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AUTOMAÇÃO E COMPETITIVIDADE: UM ESTUDO DE CASO ITALIANO

AUTOMATION AND COMPETITIVENESS: AN ITALIAN CASE STUDY

Marco Arrigone
International Plastic Group (I.P.G. Srl), E-mail: marco_arrigone@tiscali.it

Giovanni Arrigone
Serviço Nacional de Aprendizagem Industrial (SENAI/SC) e Universidade Federal de Santa Catarina (UFSC), E-mail: gio_arrigone@hotmail.com

Cristine do Nascimento Mutt
Universidade Federal de Santa Catarina (UFSC), E-mail: ecv1cnm@ecv.ufsc.br

Resumo: Este artigo descreve a experiência de uma empresa italiana produtora de dispositivos médicos, em seus passos para a automatização da produção, a fim de alcançar uma melhor produtividade e tornar-se mais competitiva no mercado a fim de ser referência. É apresentado um estudo de caso que envolve o processo automatizado de produção de uma válvula heparinica, desde a matéria-prima para a obtenção até o teste do produto final. É feita a consideração sobre as vantagens competitivas obtidas pela adoção desta abordagem automatizada na empresa. A empresa foi bem sucedida até agora na competição com outras que operam em países onde os custos salariais são muito mais baixos do que no mercado italiano. Por meio da aprovação automática e semi-automática de sistemas de produção, a firma poderá cortar custos em mão-de-obra intensiva, ainda assim mantendo um alto padrão de qualidade, que é, juntamente com os custos, a mais crucial vantagem competitiva que uma empresa no setor médico deve garantir. A automação trouxe à empresa um retorno financeiro significativo, e apesar de o investimento inicial ter sido substancial, o retorno do capital investido está acontecendo conforme o esperado e mais investimentos estão agora a ser avaliados, assim como a mudança para um lugar maior para acolher as novas máquinas que estão atualmente em construção.

Palavras chave: Automação, Competitividade, Dispositivos médicos, Válvula heparinica.

Abstract: This paper describes the experience of an Italian medical device producing company, in its steps towards production automation for achieving better productivity and become more competitive on the reference market. A case study involving the automated process of producing a heparin valve is described, starting from the raw material to obtain and test the final product together with the consideration about the competitive advantages induced by adopting this automated approach. The firm so far

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succeeded in competing with other operators in countries where labour costs are much cheaper than in the Italian market. By adopting automated and semi-automated systems of production, the firm could cut costs on labour-intensive productions maintaining a high quality standard, which is, together with costs, the most crucial competitive advantage that a company in the medical sector has to guarantee. Automation brought significant financial returns to the company, and although the initial investments have been substantial, their payback is proceeding as expected and more investments are now being assessed, as the relocation to a bigger place for hosting the new machines that are under construction in this very moment.

Key-words: Automation, Competitiveness, Medical device, Heparin valve

1 INTRODUCTION

There are certain basic activities that must be carried out in a factory to convert raw materials into finished products. Limiting the scope to a plant engaged in making discrete products, valves for example, the factory activities are:

a) processing and assembly operations;

b) material handling;

c) inspection and test;

d) coordination and control.

The first three activities, according to Groover (2000), are the physical activities that "touch" the product as it is being made. Processing and assembly operations alter the geometry, properties and/or appearance of the work unit. They add value to the product.

For firms producing medical products it is necessary to pay particular attention to the requirement of safety and hygiene during each of the activities describe before. This strict code of rules, if on one side is perfectly motivated and justified; on the other hand it introduces an additional burden for the firm in terms of quality control and inspection of the product, not only at the final stage, but for each step of its manufacturing.

This introduces an additional interesting question about the competitiveness of a small firm: will the firm acquire a competitive advantage by introducing an automated production process to the manufacture of a critically complex and safety demanding product as a medical valve?

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In this paper this issue will be discussed by trying to bring a real example of a medical firm and documenting its experience in automation. Together with this, the result of the application of an automated system will be discussed in order to understand where the benefits to the firm are to be found in terms of competitive advantage.

