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Through the centuries man has found easier and better ways to produce the goods he needs and desires. Thus through new technologies through different forms of automation, manual processes of high physical risk and high financial cost are minimized. The aim of this paper is to show that industrial automation can be applied aiming at a low cost in its implementation, presenting a fast financial return time, besides improving the product quality, reducing the production defect rates and consequently the production increase. Article was based on the automation of a modem assembly cell, where it was necessary to use four (4) operators to assemble it, the modem had a defect index of 0.12% related to annual production. The result achieved showed that after the implementation of an automatic tightening machine, only one (1) operator is required to assist in assembly and one (1) defect rate per year dropped to 0.02% per year. Industrial automation has been showing companies the power to become more competitive in the world market. Thus, it becomes essential in the process of using technologies as a tool to support business management.

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Abstract

Through the centuries man has found easier and better ways to produce the goods he needs and desires. Thus through new technologies through different forms of automation, manual processes of high physical risk and high financial cost are minimized. The aim of this paper is to show that industrial automation can be applied aiming at a low cost in its implementation, presenting a fast financial return time, besides improving the product quality, reducing the production defect rates and consequently the production increase. Article was based on the automation of a modem assembly cell, where it was necessary to use four (4) operators to assemble it, the modem had a defect index of 0.12% related to annual production. The result achieved showed that after the implementation of an automatic tightening machine, only one (1) operator is required to assist in assembly and one (1) defect rate per year dropped to 0.02% per year. Industrial automation has been showing companies the power to become more competitive in the world market. Thus, it becomes essential in the process of using technologies as a tool to support business management.

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1. Introduction

The first industrial revolution originated in England from 1760 to 1840. Gradually, artisanal manufacturing methods were replaced by steam-powered machines. The revolution was based on the use of water vapor as a source of energy. Such revolution has generated social and economic consequences due to the beginning of mechanization of manufacturing processes, especially in the textile industry (DRUCKER, 2000).

The second industrial revolution took place from 1870 to 1914, which was marked by the improvement of technologies and scientific research of practical knowledge obtained at the time. There were significant developments in the areas: electrical, chemical, biological, transportation, production engineering, agriculture, materials, among others.

The processing and storage of information in digital media occurred with the optimization of communication, as well as the development and proliferation of the internet and mobile telephony (COELHO, 2016).

Over the past century, critical segments of the mechanical industry have begun to demand an advanced stage of integration with industrial automation in a programmable and more flexible manner. Thus, space was created for a new industrial complex formed by mechanical engineering, industrial automation and computing.

This has outpaced the automotive industry on some fronts, the growing weight of the electronics industry has gained expression and the rapid growth in the share of value-added products, employment and income formation in industrialized countries.

Having thus created a new production paradigm - flexible automation, the technological trend of microelectronics generating impact on industrial processes. Electromechanical twentieth-century automation with repetitive, non-programmable automation of contactors, switches, and relays; has become the subject of improvements and enhancements. Substituted, electronics by electromechanics as the basis of automation (SILVEIRA; SANTOS, 2015).

Dedicated microprocessors and computers have become able to guide the machine system or part of the chain that belongs. Continuous integrated production processes have come to make use of: programmable logic controllers, sensors, distributed or centrally controlled digital meters, whether in process control optimizing production flows, partially or totally improving the systems that needed time control real (COUTINHO, 2016).

Last and newest, market demand is for industry 4.0, created in Germany in 2011, a high-tech strategy for the year 2020 (ZHOU; LIU; ZHOU, 2015). Thus, businessmen, politicians and universities collaborate so that their ideas stimulate competitiveness among the country's industries. Where the fourth industrial generation is expected to offer improvements in industrial processes involving: operation, engineering, production planning and control, logistics and continuous analysis during the life cycle of products and services (QIN; LIU; GROSVENOR, 2016).

