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Distributed Control Systems in Food Processing

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ABSTRACT
The Objective of this study is to address the critical need for automation in the domestic food processing sector and to study its impact. This study investigates the challenges arising out due to the dependency of the modern human for processing of food. Through the medium of this study a pressing need for the development of an automatic cooking machine is proposed. The impact of the development of this product has also been profoundly discussed.

The advantages offered by the distributed control system(DCS) so far enjoyed by large, continuous process plants are now available to small users and to batch processing industries. Examples of DCS applications in the food industry are described.

KEY WORDS: *Automation, distributed control system, Automation, Food Processing, Impact on Economy, Processing Individual.*

I. INTRODUCTION
Automating the food processing industry is becoming Critical in today's rapidly changing environment. Several factors are pushing the industry towards using automation, which may range from simple controls to highly sophisticated controls using advanced sensors capable of measuring intangible properties such asflavor, taste, smell, etc.

These factors include:
1. Increasing competition from globalization and mergers,
2. The consumer demand for higher quality goods,
3. Higher emphasis on cleanliness and hygiene,
4. Safety factors and the high costs of insurance and compensation, and
5. Flexibility in manufacturing for more diversified Product lines.

For example, in today's competitive market, it is not uncommon for manufacturers to change the processing conditions or formulation to provide a 'new and improved' version of their own existing products. This requires a control system with which the chemist or process engineer can easily modify the recipe. To remain competitive, the industry must build in manufacturing flexibility, allowing for greater product diversity and manufacturing yield, better quality control to satisfy customer requirements and tighter material flow control to contain product cost. Automating plant operations is one of the ways the industry can respond to these challenges (see Figure I).Because of these new requirements.

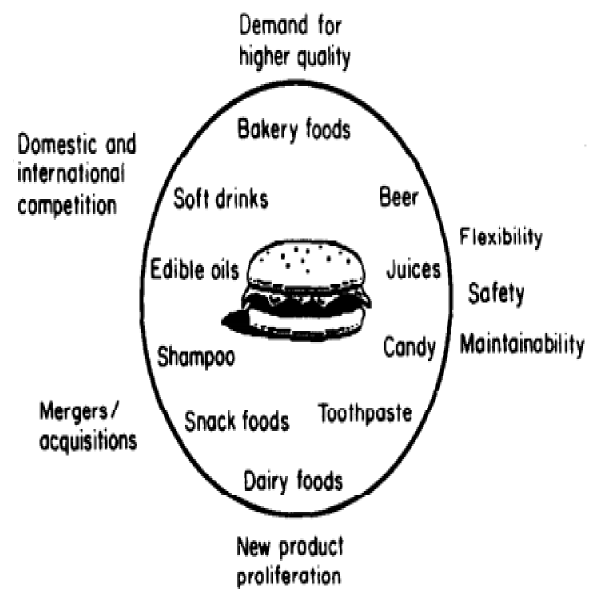

Fig: 1, Food and Consumer design

II. PROCESSING OF FOOD
Food Processing is a technique to convert raw ingredients into consumable food form (by the modern human). It typically involves operations and activities such as mincing, macerating, boiling, emulsification, pickling, canning, etc. Presently, the

processing of food mainly takes place at two major processing stages i.e. at the industry and at the domestic level. The agricultural produce provides the basic raw ingredients that undergo processing in the subsequent levels as shown in Fig. 2.

Industrial food processing includes the production of Marketable food (purchased by consumers) from raw Ingredients provided by agricultural produce. It includes a variety of operations such as the addition of chemical ingredients, filtering, packaging, etc. In conventional times, the primary rationale behind industrial processing of food was to preserve the food for a longer duration and ensure its supply round the year. Various methods such use of additives, salt, cold storage, etc. were employed to preserve the food.