An example of a medical product of the type discussed before is the heparin check valve, used to control the flux of heparine injected to a patient. Heparin sodium injection is a type of medicine called an anticoagulant. It is used to stop blood clots forming within the blood vessels. Heparin is used to treat blood clots that have formed abnormally inside the blood vessels. It can also be used to prevent these types of dangerous blood clots. Heparin is given by injection or by dripping into a vein (intravenously) or by injection under the skin (subcutaneously) to treat and prevent these types of blood clots (NETDOCTOR, 2007).

The investigation described in this paper was focussed upon the impact of the application of automation to the production process of a small Italian firm (that will be indicated as Firm X in the rest of the article), in particular in relation to the competitiveness of the firm itself.

We interviewed the person, in charge of business development activities at the Firm X who is responsible for the management of production within the company and its development on the Italian and international market, this task being of crucial importance in this period of fierce competition by Eastern European and Chinese lower cost markets.

The interview was twofold:

a) technical: a thorough description of the automated system acquired by the firm and a detailed explanation of its operation;

b) conceptual: a description of the competitive advantages of the application of automation and considerations about the possible advantages of a similar experience for a hypothetical Brazilian firm.

2 COMPETITIVENESS ADVANTAGE AND AUTOMATED PROCESS

Interest in competitiveness in general has increased since Porter (1990). The referred author focused on the development of competitive advantage based on firms' initiative and upgrading efforts as a way to obtain sustainable competitive advantage.

With the level of today's world globalization, for some industries the main market is, unavoidably, the world market. Even if domestic factors play an important role in strengthening industries' competitiveness, competition also plays a very important role in the success of companies, as it prompts them to innovate and upgrade. (MUTTI, 2004)

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According to Porter (1990), the most competitive industries are the ones that make the most of their competitive advantages. There are two basic types of competitive advantage: lower cost (the ability of a firm to design, produce and market a comparable product more efficiently than its competitors) and differentiation (the ability to provide unique and superior value to the buyer in terms of product quality, special features and after-sale service). Any of these types of competitive advantage should bring a company higher productivity than that of its competitors. The low-cost firm produces a given output using fewer inputs than competitors require.

According to Wignaraja (2003), developing countries today face a new manufacturing context. World economic integration brought intense international trade and foreign direct investment (FDI). Over the last two decades, world trade growth has exceeded world Gross Domestic Product (GDP) growth and world foreign investment has exceeded both of them. In developing countries, a new manufacturing context emerged, based on knowledge and technological progress. This provides opportunities and risks for industries in developing countries. The opportunities are access to new technologies, skills, capital, and access to markets, bringing faster industrial growth. Disadvantages such as lack of resources and small markets can be overcome as developing countries have access to global resources. On the other hand, world economic integration brings imports and more foreign direct investment to countries, which means more competition to domestic companies. The economic debate on competitiveness focuses on the creation of a more efficient industrial capacity in developing countries, so that they can cope with global competition.

In the observed case, the introduction of an automatic machine allowed the company to cut costs of assembly by a great deal, allowing the possibility not only to produce more pieces per hour of work (productivity), but also to further cut personnel costs, as the production of the valves through this machine entail the use of 1/3 of the time of the operator, the remaining 2/3 being used by the operator on other activities.

Here, the aim is to focus the attention upon the experience of a firm that moved into automation to promote competitiveness and, at the same time, try to suggest options based upon this experience, for firms in a country in rapid development like Brazil, a developing country.

One of the important issues is the possibility of using the same approach, in terms of automating the process, for a similar sized firm in Brazil.

One important consideration is the cost of training the personnel for the operation of the automated system. Although costly, this seems a viable proposition in Brazil considering the formation of technical personnel by, for example, institutions such as SENAI (Serviço Nacional de Aprendizagem Industrial) with its very successful “industrial automation” course.

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3 CASE STUDY – FIRM X AUTOMATED SYSTEM

3.1 DESCRIPTION OF THE AUTOMATED SYSTEM

The object of the investigation in this paper is the work carried out by an automatic machine used by Firm X, a small sized company in northern Italy, in its daily production, and the effect on the competitive performance of the firm.

The operation of the machine is described in detail after the observation was performed and an interview was conducted with the person in charge of the business development of Firm X (which will be referred to as the interviewee in this paper). A photographic register was made during the observation, so that the description and analysis can be more easily illustrated.

