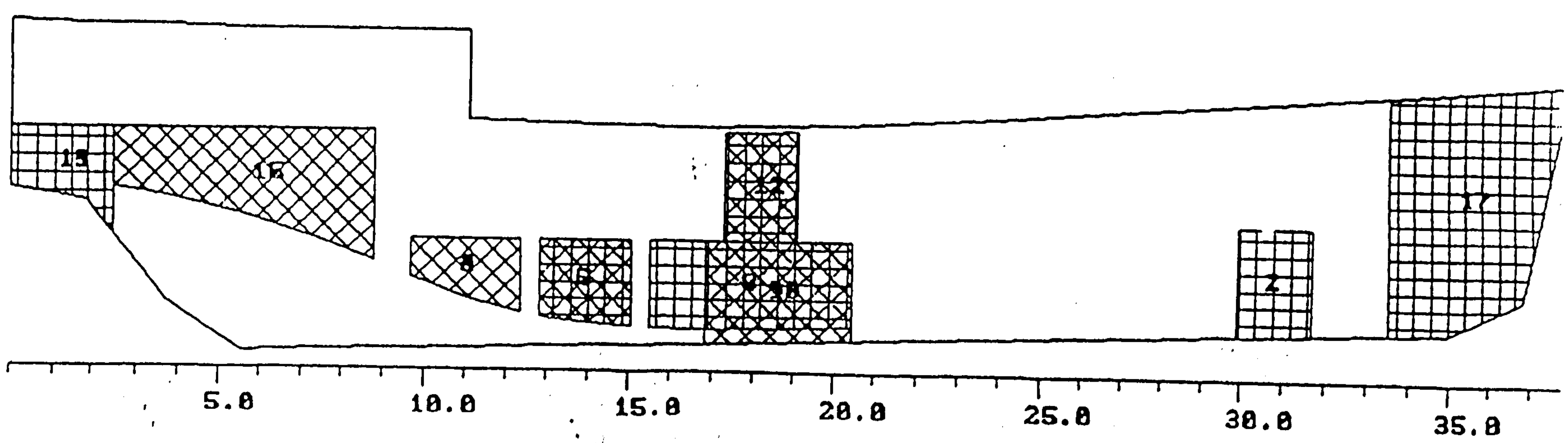


1 dw bb
2 dw sb
3 vuile olie
4 vuil water
5 dw sba
6 dw bba
7 fo sb
8 fo bb
9 fo sbm
10 fo bbm
11 lo
12 dagtank
13 fo sba
14 fo bba
15 fo sbmk
16 fo bbmk
17 vp- tank

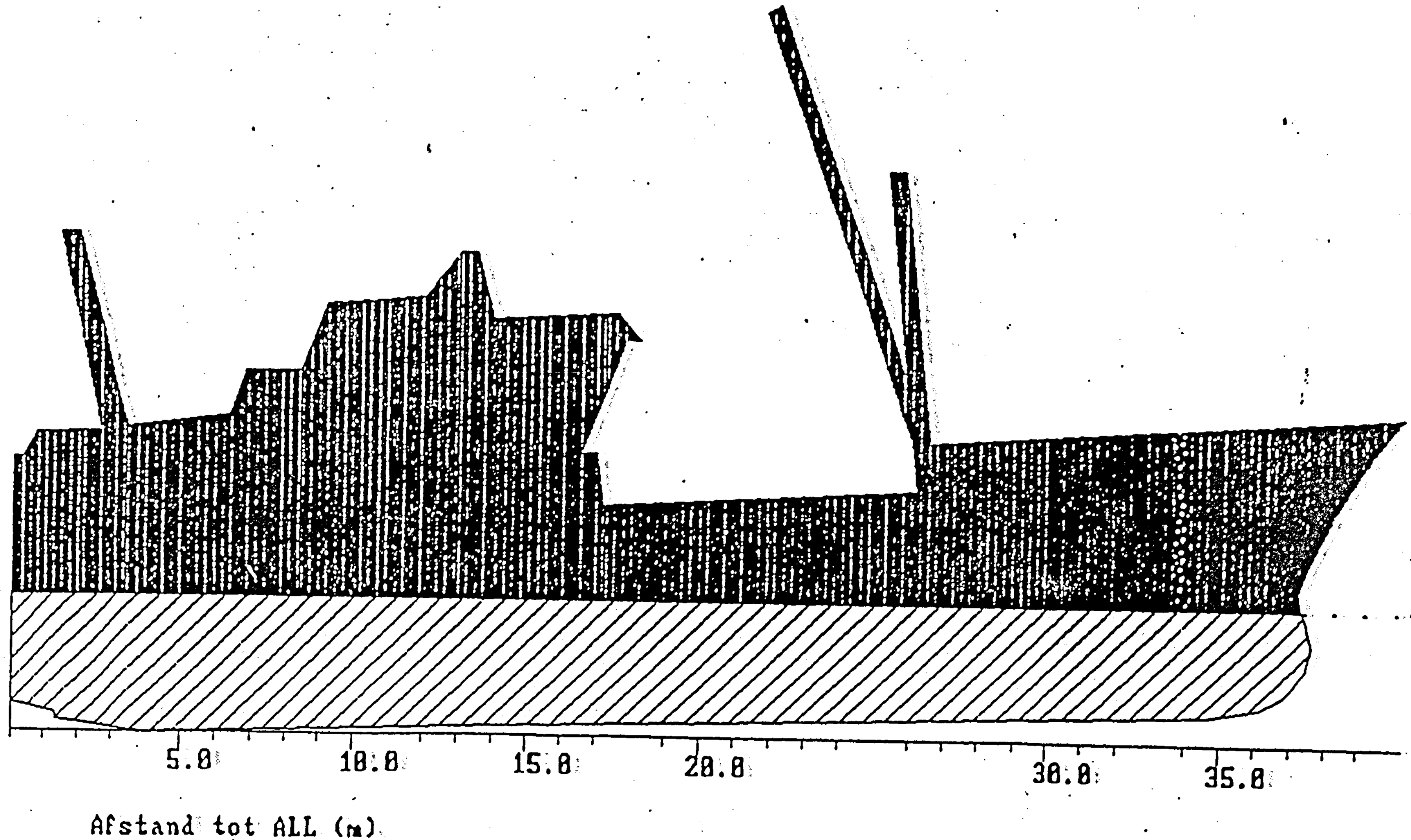
tank	s.g. [t/m^3]	gew [t]
dw bb	1.000	9.797
dw sb	1.000	9.797
vuile olie	0.900	3.453
vuil water	1.000	3.837
dw bba	1.000	7.293
dw sba	1.000	7.293
fo bb	0.850	17.623
fo sb	0.850	17.623
fo bbm	0.850	15.679
fo sbm	0.850	15.679
dagtank	0.850	3.582
lo	0.900	3.582
fo bba	0.850	9.688
fo sba	0.850	9.688
fo bbmk	0.850	17.701
fo sbmk	0.850	17.701
vp- tank	1.025	39.660



