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## Work preparations in infrastructure projects

A case study of Skanska Civil Sweden

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## ABSTRACT

Increasing on-site productivity in the construction business is a topical issue and finding ways to achieve this has high priority in Skanska Civil Sweden. By planning the work activities accurately and documenting them through the making of work preparations, different kinds of waste can be prevented. The purpose of the study is to investigate how successful these work preparations are within Skanska's infrastructure department and determine the department's confidence in this productivity increasing tool. Project visits, with interviews of the key personnel and a written survey answered by all those actively involved in each project, underlie the result of the study. Furthermore, a comparison to other relevant studies is carried out. The results indicate a varying progress among Skanska's personnel, but a great belief in work preparations as a productivity increasing tool in the construction field. 'The main objective is to change the attitude towards work preparations and integrating them with the daily work and emphasise that time can be saved through their use. Skanska has come far in integrating work preparation with the standard work procedure, but has reached a crossroad in respect of how much effort will be invest in this productivity tool as the answer to meeting the increasing competition of infrastructural projects in Sweden. More comprehensive work preparations, together with a central system for retaining knowledge gathered, is a precondition for this tool to be successful throughout the company and its many projects.

Key words: Work preparation, Productivity, Planning, Construction industry, Infrastructural projects



# Introduction

Planning has always been a topical subject in the construction industry. In an ever increasing climate between construction firms for available jobs, the importance of good planning is important in order to cut costs and stay competitive (Rojas, 2008). All contractors are striving for productivity improvements to gain competitive advantage (Porter, 2004). In Sweden, plenty of contractors have chosen to apply a subdivided work plan on-site, called work preparations. Under Swedish law, work preparation for some construction work environment risks are mandatory to undertake, before starting the job (AFS, 1999). These work preparations are to be written and handed in to the client for approval. Preparation of work activities is more practically always performed, but far from all times in a very committed way. Skanska's interpretation of work preparations is stricter than the law requires, i.e. they are more detailed and characterised by a desire to apply them in all activities on-site to increase productivity. The work preparation comprises important aspects like safety, risk identification, material deliveries and a step-by-step guide to perform work activities. The basic idea of work preparation is to anticipate difficulties and to reduce waste of resources, time and money (SBUF, 2009). This paper explores and examines the use of work preparation in infrastructural projects in Skanska Civil Sweden, hereinafter referred to as 'Skanska'.

In Skanska, productivity, and possibilities to increase it, has a huge internal focus. Since year 2009, productivity has its own chapter integrated in their business plan. The ambition of the infrastructure department is to establish work preparation as the most essential component for increasing productivity on-site. A qualified judgment of today's work preparation standard can be summarised as: the quality of the work preparations is too poor and they lack focus on productivity, choice of method and goal. The process of applying the work preparation in production is inadequate due to their late produce, lack of involvement and poor establishment in the production. Skanska considers the number of work preparations performed to be too low and the different activities during the construction time not to be represented enough. Disagreements exist in the organisation as to why work preparations are made; when and by whom they are to be produced and how they should be structured.

The purpose of this study is to examine to what extent the construction industry have progressed in performing work preparations, and also to suggest how further development of work preparation can increase productivity in infrastructural projects. The study aims to examine work preparations and find a unified way to develop and use work preparations in order to increase on-site productivity. The method used to collect information for this study is a semi-structured interview with two key employees at each of the, in total five, projects visited. To support information gathered, a questionnaire was distributed to all employees to each project. The result from these sessions together with theoretical references forms the basis of the findings and analysis of the present report. It is limited to in-depth analysis of the current situation in Skanska only, albeit with support from other available sources. The core questions to be answered in the study are:

- What is the current status of using work preparations throughout Skanska Civil Sweden's organisation?

- How can work preparations be applied and improved for the purpose of increasing on-site productivity?
- How can the next generation of work preparations be designed?