The task of the machine is to assemble two different types of medical heparin check valves (Figure 1) to be used in conjunction with blood sets in the assistance to hospitalised patients when in need of anti-coagulant injection. This valve is a one-way type valve, allowing the passage of liquid in one direction only.

Figure 1: Heparin check valves compared with a tape meter (first on the left).

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The two valves present critical assembly requirements which are difficult to deal with if done manually. The major features that made Firm X to choose an automatic process rather than a manual one can be summarised as follows:

a) size of the components and crucial orientation: typically of the order of few millimetres;

b) performance tests to be carried on the valves;

c) difficulty in handling and keeping the pieces together prior to their welding;

d) velocity of assembly (productivity).

On account of the size of the components, there are parts that are not only small for an accurate and quick handling, but also there are parts that easily attract dirt from the hands or from the air, notwithstanding the class 10.000 clean room (the medical devices are all dealt with in a clean room, from the opening of the carton of the components to the packaging of the finished product).

Tests have to be carried out on the valves, namely a test of their activation and a pressure test for avoiding the presence of leakages. These tests, if carried out manually valve by valve, involve the use of dedicated pieces of equipment and are time consuming in terms of seconds that are necessary for the test to be carried out effectively.

It is furthermore difficult to manually assemble all the pieces together prior to the ultrasonic welding of the cap of the valve. One would have to use some sort of aid in keeping all the components in the right position and then place the whole piece on the platform of the welding machine.

All these features make the assembly process very time consuming, thus involving a higher cost of production for any single valve.

The managers of Firm X then decided to dedicate a fully automated machine that could not only solve the above problems, but also that could speed up the production rate per hour, maintaining at the same time the high level of accuracy and reliability required by the medical device. The machine was designed to have all the controls and tests that a human being would apply in assembling the components.

The machine as can be seen in Figure 2 (on the left) is completely automated and enclosed in a panelled enclosure to avoid interference or contamination and ensure a high level of safety in case of human intervention.

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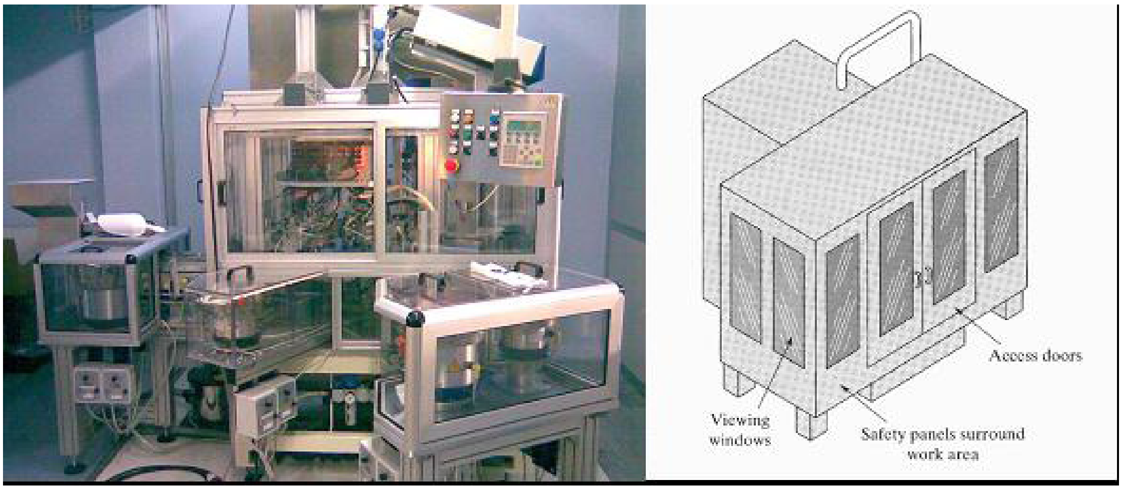

Figure 2: The machine at Firm X and a schematic (right) showing safety panels installed.

In the specific, the operation of the machine can be divided into eight different steps.

During the first step, a vibrating spiral (shown in Figure 3) selects and places, through a rotating and vibrating movement, the first component (the body of the valve) on a cursor in a fixed orientation; a mechanical "fork hand" then takes the piece and places it on the rotating table of the machine.

