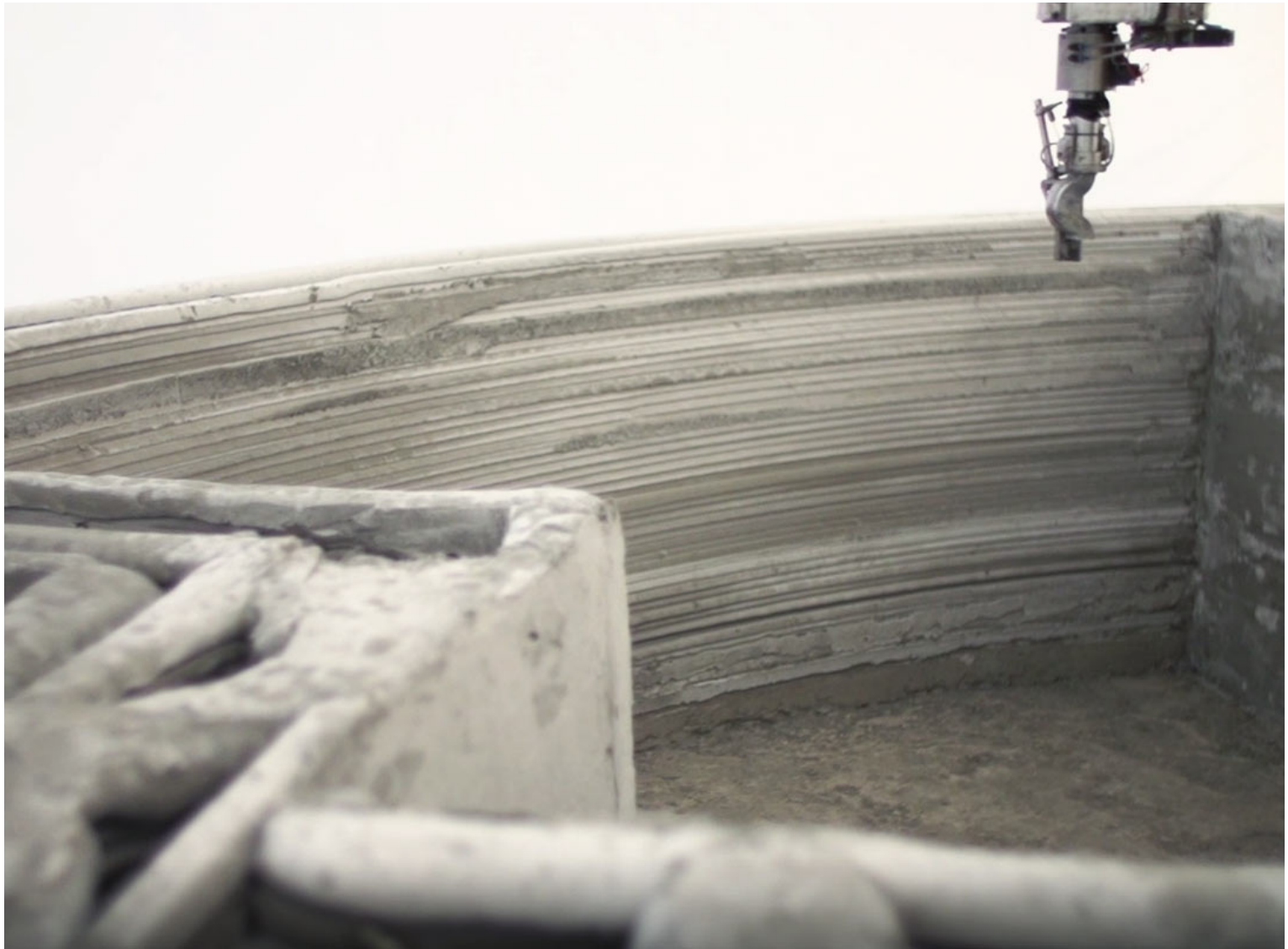


# ROBOTS AT THE CONSTRUCTION SITE

AN ADJUSTED BUSINESS MODEL FOR CONSTRUCTION COMPANIES



## REFLECTION

Liselotte Hoogewerf  
November, 2017



## REFLECTION AND RECOMMENDATIONS

This document looks back on the entire graduation process, the methods used, but also summarizes the lessons learned for practice and recommendations for further research.