## **Theoretical frame of reference**

For most construction firms today, improving project performance is essential to survive in a fast changing economic and financial environment. The ability of firms to continuously capture, combine, organise, share resources and knowledge in new unique ways will provide their customers and stakeholders with more value compared to what their competitors are able to provide (Teece *et al.*, 1997). Creating an environment where an individual employee's knowledge is transformed into organisational knowledge is of great importance, since it enables more deliberate decisions to be made (Nonaka & von Krogh, 2009). In an organisation, different actors who contribute towards organisational processes are bound by knowledge flows (Zhuge, 2006). Nevertheless, as pointed out by Argote *et al.* (2000), transferring knowledge within the construction industry poses a complicated challenge in practice

All construction projects generate a large amount of knowledge to distribute and reuse in other projects of the company (Nonaka & von Krogh, 2009). Although construction projects are unique in terms of how knowledge is shared and used, project performance can be improved when employees communicate information about lessons learned, insights, best practices, experiences and new knowledge (von Krogh, 2002). Organisations which succeed to embrace that knowledge have a long-term competitive advantage (Ribeiro, 2005).

Anticipating risks and implementation of the best known solutions are two of many factors influencing the execution and result of construction projects. Consequently, the most crucial activity in all construction projects is the preparation of the project before execution. Efficient and well-performed preparation of work involves many different aspects, some of the most important of which are: identifying the activities and their main characteristics, be in line with the work schedule, planning resources in terms of equipment and materials and re-estimating (Kerzner, 2006).

### **The planning process**

The project planning phase provides the project organisation with information pertaining to what is to be done; when it must be done; and what resources to use in order to successfully complete the project (Meredith & Mantel, 2006). The project plan, the most important outcome of the project planning phase, includes: overview, project objectives, general approach, contractual aspects, schedules, resources, personnel, risk-management plan, and evaluation methods (Meredith & Mantel, 2006). Some research suggests that there is a shortage of skills in the area of construction planning, in particular with regard to the number of planners having the ability and knowledge to efficiently plan construction projects decreasing (Heesom & Mahdjoubi 2004). This is questioned by Zwikael (2009) which found organisations belonging to the construction sector to obtain a high quality of project planning and the highest success rate relative to other industrial sectors. The timetable, quality, and procurement planning are most frequently executed in construction projects and the processes with the greatest impact of project success in the construction sector are 'activity definition' and 'project plan development'. Nevertheless, critical planning processes are not always devoted sufficient time by construction project managers at

all times. In order to improve the performance, more focus on project activities and project plan development should be undertaken (Zwikael, 2009).

## **Productivity and standardisation**

In order to meet increasing customer requirements and expectations, constant improvements in production, with particular regard to cost, timing and quality of the construction output, is substantial (von Krogh, 2002). Active performance improvements are a key factor in order for a company to maintain and strengthen its competitive position in the business (Oakland and Marosszeky, 2006). One of the challenges to fulfilling this requirement is finding the best practice for all on-site activities. This starts with the organisation exploring its operating system and proceeds to benchmark and comparing its performance to competing organisations (Porter, 1986). Opportunities for improvement, in terms of productivity and competitiveness, are generated. In the long run, cementing innovative practices can secure an organisation's place as market leader (Porter, 1986). Construction productivity, in general terms, can basically be illustrated by the difference between the output and the input (Park, 2006).

Productivity for the contractor are often derived as percentage of the costs below or above the payment received from the owner. The effectiveness with the resources engaged to support the activities in order to complete the construction are evaluated. There are a number of productivity models available, which describe factors and estimate productivity based on data assembled, but normally contractors generate productivity information from their own historical productivity data in order to evaluate future projects (Anbari *et al.*, 2008). This estimation can be used as a baseline for productivity and can be obtained through use of historical data from similar projects. However, the non-repetitiveness and uniqueness of construction projects make it difficult to develop a standard definition and measurement for productivity (Sweis, 2000). Incommensurability is one of the consequences of the problem of not having uniform system of measurement within the construction business and between different contractors, thus ruling out the opportunity to make a productivity comparison (Stanford, 2009). Measurement itself, do not lead to an immediate performance improvement. However, performance improvement over time can be achieved through recognising the need for improvement.

Improving productivity of on-site operations requires promotion of a work environment which supports implementation of ideas occurring at work sites and raises awareness of new techniques and technology available for enhancing productivity. The construction business has been characterised by few innovative ideas due to modest research, but has changed as more research is being undertaken (CII, 2001). According to Panas *et al.*, (2010), the number of construction productivity journals written throughout recent years is steadily increasing, implying increased focus on this topic in the construction business. It is suggested poor productivity of construction workers is one of the major causes of cost overruns and schedule slippages in construction projects (Doloi, 2008). However, occasional evidence indicates workers attitude towards higher productivity may not be limited to just financial rewards, but also linked to many other latent factors (Doloi, 2008).