1 dw bb
2 dw sb
3 vuile olie
4 vuil water
5 dw sba
6 dw bba
7 fo sb
8 fo bb
9 fo sbm
10 fo bbm
11 lo
12 dagtank
13 fo sba
14 fo bba
15 fo sbmk
16 fo bbmk
17 vp- tank



SILHOUET



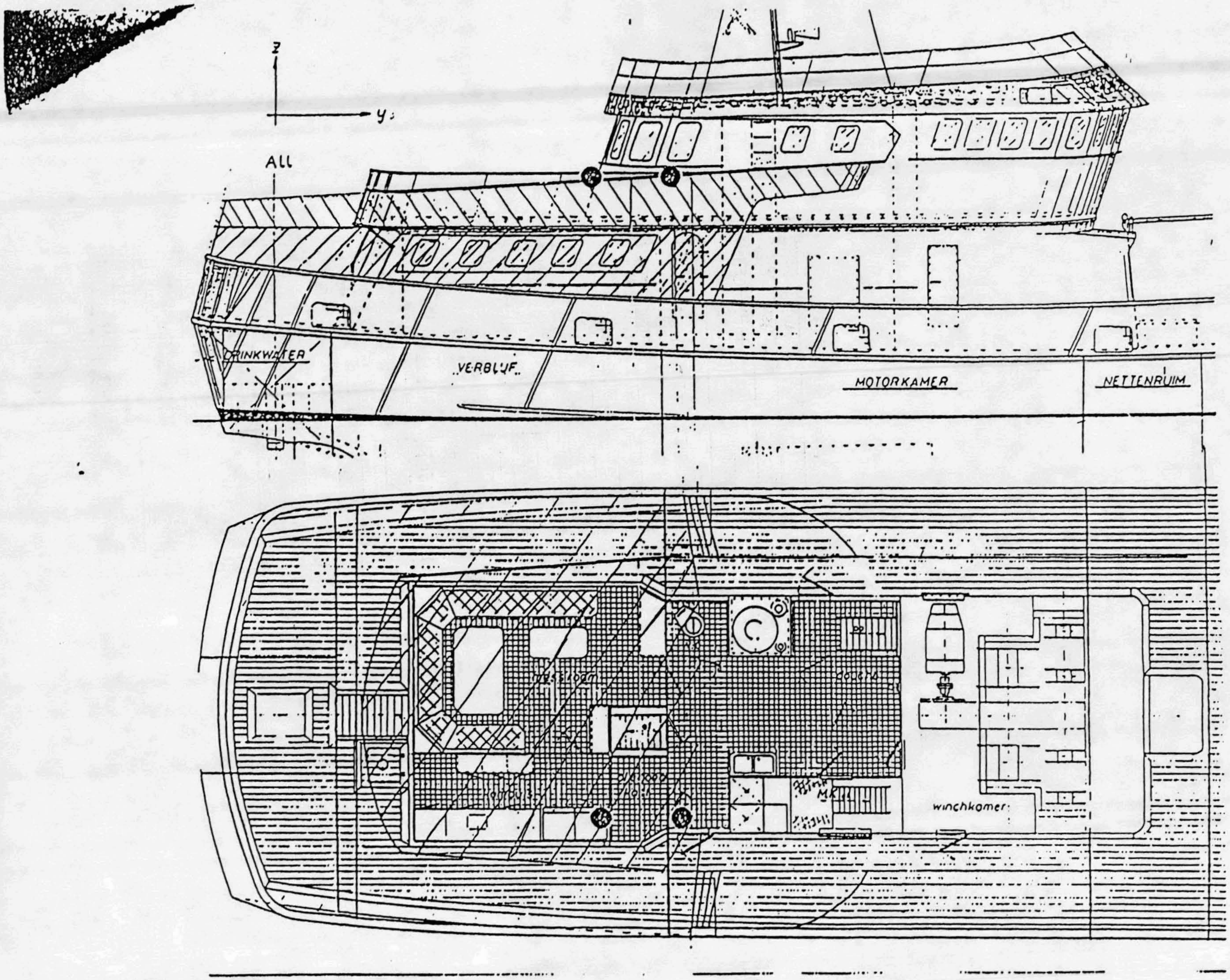
BEREKENING WINDMOMENT

Diepgang	Gebied 1	Gebied 2	Moment	Arm
3.500	51997	71556	123553	0.192
3.600	52331	68753	121085	0.181
3.700	52671	65946	118617	0.170
3.800	52955	63233	116188	0.160
3.900	53120	60721	113842	0.151
4.000	53201	58353	111554	0.143
4.100	53182	56154	109335	0.135
4.200	53061	54125	107186	0.128

