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Why I want to be a future Swedish shop-floor operator

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Abstract

When looking in rear view mirrors the Swedish as well as the international production industries can overview several years of progress covering all aspects of production. Production methodologies and machines etc. have changed and evolved, and so has the environment of the shop-floor operator. The demands on the shop-floor operators have grown from simple monotonic tasks with low complexity to pro-active team work requiring flexibility, continuous improvements and a holistic approach.
With a base in a study where production and HR-managers at six Swedish manufacturing industries have been interviewed this paper identifies the role of today's and the future Swedish shop-floor operator. The response to the described role of the future operator is compiled from the ones who will become the future Swedish shop-floor operators – today's teenagers attending technical high-school. Their views of the environment of the future shop-floor operator are described by accuracy, development, a good working environment and team work. The paper also reveals what the offer should include to make these teenagers say: I want to be a future Swedish shop-floor operator.

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Keywords: Productivity; Decision making; Shop-floor operators

1. Introduction

In the past decades Sweden, being a strongly industrialised nation, has had a high national trade surplus. An international market where competition constantly grows and evolves demands a proactive approach to maintain a front-edge position being an export intensive nation. The manufacturing companies of Sweden face pervasive challenges preparing for future requirements and businesses. These challenges include not only increasing flexibility and productivity but also an increased level of knowledge used during production. It emphasizes the importance of developing and utilizing the employees' knowledge, ability and achievements. Collaboration between both novice and highly experienced operators in a production environment with a high level of automation is vital when complexity and demands in future production systems increase. An information intensive working environment with increasing complexity demands for technical supporting systems to help the shop-floor operators to cope with, prioritize and plan tasks to keep a high production output.

The Swedish production industry has identified an extended need of technical competence for its coming employees to be able to handle the future production systems [1, 2]. A key to future competitiveness and effectiveness are the shop-floor operators who handle the production systems. There will be a need of supporting tools facilitating collaborative work and thinking enhancing knowledge and ultimately production output [3-5].

Views of the present and future Swedish shop-floor operators and their working environment have been discussed with eight production and HR-managers at six Swedish manufacturing companies. These companies process and cut metal and wood having workforces in a spectrum of 60 to more than 1000. The shop-floor operators at these companies are engaged in machining as well as assembly operations. The conclusions of the production and HR-managers have been presented to their possible future shop-floor operators,

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second year high-school students. Their response includes both consensus and deviations.

The rest of this paper is organised as follows. A literature review of the evolution of the Swedish shop-floor operator is presented in Section 2. Section 3 presents views of the future Swedish shop-floor operators emerged from interviews with the production and HR-managers. Section 4 presents the high-school students response and interpretation of the presented views of the future shop-floor operators. The paper is concluded in Section 5.

2. Evolution of the Swedish shop-floor operator

Not only external variables such as fluctuating market demands affect the shop-floor operators working environment but also internal stochastic events and variables, such as missing or broken tools, machine failures, express orders and changes in number of available operators. The stochastically changing production environment requires knowledge and ability of the shop-floor operators to handle and act in an information intensive environment with fluctuating degree of uncertainty. Such events and variables negatively influencing the production system and output cannot be handled using a traditional planning system or traditional control systems [6]. To focus on only one specific task or to be stationed at one machine was the reality of yesterday's shop-floor operator. Today the shop-floor operator has to deal with an increasing scope of responsibilities and tasks. This transformation has taken place in parallel to a fading difference between blue and white collar responsibilities, as past-time engineering duties are often performed by the shop-floor operators today [7].

The working environment of the shop-floor operator of course goes hand in hand with changing conditions of the manufacturing industry. Altering management strategies obviously affects all employees one way or another. In the concept Scientific management presented by Taylor in the beginning of the last century the focus was efficiency. The shop-floor operator was almost seen as a machine. According to Taylor the shop-floor needed strict guidance and rigid structure to be able to achieve high productivity. During the 1920s Scientific management got a breakthrough in Sweden and a new era for Swedish industry and its operators began [8-10].