Recurrently regarding productivity in construction is information of low productivity being a result of lack of adequate planning and control of activities. Based on case

study projects, materials management problems that include late or out-of-sequence deliveries can influence productivity loss ranging from 5.4% to a high of 56.8 % (Thomas & Sanvido, 2000). For construction workers, the learning curve is an important factor in the area of productivity. The learning curve theory states that the productivity of the same repetitive work will be continuously improved as a result of greater familiarity with the activity, better management, and more efficient use of tools and equipment (Oglesby *et al.*, 1989).

Standardisation is recommended within the construction business, in order to keep focus on value-creating activities and avoid 'reinventing the wheel'. A key to successful standardisation is realising each project is not unique, but to a great extent a reproduction of both process and production from previous projects. However, the concepts underlying, on the one hand, standardisation and, on the other, innovation, present an obvious divergence in what each process strives to achieve in order to accomplish performance improvement (Kondo, 2000). Through introduction of standardisation, consistency in extensive use of innovation can be achieved. Such consistency requires a stable system and stable processes, but risks creating a too stable and unchanging system, which would have adverse consequences for the possibilities to implement and maintain innovation (Kondo, 2000). Therefore, innovation and standardisation depart from each other as to their fundamental needs, in terms of performance improvement. Firstly, in order to reach and increase the level of desired performance improvements, the innovation drives must constantly be encouraged so that processes and operation remain efficient at all times. Secondly, stability and consistency are fundamental factors for the standardisation procedure for performance improvement measures to become implanted in operational processes. Effective solutions to close this gap in order to take advantage of both phenomena are central in improving the on-site performance (Beer *et al.*, 1990).

### **Streamline processes**

A report from Sweden indicates that 30-35% of the total production costs pertain to the category of waste. Waste is here exemplified as, *i.a.*: negligence, bad planning, stationary machines and work related injuries (Josephson & Saukkoriipi, 2005). 'Lean construction is a concept developed for the purpose of decreasing these costs by using the resources better. The concept is founded on the same principles as lean thinking and lean production, *i.e.* identification and elimination of activities which do not contribute to any value for the end customer (Lessing, 2006). Womack and Jones (1996) separate the activities necessary for the creation of a product into three different categories. The first category refers to purely value adding activities. The second category comprises activities which do not generate any value, but are still necessary due to available technology and design of processes. Activities in the third category do not add any value whatsoever and are easy to identify. For a construction firm to advance towards becoming a lean construction firm, the first step is to eliminate activities in the third category, followed by the more complicated challenge of decreasing and removing activities related to the second category.

For craftsmen at constructions sites, physical efforts are often required for extensive periods of time (Oglesby *et al.*, 1989). Further, Oglesby *et al.* (1989) made the observation that the amount of energy required for building a typical structure is about six kilocalories per minute. The recommended effort level of five kilocalories for males and three and a half kilocalories for females is thereby exceeded. The effect of



this energy consumption results in exhaustion after about 25 minutes of work. Both in the past and still today, work design adapted to craftsmen for construction jobs is rarely found in practice. Due to a combination of lack of knowledge of ergonomics and together with concerns of productivity and safety, the death rate in the line of construction business is four and a half times higher than compared to in the manufacturing business. The construction business occupational unintentional-injury deaths are the highest among all industries, but sorted on death rate by industry construction is placed fourth (NSC, 2008).

Successive improvement is all about striving to reach the perfect state. This state is impossible to attain, but it is a goal to strive to in all organisations. Working with knowledge management is one important factor, which enables process standardisation. This, in turn, is a basis for continuous improvements and increasing quality (Liker, 2004). Project knowledge is also a *post hoc* analysis exercise and a source of insight generated from carrying out projects. In spite of, the significance of the project knowledge for gaining a competitive edge, Desouza and Evaristo (2004) claim research on capturing, organising, and sharing the valuable knowledge in major projects to be very limited. Ribeiro (2006) agrees and says that knowledge and lessons gathered in different construction projects are not systematically integrated into the company's organisational memory.

## Method

In order to understand work preparations within Skanska, a qualitative case study approach was undertaken whereby ten representative employees from the management staff in the company were interviewed in a semi-structured setup. The initial issues were general with emphasis on the interview subject's interpretation and viewpoint on work preparations, in accompaniment with an open questionnaire which invited the interviews to be flexible with rich and detailed responses, according to Bryman (2004). The semi-structured interview method suits the purpose of answering the core questions of the study well, i.e. it provides answers to the questions how, why and for whose purposes work preparations are made. Admittedly, this can be evaluated in other ways, but the interview is considered one of the most important research methods within the case study area (Yin, 2009).