According to Cheng et al. (2016), the essence of industry 4.0 is based on the cyber-physical (CPS) and Internet of Things (IoT) systems, which led factories to reach a new level of production. CPS is based on the dynamic configuration of manufacturing. Unlike traditional production methods, the dynamic configuration is above production and the processes involved, because the dynamism makes the system able to change the initial design of the product at any time.

For a company to become competitive in a globalized economy in which market laws are free-flowing, both internal and external, as well as broad competition, requires a defined conceptual strategic model so that the decisions made are dynamic and flexible, so as to provide fast speed adaptation to the perceived need.

According to Silveira; Santos (2015), the integration of production systems, this integration can occur in three distinct ways: Organizational integration - characterized by the union of one or more activities previously separated; Computer integration - is characterized by the exchange of information via computer between sectors and previously isolated activities; Multiple integration - is the organizational and computer integration at the same time.

Thus, companies that apply an integrated production planning model are those that have: technological resources employed with a high degree of computerization developed, an installed database, with reliable information.

With all process variables being integrated, it is possible to establish and set an actual cost estimate for your future pricing. Establishing a master production plan at this stage, involving quantity of products to be manufactured, product types and lead times taking into account customer demand.

This paper aims to demonstrate that the investment in the transformation of manual processes into automated processes, seeking to minimize low cost and a quick pay back (investment recovery period), modeling industrial processes Manaus - AM, from the years 2017/2018. designing for 2019.

2. Materials and Method

2.1 Kind of study

The types of approaches adopted in the research describe the descriptive methods. According to Fantinato (2015), the descriptive research exposes the facts and phenomena of reality and the exploratory seeks to correlate the problem in order to make it more explicit for hypothesis construction.

Therefore, this study is described as a qualitative research given the theoretical and empirical orientations, as well as quantitative evaluation described by its measurable attributes (GERHARDT; SILVEIRA, 2009).

Study area

The selected area has a high demand for human labor in a company in the Manaus - AM Electronic sector, specifically in a cell, as part of an assembly line. For confidentiality reasons the company will not be cited. The company considers for productivity calculations 8.4h and on average 20 days / month. In the assembly line, about 36 operators work separately per cell, such as: initial assembly, initial testing, final assembly, functional testing and packaging. Being the focus of this work act in the final assembly process (Figure 1).