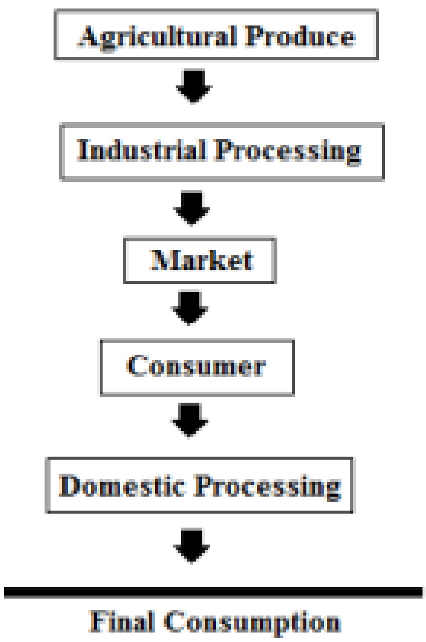

Fig: 2, Stages of food processing

III. CONTROL SYSTEMS FOR THE FOOD INDUSTRY

The level of automation in the food industry varies Considerably between companies, as well as between plants within the same company. Most food processing plants have evolved from small operations with a rather conservative, gradual approach to technological changes. In the food industry, automation began with the application of programmable controllers and single board computers on manufacturing equipment, and very simple control systems. These devices, particularly programmable controllers, were widely accepted by food processors because they were simple to operate and maintain. They were limited in what they could do: usually replace relays, timers and counters (Marien, 1988).

Due to increased competition, however, the need for Production flexibility, frequent changes in the manufacturing process and small engineering staffs, food processors can benefit from using flexible, easily configured control and process management systems.

Today food processors have a choice of upgrading their programmable logic controllers (PLCs) or installing distributed control systems (DCS). They can build upon their existing PLCs (Marien,1988) to achieve fully integrated control systems performing various functions such as process control, raw material management, sales order processing, financial management and reporting. DCS-based architecture has performed these functions for large continuous processes. The DCS with all these benefits is now available small continuous and batch operations at a competitive price. The remainder of this paper describes the distribute control system and its advantages.

IV. DISTRIBUTED CONTROL SYSTEM (DCS) FOR THE FOOD INDUSTRY

Distributed control systems have evolved significantly in the last ten years. From large systems tailored to the needs of continuous industries, such as refineries, DCSs can now respond to the requirements of small batch-oriented processes and can address a variety of automation projects. Many elements make up the subsystems of the DCS. Figure 2 shows a hardware configuration of the DCS.

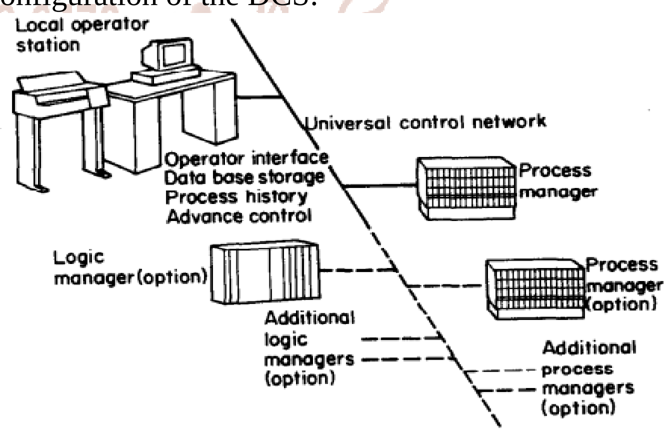

Fig: 3, Distributed control system

The philosophy of distributed control is to break downa large application into smaller subsystems and bring the level of control down to the unit level when Appropriate to decrease overall system response time. This makes it possible to exchange information between the different control units and allows for integrated decision making at the product line or plant level.