### Research process

More than one year ago, I had to choose between two research topics of two different graduation labs. With the first subject, I was quite familiar, and this topic had drawn my attention for quite a long period. The second subject seemed to be far out of my comfort zone and was completely new to me. However, I decided to extend my knowledge and chose to challenge myself with an extremely trendy subject: Robotics. Although I was unfamiliar with robots, during the entrepreneurship annotation which I followed in addition to my master, I found out that business models and innovation were in my interest. I saw this as an opportunity and combined my knowledge of design and construction management and entrepreneurship in this thesis. Also, I extended my knowledge about robotics. Looking back on last year, the conversations and meetings I had with innovation managers, entrepreneurs, trend watchers, directors of large construction companies, and also with farmers, I think that there was not a more suitable research for me than this one. I truly enjoyed the whole process, but of course, there were also tough moments.

The graduation year started already chaotic. In the first semester, I set big goals for myself. With additional entrepreneurship goals, extra electives, research courses and this thesis, my agenda was filled with more than 20 ECTS in one-quarter. If that was not enough, I became part of the BOSS-board, the practice association of the master, for which I had to organise a study trip in the summer of 2017, and I had a part-time job of 12 hours a week. It was no surprise that the proposal phase of the research slowly progressed and a lot of stress was accompanied by submitting my research proposal.

With this unfortunate start, also the literature study became a struggle. By achieving the P2 in February, I could start looking for a graduation company. Heijmans and especially Jurre van der Ven, innovation manager, helped me defining the demarcation of my research. Due to the literature research, I expected that several kinds of robots for construction would be on the market. However, this was not the case. On the advice of the company supervisor, I, therefore, started to look for a case study, in the hope of easily identifying the choice of a specific robot. Although this did not help me finding a suitable robot, it helped me in a way that the change in another industry inspired me somehow. Since the available and 'proven' robots on the market, were not suitable for my research question, which emphasises on-site robots, a solution was found in the 3D concrete industry, in which Jurre was involved a while ago. Therefore, I got in contact with Cybe.

Meanwhile, I was in contact with a lot of (highly interested) construction companies who all like to participate in my research. During a little more than two months, eight companies were interviewed in order to understand the current business model. Although conducting interviews is something I enjoyed, transcribing almost 300 pages was terrifying. Meanwhile, the time flew by, and it was hard staying focused with my graduation thesis since I was responsible for the study trip.

With the gathered information about the current business model of construction companies. I found out there was not something such as archetypes of generic business model possible for construction companies. Therefore, it became hard to make the first draft of an adjusted business model. The first draft was validated by a focus group of experts. This was mainly one of the hardest tasks, to get all the experts together. After two failed attempts at the end of May, it finally took place. I was not satisfied with the result of the focus group, the participants employed different functions, and some did not feel comfortable with themselves. Therefore, the output of

this focus group was a little disappointing. With the main result, those calculations are required in order to convince construction companies.

However, conducting financial information, even at the graduation company self-was hard. After several miscommunications and a very busy calculation expert, my supervisor helped me find another expert. Making an appointment with him, was quite challenging and after the summer I finally managed to make calculations. Unfortunately, due to the limited time, it was not possible anymore to validate these findings with experts.