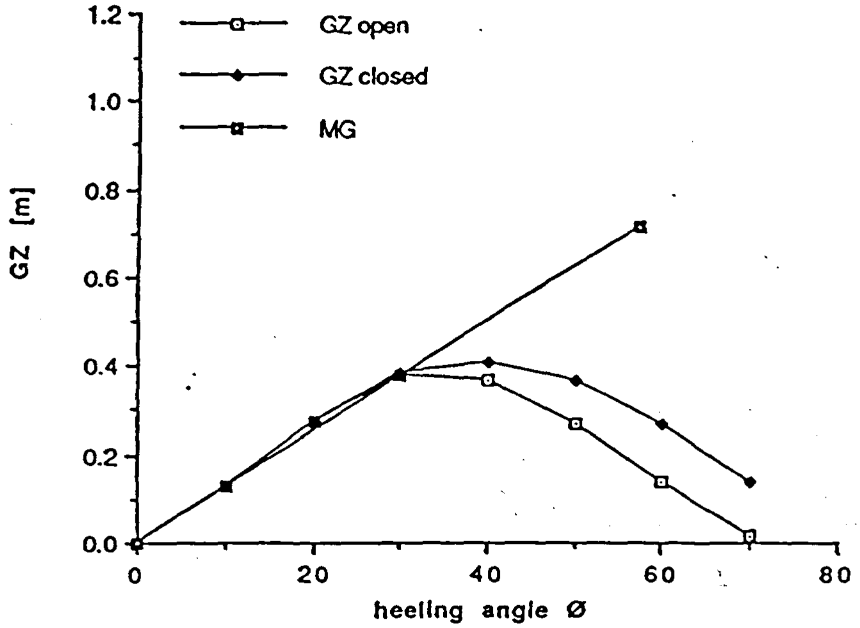
Winddruk	75.00	125.00	kg/m²
Ondergrens		5.00	m
Bovengrens	5.00		m

MAIN PARTICULARS:	
H [m]	5.10
B [m]	9.00
Loa [m]	40.10
Lll [m]	36.80
displ. [ton]	696.30
mean draft [m]	3.70
draft AP [m]	4.49
draft FP [m]	2.91
trim [m]	1.59
MG [m]	0.72
KG [m]	3.71
LCG (AP) [m]	18.07
RADIUS OF GYRATION [m]:	
pitch	9.27
	10.30
	11.33
roll	3.60
	4.00
	4.40
SPEED [kn.]:	3.00
	6.00
	12.00
BILGE KEEL:	
(st. 6- st. 13)	
height [m]	0.40

Shipmotion calculations BEAMER 2000.


z
y
All
DRINKWATER
VERBLIJF
MOTORKAMER
NETTENRUIM
winchkamer

Appendix h: Static stability curves open and closed ship.



STATIC STABILITY DATA		
1	2	3
	open ship	closed ship
dyn. height up to 30° [mrad]	0.105	0.105
dyn. height up to 40° [mrad]	0.171	0.175
dyn. height 30°- 40° [mrad]	0.067	0.071
GZmax [m]	0.387 at 33.9°	0.412 at 38.5°
MG [m]	0.72	0.72
angle [deg]	GZ curve open ship [m]	GZ curve closed ship [m]
10	0.13	0.13
20	0.28	0.28
30	0.38	0.39
40	0.37	0.41
50	0.27	0.37
60	0.14	0.27
70	0.02	0.14

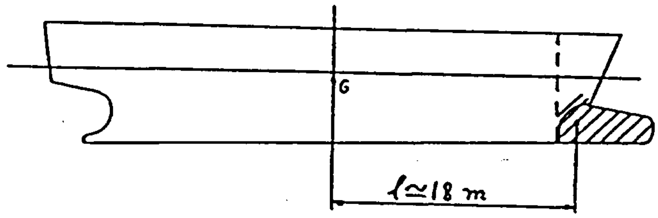
Appendix i: calculation of the longitudinal radius of gyration

Ship without a bulbous bow:

Radius of gyration: K= 0.25*L, mass mom. of inertia: I= 5/80*Δ*L^2 [tm^2]
L= 40 m
Δ= 696.3 t

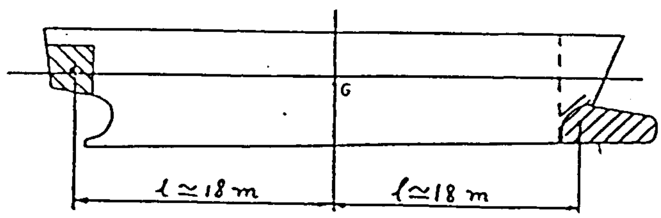
I= 70,000 tm^2
K= 10 m

Ship with bulbous bow:



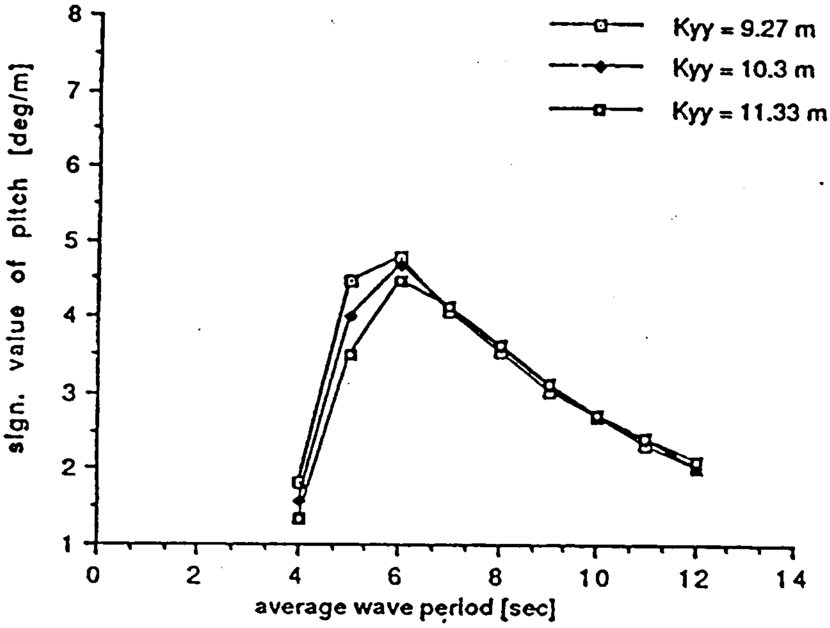
I bulb. bow= Ibulb+ m*l^2= ±0+ 8*18^2= 2592 tm^2
l= ± 18 m
m bulb.bow= ± 8 t
I ship with bulb= I ship+ I bulb= 70,000+ 2592= 72592 tm^2
K ship with bulb= √I ship with bulb/√m ship with bulb= 10.1 m