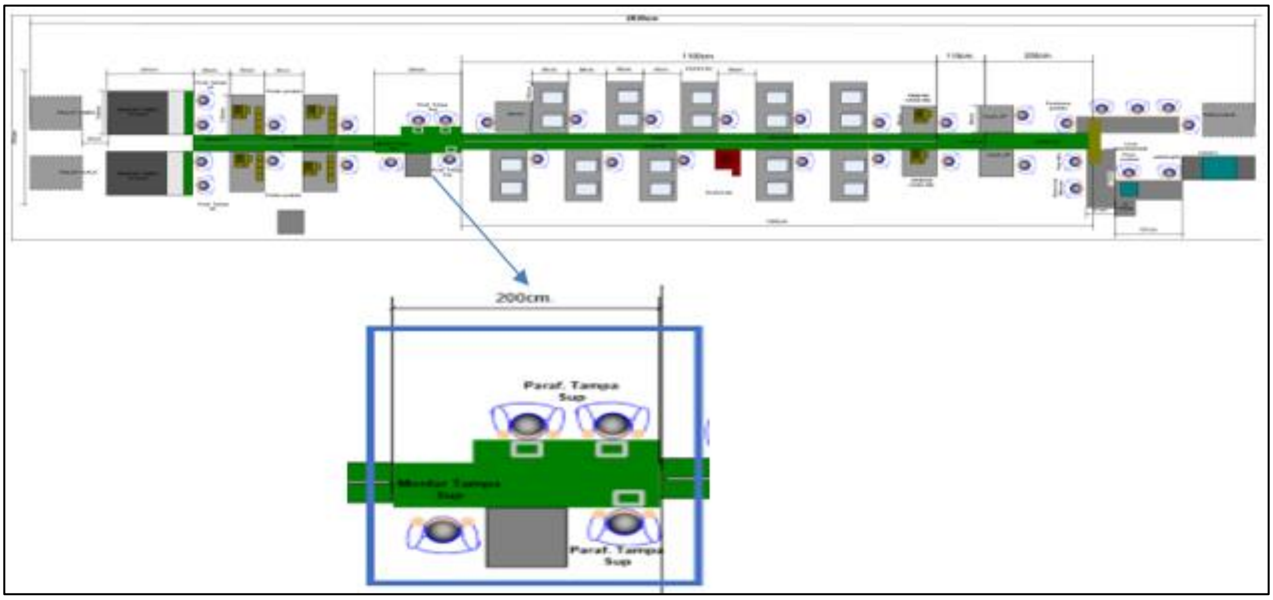


Figure 1. Production Line Layout
Source: Provided by the analyzed company (2018).

Given the above, it is expected to identify a way for the automation of the final assembly process to replace operators with machines, in order to promote improvements and economy in the assembly line. The company pays per operator to perform repetitive tightening movements. Thus, the payback calculation, how much the company would stop spending, resulting in savings for the company.
The profile of their customers is diverse, most of which are companies that provide internet and pay-tv services. The company is a leader in the modem and Se-top box manufacturing industry.

2.2 Old Method

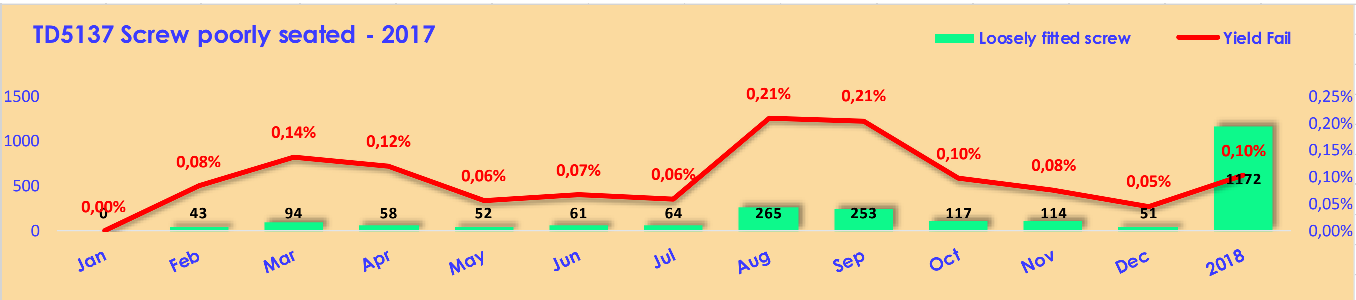
Most tasks are done with both hands, and the entire assembly consists of a relative number of fundamental movements that repeat and combine to take, screw, release. Study was carried out in the manufacturing process of a modem, composed of: a lower cover, a plate, an upper cover and four screws.
The evaluation was based on the tightening process where, due to the tack time of the line being 6.05 sec, takt time is a metric that establishes the rate at which a product should be made (DENNIS, 2008). "Cycle time is the time that passes from the start of an individual process or activity to its completion. Several cycle times may be included in an individual process or function "(TAPPING; SHUKER, 2010).
For this scenario four (04) operators were used in the final assembly process in the production line, where one (01) to close the product (top cover with the byproduct), and two (02) to screw the product, where 01 screw 02 screws on the right side and one screw 01 screws 02 screws on the left side of the modem, one (01) checks the ones that were screwed and releases to the next post, as shown by the production line capacity study, informed by the Engineering Department. Company Processes and Development (Chart 1).

Table 1. Production Capacity Study.