With a basis in Taylor's concept Scientific management, Henry Ford's thoughts of how the production should be managed and arranged emerged. He introduced assembly lines and increased the amount of work performed by machines and reduced the scope of the operators and by doing so increased the productivity. Decisions were made by white collars and explicit knowledge was not asked for amongst the operators on the shop-floor.

The MTM-concept (Method Time Management) was presented in 1948 and introduced in Sweden the following year. MTM analyses manual tasks focusing and evaluating improvements, to work smarter. The concept has had big importance on the development of industry's productivity and competitiveness and of course also the shop-floor environment. In the 1980s the production and management concept in TPS (Toyota Production System) was spread over the world and of course also influenced Swedish industry. Together with TQM (Total Quality Management) the focus was set on customer needs and expectations together with quality and flexibility. These in some ways new focuses led to an increased motivation to work with continuous improvements and waste elimination on the shop-floor including not only engineers but also blue-collars. A key-factor to reach a lean production is the engaged and versatile operators who affected the work on the shop-floor. The principles of TPS and Lean Philosophy have had, and still have, a great influence on Swedish production companies [9, 11-17].

The importance of having a proactive approach on the shop-floor is discussed in [7]. They conclude that shop-floor operators having a proactive behaviour counteract possible uncertainty leading to flexibility gains and also reduction of the total lead time at assembly lines. The design of proactive assembly lines and how the potential of the operators should be utilised through interaction of the areas automation, information and competence is discussed in [3]. An approach to define the "Operator of the future" and its definitions, requirements, tasks and needs through workshops was made by engaging several Swedish manufacturing and process industries. One main requirement found for the operator of the future was the ability to interpret information. The ability to adapt to different situations are one of the strengths of the human operator [15]. But in a dynamically changing environment with stochastic events it is not possible to make the right decisions without proper decision support since the operator does neither possess all production data nor an ability to process or evaluate it in real time. The operator needs tools that support communication, control, collaborative work and constant learning. Intuitive systems with in-situ information will increase the flexibility for the operator and enhance proactive decisions on the shop-floor [4, 18, 19]

It is important to develop not only the individuals but also the whole team on the shop-floor. The future shop-floor teams will have increased responsibilities and scope in a working environment having more complexity compared to today. Shop-floor operators of the future must be able to properly interpret and interact with the working environment to be a part of it [19]. Today's working environment, demands and views of the Swedish shop-floor operator from literature and interviews with production and HR-managers are described in Figure 1.

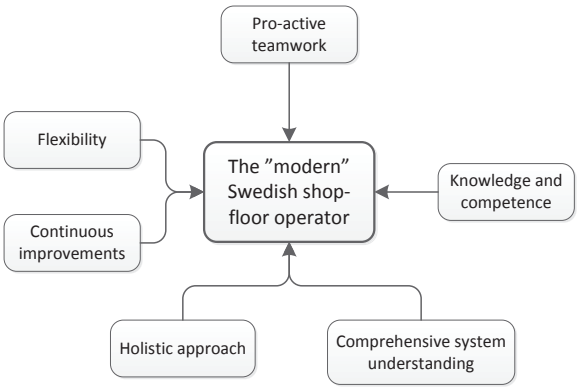

Figure 1. Demands on today's Swedish shop-floor operator.

3. Managers views of the future Swedish shop-floor operator

Eight production and HR-managers from six production companies were interviewed on their view of the present and future Swedish shop-floor operator. A model presented by [19] covering four quality areas for developing industrial work was used as a basis for the interviews. The four areas of the model are: Individual – team, Skills, Improvement and development work and last Management and communication. The citations in this section are from the interviews.