Ship with bulbous bow and after peak tank:



I tank= Ibulb. bow= 2592 tm^2
m tank= m bulb= 8 t
I ship with bulb and a.p. tank= I ship+ 2*I bulb. bow= 70,000+ 5184= 75184 tm^2
K ship with bulb and a.p. tank= √I ship with bulb and a.p. tank/√m ship with bulb and a.p. tank= 10.3 m

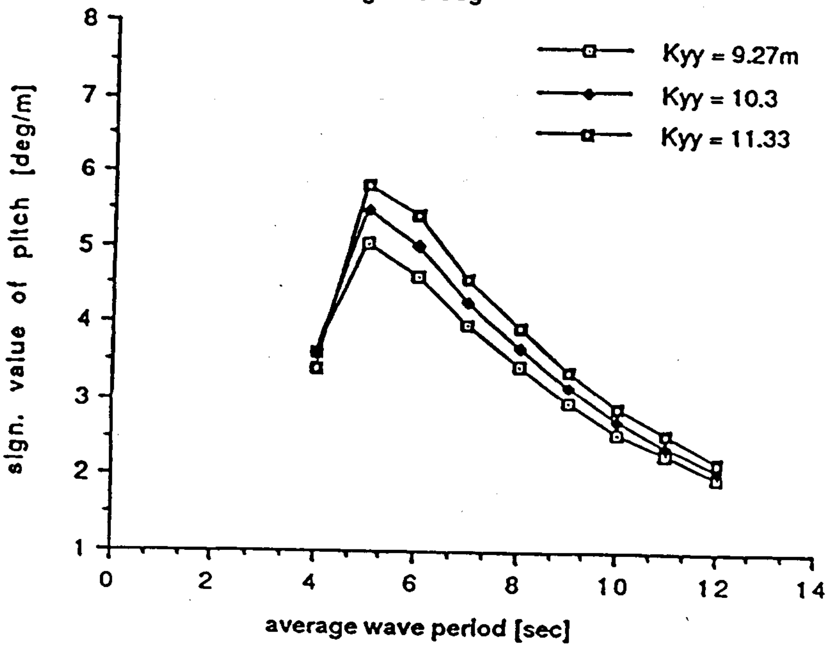
Appendix i: sign. value of pitch
Jonswap wave spectra
speed- 12 kn. heading 180 deg



speed (knots) = 12.0
heading (deg) = 180

average wave period [sec]	Kyy = 9.27 m	Kyy = 10.3 m	Kyy = 11.33 m
4.000	1.800	1.580	1.330
5.000	4.480	4.020	3.500
6.000	4.790	4.700	4.470
7.000	4.090	4.140	4.130
8.000	3.530	3.590	3.630
9.000	3.040	3.100	3.140
10.000	2.690	2.690	2.740
11.000	2.330	2.380	2.420
12.000	2.010	2.060	2.100

Appendix J: sign. value of pitch
Jonswap wave spectra
speed- 3 kn. heading 180 deg

