FUTURE SCENARIO REPORT

AUTOWORK

automation of work in construction

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Authors: Håkon Fyhn & Kristoffer Nergård

Summary: This report presents the results of a future scenario workshop aimed at the construction industry and construction technology. The workshop was designed to explore and imagine potential futures for the construction industry, focusing on the role of technology in improving the working environment and interaction between different actors on a construction site. The report provides an overview of the workshop methodology, key insights and recommendations for future research.

About the AUTOWORK project

AUTOWORK is a research project in collaboration between the Norwegian University of Science and Technology in Norway and Monash University in Australia. We explore the transformation of working life and society as a result of automation. We focus in particular on three sectors: Construction, sales and service, as well as health services. The background is a situation where increasingly advanced, complex and intelligent machines are proving capable of carrying out work that was previously mastered by humans alone. The effects and implications of this for both the individual employee and society are not yet known.

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FUTURE OF AUTOMATION OF WORK IN THE CONSTRUCTION SECTOR IN NORWAY

1. Introduction to automation in construction sector

Construction is a large and versatile sector. Automation makes itself felt on construction sites, in the form of robots that carry out manual work and certain aspects of the organization. Prefabrication is the area where automation has made the most sense, and in addition tasks within planning, organization and design are also automated through digital work processes.

2. Future scenario workshops

The purpose of a future scenario workshop is to explore and envision possible futures for the construction industry. Representatives from various parts of the industry gather for talks and exchange of ideas, about how automation in the industry can take shape, what consequences it can have, both desired and unwanted, intended and unintended. Through the use of scenario techniques, participants who know the industry first hand can imagine different futures and assess the opportunities and challenges that come with them. An important goal is to be able to give input on how we can influence development so that automation provides the best possible future for employees, the industry and society. A future scenario workshop is a method for exploring possible futures. First, this involves creating an overview of the current situation with technology and practice, based on research and participants' experience. A scenario planning exercise is then carried out to visualise possible futures, though group discussions and exercises. Finally, a synthesis of the scenarios and important insights is set up and discussed by participants.

WHEN	**WHO**
March. 1st 2023 16:00-19:00	**Organizers:** NTNU Social Research (2 researchers, 2 research assistants). **Participants:** Major Contractor (3 crue-leaders) Small contractor (1 crue-leader) Union (2 representatives) Sintef (1 representative with long experience from the industry) Teachers of vocational construction (3 teachers)

WHEN	Total: 14 participants
Scandic Lerkendal Trondheim	

2.1 Methodology

The workshop brought together experts and stakeholders from different parts of the industry: carpenters, teachers, trade unions and researchers. Through a scenario planning exercise, the participants explored various possibilities for the future construction industry, with particular emphasis on new construction sites and the integration of new technology in rehabilitation projects. The workshop also included group discussions, ideation exercises and a synthesis of the scenarios.

3. Futures imagined

Figure 1: The AUTOWORK team and participants at the workshop.

3.1 Health and inclusion in the construction industry

Automation can contribute to workers having less wear and tear on their bodies, and so that they can stay longer in work. This includes robots for heavy lifting, for example of windows and

construction elements, robots for repetitive work, such as drilling in the ceiling, and robots doing dirty work such as drilling in concrete without having to breath in concrete dust. During the workshop a builder expressed a hope that maybe one day, also builders in the construction industry could expect to be bale to work until they reached the normal retirement age of 67, as in most other professions. Today, builders don't expect to be able to work that long. Already today, there are robots, or machines in use to conduct heavy lifting. In the near future exoskeletons was mentioned as a possible enhancement in respect to this kind of work. There was, however voiced a need to make this technology more user friendly, and adapted to all kinds of bodes, in particularly women. Also robots for drilling in concrete is a technology that is already in use, but currently they demand a lot of preparation and a dedicated operator, and they do not move very well between floors, and they cannot work close to human workers. There was expressed a hope that one day these robots might be able to move more independently around the bluing site and drill the wholes at the right spots outside normal working hours. Such a future scenario calls for a more agile machine and a tighter correlation between digital plans and physical buildings.

The hope that automation would improve the issue of bodily wear and tear in construction work, was unison. There was no obvious dark side to this hope. However, we where reminded that technology is not the only thing that determines wear and tear of workers' bodies, also organisation, general working conditions and education are equally important.

3.2 Inclusive work-life

There was also expressed hope that the technology for reducing bodily wear and tear also could contribute to recruiting more female workers in the building sector. Today, there are very few women working as builders, the physical strain is suggested as one reason for this. At the future scenario workshop there seemed to be full agreement that more women in the industry would be a positive contribution. We should still have in mind that there might also be other reasons why there are so few females in the sector, for example a male dominated culture marked by a rather direct language, and humour.