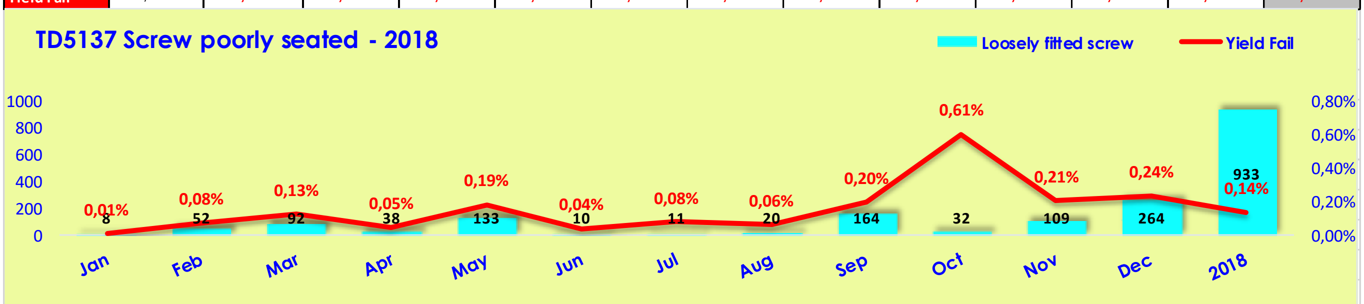
Tour	Cycle (s)	Losses	Real Cycle (s)	Equipment Qty	OP QTY	Product QTY (hours)	Product QTY (Day)
INITIAL MOTAGE	17,8	5%	18,74	0	4	769	6456
PRINTING I	18,1	2%	18,47	4	4	780	6549
FINAL ASSEMBLY	**18,3**	**10%**	**20,11**	**0**	**4**	**716**	**6015**
FUNCTIONAL TEST	90,2	3%	92,99	20	10	774	6504
PRINTING II	8,8	2%	8,98	2	2	802	6735
GENERAL CHECK	9,4	2%	9,59	2	2	751	6305
PACKING	17,6	1%	17,78	0	4	810	6804
FINAL VERIFICATION	4,8	2%	4,9	1	1	735	6174

Source: Provided by the analyzed company (2019).

The rate of poorly closed modems averaged 0.12% of production in the analysis period of 2017 and 2018 (Figure 2 A B). Each reworked modem has a cost of $ 5.00, as informed by the company's Quality Engineering department.



MTH	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2017
Total process	48072	51340	68008	47820	90100	89720	106120	126500	122840	118540	148981	108820	1126861
Loosely fitted	0	43	94	58	52	61	64	265	253	117	114	51	1172
Yield Fail	0,00%	0,08%	0,14%	0,12%	0,06%	0,07%	0,06%	0,21%	0,21%	0,10%	0,08%	0,05%	0,10%



MTH	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2018
Total process	67660	68905	72879	74747	71595	22842	13812	31143	82809	5280	52283	111467	675422
Loosely fitted	8	52	92	38	133	10	11	20	164	32	109	264	933
Yield Fail	0,01%	0,08%	0,13%	0,05%	0,19%	0,04%	0,08%	0,06%	0,20%	0,61%	0,21%	0,24%	0,14%

Figure 2 Index of Bolt poorly seated in 2017 (A) and 2018 (B).

Source: Provided by the analyzed company (2018).

To make a payback study, it is necessary to perform an analysis of the cost that the company has for each operator, where each operator costs R $ 4000.00 thousand total cost per company per month, multiplying by 4, a total of R $ 16000,00 thousand reais per month in relation to this analyzed cell.