The interviews were preceded by visits to selected infrastructural projects in Sweden, which included informal conversations with managers and employees within the project organisation. Five infrastructure projects were visited, selected on the basis of their type of work and their varying experience of work preparations: one in the southern region of Sweden, three in the western region and one in the eastern region. The employees were carefully selected based on their involvement in producing and administrating on-site work preparations. In order to keep track of the interview and ascertain answer formulations, a dictaphone was used. Afterwards, the interviews were transcribed into protocols, in accordance with the procedure envisaged in (Kvale & Brinkmann, 2009).

As to the selection of interview subjects, the respective head of production, site manager, was always interviewed. Due to their commonly vast experience in respect to work preparations in the construction business, they were assumed to be able to contribute with a broad perspective on how work preparations are executed among staff management of the construction project. The head of production is also the

person ultimately responsible for approving all work preparations made with respect to safety and choice of work method. Also, a head of unit, foreman, was interviewed in order to capture the manufacturing and performance part of the work pertaining to the work preparation. At one project, the project manager was interviewed instead of the head of unit. The interviews lasted for about 90 minutes each and covered the aspects of work preparation as a planning tool and its importance and relation to productivity, risk and safety considerations. The opinion of the workers is covered in the questionnaire and their recently minor importance regarding work preparations.

As a complement to the interviews, almost all employees in each project organisation answered a questionnaire. All workers accessible during the visit completed a survey during a break, but due to the large distance to two smaller worker establishments a few workers were unable to participate. The questions were short, closed and developed to complement and reflect and consistently reflect the opinions of work preparations permeating the organisation on-site. The attempt here was to explore the role and significance of specific factors which are believed to affect productivity. The questionnaire purported to assist the interviews findings and validation of prescribed comprehension (Bryman & Belle, 2011). The high number of 100 participants in the questionnaire is a condition to ensure reliability of the result (Bryman & Belle, 2011). The advantages of using a questionnaire are many, including, but not limited to, fast administration and non-existent risk of influence from the interviewer. The disadvantage of the questionnaire, as a method, is the lack of opportunity to ask follow-up questions and the risk of not covering all relevant aspects. According to Bryman (2004), loss of questionnaires is common, but was prevented here through both distribution and collection of them in connection with the project visits. A few questionnaires lacked answers to one or more questions. For this situation, the average value of all the other responses for that question was used. The questionnaire results were examined in two ways, as for average value acquired from each project and job type. *Table 1* presents some short information about the projects visited, the questionnaire distribution and the interviewees work experience.

**Table 1. Background information of the projects visited and people interviewed.**

| <i>Project</i> | <i>Type of project</i>                        | <i>No. of survey answers</i>                                                    | <i>Personnel interviewed; no. of years in construction; no. of years in Skanska</i> |
|----------------|-----------------------------------------------|---------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| 1              | Power line; 35 km                             | Management staff: 7<br>Skanska craftsmen: 6<br>Subcontractors: 5<br>Total: 18   | Production manager: 7 & 7<br>Head of unit: 17 & 4                                   |
| 2              | Railway and highway;<br>3.5 km and one bridge | Management staff: 8<br>Skanska craftsmen: 15<br>Subcontractors: 4<br>Total: 27  | Production manager: 8 & 8<br>Head of unit: 22 & 22                                  |
| 3              | New traffic junction                          | Management staff: 3<br>Skanska craftsmen: 3<br>Subcontractors: 1<br>Total: 7    | Project manager: 17 & 17<br>Production manager: 10 & 10                             |
| 4              | Highway road                                  | Management staff: 10<br>Skanska craftsmen: 7<br>Subcontractors: 4<br>Total: 21  | Production manager: 32 & 16<br>Head of unit: 14 & 14                                |
| 5              | Highway road, bridges                         | Management staff: 6<br>Skanska craftsmen: 10<br>Subcontractors: 11<br>Total: 27 | Production manager: 23 & 17<br>Head of unit: 20 & 10                                |

In order to fully understand the origin and creation of the work preparation process in Skanska, the intention was for the author to participate as an observer during work preparation meetings. This, however, was not practically possible due to the divulged and long process of manufacturing work preparations. The compromise was to find out, step-by-step, how it is normally performed at each project. During the interviews, questions were asked to clarify the objective, motives, and the details behind the work preparation meetings. The pattern of work preparation production was identified, controlled and verified by consulting different craftsmen on-site.

