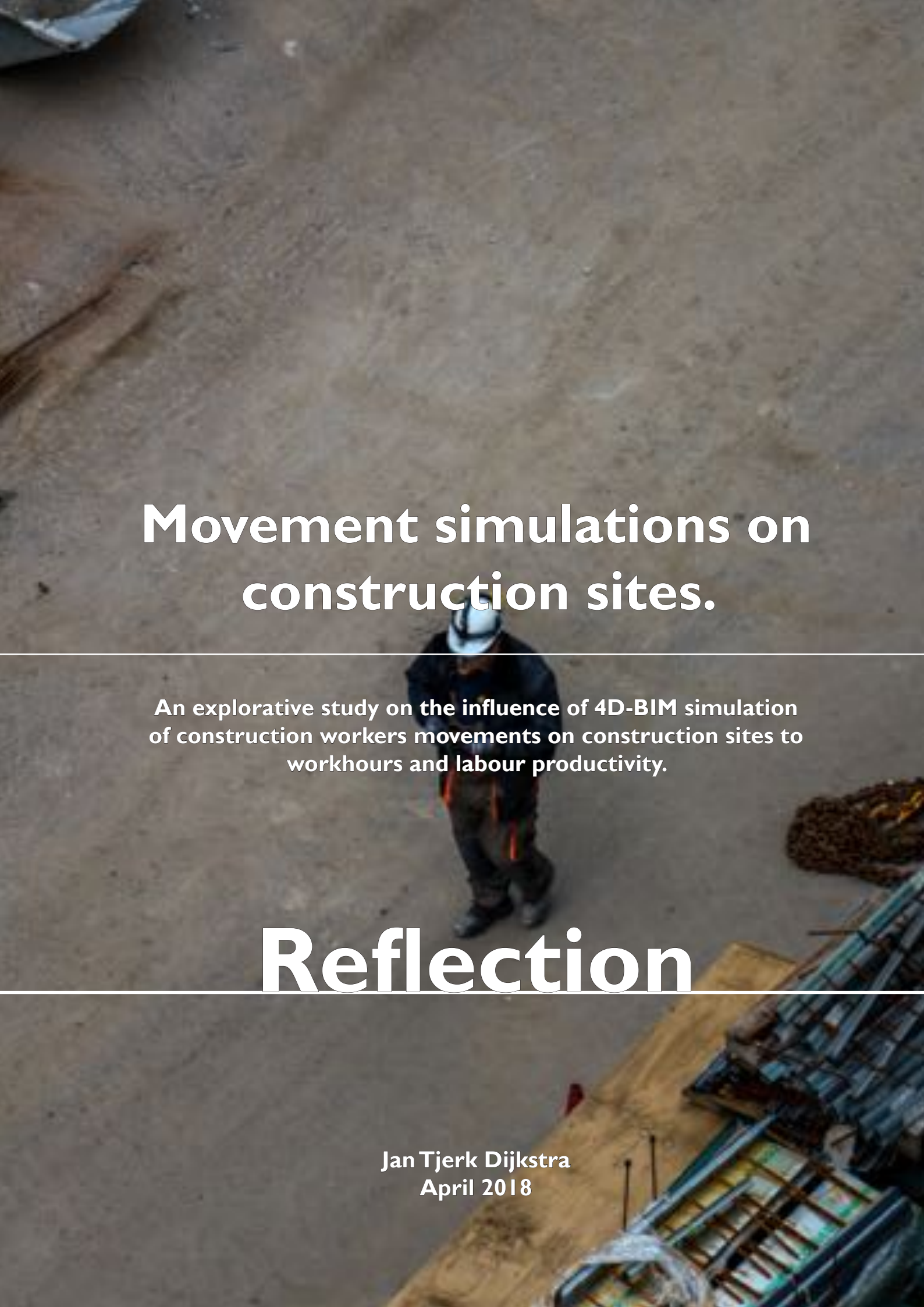

Movement simulations on construction sites.

An explorative study on the influence of 4D-BIM simulation of construction workers movements on construction sites to workhours and labour productivity.

Reflection

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25 Reflection

This reflection provides an overview of the complete graduation process: the process itself, my personal experience, the relevance for the scientific and social field, and the relation to the graduation track.

25.1 Research methodology

In this research, a distinction is made between the model and the productivity. Both aspects were relatively new to me when the graduation research started. Thus, I reviewed literature reviews, received guidance from my mentors, held meetings with experts from knowledge institutions like TNO to make myself acquainted with these aspects.

This research introduces a new way of modelling into which different existing concepts are combined to perform a new kind of simulation. This asked for a framework on how to work and what information was needed to be able to perform this kind of simulation. From this, the choice was made to perform an explorative study, in which this new kind of simulation would be explored, tested, and that would provide as in incentives for further research.