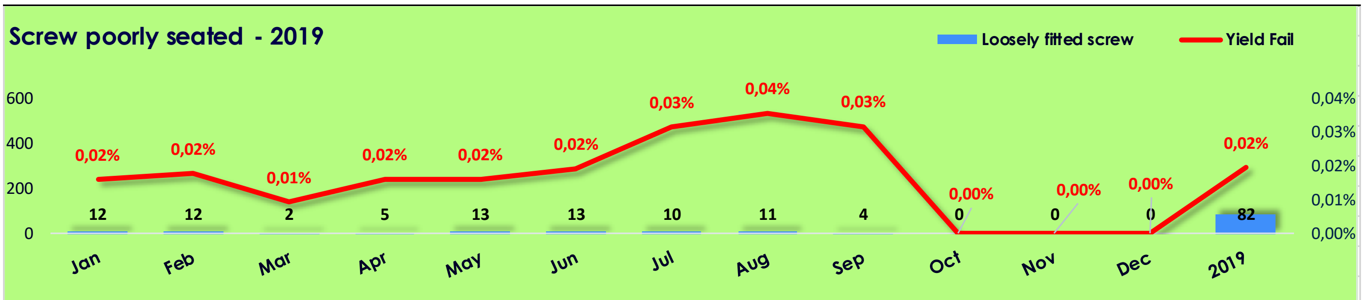
3. Results and Discussion

Industrial Automation and its earnings

According to management, there was a 50% increase in demand for the production of mondens. Modem manufacturing accounts for about 19% of the company's annual revenues. The decision to invest in the automatic tightening machine was due to the growing demand for Modens and the need for expansion of the company.

It is a complex machine with manual feed, where an operator closes the product (process of assembling the top cover with the by-product) and positions in the machine. The machine performs the screwing process one screw at a time. When the bolting is completed, the same machine checks that the bolt has been placed correctly, if not, it releases the defective product to the repair area by means of a mechanical arm. If the product is screwed correctly it is released to the next post.

With the implementation of the machine in 2019, the cell had a reduction of operators in the manual process, from four operators to just one operator. The process boiled down to the following flow: an operator mounting the top cover on the byproduct and positioning on the machine; the machine screws the four (04) modem screws, where it releases the screwed modem on the production mat, to complete the testing and packaging flow. Thus, its misplaced screw index decreased considerably on average from 0.12% to 0.02%, as shown in Figure 3.



MTH	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2019
Total process	74860	67392	21438	31104	80325	67743	31671	30861	12597				417991
Loosely fitted	12	12	2	5	13	13	10	11	4				82
Yield Fail	0,02%	0,02%	0,01%	0,02%	0,02%	0,02%	0,03%	0,04%	0,03%	0,00%	0,00%	0,00%	0,02%

Figure 3. Screw Index misplaced in 2019.

Source: Provided by the analyzed company 2019.

After the reduction of operators and implementation of the machine, a new scenario emerged, the maintenance of the machine. During machine development, one operator was selected to receive training to perform maintenance and machine maintenance, and others were relocated to other company production lines.

In this case, what is the recovery period criterion, one asks: 'How many time periods does the project need to take to be acceptable in terms of value?' For Souza; Clemente (2012), project risk increases as Payback approaches the end of the planning horizon. Therefore, the faster the investment returns, the lower the project risk.

Analyzing the old method, the cost of the cell for two years (2017 and 2018), was $ 384,000.00 and annual cost of $ 192,000.00. With the current method or with an initial cost of R $ 356,000.00, given the investment in the purchase of the machine and the training required to keep the machine running (Figure 4).

Prior Method vs. Improved Method		
	Before	Improved
Number of Operators	4	1
Operator Cost per Month	R$ 4.000,00	R$ 4.000,00
Machine maintenance cost	-	R$ 500,00
Cell cost per Month	R$ 16.000,00	R$ 4.500,00
Cell cost per year	R$ 192.000,00	R$ 54.000,00

Implementation Cost Analysis	
Machine Cost	R$ 300.000,00
Maintenance Training	R$ 50.000,00
Maintenance by Year	R$ 6.000,00
Total	R$ 356.000,00

Figure 4. Payback analysis by method change.

Source: Adapted Payback Analysis.

