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The Knowledge-based tools for the steel industry

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Abstract: During last years, the evolution of process supervision shifted from a rule-base-oriented to a knowledge-base-oriented approach, where the automation systems relieve the human operator from most tedious and repetitive low-level information manipulation tasks; knowledge is considered more important than man by the introduction of applications for strict process control and tools for decision. In this context, Danieli Automation set itself a goal to design a new generation of supervision and control systems, which could provide added value to the operation of plant areas, taking advantage of recent advancements in user interface and information technology. These goals were met by creating new applications in which the know-how is transferred from operators to automation systems and the human-machine interfaces are optimized in order to improve the quality of the operator work, making decisions faster and more accurate. The result is an innovative man-machine interface, called OPERATOR ASSISTANT. This paper aims to explain all the studies that have been done to develop this new tool, from ergonomics to the choice of the development platform, passing through the decision for the multi-touch technology, the minimization of complexity, the consideration of cultural factors and the restraint of the emotional stress for the user. Furthermore it outlines the activities that are currently being made to optimize the product.

Keywords: Knowledge-based, ergonomic, cognitive, process control, 3Q, Danieli.

1. INTRODUCTION

In industry, actually characterized by increasingly sophisticated production techniques that can put in difficulty even a prepared user, there is an increasing demand for those systems that simplify the management of the production process. In this context Danieli Automation offers the technological solutions that have as their primary target to "simplify the sophistication". But what can justify new investments in the automation nowadays?

It is important to keep in mind that until a few years ago a significant burden on the industrial production was not certainly the price of raw materials, water or electricity, and not even the attention to emissions level and waste. The biggest burden was presented by electronic, automation and programming controls. Nowadays, on the contrary, we are witnessing the inverse phenomenon where the price of electricity is highly oscillating, the cost of water and raw materials is continuously increasing, the emissions regulations and the high waste cost are in contrast with the investment in control, software, and information technology. This is one of the reasons why the leading companies in the market have chosen to invest in automation in order to improve their operational capabilities (quality, quantity and speed).

Until the 80s production machines were seen as a set of devices that were to be guided by a number of packets in distributed logic: regulations, process controls, measurement equipment. At the beginning of the 90s industry started to see the benefits of the integration of different technologies, but, contrary to expectations, this produced a bigger quantity of information, sometimes very complex, not aggregated and, therefore, not often easy for understanding by the end user. The modern control system requires the information provided to be simple and integrated, and it requires the user to provide elements for evaluation only when it is absolutely necessary. The system shows the user the actions to be taken. It is the final abandonment of the concept of operator who knows what and when to do. Step by step we are passing from the stage at which the man was assisting the computer to the stage where the information systems are designed to assist the man [Parasuraman et al].

2. 3Q CONCEPT

Danieli Automation meets these needs by creating new applications "operator independent", not only with transfer of know-how from the man to the machine, but also through the optimization of human-machine interfaces in order to improve the quality of operator's work. A key factor is the ability to understand the operator's tasks and to design the work environment elements that effectively support such requirements [Dix et al.]. Therefore the specialists' common opinion is that it is worth investing in the environment design of the facility operation and in qualified staff. The process manufacturing industry begins to realize that the development of the operator interfaces and optimal work environments can have an impact on facilities safety and profitability. The automation became the factor that enables operators to make

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the product better, more efficient and in line with the HSD targets (Health, Safety and Development).

3. 3Q ARCHITECTURE

The core of the application is a highly sophisticated automation system that coordinates the metallurgical processes. The system mainly manages the technological packages and it works in parallel with the applications designed for the supervision of the facility performance. The most striking difference from the old control systems is an innovative man-machine interface, called Operator Assistant - OA. Concentrating the biggest part of the necessary intelligence within the automation system, it is possible to offer a new approach to the process control, simplifying and reducing to a minimum the number of commands that the operator had to consider previously, reducing his intervention to a limited number of situations.
In Fig. 1 the new architecture of the 3Q (Quality-Quantity-Quickness) can be seen, which gives large importance to the disappearance of the concept of levels of automation based on the "Purdue Model"[CIM] and focuses the attention on the role of the functions, and in particular of the technological package.
On the TOP there is the Q3MET, the Manufacturing Execution System for Metals (ex Level 4 of the Purdue Model), that supports the metals industry with efficient functions, to optimize, track and react on real plant data, which are essential to guarantee business success.
On a lower level, there are the Danieli Automation Business Intelligent together with SAFESTAR System and the Q3Technologies (ex Level 3 and 5 of the Purdue Model).
Then, there are the three fundamental applications (Q-METAL, Q-FLAT and Q-LONG) that operate the various different technological packages, placed on the bottom of this architecture (ex Level 1 and 2 of the Purdue Model).