As this kind of simulation was new, it made it hard at times to obtain the right information. Information in this study was derived from literature, previous research within the graduation company, and interviews held at the graduation company. When information could not be collected, an informed assumption was made. For example, in the case of waiting times of certain rooms.

To be able to perform the simulation a parametric model was needed, which would read and write information from and to the BIM. This was mostly done by programming the model for the simulation. This model was set up step by step, guided by the overview of data derived from literature reviews done before and during the programming. This model was constantly tested to see if it worked, or that adjustments were needed.

Finally, the simulations could be performed on the hand of the model programmed. These simulations were fed with information derived in the earlier steps of this research. The results where compared with each previous research. An expert panel verified the final model and results from the simulations after a presentation about the model and results, which resulted in a discussion of the model and results.

25.2 Graduation lab

The research performed is part of the graduation lab ‘Business models for robotics in construction’, which is chaired by the Design and Construction Management section of the Management in the Built Environment Master Track. Students were asked to come up with a way increase the use and effects of robots and 3D-printing in building design and construction. Another part of this graduation lab was to be part of a larger research about construction logistics, where BIM and mathematical models were used to investigate if they could influence construction logistics.

At first sight, this research seems to have nothing to do with construction logistics, which is commonly seen the decrease of logistical movements to and from the construction site. But from my perspective that is not true, because it does look at construction logistics. Commonly, research on construction logistics focuses on the movement to and from the construction site, but the movement on construction sites are addressed less. Furthermore, labour productivity may be improved by decreasing the time spent on non-value adding activities of construction workers, which is important because of the high levels of waste in construction industry. Which is all supported by BIM.

25.3 Scientific relevance

The scientific relevant can be explained in threefold. First, as mentioned before by Koskela and Vrijhoef (2001); Thomas et al. (1990), labour productivity in the construction industry is relatively low. The current research contributes knowledge on increasing this productivity. Second, research is primarily focused on examining abilities of 4D-BIM in terms of site layout and construction sequencing, but not on investigating the ability of modelling labour and movements of workforce. Third, the research of the consortium on building logistics is primarily focused on the movements from to construction sites and the used of possible hubs. This research adds another aspect to this consortium, which is the logistics on the construction site itself.

25.4 Social relevance

As mentioned by Kraan et al. (2011) a majority of the construction workers is not able to work until the legal retirement age, due to the physical high demanding nature of the job. The model presented in this research provides insight and information to the contractor to make the construction site more productive. Making the construction site more productive within this research means decrease of non-value adding activities. This decrease should help to reduce the unnecessary work strain on the construction workers and make employment more sustainable.

25.5 Practical relevance

Construction site layout is primarily built on experience and gut feeling. This model helps to provide insight and indicate potential in multiple ways. It helps the contractors to crate insight in types of waste related to the construction site layout. With this insight, the contractors can make decisions construction site layout and check different scenarios. From this, a well-informed decision can be made on how to execute the construction site layout. Furthermore, 4D-BIM helps the contractor to provide insight in the simulated productivity on different project. With future research on site, the actual productivity can be monitored and checked. If necessary, adjustment can be made to the model or the site. Also, 4D-BIM helps the head-contractor to better facilitate their own employees and sub-contractors on site to execute their jobs.

25.6 Personal reflection

The learning process for me had ups and downs, and entails gaining knowledge, dealing with practice, companies and independent working. The start of the graduation process until the P2 was an educational period to me. This period went by quickly as I followed additional courses at the same time. The subject of the research evolved quickly and became quite clear to me. Since I knew I wanted to do something with BIM, the relation with the consortium of construction logistics became quite clear in conversations with the supervisors. After the P1, it felt like the elaboration of the subject can be executed. The mistake made within this part of the process was

to be too reserved. Between P1 and P2 I did not appoint my supervisors as much as needed, which should have helped with the P2.

After the P2 I started to execute the graduation plan presented before. But during the first weeks I tried to execute this is found that the software chosen did not have the abilities to be able to deliver the wanted product. So, for me this was quite a setback, and made me think of alternative options. Luckily, an alternative option was found. Due to this program I had the abbility fully program the model to be able to execute the simulations. From retrospect, I quite enjoyed this. Because the chosen option did not work, I was thrown into the dark and had to find another solution. Which in the end gave me more freedom, and this let me start from scratch.

Furthermore, the internship with Dura Vermeer gave feedback and sense from practice. Which helped to defines problems and gain data needed to execute the research. From my point of view the internship had an added value to the research.

As where I enjoyed programming the model, the last part of the research was less enjoyable. This was due to the large amount of information which had to be structured I the report. During this research, I dug into the subject for one year, and for me everything was quite clear. But to be able to transfer this knowledge to other people can be quite hard. With some help of my supervisors I think a structured report is now presented.