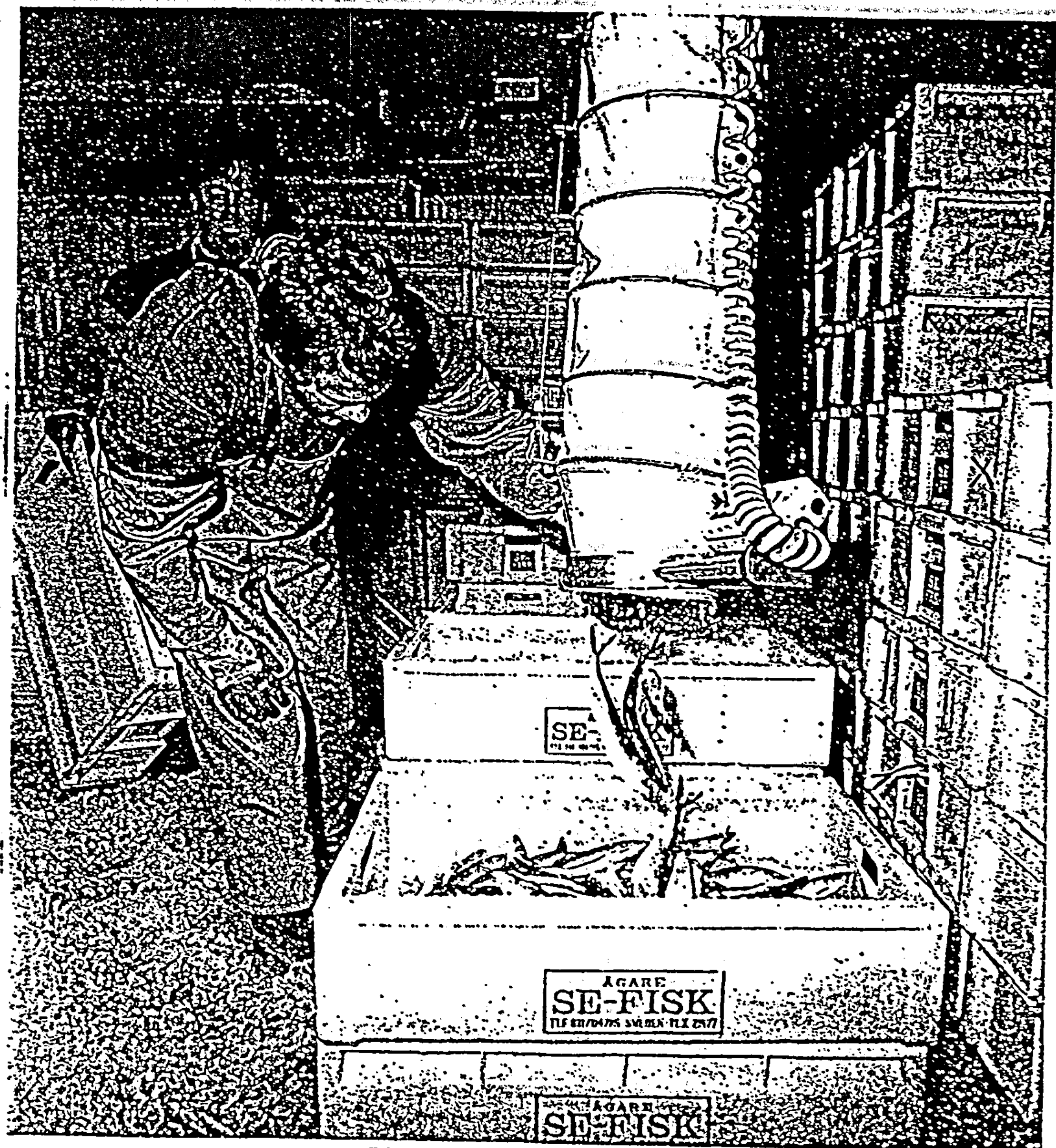


speed (knots) = 3.0
heading = 180.0

average wave period	Kyy = 9.27 m	Kyy = 10.3 m	Kyy = 11.33 m
4.000	3.610	3.590	3.400
5.000	5.060	5.490	5.830
6.000	4.610	5.010	5.420
7.000	3.980	4.290	4.600
8.000	3.430	3.670	3.930
9.000	2.960	3.160	3.360
10.000	2.570	2.730	2.900
11.000	2.270	2.400	2.550
12.000	1.970	2.080	2.200

EFFICIENT FISH-HANDLING ON BOARD

KVA



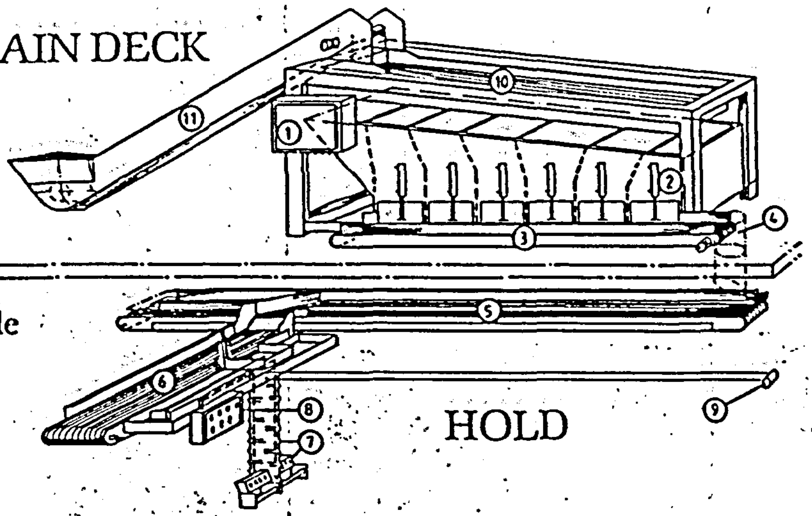
THE KVA PROCESSING SYSTEM

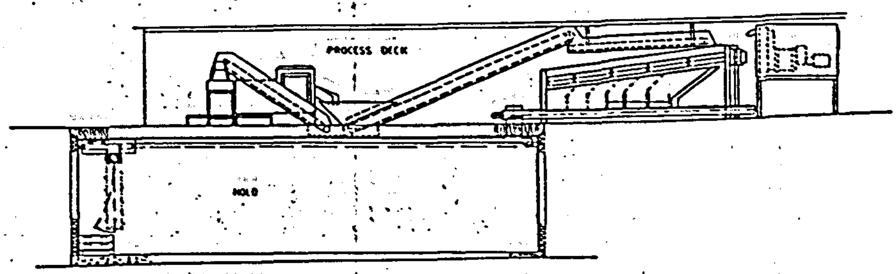
Complete designs that include gutting, sorting and filleting as well as icing and hold refrigeration.

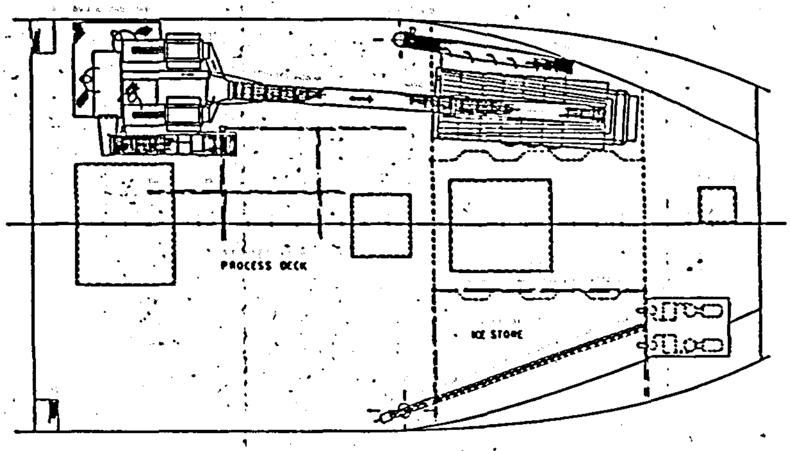
The KVA fishhold storage system on board BEAMER 2000.

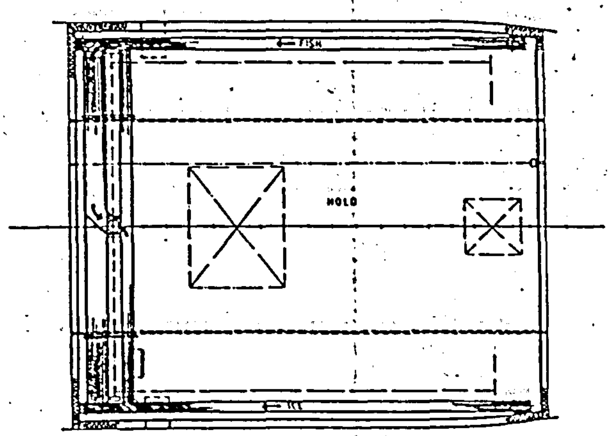
THE KVA PROCESSING SYSTEM

1. Hydraulic cubicle
2. Bin hatch
3. Feed conveyor
4. Deck penetration
5. Longitudinal hold conveyor
6. Transverse conveyor
7. Telescopic tube with control boxes
8. Electrical automatic-equipment cubicle
9. Telfer for item 6
10. Grading machine
11. Elevating conveyor









