

The 5th International Symposium on Robotics in Construction June 6-8, 1988 Tokyo, Japan

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Better working conditions on site. (1)

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"If they can send man to the moon, why can't they make better working conditions on site?"

(Construction worker, 35 years old)

Yes, why can't they?

The Danish construction industry is very important in the Danish society. It accounts for approximately 50% of the total yearly investments and employs directly more than 150.000 persons. To this is to be added the large number of persons who indirectly are related to and benefit from the production in the building industry.

The industry as a whole serves as an economical regulator for the state, which can be seen in a somewhat fluctuating development in the industry.

In the fifties the industry was in crisis, whereas the working productivity increased in the seventies with an average increase of 8 % per year, due to new innovations. In the beginning of the eighties the increased productivity still was noticeable, whereas the production rate seems to have stabilized in these years.

Taken together the building production branch consists of 20.500 firms (1984). This number does not include stationary plants.

1/3 are very small firms with 1-4 employees and only 4,4% have more than 20 employees. 7 firms have more than 500 employees.

New buildings, as well as dwellings and industrial houses, and renovation work accounts for more than 2/3 of the total production. The last 1/3 is export activities, large heavy construction jobs and other types of work.

The ratio between the blue-collar-workers and the white-collar-workers has changed immensely over the years. To-day only 2 out of 10 employees are blue-collar-workers and directly

(1) "Consequences for the working conditions on site with increased use of CAC/CAM in construction",
S. Bonke, N.A. Jensen, F. Münster, E. Frydendal
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University of Denmark, 1987.

engaged in the production, whereas the ratio in 1970 was 10 blue-collar-workers to 1 white-collar-worker. This of course indicates some major technical changes in the industry, which I shall come back to.

The Danish construction-worker (blue-collar-worker) is highly qualified. More than 50% is formally skilled in traditional handicrafts. This education lasts 3-4 years and consists of school-training combined with on-the-job-training. The other part of the work-force is semi-skilled, as they receive an informal training on site in the gangs and short term (weeks) specialized training offered by the state.

All construction-workers are members of a union. The most common payment is lump-payment, however hourly payment can also be found mainly at renovation work.

Working conditions and health:

Working conditions on site have a lot of environmental aspects, many of which are considered positive.

This is among other things connected to the traditional high degree of autonomy of the construction workers. ⁽²⁾ Most construction workers work in gangs in which each person on one side experiences a groupbelonging, and on the other side in this setting is supported overiewing big and often complicated working processes.

The work materializes in a building, which is the visible and satisfying result of a mutual working effort.

The relationship on site is often direct with sharp and free manners of speech.

On the other hand working condition on site is also a very hazarous matter, which results in many accidents, physical strain, time pressure and stress, many and dangerous chemicals and problems related to the weather. Site is also a place, where useful working experiences rarely - nor automatically are carried over as improvements of the working conditions to the next site. For one thing it may not be the same persons working together.

In the following some of the above mentioned hazards are to be discribed more in details.

Accidents in the building industry:

The construction branch as a whole is among the three most dangerous trades in Denmark. Sharing this questionable top-position is farming, transportation and the construction industry.

In the period 1980-84, 11% of all registrated accidents occured in the building industry. 14% of all death accidents in the same period was also to be found here.

(2) By autonomy is meant "margin for independant action (A. J. Hinkel: "New Technology's social functions and consequences, Copenhagen 1983, p. 215).

demands for safe materials to subsidize hazardous chemicals. And it has also successfully resulted in intensified research in the paint industry to develop water-based paint.

Psysical work strain:

Psysical problems have always been known in situations, where many persons work closely together, experienced both as an individual problem and following disharmony in interpersonal relations. The atmosphere on site can be characterized as "tough" and the work as being "hard, but free", which in a positive way reflects the psysical freedom the construction workers feel.

However, at the same time increased pace, a marked reduction of the sizes of the gangs, introduction of new specialized workers, who often only works a few days or hours on site, seems to be followed by increased complaints of symptoms and problems, which can be related to psysical strain.

"Man to man" this may not be something one talks about on site, but the same studies as mentioned earlier reveals, that 30% of the concrete workers experience regularly one or more stress symptoms, whereas as high as 60% of the crane-operators feel this. The difference can be explained by this position of the crane-operators on site, as a keyperson in the production-flow and at the same time being "everybody's servant", which introduces many conflicts every day for this one person.