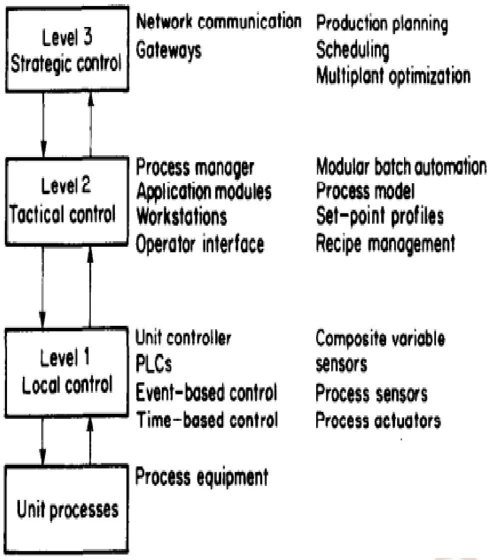

Fig: 4, Control system hierarchy

The next level of hierarchy, labelled as the tactical level, improves control by integrating the control of independent process parameters. For example, if the Product quality is out of specification, then set-point Profiles or the recipe may have to be modified on-line. To perform on-line modification of set points or recipes, a model of the process is required. The model can be a set of heuristic rules, a mathematical description of the process, or a combination of the two. DCS and other automation systems provide a user programming facility for such intelligent control of the process. For batch processes, vendors are currently offering preconfigured software modules.

Quality of Food

The nutrient density is typically an indicator of the proportion of nutrients present in a food item and can be selected as a measure of the quality of food. The nutrient content composition changes in food items depend upon the particular nutrient, the commodity, post-harvest handling, storage and home cooking conditions [7]. The time between the harvest and the final consumption also significantly affects the quality of food.

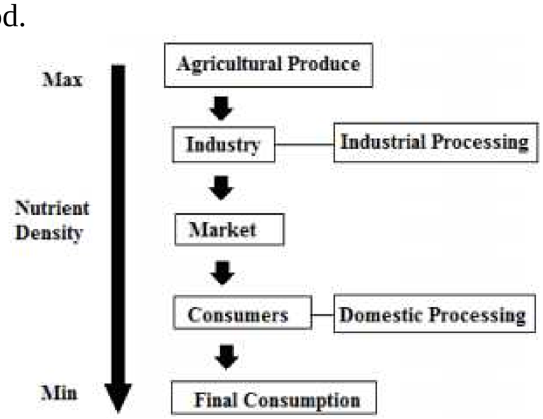

Fig: 5, Effect of food processing

V. BENEFITS OF THE DCS

The distributed control systems provide the following benefits.

Firstly, there are smaller logical blocks involving incremental programming and checkout, together with easy fault isolation and maintenance. A direct advantage of distributed control is to allow the software program to be broken down into smaller logical pieces, independent of system hardware. This makes system design more efficient and simple to modify. Software programs enable efficient recipe management, accurate recording and analyzing of production data, and statistical process and quality control functions.

Secondly, there is a graceful degradation from failure. The distributed nature of the overall system provides enough autonomy to the subparts so that massive failure of the system is unlikely. This is in contrast to a direct digital control strategy based on a single computer controlling the entire process.

A third benefit is that islands of automation are removed via an integrated system. The distributed control systems enable communication across the different subunits of the manufacturing process, providing easy coordination of overall production rather than isolated islands of automation based on single controllers.

VI. CHECKLIST FOR AUTOMATION IN THE FOOD INDUSTRY

A successful automation strategy hinges on:

A. Defining a future vision of the company and its operations.
B. Developing alternative automation scenarios.
C. Defining criteria to evaluate each scenario such as: need for production flexibility (multiple products on a single line, frequent recipe changeover);need for system expandability to meet increasing automation requirements in the future; requirements for open architecture (ability to integrate with existing equipment and/or with plant host computer);ease of operator and engineer interaction with the system; availability of support from vendor (training, application expertise, maintenance);range of advanced, proven technologies offered by the vendor (commitment to continuous evolution)

VII. CONCLUSIONS

The increase in dependency for processing food could prove to be fatal for the modern human beings i.e. Homosapiens and hence an independent automated system needs to be developed to process the food at the domestic level. This in turn shall eliminate the dependency on processing individuals. More research needs to be done regarding automation at the domestic level. One has to look beyond individual automation units and incorporate a holistic approach.

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