All of the companies in the interviews use a team-based approach at the shop-floor and the operators rotate workplaces within the team. Interaction and discussion are vital to the shop-floor environment and the importance of social interaction is emphasized by all interviewees. The shop-floors' comprising scope though requires the operators to have an ability to handle an extended number of tasks still maintaining high quality output. All the interviewees agree that team based work also in the future will be the leading approach on the shop-floor. In some of the companies a trend towards factories within the factory was identified. Within each of these in-house factories the team had full responsibility to optimise the production output. Their scope included not only normal assembly/machining tasks but it also included for instance measuring, analysing, improvement work, preventive maintenance and handling failures. The members of the shop-floor teams will change and some of the interviewees emphasised the importance of assuring the teams' total competence over time to be able to keep a high productivity and quality.

"It is popular to give the operators and the team more responsibilities. This is both positive and negative. The organisation must have a maturity to handle this to have a positive output. Man is lazy; it is the way it is. You cannot just give full responsibility to the team and expect that every problem will be solved."

The foreseen increasing responsibility scope indicates that the operators' individual competence might be a limiting variable. The interviewees specify the operators' own interest and experience as the most important variables facilitating the level of individual responsibility and ultimately the teams.

When engaging a shop-floor operator today most of the interviewees demand a technical high-school degree. Other knowledge areas commonly requested are: NC, automation and materials science. But as important as these variables is the individuals' personality. All interviewees agree that technical competence never can compensate for lack of individual commitment and momentum.

The interviewees agree as [19] states that for all employees are understanding and acceptance key variables for reaching good improvement and developing work. Engaged operators and taking their knowledge and ideas into account are vital to a process of continuous improvements. During the interviews the importance of short decision processes became apparent. It ensures that the engagement on the shop-floor is not lost. The importance of a customer focus was also highlighted during the interviews. The shop-floor operator must understand the level of quality required by the customer.

"We engage the operators in all improvement and development projects. It is obvious why. They are the ones who will work with the machine/process."

The level of automation and number of embedded IT-systems in the production systems increase and is foreseen to continue to do so. Besides technical excellence, which will become even more vital than today, the following attributes are seen as vital to future shop-floor operators among the interviewees besides a thorough technical education and being skilled in languages: not only being a creative team player with logical and mathematical thinking but also having abilities such as dexterity, flexibility, awareness, commitment, innovation, momentum and accuracy.

Other identified keys for future success are commitment and inclusion and it was discussed how these variables are affected by how production data are displayed in real-time at the shop-floor. The steep technical progress will offer new ways of how information can be presented in real-time. Today's teenagers becoming the future shop-floor operators are used to have smartphones and other IT-devices as a part of life but using these on the shop-floor is a sensitive matter for many companies today. Some of the interviewees see smartphones as possible future shop-floor tools and all of them predict that the importance of supporting tools on the shop-floor will increase.

"Young people do not perceive industry as an attractive place to work. We are still seen as boring. How do we want it to be in the future? I think it would be really good if we could create a working environment looking more like a video game!"

Augmented reality is mentioned by several of the interviewees as probable technology to be integrated into the future shop-floor operators' everyday life together with a close integration of operator and robot tasks. The timeline is generally estimated to be ten years until these technologies

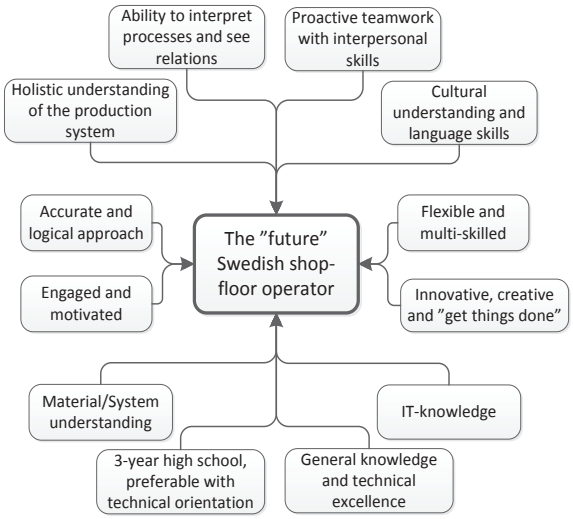

Figure 2. Demands to meet for the future Swedish shop-floor operator

are implemented on the shop-floor. It is also expected that an increased level of technology for the shop-floor operators will appeal young people to work within production in the future.