3.4 Safety vs. Surveillance

Automation can make the workday safer. An obvious opportunity is for robots to perform tasks that can be dangerous for humans, as we have already discussed concerning heavy and health-damaging work. Another opportunity lies in the increasing digital control over the construction site, where AI can, for example, be capable of identifying areas that need to be secured. A key factor here is the increased number of sensors located around the construction site, including mobile sensor systems like the robot dog "Spot". This not only makes it possible to continuously calibrate physical structures and digital models but also to detect possible health and safety risks as soon as they arise, or preferably before they occur. A contribution to this that led to much discussion was the use of sensors and helmet cameras on workers. This could make the work safer and perhaps also more efficient. Videos from the helmet cameras could serve as learning examples in health and safety briefings. Furthermore, with the use of AI, data from the

cameras could be analysed in real-time, and possible hazards could be automatically alerted.

Although the workshop participants saw great potential in this technology, they also envisioned a possible nightmare scenario where this data collection technology would be used for surveillance. There are already examples from other sectors of how such technologies are used for what can be termed worker surveillance, such as the much-discussed wristbands of Amazon workers. Considering this, the use of surveillance technology to enhance worker safety would require a highly regulated labour market where workers and unions have a significant say, even in the future. If there is uncertainty regarding the future of a regulated labour market, the surveillance technology itself becomes a threat and something that perhaps should be avoided.

One challenge is that data collection is increasingly embedded in all new technology, and data gathering is becoming part of every business. Personal data is referred to as "the new oil," and the collection of data appears to be reason enough for harvesting data. Perhaps it will be practically impossible to prevent data collection related to individual skilled workers? Considering this, it will be especially important to protect the regulated labour market we have in Norway.

In the wake of this, we can note that data harvesting and AI training at construction sites raise some important questions regarding ownership of data and training grounds for AI, which will play into contract strategies and collaborative relationships in large projects.

3.5 Standardization – Efficiency vs. Monotony

Automation entails and suggests standardization. Participants demand standardization in the industry and find it strange that the industry is not more standardized than it is. Regardless of automation, increased standardization could make the industry more efficient. Standardization applies to everything from dimensions of screws and elements to standardized solutions for construction details. For automation, a certain level of standardization is a prerequisite. While standardization is sought after, participants express concern that it could lead to a flattening of construction practices and more difficult conditions for small actors.

3.6 Efficiency vs. Human Work

Automation can yield significant gains in terms of cost-effective and rapid construction processes. There is agreement on this, while some challenges are also raised. “The robot only does half the job,” it was said. There is still a need for humans to complete the job. We can say that robots produce “residual work” for humans. In discussions, several examples emerged of how automation ended up requiring as much labour as doing the entire job manually. The robot required so much facilitation, mending, and work-tasks outside the plan that in some cases it would have been faster to do it oneself from the start, thus achieving a more efficient workflow. For automation to truly be effective, it is essential to cinder the entire job that must be done until a building is completed. The way it functions today, too much is overlooked or does not work, thereby producing extra work.

It is also pointed out that Norwegian conditions are special with extra requirements for

insulation and tightness in buildings, as well as additional challenges in avoiding moisture damage. This makes automation particularly demanding here. When it comes to renovation and upgrading of existing buildings, automation is even more challenging and is described as "hopeless." The attitude in discussions was that in the foreseeable future there will be a need for a lot of human effort in the industry, and that the dream of a human-free construction site is likely unrealistic. But as one person said, "We should never say never," as sometimes it is surprising what tasks machines can solve.

Skilled workers in the construction industry are generally not afraid of losing their jobs to machines. However, some are concerned that automation may lead to lower status and poorer working conditions – that one becomes an "assembly worker" rather than a craftsman. As a counterpoint to this, it was pointed out that automation will also require specialized expertise, which could contribute to increased status for those who possess the skills. What is important for skilled workers is that they are the ones who possess this expertise. The argument is that the ones who knows how to build properly also should be the once handling the automated building technology. This will require that education keeps pace.

Education was highlighted as extremely important. It is crucial that education is able to keep up with the development of technology. Especially that vocational schools have access to the latest technology, so that students are ahead of what they will face in the labour market. This is a significant challenge due to the schools' finances, which do not always allow them to stay updated.

Technology is evolving rapidly and changing the conditions in the industry. The need for increased investment in continuing education was clearly articulated, and perhaps this was the concrete measure most requested at the workshop. It was pointed out that older skilled workers and their solid professional knowledge are essential on the construction sites. Making it easy for these individuals to stay updated would be of great value.