In all, the site is both a fascinating working place and a strenuous one. Problems that show this more than anything is the fact, that very few construction workers stay in construction work until they get pensioned at an age of 67. The industry has increasing difficulties in getting young people interested in construction work. And one might add, that female construction-workers are a rare sight in the branch. The latter are well-known to put special demands on good working conditions.

Technological changes and developments in the construction industry:

There are 3 areas in which technological changes have taken place since the early fifties and they are:

1. **Increased prefabrication and changes in the choices of materials.**

In the early fifties approx. 300 items were being prefabricated to-day the number is approx. 40.000 from small fittings to "key-houses".

2. **Increased mechanisation and development of the materials.**

The use of excavators and cranes for lifting is, as mentioned before, widely spread to-day, and so is specialized electrical handtools.

These innovations were grounded in the booming productivity in the productive part of the industry from the fifties and up till to-day.

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To-day rationalization is introduced by use of the information technology such as EDP-systems, CAD-systems etc. The need for rationalization has shifted from the productive part of the industry to the planning and the constructive part. This shift is partly due to the high cost, which this planning and the constructive part put on the productive part.

3. **Changes in the organisation of work and in the workplace.**
Increased use of subcontractors on site, new production systems, such as "just in time systems" mainly in the stationary plants, increased public (user) demands for better quality of work and influence, the many new prefabricated items, the diminished sizes of the gangs put in combination with the ability of information technology to handle big amounts of data, focus on the need for new management theories and tools.

Robotics on site?

History teaches us that new innovations have to be analyzed closely in terms of what specific impact they might have on the overall working conditions.

One might ask, why not robotics?

It can reduce a lot of the most strainous work tasks from working man, for instance work in narrow and small rooms and at demolishing tasks.

One might also ask, why robotics?

Changes in general physical workload may introduce dangerous peak-loads. This is for instance the case when lifting big items into place. Here the crane has taken out the general heavy lifting load, leaving back unexpected peak-loads when steering the items into position, which often is done in poor working positions, maybe with the risk of falling down.

Changes in the physical workload may also introduce one-sided increase in the working-load and psysical strain due to changes in the pace in which work is done.

A case study assessing a new system of scaffoldings in a gang of bricklayers showed on the positive side a decrease of working positions below knee-hight and above shoulder-hight, and on the negative side that one member of the gang had his workload increased more than 50%, because of shifts in the work arrangement. It also showed, that the change as a whole increased the psysical strain for all members of the gang due to an increased workpace.

The future site:

Robotics and other EDP-based technologies introduce fundamental changes in the traditional structure and organisation of the building industry. It introduces - as pionted out - new

needs of communication, new working partners, new materials etc.

It brings up a need for offensive and creative discussions of the future site, highlighting the positive potentials of the technology to create better working conditions.

A proactive technology assessment should include the influence and experience of both the construction workers and the technical staff giving equal opportunity to express needs and ideas, and the opportunity to participate critically in the evaluation of proposals of changes of work and tools, including robotics.

Emphasis should be put on including knowledge and expertise from ergonomics, health personnel, designers and others to ensure better quality of the final results.

Focus should be put on training and education for all parties in the construction industry.

And finally and maybe most important the whole question arises to be discussed, who is to be "in command" of the new technology. Leaving out the construction workers in this discussion would be a fatal disposition.

".... However, much technology you may put into site, one should not forget, that at one time, you got to have the skilled and qualified worker to build the house."
(site-manager, EDP-engineer, 34 years old)

Conclusion.

Robotics is a new and very important step in the technological development.

It carries out man's dream of being able to rationalize the work-process, to be in power of big and complicated machinery and to get rid of the unpleasant and dirty work.

The aim of this paper is to point out, that robotics should be used to improve working conditions on site.

That research should concentrate on developing robots to specific tasks, which is known to be injurious to health for man - and not as it often is seen, that the straight forward tasks are being adapted to robotics leaving even more straining and peak-loaded tasks to man.

It is argued that also social and health research and -knowledge as well as technological assessment is necessary in this development.

Finally the importance of including the construction workers, who are going to use the technology, is stressed, to insure that robotics can be of true benefit to the working conditions on site.