4. Views of the future shop-floor operators

The view on and demands to meet for the future shop-floor operator, as seen by the production and HR-managers, is concluded in Figure 2. Drastic increases in number of sought skills are clear compared to the situation of today's shop-floor operators (Figure 1). Most of the requested capacities are defined by the managers as non-technical or personal abilities (modelled to the left, above and right in Figure 2). Only few of them (modelled below in Figure 2) are referred to as technical knowledge/ability and requested level of education.

The managers' prediction of future employees' abilities and knowledge was presented to their possible coming employees and colleges: 79 high-school students, 17 years old, attending 2nd grade of different three years technical programs at four different schools. The students' personal inputs on working at a manufacturing company are shown in Figure 3. Many of them have been visiting and/or working at a manufacturing company, only six of them state having no input on working at a manufacturing company. The answers from these six students do not significantly diverge compared to the ones stating a personal experience of working at a manufacturing company. The students were asked to each select 3-5 words/short statements out of a total of 30 corresponding their view about working as a shop-floor operator at a Swedish manufacturing company. An alignment of their answers is shown in Figure 4.

So how do the students interpret the managers' predictions as presented in the interviews? Each student was given two of the statements and asked to write down their own interpretations given the context that they were a shop-floor

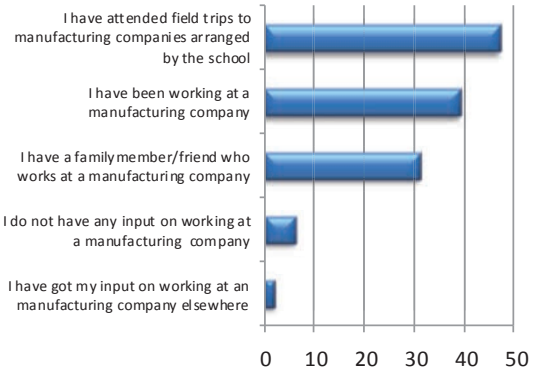

Figure 3. The students' input on working at a manufacturing company

operator working at a production line with both manual and automatic assembly stations. Six of the total twelve statements were given to the students.

4.1. Innovative, creative and "get things done"

The students' answers to the question "What does it mean being innovative, creative and get things done?" could be referred to two major equally numbered groups embracing 25 of the 28 answers. One group of the answers referred to it as finding new solutions and new ways of working having a positive attitude and engagement. The other major part of the answers concluded it as having a broad knowledge, doing a good job and being part of a development process for both company and individuals.

4.2. Holistic understanding of the production system

The answers to the question "What does it mean to have a holistic understanding of the production system?" could be divided into three levels of expected detailed knowledge. Eleven of the 23 answers understood the question as generally understanding the process/system. Four interpreted it as having detailed knowledge of the system and four stated that to be able to have a holistic view you had to in detail know all sub-processes and stations of the production system. Four of the answers could not be referred to any of these three groups.

4.3. Flexible and multi-skilled

The question "What does it mean to be flexible and multi-skilled?" also generated answers that could be divided into three groups or levels of ability. In total 25 students answered this question and 16 of them though it to be an ability to work with a lot of things and to know a lot. Five of them referred to a proficiency to solve problems, to think outside the box and two of them understood it as an ability to perform tasks beyond ones education. Two of the answers could not be referred to any of these levels of increasing ability.