Regarding education, it was also noted that automation and technologization do not make classical craftsmanship knowledge less relevant. It is still equally important to know how to build tight and durable structures, whether machines are involved in the work process or not.

3.7 Community at stake

The professional community, or work community is highlighted as central in the industry. It has value in several ways: 1) the work community provides well-being and motivation at work. 2) It is through the work community that training and knowledge sharing occur. 3) The work community is important for unions and the safeguarding of workers' needs and rights vis-à-vis employers.

Several technologies appear to challenge the work community. One such technology is lifting machines and the types of robots, previously mentioned as important for safeguarding the health of workers, for example a machine that can move and lift heavy windows for installation. This means that a single worker can now perform the same job that previously required 3-4 people.

The advantage of the machine is obvious, but a consequence is that this worker now risks being alone all day, rather than working in a team. Further, there is a tendency for workers to specialize in different semi-automated systems, resulting in generally less interaction between humans, and more interaction with machines. These tendencies put the working community is at stake. This does not have to be a problem, provided the community is well taken care of during lunch and other breaks, and that investments are made in the community. This is perhaps especially important regarding training, in a profession where learning occurs in the work done together, between experienced and less experienced workers. Here, it is essential to devise strategies to maintain space for learning in a community of practice at construction sites.

The possibilities for remote control of machines are also discussed as a double-edged sword in relation to communities. On one hand, it could make the workday more flexible and the labour market more inclusive. An excavator operator pointed out, for example, that his machine was already practically set up for remote control. In theory, he could operate it from home, which would make it easier to combine family life with work on the construction site. On the other hand, another construction worker saw the idea of working from home as the greatest nightmare. For him, being at work with colleagues in the work community was absolutely essential. Automation that would remove that part of the job would destroy his motivation to work in the construction industry.

A conclusion is that the ongoing automation in the industry requires us to take extra care of the workplace community.

4. Key Insights

The workshop generated several key insights on the future of the construction industry and the people working there. These insights include:

- ➔ Automation can help reduce wear and tear on workers' bodies, allowing them to stay in their jobs longer.
- ➔ Automation can contribute to a more inclusive industry.
- ➔ Automation can make the workday safer, but the same technology can be used for surveillance. This is especially true for sensor and documentation technology, such as helmet cameras combined with AI.
- ➔ Automation requires standardization. While there is a demand for standardization in the industry, there are also warnings against the flattening of architecture.
- ➔ Automation can lead to increased efficiency, but not always. In many cases, automation produces "residual work" and results in less efficient construction processes.
- ➔ There will still be a need for humans in the future construction industry, especially in renovation and refurbishment, considering the specific requirements that the Norwegian climate imposes on insulation, ventilation, and tightness.

- ➔ Skilled workers in the construction industry are generally not afraid of losing their jobs to machines, but to maintain status, there is a need for increased investment in education, particularly continuing education.
- ➔ Automation challenges the work community by leading to individuals working alone and less in teams. This affects the work environment, learning in the workplace, and labour organization.

4.1 Recommandations

Based on the insights generated during the workshop, several recommendations for future research are proposed. These recommendations include:

- ➔ The use of robots creates a need for better planning, design, logistics, and standardization to contribute to a more efficient industry with good working conditions.
- ➔ Automation presents new opportunities for surveillance and dehumanization. This will require efforts to preserve a regulated labor market and labor organization.
- ➔ Automation opens the door to more individual and isolated work. Prioritize measures to care for the work community, and facilitate work situations that allow for knowledge sharing and combat loneliness.
- ➔ There will always be a need for humans on the construction site. Facilitate this. Rehabilitation expertise will largely not be replaceable by robots. The Norwegian climate makes automation more challenging.
- ➔ New technology requires new skills, and the placement of these can contribute to maintaining or diminishing the status of the profession. Continuing education will become increasingly important.

5. Summary

The report details the outcomes of a future scenario workshop focused on automation in the construction industry, emphasizing the impact of technology on work environments, efficiency, and workforce dynamics. Organized by researchers from NTNU and Monash University as part of the AUTOWORK project, the workshop gathered industry stakeholders to explore automation's benefits and challenges. Key insights highlight automation's potential to reduce physical strain on workers, increase inclusivity, and enhance safety, albeit with risks of surveillance and workforce isolation. Concerns around job status, efficiency trade-offs, and the necessity of continued human expertise in construction, particularly in renovation, were also raised. The report underscores the importance of balancing technological advancements with labor protections, education, and workplace community sustainability.