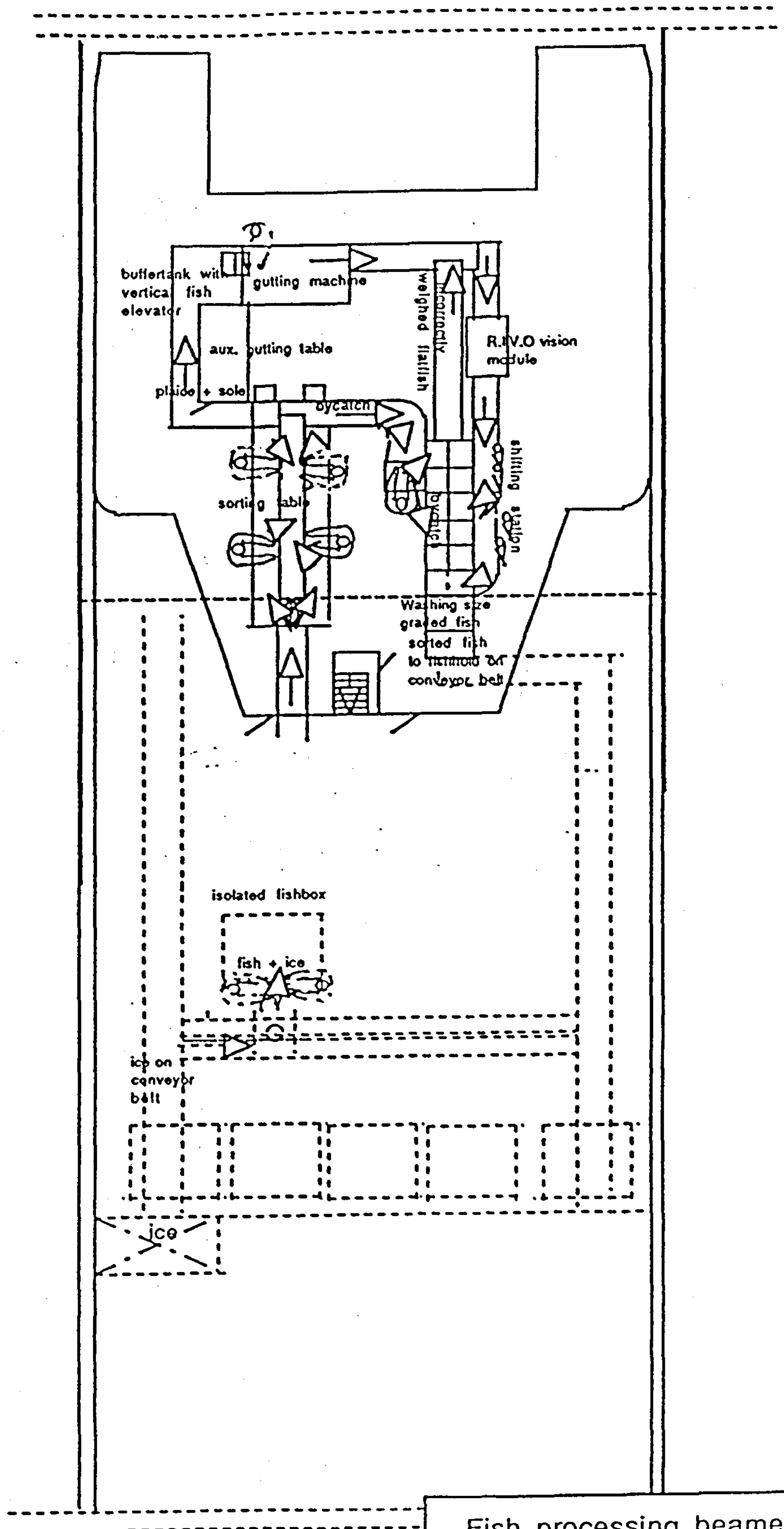
Retailer

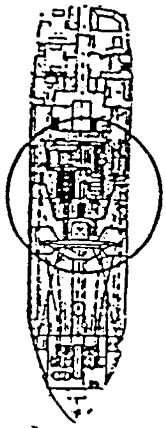
KRABBESKÄRS VERKSTADS AB

KVA fish on board

Handlingsystems

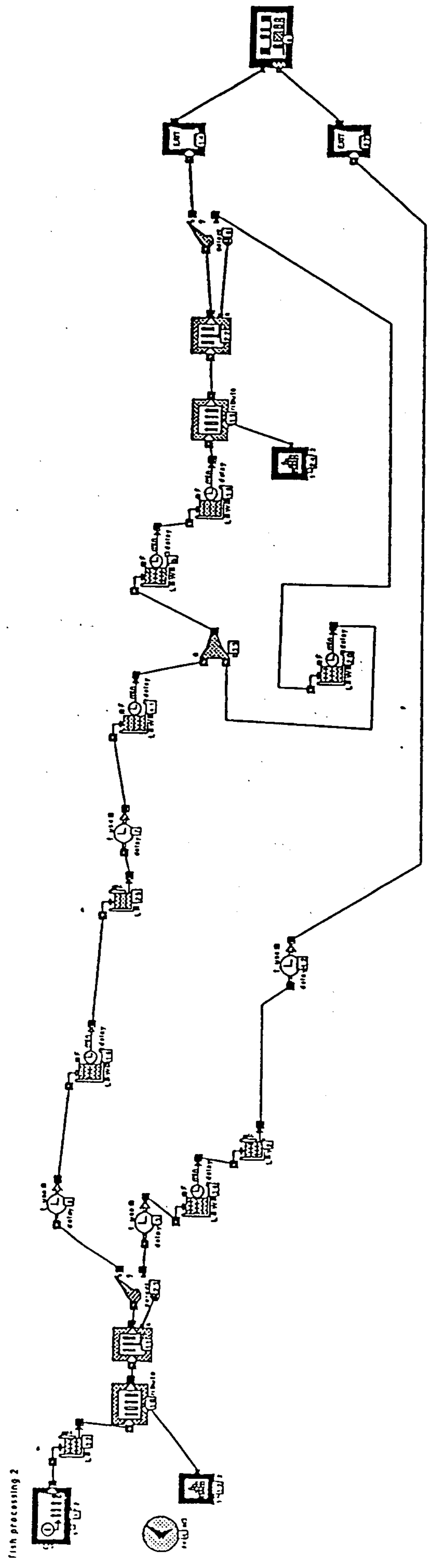
Hälleflundregatan 8. S-421 58 V. FRÖLUNDA (Fiskebäck) SWEDEN
Telephone INT+4631-29 74 76. Telefon 031-29 74 76. Fax 031-29 72 45.





