Engineering tasks for BFT quality assurance

Roca J., Roca J.J., Soto F., Villarejo J.A., Mateo A.

in

Bridges C.R. (ed.), García A. (ed.), Gordin H. (ed.).
Domestication of the bluefin tuna Thunnus thynnus thynnus

Zaragoza : CIHEAM
Cahiers Options Méditerranéennes; n. 60

2003
pages 171-176

Engineering tasks for BFT quality assurance

J. Roca, J. Roca Jr., F. Soto, J.A. Villarejo and A. Mateo
Universidad Politécnica de Cartagena, G.I "Electrónica Industrial y Médica",
EIMED, Antiguo Hospital de Marina, Muralla del Mar s/n, 30202 Cartagena, Spain

SUMMARY – Due to the spread of bluefin tuna farms and processing plants, automation (among many other engineering techniques) may help in the development of effective quality assurance methods. This paper seeks to display the technological resources available, as part of an ideal system conceived to achieve this goal from a global standpoint.

Key words: Engineering resources, intelligent cages, onboard, plant processing.

RESUME – *"Travail à réaliser en ingénierie pour l'assurance qualité du thon rouge". Dû à l'expansion des fermes de thon rouge et des usines de transformation, l'automatisation (parmi de nombreuses autres techniques d'ingénierie) peut aider au développement de méthodes efficientes d'assurance qualité. Cet article vise à présenter les ressources technologiques disponibles, comme élément d'un système idéal conçu pour atteindre ce but du point de vue global.*

Mots-clés : *Ressources en ingénierie, cages intelligentes, à bord, usine de transformation.*

Motivation

As in many other fields, the needs detected by biologists, scientists and farmers in the BFT farming industry should be covered by the developments offered by the engineers. As in the starting point of any other technological design, it is necessary to know the final scope of development in order to set the capabilities/cost balance.

At this point, it should be said that this ratio will be different for scientific and for industrial purposes due to the difference in pursued results; thus leading to the first restrictions for the design. In scientific plants, information data should have priority over the efficiency of the production; while in industrial farms, is obvious that this balance will be in the opposite direction. In order to cover both worlds, the scientific and the industrial, this paper will consider the design of a integral system that would cover the necessities of both parts.

Our proposal

The improvement of the BFT processing chain should be centred on the development and adoption of specially designed techniques to assure an increase in: Quality assurance, Product tracking and Process automation.

Going further, these three topics should be approached from a common waypoint in order to maximize the pursued benefits in front of the economical effort for the adoption. On the other hand, the final system should integrate all of the proposed techniques within the managing system at production in order to get the desired improvements.

The proposed system will be structured in three stages, covering the whole process from the feeding of the tuna at the cages, the harvesting and pre-processing onboard and the final processing in the plant; each one of these should be set as follows.

Intelligent cages

Quality assurance should start at the feeding stage in the nets, recording the different data such as the kind and amount of feed, conditions of the exploitation environment, fish population and many others. This stage will comprise the design of an "Intelligent Cage" fitted with a transducer network specially conceived for the measurement of several physical and chemical parameters of the farming cage environment.

The sensing network (Fig. 1), could include information for the measurement of different parameters such as the water temperature, turbidity and speed, asses the fish population conditions (such as biomass estimation through acoustic techniques, presence of other species, etc.), and relay information about the strain forces in the net and the mooring of the cage as in Bugrov (1997). Due to the natural trend to force cage location off-shore, a GPS or Galileo positioning system receiver will help in the detection of the net in case of mooring system failure (Savage *et al.,* 1997). In order to acquire the data, a solar powered autonomous data logging system would send all the information data through a standard communication channel (RF, GSM, GPRS, UMTS), in response to remote query commands or local alarms, to the host placed either onboard or in plant, and indexed within the exploitation data base.