In the end, I look back at a rather successful process. I just know increased my knowledge about robots, business models and construction companies. But also, learned a lot about doing scientific research, about organising focus groups and about planning. Due to the busy schedule, last year it took me three months longer to graduate. In the first instance, while starting, I planned to graduate before summer. Due to my busy schedule and full agenda, I did not accomplish this goal. During last year, I found it quite difficult to combine the board, graduation, my job in the hotel and the internship. However, as Hans Wamelink suggested multiple times during our meetings is that I just had to manage my committee, I had to delegate tasks. All the time, I found it hard to spend jobs. Therefore, I had limited time presented at the graduation company which is regrettable since this was the opportunity to get to know this company. However, after the study trip, with increased pressure with the graduation deadline nearing, I finally used my position in the committee to outsource tasks, just like construction companies.

To conclude this: each start is difficult, and without planning skills, the ends are difficult too. The last few weeks have been a battle against time. Hopefully, it turned out to be successful.

## Validity and reliability

In the preparation of the research, validity and reliability were taken into account. However, when looking back on the process, the following remarks can be made on the chosen research method.

First of all, the explorative interview with the business developer of the 3D-concrete print manufacture might be biased. This company has a monopoly function in the Netherlands. Therefore, other 3D-concrete-print manufacturers outside Europe should be interviewed as well to validate the given features. Or institutes such as the University of Eindhoven could have been interviewed; they are also working on 3D concrete printing. However, to increase the validity and the current state of the art the features, multiple interviews are conducted during the research, with different interviewees. Also, a case study has been made (by the company itself) to show the influences on the construction process. The prices asked, are compared with another 3D printing company. The Dutch company turned out to ask much higher prices. In order

The interviews with construction companies are held with only one person per organisation. In order to increase the reliability, interviews could have been held with different persons in the organisation. Although semi-structured interviews were being prepared, the information per interview differs. To complement the information and to check the designed business model, construction companies were asked to review the findings. However, only four companies completely reviewed the requested documents, two did not apply at all. Therefore, there is a difference in the reliability of current business models. In addition, it was difficult for the interviewee to not steer the answers, by means of additional questions, the interviewee is actually per accidentally sent in a specific direction. Also, some questions were not objective, such as 'It the business model used for the selection of projects?' This already implies that somewhere it is stated that this can be a function of the business model. The question, in this case, could have been: What is the purpose of a business model?

Case studies are just conducted in one other industry, the dairy farms. The findings of this case study are used to redesign the business model of construction companies. The external validity has not been checked. This could have been done by means of a case study in another sector. Therefore, the external validity of the dairy farms is not proved.

The first draft is based on the inspiration gained from the case study, the current business models and impacts which the robot will have, according to the developer of the robot. As a result, the first design is very optimistic. Information such as cheaper, more sustainable, and faster, is assumed as truth, while during a project comparison, it appears that both the speed and cost of the project will not be improved. As this comparison took place, after the focus group, the information and validation during the focus group were too early in the process. Here, much more could have been learned, if a comparison with the traditional and prefab construction methods had already been conducted.

The focus group turned out, not to be the best research method to check the design of a new adjusted business model. Since construction industry is a competitive industry, construction companies are not free to speak. Also, the difference in age and function and the personality of the participants have influenced the outcome. One participant is working for a company which is highly involved in 3D printing. However, he did not admit this during the focus group. One participant took the lead in the discussions; his opinion was adopted by all the other participants. Therefore, the focus group was steered into one direction. This has led to limited discussions. Hence, the observer and the conversation leader had to steer the conversation with statements and questions. Both observer and conversation leader, therefore, influenced the focus group. This should not be the case, in terms of a focus group. Private interviews would have been more valuable for this research.

In general, the data of this research has been collected in Dutch. Therefore, all the information had to be translated into English. This can cause translation errors.

### Limitations of the research

This research has been done to the residential department of Dutch construction companies and is only focused on row-houses. Therefore, not all the benefits and added value of the 3D concrete printing robot is research. Besides, this research has only focused on the large size construction companies. Since the small size construction companies, in general also have individual customers, the robot might have an added value for these companies.