Fish processing beamer 2000 (3)
Scale 1:100 Drawn: N.Mul
R.I.V.O. IJmuiden, October 1990

Enclosure IV Mac-extend/IQAS simulation on board BEAMER 2000



Generator

Generates items at arrival times according to the distribution below.

OK | Cancel | Help

- ○ Uniform Integer (a->b)
- ○ Uniform Real (a->b)
- ○ Binomial (B)
- ○ Poisson (P)
- ○ Normal (N)
- ○ LogNormal (L)
- ○ Exponential (M)
- ○ Erlang (Er)
- ○ HyperExponential (Hr)
- ○ Weibull (W)
- ◉ Constant (C)
- ○ General (G) ->

N = 200

Plot N Members

- ◉ Discrete
- ○ Stepped
- ○ Interpolated

(1) Constant: 7200

(2) Unused: 1

Items output/event (v) = 2000

General

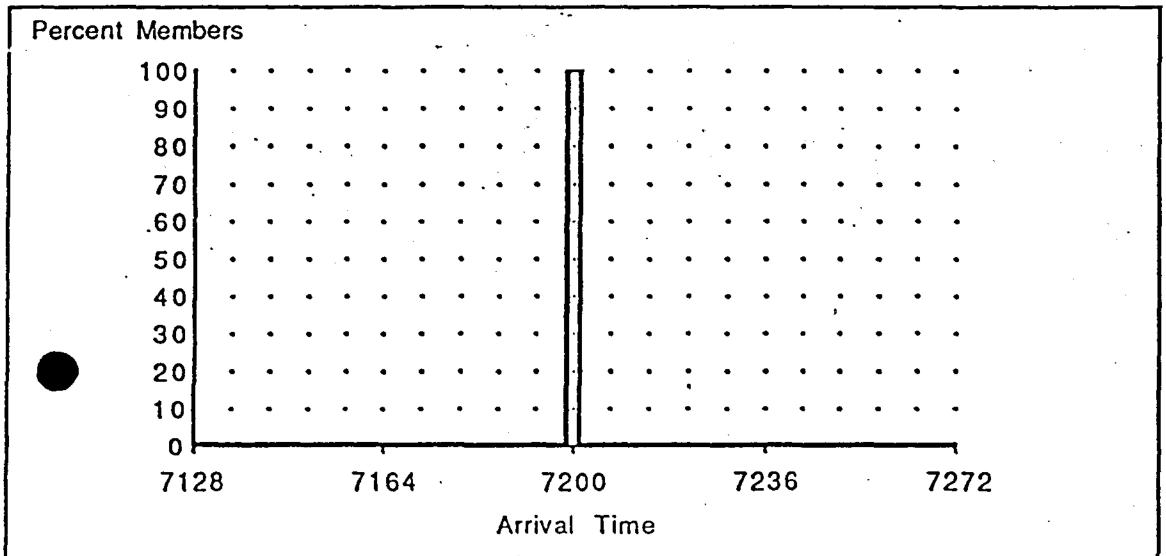
Plot Table

	Range/Time	Probability
1		
2		
3		
4		
5		
6		
7		

Comments

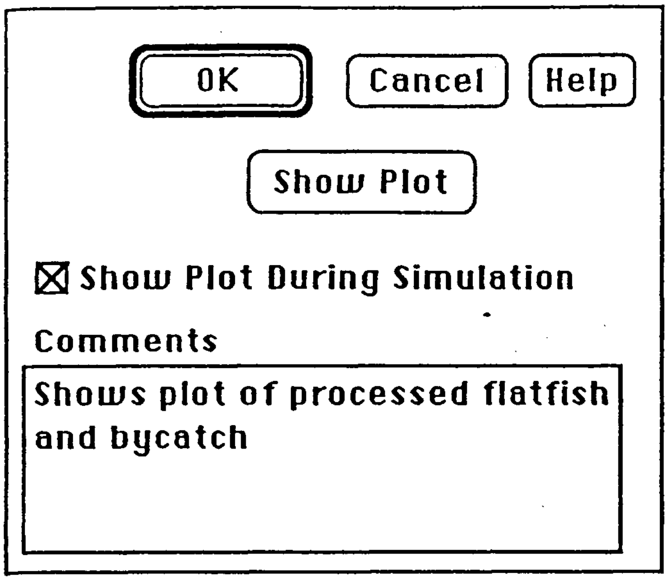
Each haul takes 2 hour, 2000 fish are caught