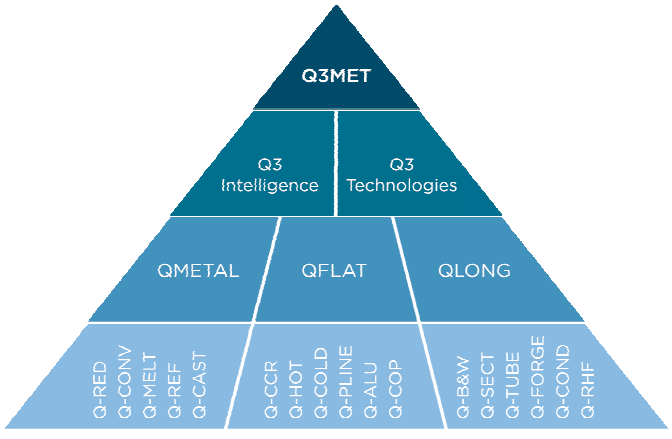

Fig.1 3Q components of Danieli Automation

4. 3Q DESIGN CONCEPT

The 3Q system is a complete suite of functionalities covering all the steelmaking processes, from raw materials handling to final products shipping. It comes from a long operational support experience of the plants grown up within the Danieli Group, sustaining the numerous demands of customers and making a synthesis together with an ergonomic and sophisticated analysis and an exploitation of the most modern information technology and electronic equipment. The three elements that coexist in the 3Q applications are: Ergonomic, Knowledge and the Advanced Architecture.

Fig. 2 and the next paragraphs describe how these three elements have been developed.

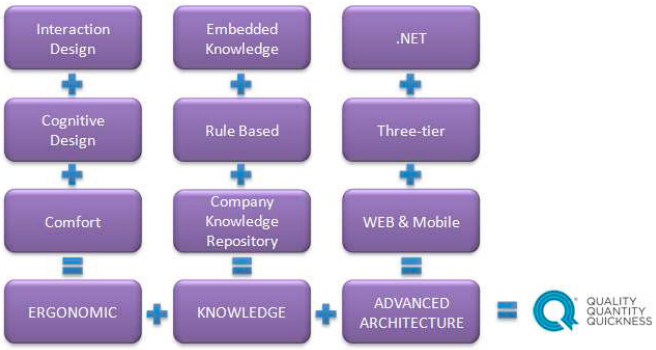

Fig. 2 3Q Design Concept

4.1 Ergonomic

There have been conducted numerous researches and there have been carried out comprehensive studies of cognitive engineering [Dix et al.] with the main target on the one hand, to reduce the number of commands and signals useless for the operator and, on the other hand, to get all of the extremely useful data that would allow him, with a quick observation, to make immediate decisions. In fact, the main component enabling to take correct decisions is to have the right information on time.
The first and fundamental study of the entire structural system necessary for the construction and evolution of the entire interface was the study of space organization [Saffer]. Once the Operator Assistant vertical progression was defined, some devices have been used in structuring in order to increase the efficiency and accessibility and, as a consequence, ergonomics. The first analysis had as a target to identify the areas of natural ergonomic movement and those of constrained movement. The upper zone of the applications plays an important role in the communication of the information useful for the operator, while the lower zone assumes the function of active interaction with the operator. For this reason, it was decided to concentrate all the commands that require direct interaction with the operator at the bottom or at least to make them appear more often in the lower part than in the upper one. The various sidebars, the upper and the lower and the menu can be easily resized and adjusted according to the cultural (for better readability) or personal needs (left-handed operators). Even tonality is an essential and immediate means of communication. That's why the buttons, colors, icons, labels, fonts and graphic elements were chosen so that to be in line with the idea of simplicity and immediacy.
The use of highly selected and easily understandable symbols means that the 3Q system conforms to the IEC 60417 and ISO7000. In addition, for the realization of Human-Computer Interfaces have been followed standards