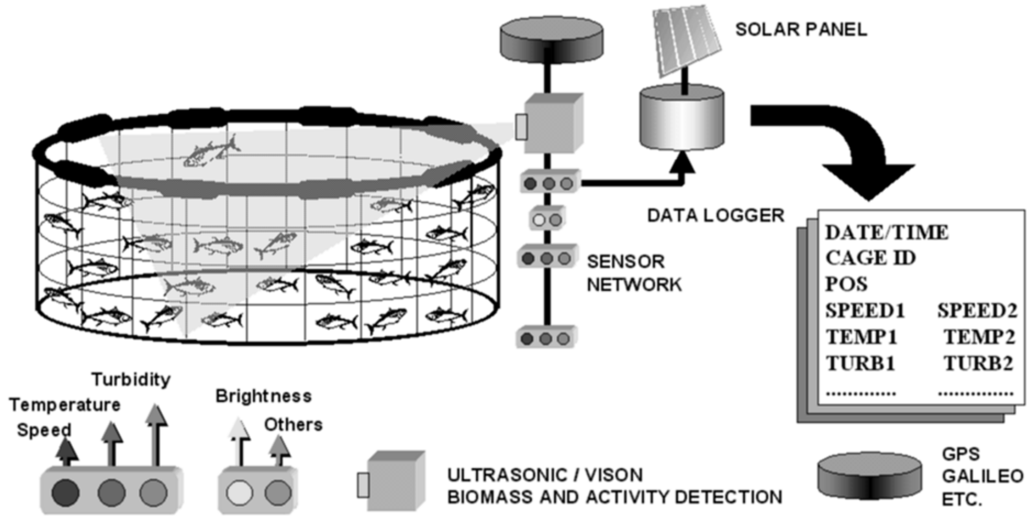

Fig. 1. Intelligent cage: sensing system.

On the other hand, the cage should be fitted with some additional installations not covered by the existing regulations in order to extend current systems capabilities. In this line, a hydrophone network could offer the possibility of tuna sound recording in order to analyse the differences with the wild behaviour, and set feeding strategies such as those used in other inland farms. This point could also be achieved by means of a water sprinkling system designed to alter the water surface as the little fish do in nature in order to induce the feeding (Fig. 2).

Onboard pre-processing

After the slaughtering onboard, each one of the fishes should be tagged by means of an electronic transponder containing a chip able of recording multiple data such the weight (by means of a motion-compensated cell load at the elevating crane), dimensions (obtained by an artificial vision system), capture details (date, time, ship, fisherman, method, etc.), processing instructions (destination, method). All of these data would be available at the plant as soon as the fishes were captured in real time in order to prepare the resources for the processing work (trucks, people, packaging elements, etc.) as seen in Fig. 3.

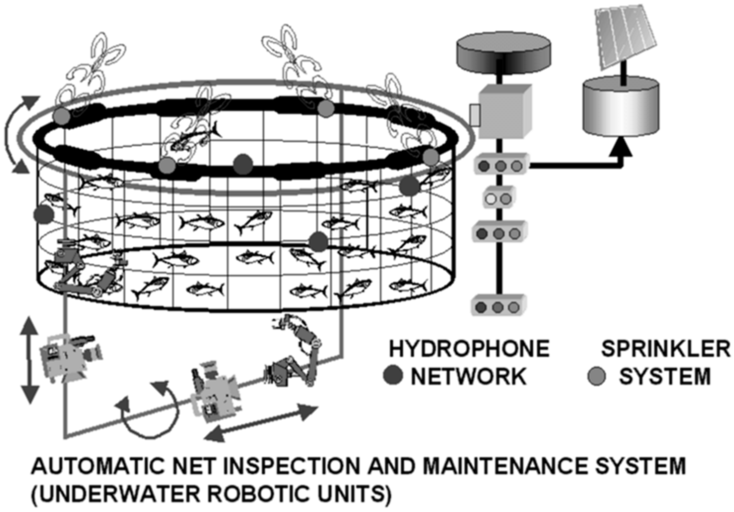

Fig. 2. Intelligent cage: utilities system.

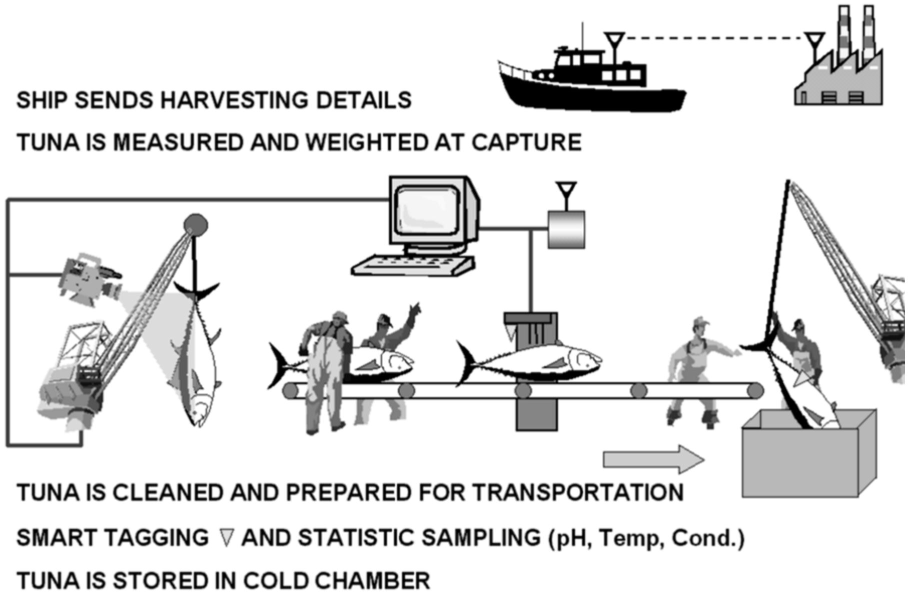

Fig. 3. Onboard pre-processing.