Member plot

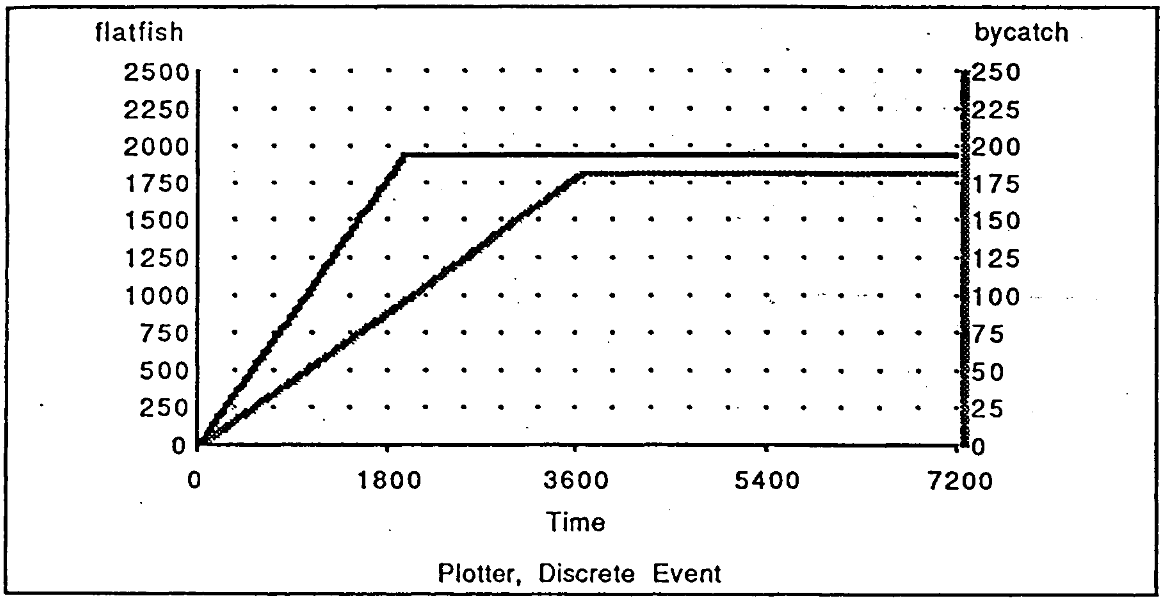


Member plot

5) Plotter, Discrete Event



6) Plotter, Discrete Event



Resources

Generator	Provides items for a discrete event simulation.	Customers, factory parts, computer programs, network messages
Queue, Attribute	Provides a first-in-first-out (FIFO) queue where items with a particular attribute have a higher priority than other items.	Sort on color, failure rates, or quality
Queue, FIFO	Provides a first-in-first-out (FIFO) queue.	First-come-first-served lines, inventory turnover
Queue, LIFO	Provides a last-in-first-out (LIFO) queue.	Unrotated stock, vertical stack of books at the bookstore
Queue, Priority	Provides a queue that releases the highest-priority item first.	Priority mail, project management, triage
Resource	Holds items to be used in the simulation.	Labor pool, parts bins, finite memory, disk size

Activities

Activity, Delay	Holds an item for a specified amount of time.	Red lights in traffic, teller's service time, multitasking CPU time
Activity, Delay (Attributes)	Allows the delay activity to interact with item attributes.	Customers with specific problems that take specific lengths of time, preparation periods
Activity, Multiple	Holds many items and passes them out based on the delay and arrival time for each item.	Ceramics kiln, bakery oven, supermarket
Activity, Service	Passes an item only when the *service* connector is set to 1.	Flight arrivals, customers in a line, sales orders
Batch	Allows several items to be joined into a single item.	Parts kitting, a classroom, damaged goods repaired with parts
Combine	Combines the items from two different sources into a single stream.	Merging traffic, customers coming from many entrances to form one line
Unbatch	Generates several items from a single input item as specified in the dialog.	Route messages or invoice copies, duplicate a message packet, release a resource in use, generate a signal

Decisions

Select DE Input	Selects inputs based on a decision.	Traffic signals at an intersection, candidate selection, CPU interrupt access
Select DE Output	Selects outputs based on a decision.	Choice of shipping method, routing priority

Attributes and priorities

Get Attribute	Looks at or removes attributes on items.	Reading a parts list, a movie rating, or an employee record
Set Attribute	Sets the attributes of items passing through it.	Adding to a parts list, writing part of a movie rating, writing in a employee record
Set Priority	Assigns a priority to items that pass through.	Police dispatcher, job priority, first class passenger

General

Executive	Allows the duration of the simulation to be controlled by the end time or by events. This block is the heart of each discrete event model and must be placed to the left of all other blocks in the model.	
Exit	Passes items out of the simulation.	Scrap, finished goods, completed projects
Make Your Own	Acts as a template for your own blocks.	
Plotter, Discrete Event	Plots one or two signals.	
Program	Schedules many events.	Coffee breaks, end of work days, computer programs
Show Times	Displays the values in the global0 timeArray as the simulation progresses.	
Status	Displays information about an item or values coming from another block.	
Timer	Allows you to view the time that it takes an item to pass between two connectors.	Time to run an errand, production time

VISVERWERKINGSLIJN — KWALITEIT

Platvis

	tijd per vis in de module	gemiddelde tijd van de totaal verwerkte vis in de module [sec.]	gemiddeld tijd van de totaal verwerkte vis in de module [min.]	temperatuur van van het medium waarin de vis zich bevindt [°C]	temperatuur van de vis [°C]
module	**tijd/vis**	**tijd/totaal**	**tijd/totaal**	**temp.buiten**	**temp.vis**
Vangstverwerker	0.49	499	08'19"	20	?
Uitzoektafel	0.5	0.5	00'0.5"	25	?
Lopende band 1	22.5	22.5	00'22.5"	25	?
Resevoir	2.1	1240	20'40.1"	15	?
Stripmachine	2	2	00'02"	25	?
Lopende band 2	7.5	7.5	00'7.5"	25	?
Lopende band 3	1	1.5	00'1.5"	25	?
Lopende band 4	22.5	23	00'23"	25	?
Afwerpstation	7141	5406	90'06"	0	?

Bijvangst

	tijd per vis in de module	gemiddelde tijd van de totaal verwerkte vis in de module [sec.]	gemiddeld tijd van de totaal verwerkte vis in de module [min.]	temperatuur van van het medium waarin de vis zich bevindt [°C]	temperatuur van de vis [°C]
module	**tijd/vis**	**tijd/totaal**	**tijd/totaal**	**temp.buiten**	**temp.vis**
Vangstverwerker	0.49	499	08'19"	20	?
Uitzoektafel	2	2	00'02"	25	?
Lopende band	15	15	00'15"	25	?
Resevoir	10.1	464	07 44"	15	?
Strippen bijvangst	10	10	00'10"	25	?
Afwerpstation	7162	6210	103'30"	0	?