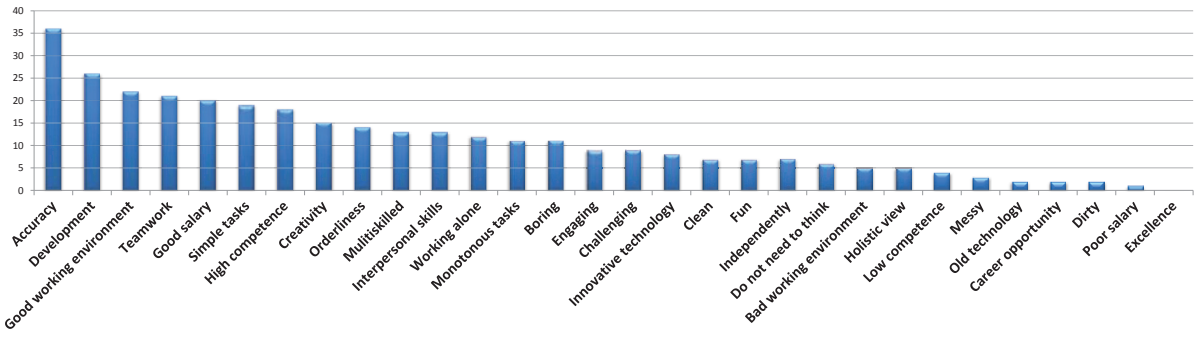

Figure 4. The students' corresponding view on shop-floor work

4.4. To be a team player with interpersonal skills

The answers to the question "What does it mean to be a team player with interpersonal skills?" showed a convincing conformity. All of the 24 answers referred to it as an ability to cooperate and support each other.

4.5. IT-knowledge

From answers to the question "What does it mean to have IT-knowledge?" three levels of IT-abilities emerged. The first level of IT-knowledge can be referred to as having a general knowledge of computers and basic ability to use them. Seven of the 26 respondents gave answers similar to the first level. Ten of the answers could be referred to in addition to level one having knowledge and ability to use the IT-systems in production. Five of the students gave the question yet a deeper understanding. They referred to it as a knowledge and ability to program computers/robots used in production. The four remaining answers were related to the shop-floor operators tasks rather that knowledge and abilities concerning IT.

4.6. Work proactive and an ability to interpret processes and relations

The last of the six questions was "What does it mean to work proactively and have an ability to interpret processes and relations?" and the answers were widespread. No clear common understanding emerged from the answers. Understanding of how it works and thinking outside of the box were some of the answers while others thought of problem solving, capability to read and understand instructions and an ability to work towards the future. This was the area were the answers clearly comprised the largest and in some cases incompatible scope.

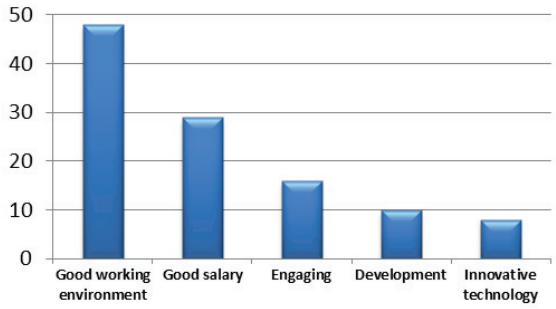

Figure 5. Important issues for the teenagers' future work.

5. Conclusions

How to engage future staff is a current and important issue for most manufacturing industry today. Reflections on this matter are met not only during the interviews but are also a common topic in industrial press and focus of several ongoing research projects.

When looking at the top-10 of the students' answers in Figure 4 an appealing interpretation and experience of the shop-floor operators' working conditions are revealed. A positive view and many of the words with negative scope are recognised by less than five of the respondents. Does the teenagers' view of the shop-floor conditions correlate with the working conditions asked for in general? They were also asked to list the most important conditions if they were to work as a shop-floor operator in five year from now. Their absolute first priority was good working conditions followed by having a good salary. Their answers are compiled in Figure 5.

During the interviews the managers give a versatile picture of the future shop-floor operator with comprehensive demands especially for personal abilities. Some of them are jointly defined by the teenagers and other answers show divergent understandings. To be able to tomorrow attract today's teenagers to work on the shop-floor in manufacturing industry there are some deviating understandings or poorly defined demands that needs to be updated and clarified. The teenagers believes in having good working conditions and their view of the shop-floor is generally positive and does not vary that much. One answer from a high-school student on the meaning of having IT-knowledge that pin points a gap of expectations in relation to reality was:

"IT-knowledge is as important during your work as in everyday life, though industry is possibly a little bit behind".