Plant processing

Once the fishes were unloaded at port, these electronic tags, powered with small data logging capabilities (i-button, touch free cards, etc.), would be able to record the temperature along the transportation to the processing plant, in order to guarantee freezing chain continuity (Fig. 4).

These tags should be automatically read once in plant to record the registered information within the processing database, in order to decide the correct processing path for each one of the fishes. Once on the processing chain, the fish would enter in the damage inspection system which would determine the effects of slaughtering (spinal damage, bullet presence, etc.) by means of an artificial vision system based upon an industrial X-rays or echo-graphic tunnel, data that will be used to select the final processing method (whole or in pieces).

In the next stage, the quality inspection, fat content, colour and texture of the meat would be evaluated by means of bio-impedance measures and an artificial vision system which would objectively set the quality rank for the final product. At this point it should be important to mention the necessity for establishing quality standards in terms of quantitative indicators such as weight, fat content, pH, colour, texture, etc. The packaging island would label each one of the products according to the data registered along the whole process, with a barcode or a smart label that could include a small temperature data logging system for quality assurance over the shipping to the final dealer. Additional improvements could include an autonomous guided vehicle (AGV) for automatic stock piling up at the freezing chambers (–60°C) as seen in Figs 5a and 5b.

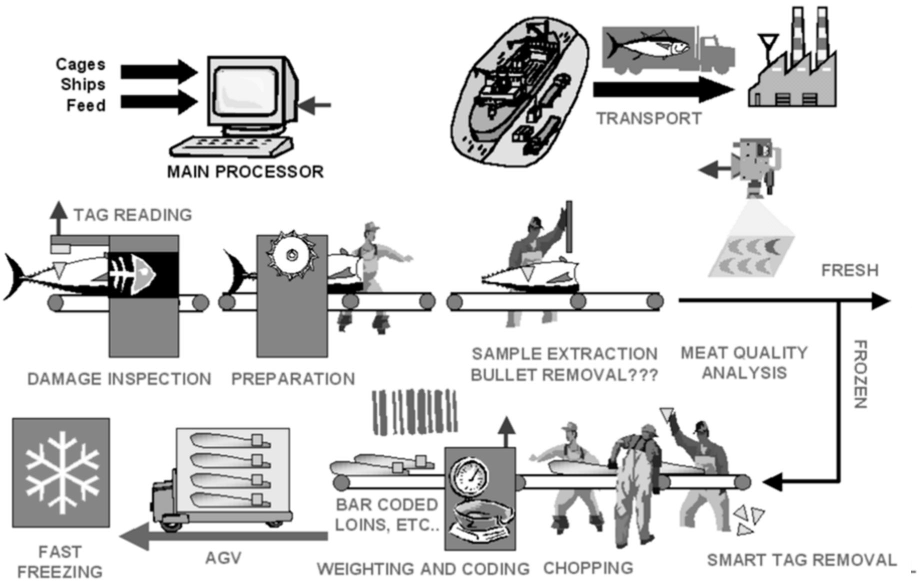

Fig. 4. Plant processing.

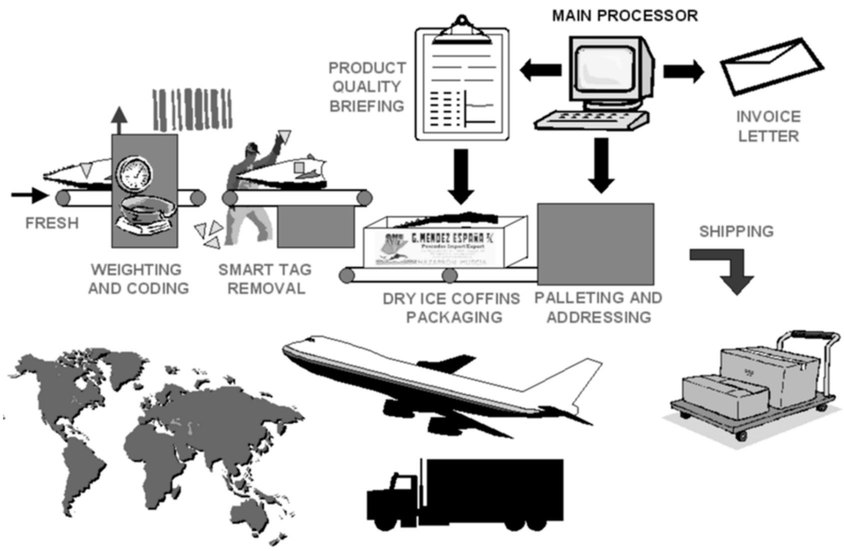

Fig. 5a. Final product handling (fresh processing).