Figure 3: Vibrating spiral.

An infrared sensor checks that the piece is present on the cursor; if the piece is present, the sensor allows the fork hand to move; once the piece is in position the rotating table allows it to make it first movement towards step n. 2.

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Another vibrating spiral puts on a cursor the smallest piece of the valve. Since it is not possible to effectively use a mechanic “fork hand” to pick up the piece, a vacuum tube (vacuum picker) is used, aspirating the piece from the cursor and placing it on the table next to the body of the valve (Figure 4). Here again a set of sensors check the presence of the components on the feeding spiral and on the cursor for allowing the rotation of the table towards step n. 3.

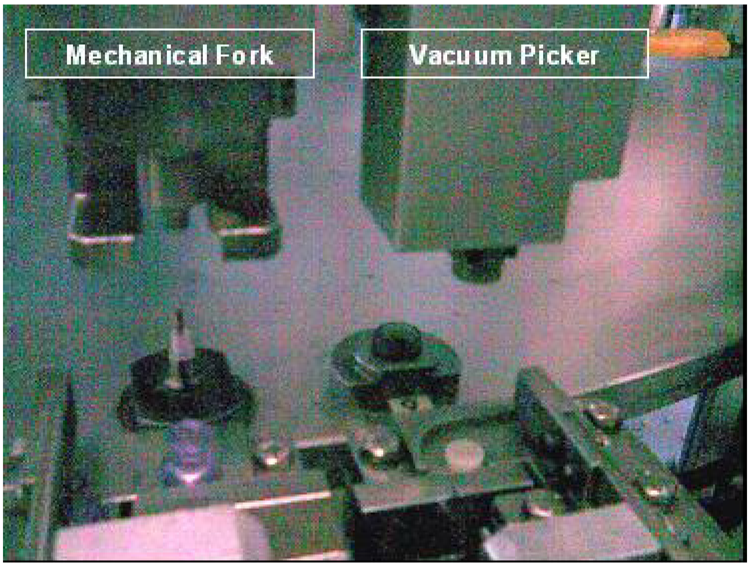

Figure 4: Manipulators, fork hands on the left and vacuum picker on the right.

Here there are two vibrating spirals feeding the table. One is for the core of the valve to be inserted in the main body of the valve while the other places the “cap” of the valve above the small component.

The table rotates to accomplish step n. 3 if the sensors “read” the presence of the pieces in their right position and if the mechanic hands are back to their starting position. In this position, a mechanic manipulator hand assembles the two pieces together to the left on top of the body to the right. If the sensors “see” that all the pieces are present and in the right position they allow the table to rotate to the following position corresponding to step n. 4 where the ultrasonic welding is done.

At this point the pieces are welded and the machine checks a series of variables, such as force used, distance and power applied; if one of the variables is not within the accepted range, the machine recognises the piece as faulty, thus discharging it into the fault pieces container.

If the welding is successful, the table then rotates to perform step n. 5 where the first functional test is carried out.

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The first test entails the activation of the valve, i.e. the valve can only allow the passage of liquid (blood or medicine) if the small piston inside the valve is pressed. A device on the machine presses this piston and allows a flow of compressed air, if the air does not flow it means that the valve can't be activated, thus is faulty. If on the other hand the air flows while the piston is pressed, then the piece is a good one and the table can rotate to reach step n. 6.

Another test is carried out here. A leak test is carried out allowing compressed air into the valve without its activation. This is done to check if the welding covers the entire circumference of the cap of the valve. A higher pressure than the one used in previous test is applied to the valve for a number of second necessary to the tester to highlight possible leakages.

If the valve is correctly sealed then the table rotates to perform step n. 7 where the piece is placed in the "good parts" container, while if the piece has failed one of the tests or the welding then the mechanic hand does not move leaving the piece in position until the next rotation of the table where another mechanical hand picks the pieces and puts it in the "faulty" container (step n. 8).