In the first year an investment of R $ 164,000.00 more than the investment, which was already scheduled to be made, was required. Therefore, the payback for the project occurs in two years, because the cost of the cell decreases from R $ 192,000 to R $ 54,000. By 2020, an even more considerable cost reduction is expected, being R $ 132,000 compared to the old method, multiplying by 2 years, generating savings of R $ 276,000, by the projection.

4. Conclusion

It's important to note that managing a business is based on analyzing sales, cost, production, inventory level, finance, and so on, and that a good manager will need reliable, up-to-date information available at any time, only then will you be able to minimize errors in decision making.

In the current scenario of intense economic competition, organizations are struggling to stay in business. Faced with so many challenges, they seek to apply automation in their production processes, especially for its proven contribution to reducing production costs, efficiency and quick response to market demands.

These market demands lead organizations to seek constant innovations and improvements in their production processes. Industrial automation has been showing companies the power to become more competitive in the world market. Thus, it becomes essential in the process of using technologies as a tool to support business management. It is also crucial that these companies view automation and information technology as a tool of competitiveness and not as an extra cost, being a tool that will help in the consolidation of the company.

5. References

COELHO, Pedro Miguel Nogueira. Rumo a Indústria 4.0. 2016. 62 f. Dissertação (Mestrado) - Curso de Engenharia e Gestão Industrial, Faculdade de Ciências e Tecnologia Universidade de Coimbra, Coimbra, 2016.

COUTINHO, Luciano. A terceira revolução industrial e tecnológica. As grandes tendências das mudanças. Economia e Sociedade, [s.l.], v. 1, n. 1, p. 69-87, out. 2016. ISSN 1982-3533.

DAVILA, Tony. As regras da inovação, como gerenciar, como medir e como lucar. Porto Alegre: Bookman, 2009.

DENNIS, Pascal. Produção Lean Simplificada. 2ª ed. Porto Alegre, Bookman. 2008.

DRUCKER, P. O futuro já chegou. Revista Exame, [s.I], v. 8, n. 710, p.12-19, 22 mar. 2000.

FANTINATO, M. Métodos de pesquisa. Apresentação de aula, USP 2015.

GERHARDT, T.E.; SILVEIRA, D.T. Métodos de pesquisa. Universidade Aberta do Brasil – UAB/UFRGS e Curso de Graduação Tecnológica – Planejamento e Gestão para o Desenvolvimento Rural da SEAD/UFRGS. – Porto Alegre: Editora da UFRGS, 2009.

QIN, Jian; LIU, Ying; GROSVENOR, Roger. A Categorical Framework of Manufacturing for Industry 4.0 and Beyond. Procedia Cirp, [s.l.], v. 52, p.173-178, 2016. Elsevier BV. http://dx.doi.org/10.1016/j.procir.2016.08.005. Disponível em: <http://www.sciencedirect.com/science/article/pii/S221282711630854X?via=ihub#bibl0005>. Acesso em: 10 maio. 2019.

SILVEIRA, Paulo; SANTOS, Winderson. Automação e Controle Discreto. São Paulo: Érica, 10° edição, 2014.

SOUZA, Alceu; CLEMENTE, Ademir. Decisões financeiras e análise de investimentos: fundamentos, técnicas e aplicações. 6. ed. São Paulo: Atlas, 2012.

TAPPING, D.; SHUKER, T. Lean Office: gerenciamento do fluxo de valor para áreas adminitrativas – 8 passos para planejar, mapear e sustentar melhorias lean nas áreas administrativas. São Paulo: Editora Leopardo, 2010.

VASCONCELLOS, Marcos A. S. Garcia, M. E. Fundamentos de Economia. São Paulo: Saraiva, 5° edição, 2012.

ZHOU, Keliang; LIU, Taigang; ZHOU, Lifeng. Industry 4.0: Towards future industrial opportunities and challenges. 2015 12th International Conference on Fuzzy Systems and Knowledge Discovery (fskd), Zhangjiajie, p.2147-2152, ago. 2015. IEEE.