Furthermore, this research should have shown the earnings model of robots in a construction company, but the financial image is just based on business cases and not on the whole organisation. Therefore, the break-even point has not been demonstrated. According to Cybe, 3D concrete printing only interesting and feasible for large size construction projects, due to the prior calculations. However, in this research, it is assumed that costs such as for the contractor are already included in the general costs, and are there left out of the scope. Also, the costs for WIFI, water, electricity and education and retraining of the operational team for the robot are excluded.

This research primarily focused on the current developed robots and features. In the near future, the price of robots will drastically decrease, and it is also expected that the robots will become faster. However, since these are all assumptions this is not included in this research.

### Recommendations for practice

The recommendation for practice is related to the robot manufacturing company as well as to the construction companies. Starting with the construction companies, it is suggested that within the companies more attention should be given to the business model. In the most companies, it is not clear what a business model is, neither to the employees the own business model of the construction works. If even the directors of companies are struggling with their explanation of the business model, this cannot be communicated clearly to the employees. However, with the bright construction future for construction companies, and a lack of craftsmen, innovation of the process or product will be the only solution. According to Pekuri (2015), this will only be possible by the understanding of the current business model, the content and potential, provides a starting point for managers in the construction industry to exploit the possibilities of innovations.

Also, if the only innovation happening in the construction industry is introduced by sub-contractors, this will increase the competitive market. Start-ups, but also companies such as IKEA will take over the construction market, with their new ways of construction. Darwin's quote also counts for construction companies:

*'It is not the strongest of the species that survives nor the most intelligent, but the one most responsive to change'* - Charles Darwin (1809)

In addition, I agree with all the comments received on the chosen robot. I, indeed think that the 3D concrete printing robot is not satisfying enough to be implemented yet. The price is too high, and the features and thus the influence on the construction process is minimal. At this moment prefab is still, faster and cheaper. However, there are 3D concrete robots which can already print floors. In the case of a total Casco, the efficiency of 3D printers and the influence and benefits on the construction process might be bigger.

As a recommendation for the 3D concrete printing factory, I would suggest rethinking the business strategy. Currently, 3D concrete print manufacturers outside Europa have proven that the cost price of 3D printing can be much lower. For now, the printer might be used for unique projects, but the scope can enlarge when the price decreases. Especially the cement price is way too high. Inventing cheap fast-drying cement is not that difficult for in-house concrete experts of construction companies. When selling the robot to construction companies, with the idea of a razor and blades business model strategy, this company will not survive. When the expensive blades (the cement) can be changed for own developed concrete, the business has to be reconsidered. Also, the service costs compared with the dairy farms, are extremely high. In addition, although they want to sell the robots, the market has proven that they prefer this company as a sub-contractor.

## Recommendations for further research

This research is an explorative research. A first research to the innovation of robot in the construction industry. This research is limited to on-site construction since the prefab factories are already using robots in conditioned environments. However, there is not yet a research published on the available offsite robots.

As a recommendation of the practice, the masonry robot and finishing robot are in the interest of the construction companies, therefore a next research can focus on these robots, which will probably have other impacts on the business models.

To validate this research, more case studies can be done in other industries. And another 3D printing company can be approached in order to recalculate, the case project. I suspect that for example, the Chinese Winsun will be much more affordable and therefore more interesting for construction companies.

Due to the limited time, the legislation in general of robotics in construction is not researched. Before construction companies apply robots, an investigation has to be made, what the specific legislation is, and how they can be met.

Also, the construction companies indicated that robots would just be used when they are faster than the currently used construction methods. However, research can be done to the optimal construction time, since I expect that an increase of construction time will not increase the total project time, due to the long permits application time etc. In addition, initiators also need some time to find possible end-users.

Furthermore, as research has stated that the size of the construction influences the business model and strategy of a company. Research can be done to the different business models of large and small size companies. Perhaps the business model of small size construction companies is more suitable for the implementation of robots.