A number of sensors are placed on the machine:

a) on the vibrating spirals, checking the presence of the pieces in their correct orientation;

b) on the cursors, to check the presence of the pieces allowing the mechanical hands or vacuum tubes to place them on the rotating table; sensors and measuring panels on the test positions; piece counters and statistics on the front panel (piece per hour, fault pieces by kind of faults, total number of pieces produced, etc.). A computer programme embedded in the machine allow the change of the parameters of the tests for the second valve that is produced by it, being only the body of the valve different, the other components being the same, according to where and how the valve is placed on the blood line (two tubing or single tubing).

The entire assembly process can be visualized through a flowchart as in Figure 5:

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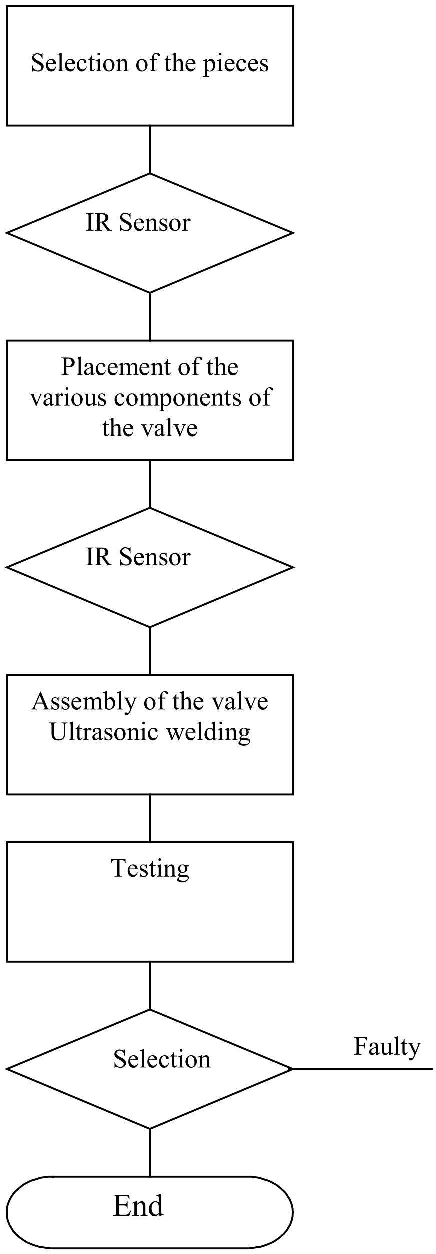

Figure 5: Flowchart describing the assembly process.

3.2 THE COMPETITIVE ADVANTAGE FOR FIRM X

The effect of the introduction of automation in the production process for Firm X is described by the interviewee (referred to in 2.1) in terms of two main points:

a) the effect over the process itself;

b) the effect over the competitive character of the firm.

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In terms of the production process there is a net improvement of the performance in terms of reduction of wasted raw material, energy and time.

The quality of the end products is improved due to the inherent quality controls of the automated system described before, giving a final product decidedly more reliable in terms of quality and adaptation to the required safety standards that, for a firm producing medical equipment, is of paramount importance.

This last point is even more interesting for the firm because it places it at the top of the scale of medical supplier for her reliability and safety, thus giving a firm competitive advantage upon other firms nationally and internationally.

It is interesting to note that if it is true that foreign firms, in particular from the east, can flush the market with their low cost product due, primarily, to the cheap labour costs, on the other hand in the medical field, cheap is not necessarily good. Safety is a more touching requisite in the case of production of delicate medical equipment and cannot be overseen.

The competitive advantage of Firm X is thus based upon this crucial concept of link between automation and safety.

The interviewee stresses this point and even adds that if it is true that cheap labour means more products it is also a synonym of high margins of defective products. So the possibility to buy cheap big quantities from the east not always translates in delivering big quantities of working products.

The rationale for the investment in the automatic machine carried out at company X can be better understood through the following data.

Prior to the introduction of the automatic assembly, the hourly production of the valves was 300 pieces per hour using 2 operators, one welding machine, one leak tester and a pressure tester for the activation of the valve. With the automatic machine, productivity has increased to 950 pieces per hour with the employment of 1/3 of an operator, thus saving the 2/3 of the operator's time that is used on other activities.

Furthermore, adopting a rotation of the personnel, the machine is usually kept working also during breaks.