If these obstacles can be eliminated and front edge technology is implemented for everyday work on the shop-floor the teenagers are likely to say: I want to be a future Swedish shop-floor operator.

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References

[1] Teknikföretagen, Swerea, Academy SP. Svensk Produktion 2025: Strategisk forsknings- och innovationsagenda för att möta de globala utmaningarna. (in Swedish). 2011.

[2] Teknikföretagen, Swerea, Metall I, Academy SP. Made in Sweden 2030: Strategic Agenda for Innovation in Production. 2013.

[3] Fasth Å, Bruch J, Dencker K, Stahre J, Mårtensson L, Lundholm T. Designing proactive assembly systems (ProAct)-Criteria and interaction between automation, information, and competence. Asian International Journal of Science and Technology in production and manufacturing engineering (AIJSTPME). 2010;2:1-13.

[4] Grane C, Abrahamsson L, Andersson J, Berlin C, Fasth Å, Johansson J, et al. The operator of the future–a key to competitive industry in a future information society. Swedish Production Symposium, SPS122012.

[5] Karlsson M, Mattsson S, Fast-Berglund Å, Stahre J. Could the use of ICT tools be the way to increase competitiveness in Swedish industry? proceedings of the 12th IFAC/IFIP/IFORS/IEA Symposium on Analysis, Design, and Evaluation of Human-Machine Systems2013. p. 179-86.

[6] Xu X, Wang L, Newman ST. Computer-aided process planning–A critical review of recent developments and future trends. International Journal of Computer Integrated Manufacturing. 2011;24:1-31.

[7] Dencker K, Fasth Å, Stahre J, Mårtensson L, Akillioglu H, Lundholm T. Proactive Assembly Systems–realizing the potential of human collaboration with automation. Annual Reviews in Control. 2009;33:230-7.

[8] Björkman T. Den långlivade taylorismen. I Abrahamsson, Abrahamsson, Björkman, Ellström & Johansson (red) Utbildning, kompetens och arbete (in Swedish). Lund: Studentlitteratur; 2002.

[9] Börnfelt P-O. Förändringskompetens på industrigolvet: kontinuerligt förändringsarbete i gränslandet mellan lean production och socioteknisk arbetsorganisation (in Swedish)2006.

[10] Taylor FW. Scientific management: Routledge; 2004.

[11] Liker JK. The Toyota way: 14 Management Principles from the World's Greatest Manufacturer. 2004.

[12] Hellsten U, Klefsjö B. TQM as a management system consisting of values, techniques and tools. The TQM magazine. 2000;12:238-44.

[13] Johansson J, Abrahamsson L. The good work–a Swedish trade union vision in the shadow of lean production. Applied Ergonomics. 2009;40:775-80.

[14] Johansson J, Abrahamsson L, Johansson S. If you can't beat them, join them? The Swedish trade union movement and lean production. Journal of Industrial Relations. 2013;55:445-60.

[15] Payne JW, Bettman JR, Johnson EJ. The adaptive decision maker: Cambridge University Press; 1993.

[16] Laring J, Forsman M, Kadefors R, Örtengren R. MTM-based ergonomic workload analysis. International journal of Industrial ergonomics. 2002;30:135-48.

[17] Maynard HB, Stegemerten GJ, Schwab JL. Methods-time measurement. 1948.

[18] Holm M, Garcia AC, Adamson G, Wang L. Adaptive decision support for shop-floor operators in automotive industry. Procedia CIRP. 2014;17:440-5.

[19] Harlin U, Gullander P, Lundin R, Wandebäck F, Berglund M. Development o findustrial work in the future – a study of Swedish manufacturing companies. Proceedings of the 4th International Swedish Production Symposium. Linköping2011. p. 414-24.

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