



Invited Speaker/Paper

## The Process of Industrial Change and Social Transformation

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**Abstract** – The paper aims to highlight the unavoidable changes in industrial society together with the basic elements of this transformation as well as to take the attention of the readers on the healthiest change process. Some actions which are considered to be very essential in coping with the changes and getting the especially manufacturing society to be aligned with those.

**Keywords** - Industry 4.0, Change Management, Change Process, Social Transformation

### Introduction

The change is unavoidable fact of human life. As the very famous saying, everything around us are changing. There is one thing that cannot change. That is the «CHANGE» itself. Industrial society should be very much aware of this fact and try to implement strategies and policies to cope with the change in one way or another. There has been various methods and methodologies developed for handling the change in especially, enterprises. A report published by Northwestern University Information Technology [1] is one of those. The change process is well formulated and respective action plans are addressed. One of the latest report published by University of North Carolina [2] clearly points out the need for a change management board and provides a procedure for handling change requests. Ayhan and Oztemel (2013) provided a comprehensive analysis on change and a change management model is proposed to deal with the progress along with especially the change on manufacturing society [3]. Recently social transformation is heavily discussed in scientific community. The concept of Industry 4.0 and similar ones are on the agenda of not only manufacturing society but also governments and service providing organizations. Some detailed information can be found in [4-7].

Social transformation is not only triggered by manufacturing set-ups. The things are getting smaller with more functionality. An iPhone telephone which can be bought by paying \$800 can now perform the functions which could requires more than 1 million dollars to set up the same system about 20-30 years ago. According to Boston Consulting Group announces that it costs barely \$8 an hour to use a robot for spot welding in the auto industry. A human doing the same job costs \$25 an hour–The gap seems to be widen day by day [8].

### Social Transformation

Technological developments are the main drivers for social transformation. During 16<sup>th</sup> -17<sup>th</sup> centuries, the land was the main source of power in the societies. Land owners were directing the society in their wish. They had total control over

the society and respective issues. By the invention of a steam machine, the first industrial revolution did start. By the following are up to the beginning of 19<sup>th</sup> century, the “machines” become dominant in industrial life. This made the society to turn into “industrial society” and the machine owners so called bosses become more powerful in designing the social life (second industrial revolution). The progress along this line continued until 1980s. Power of the machines are enriched by automation and information technology become superimposed. Society transformed itself to information dependent life and information society become the main focus of manufacturers (third industrial revolution). This trend generated new source of power that is the knowledge. By the introduction of industry 4.0 concept by Germany, the digital society started to become superior and digitalism took the attention of both research and practical communities. Autonomy, cyber-physical systems and machine to machine communication was the main drivers for this transformation (fourth industrial revolution). It seems that this transformation will continue to start a new way of life so called a wisdom society.

### Changes from Various Perspectives

As everything is unavoidably changing, there is a need to systematically review the change process. Before looking at the details of this process, the focus of change drivers need to be analysed. Those can be listed as the following (see [9] for more detail information).

- **Technological changes:** Technological developments triggered the change from generating manual system to autonom systems as the following.
  - ⊗ Manuel Systems (primitive plough)
  - ⊗ Semi Manuel Systems (Mill)
  - ⊗ Traditional Machines (Tractor)
  - ⊗ Automated Machines (Harvester)
  - ⊗ Autonom Systems
  - ⊗ ???

- **Manufacturing system changes:** Along with the technological changes and transformation, manufacturing systems are evolved as shown in Figure

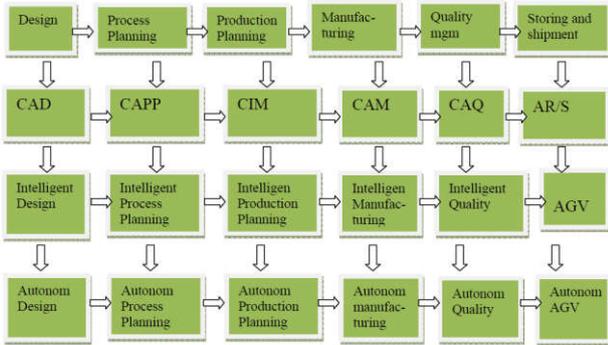


Figure 1: Changes and progress in manufacturing systems (Oztemel, 2010)

- **Changes in robotics:** Man guided big robots and robot cells are leaving their places to cage free automated robots enriched with sensors. Nowadays robots are having interaction with human and perform intelligent behaviour. Their size is getting smaller and functionality are increasing. Smart robots with Cyber-Physical Systems seems to be dominating the future manufacturing systems.

- **Methodological changes:** Along with the machine parks and hardware technology, the methodological changes are exhibiting new managerial approaches. The following transformation can be drawn for this type of changes.

- ⊗ Handcrafts
  - ⊗ Functional Manufacturing
    - ⊗ Mass/Serial Production
    - ⊗ Group Technology
    - ⊗ FMS
    - ⊗ Concurrent and Dynamic Manuf.
    - ⊗ Reconfigurable Manufacturing
    - ⊗ ???

- **Changes in planning:** Along with the managerial changes, planning philosophy is also changing as the following.

- ⊗ Single Product Production Planning
  - ⊗ MRP (Material Requirements Planning)
    - ⊗ MRP II (Manufacturing Resource Planning)
    - ⊗ JIT (Just in Time) Planning
    - ⊗ ERP (Enterprise Resource Planning)
      - ⊗ ERM (Enterprise Resource Management)
      - ⊗ SERM (Strategic ERM)
        - ⊗ Lean and Agile Manufacturing
        - ⊗ E-Manufacturing Planning
        - ⊗ ???