The machine investment is to follow a 5 year depreciation plan (for fiscal reasons) although it re-paid itself in the first 3 years (also considering personnel costs).

In summary, the resources used with and without the implementation of the automatic process are as follows:

a) manually: 2 operators, 300 pieces per hour, 8 hours working shift, 2.400 pieces per day with 2 operators, Cost of piece = cost of operator/1.200 pieces;

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b) automatic: 1/3 of an operator, 950 pieces per hour, 8 hours working shift, 7.600 pieces per day, Cost of piece = cost of 1/3 of the operator / 7600 pieces.

As for the equipment used during the manual process, namely the welding machine and leak and pressure tester, it was incorporated in the automatic machine, thus saving the cost for the purchase of new one.

Last, but not least, the percentage of rejects has decreased using the automatic machine. With the manual process, a faulty piece was detected only at the end of the assembly process, once the valve was entirely assembled, thus losing the time dedicated to it. The reject percentage with the manual process was between 2 and 3% (considering also those pieces that fall on the floor thus not usable). With the machine properly set, the rejects have fallen to 0.4% as can be seen by the screen of the machine in the following picture (Figure 6):

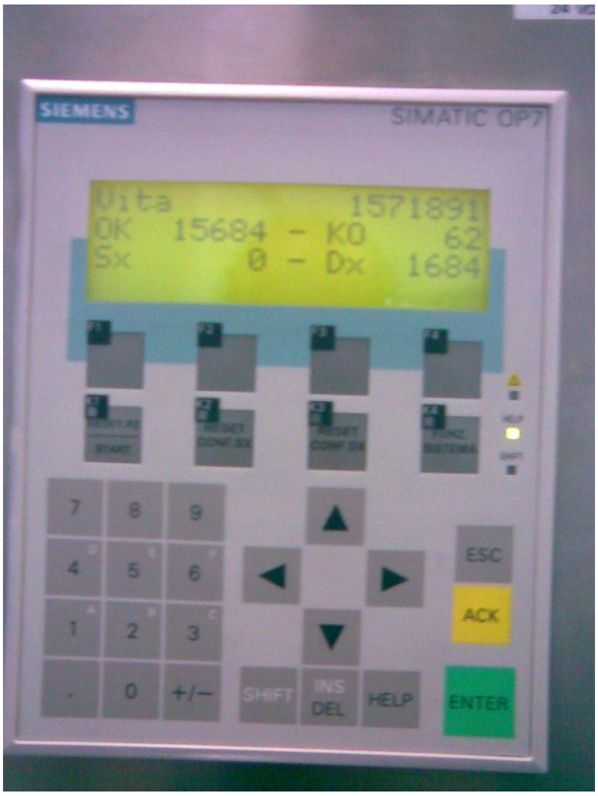

Figure 6: Control screen

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Where:

Vita: 1571891 is the total number of pieces produced since installation

OK: 15684 are the good pieces of the current batch

KO: 62 are the rejects relative to the current batch

SX: 0 is the n. of pieces in the left container

DX: 1684 is the n. of pieces in the right container

(The machine splits the finished pieces in 2 containers with a programmable quantity in order to make it necessary the change of the containers on a less frequent basis).

4 CONCLUSIONS

In this paper the results of an investigation on the effect of the application of an automated process in an Italian firm were presented together with the relevant consequences of this process of automation from the point of view of the competitive advantages introduced by it.

The final objective of the paper was then to illustrate the experience of other international operators in order to highlight the opportunity that production automation can represent for the increasingly crucial aspect of efficient productivity in a growing economy such as ours

The experience of Firm X suggests that a similar step towards automation can be chosen by a similar firm in Brazil.

It is likely that a Brazilian firm of similar size could choose this automation strategy to improve not only its competitive advantage internally but even internationally.

As it was done by Firm X, the introduction of the automated system in its production line although requiring a substantial investment in the long run brings the following advantages:

a) reduction in rejects;

b) improvement of the quality of the end product (safety);

c) reduction of damaged goods due to the high efficient testing of the single parts;

d) optimization of the workforce application and performance.

Thus the final reduction of costs and improvement in quality would certainly be a substantial differential for the firm productivity.