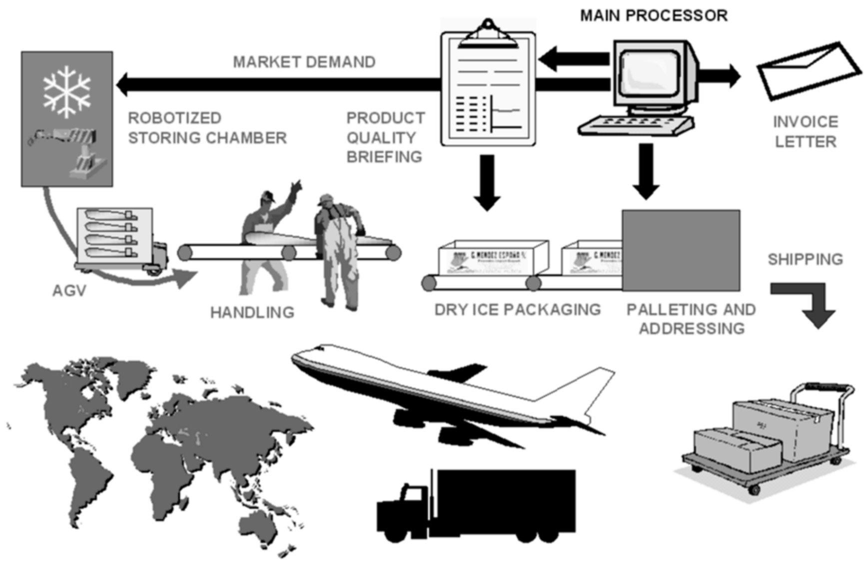

Fig. 5b. Final product handling (frozen processing).

Conclusions

This Sensing-Utilities-Communications architecture has proved its validity through the years in many other industrial fields and should be considered in the design of the future farms and processing plants. The introduction of new technologies in the BFT farming business, will decrease the production costs and at the same time open new research lines, favoured by the availability of an integral data set of the productive process. The growth of this technology will be guaranteed by availability of existent, widely used, moderate cost standard industrial components. The proposed system, which may be seen in Fig. 6, has been conceived as an integral approach to the quality assurance requirements that the emerging business of BFT has set.

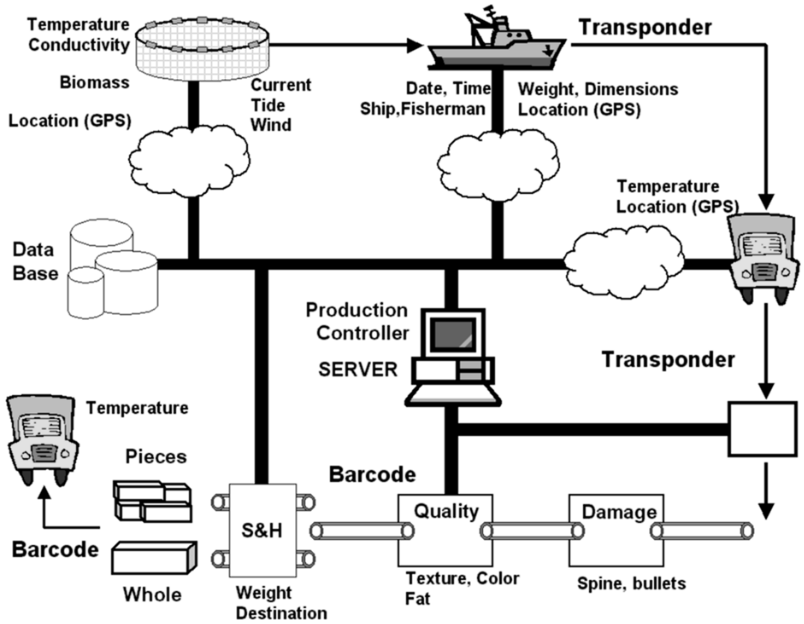

Fig. 6. Proposed system.

As a last remark, it should be stated that the present solution comprises only of the technological resources available up to date. The technology is expected to develop as the BFT farming industry spreads worldwide.

References

Bugrov, L. (1997). Biological and engineering aspects of underwater fish farming technology in open sea areas. In: *Open Ocean Aquaculture '97, Charting the Future of Ocean Farming, Proceedings of an International Conference*, Maui (Hawaii), 23-25 April 1997.

Savage, G.H., Howell, H., Celikkol, B. and Barnaby, R. (1997). Guidance for future open-ocean aquaculture efforts? The engineering design and operational experience gained from a twenty month NOAA/NMFS sponsored open-ocean aquaculture project using two different prototype submergible net-pen systems. In*: Open Ocean Aquaculture '97, Charting the Future of Ocean Farming, Proceedings of an International Conference,* Maui (Hawaii), 23-25 April 1997.