- **Managerial changes:** similar transformation is realised in management philosophy as well. There has been changes from shop management towards strategic management as listed below.

- ⊗ Shop Management
  - ⊗ Workshop Management
    - ⊗ Functional Management (Total Quality Man.)
    - ⊗ Process Management
      - ⊗ Performance Management
      - ⊗ Management by Objectives
      - ⊗ Strategic Management
      - ⊗ ???

- **Changes in customer expectations:** Due to changes in manufacturing, management, technologic progress, customer expectations are naturally changing. In the earlier days, customer used to buy whatever available on the market. When the variety of products were increased customers started to select and buy what they wanted. By the time goes on, alternatives were becoming possible. The customers were tending to buy multifunctional products. The future implies that the customers will be experimenting to buy products satisfying not only his/her current needs but also the future needs.

### Industry 4.0 and Future Manufacturing Vision

Industry 4.0 is a new philosophy of digital manufacturing. Machine suits are to be integrated by a communication network. Manufacturing components (cyber-physical systems) are communication a specific communication protocols called internet of things (IoT). This leads to smart factories where minimum level of human involvement is possible. Flexibility, speed, productivity become the main concern. With autonomy and the progress of artificial intelligence technologies, the smartness of the systems are assured. The following aims are to be satisfied.

- Self behavior
- Product and process integration
- Big data analysis
- Adaptability and flexibility
- Standardization of systems and creation of a reference architecture
- Performing efficient management
- Establishing a comprehensive and reliable industrial broadband infrastructure
- Setting a safe and secure envorment out
- Organizing and designing the work
- Personnel training
- Creating an organizational framework
- Increasing the efficiency of resource utilization

Now it is obvious that the machines;

- analyze, establish relations, make inferences and solve problems ( Expert Systems)
- learn (Artificial Neural Networks)

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- solve combinatorial problems (Genetic Algorithms).
- understand words, and perform computation using words (Fuzzy Logic)
- walk over stairs, play football, answer questions, communicate (Intelligent Agents)
- read text, understand and teach (Natural Language Processing)
- Observe, perceive, priorities, focus attention (Computer Vision)

Similarly, it is also well known that the machine can;

- speak to each other (Knowledge Protocols)
- work for the same goals (Goal/sensor modelling)
- get socialized, cooperate, and help each other (Emotional Intelligence)
- Teach each other (Intelligent Tutoring Systems)
- perform R&D and do innovation (Modelling Scientific Discoveries)

By implementing above understanding the following issues needs to be systematically formulated and respective manufacturing models needs to be developed and implemented.

- Intelligent manufacturing and smart factories
- Intelligent buildings and smart cities
- Simulation and augmented reality
- Big data and internet of things
- Cloud computing and mobile systems
- Additive manufacturing and 3D printers
- Cyber-physical systems
- Smart network and network security
- Preventive maintenance and quality
- Green manufacturing
- Robot teams (swarm robots)

Keeping this in mind, future manufacturing vision seems to be the function of products, intelligence, communication and network. Without one of those, the manufacturing cycle will not be complete and no efficiency and effectiveness will be counted for.

### Social Impacts

The technological progress and change triggers the transformation of the society. There have been various novelties societies started to experience. As reported by the report published by world economic forum, the following issues started to emerge in the recent years [10].

- Implanted Technologies in human body (Smart tattoos and powders)
- Super computer cell phones as translators
- Intelligent spectacles, headsets and eye monitoring equipment
- Wearable internet
- Free internet everywhere
- Sensors everywhere with IoT capability
- Driverless vehicles

- Artificial robots as decision makers in real boards
- Bitcoin and blockchain
- Sharing economy (UBER, Amazon, Alibaba...)
- 3D printers made products

### Action for the future

Technological developments are to be under control. Sustainable, progressive developments aligned with the social needs to be monitored and experience should be developed within the enterprises. To cope with the change and social transformation, the following action plan needs to be aligned with the enterprise to their business environment and implemented. The government should support any kind of operation regarding those.

- Clear vision and a national strategy must be defined. The industry should generate objectives aligning themselves in accordance with the overall strategy. There should be companywide strategies derived from this national one.
- Training is to be kept at the top item of the agenda. There should be lifelong learning systems to be implemented. Everybody should be learning continuously. Training is to be considered as to improve the systems rather than seeing it as the cost to bear.
- Enterprises should generate clear action plans for holding the control of the change and managing the overall transformation. The action plans should be generated at;
  - ✓ Government level
  - ✓ University level
  - ✓ Industry level
- Research and development are key success factor to deal with the change. The government should generate clustered techno cities. Industries and universities should actively involve in generating related manufacturing suits.
- Enterprises should spend effort to generate prototype systems, products and sites resembling future manufacturing systems.

### Conclusion

Manufacturing change and transformation is unavoidable. There should be systematically developed action plans to cope with those and get the enterprise aligned with the current progress. Not only the enterprises but also the governments should not be apathetic to the changes and progress. It is now time to start the journey for understanding and managing the basic dynamics of industrial transformation. The countries can prevent the technological unemployment by only getting their societies

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ready to comply with the transformational requirements. This may generate new jobs, new systems, new professions, new tools, new methodologies so on and so forth.

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