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Finally, it is possible that the experiences described can trigger further interest in automation and in competitive productivity growth concern in particular in a region where it is already successfully operating the SENAI activity of teaching and consulting in these fields.

It is possible now to answer to the initial question: will the firm acquire a competitive advantage by introducing an automated production process to the manufacture of a critically complex and safety demanding product as a medical valve?

On the basis of the experience of the firm documented in this paper it is possible to answer positively. The automated system introduces, through its embedded series of controls and sensors, a level of compliance to safety standard that gives the firm a net advantage and certainly reduces its costs.

Finally, this is an example of successful application of automation that could certainly be applied to similar scale medical firms in Brazil giving, as a result, the possibility of expanding and improving their competitive presence on the market due not only to the usual advantages for automating such as (KAPP, 1997): reduce labour costs; improve worker safety, increase labour productivity and mitigate the effects of labour shortages. But also introducing substantial competitive advantages for a firm operating in the medical field such as: improvement of product quality, accomplish processes that cannot be done manually and reduction of elapsed time between customer order and product delivery (also introducing a competitive advantage to the manufacturer for future orders).

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SOBRE OS AUTORES

Cristine do Nascimento Mutti

Possui graduação em Engenharia Civil pela Universidade Federal de Santa Maria (1992), mestrado em Engenharia Civil pela Universidade Federal de Santa Catarina (1995) e doutorado em Construction management and engineering - University of Reading (2004). Atualmente é professora adjunto II da Universidade Federal de Santa Catarina, onde trabalha desde 1997. Publicou dois livros e tem artigos publicados na área de gestão da construção e sustentabilidade em revistas e conferências nacionais e internacionais. Orientou quarenta trabalhos de conclusão de curso de graduação e especialização, e orienta atualmente vários trabalhos nesses níveis e de mestrado. Em 2005 criou o grupo SEACon, grupo multidisciplinar de profissionais que desenvolve pesquisas na área de gestão, competitividade e sustentabilidade na construção. Em 2007 foi premiada no 6º prêmio Alcoa de Inovação em Alumínio, junto com outro professor componente do grupo, com o projeto de tubos de luz para iluminação de ambientes usando latas de bebidas de alumínio.

E-mail: ecv1cnm@ecv.ufsc.br

Marco Arrigone

Graduou-se em Economia na Universidade de Reading (Reino Unido), onde também obteve o seu mestrado em “Negócios Internacionais e Desenvolvimento Econômico”. Ele tem trabalhado em consultoria em empresas líderes em Roma e Milão, e agora é gerente de uma empresa produtora de produtos medicais no Noroeste da Itália. Ele é encarregado do processo de reestruturação da empresa, onde os novos investimentos em automação e eficiência produtiva estão sendo implementados em conjunto com a identificação de novos parceiros nacionais e internacionais. Ele também definiu o sistema de qualidade da empresa que conduziu à certificação ISO 13485:2004 obtida em 2007.

E-mail: marco_arrigone@tiscali.it

Giovanni Maria Arrigone

Possui graduação em Física - University of Reading (1997), mestrado em Applied and Modern Optics - University of Reading (1998) e doutorado em FTIR Spectroscopy - University of Reading (2003). Tem experiência na área de Física, com ênfase em Ótica, análise de gases, e física quântica atuando principalmente nos seguintes temas: ftir, hydrocarbons, gas turbine engines e spectroscopy. Atualmente é instrutor 3 do Centro de Tecnologia em Automação e Informática de Santa Catarina (SENAI-CTAI) e professor substituto no Departamento de Física, na Universidade Federal de Santa Catarina (UFSC). Foi professor de física (graduação e pós-graduação) na Inglaterra, e na Universidade do Vale do Itajaí, em Santa Catarina, Brasil. Tem duas patentes requeridas, em 2007 foi premiado no 6o Prêmio Alcoa de Inovação em Alumínio (2o lugar), e tem dois livros sendo encaminhados para publicação. Atualmente tem aplicado física também para estudos em sustentabilidade, é pesquisador e co-idealizador do grupo SEAcon, da Universidade Federal de Santa Catarina.

E-mail: gio_arrigone@hotmail.com