These methods of collecting information garnered first-hand experience of the challenges of work preparations at a project-level, through interaction with those directly involved. This helped identifying potential ways of resolving the work preparations. Archived data and notes were examined to understand the recording procedures for production of work preparations. In addition, company data and performed work preparation from the projects, and other material related to the area, was examined. The questionnaire, corporate documents and interviews at different organisation levels are the main sources of evidence collected and analysed in this study. Moreover, industry and academic reports were also used to identify the best practices for project and work preparation. Importantly, to facilitate validity of the research, data has been collected from several sources (Yin, 2009). In addition, irrespective of the adopted approach and the innovative characteristics, every scholarly endeavour must be conducted within a framework of which is directed towards the achievement of validity and reliability for the results and conclusions emerging from the study (Lucko & Rojas, 2010).

The first research question is answered in the case study section and the remaining two are primarily answered in the analysis and discussion part. Subsequently, conclusions are drawn through interpretation and comparison between Skanska's current job with work preparation and external research about work preparations and its possibility to contribute to higher productivity in Skanska's infrastructure projects.

## **Case study**

In the construction business there has always been a need for planning the activities of projects. The concept of work preparation has existed for quite some time, but more recently it has grown in significance, and are used to a greater extent due to an increased awareness of different risks. The contractors are, among other things, using work preparation to increase efficiency on site; to reach a certain quality of what is built; and to reduce disrupters in production. The client's main objective is to secure quality control and safety during performance of the work activities. Work preparation can therefore aptly be described as a planning tool the main target of which is to take action against risks and simplify the on-site performance.

### **Skanska's view on work preparations**

Skanska has a long history of working with planning and related activities, with specific planners just focusing on the daily activities. The introduction of the expression "work preparation" is a bit undefined as in imputing it to a specific year, but the usage has constantly increased in Skanska during the last five years. The reason for this trend is the necessity of cutting costs in order to be able to compete with other contractors. There is ongoing process within Skanska to find the best way of performing work preparations and thereby increase on-site productivity. This report and its results forms part of a project, the aim of which is to develop different productivity tools for Skanska, such as visual control; sub-divided time plan and progress of work.

The work preparations are supposed to follow a template developed by Skanska's own personnel. The template is standardised, but can be used for all projects and for every activity on-site. It is structured as follows: what should be included in the work preparation; requirement of documents; break-down of activity; risks and measures; resources (safety equipment, machines); material/tools; estimated time needed and workers needed for the activity; actual time/resources; reasons for deviation; control demands; participants at work preparation making and training requirement. There is a guide on how to fill out the template and what activities are recommended to be work prepared. The guide advocates the management staff and the craftsmen to produce it together. This, however, does not always correspond entirely to reality, so there is an ambition to identify the deficiencies, to which the present report purports to contribute.

### **Projects presentation**

*Table 2* below, contains additional information about the projects visited. Since the distribution of participants to the various projects ought to be taken into account when evaluating the result, two separate tables are presented, *Table 3* and *Table 4*.

**Table 2. Information of progress, location and project budget for the five infrastructure projects visited.**

| Project | Progress of project | Part of Sweden | Project budget   |
|---------|---------------------|----------------|------------------|
| 1       | 80 %                | West           | 6,5 million euro |
| 2       | 95%                 | West           | 65 million euro  |
| 3       | 30 %                | West           | 7 million euro   |
| 4       | 15%                 | South          | 7 million euro   |
| 5       | 50%                 | East           | 30 million euro  |

## **The results of the questionnaire**

The questionnaire results are presented both by project, *Table 3*, and on the basis of an employment position criterion, where a distinction are drawn between management staff, Skanska's own craftsmen, and subcontractors, *Table 4*. Henceforth, craftsmen and subcontractors are sometimes denoted as 'workers'. The subcontractors who participated in this study are people operating excavators and such, and who are paid by the hour and often hired by Skanska. All questions could be graded from one (meaning: 'I do not agree at all') to seven (meaning: 'I completely agree').

The questions in the questionnaires were arranged by four different categories, the topics of which, with some minor changes, reappear in the headings. First, the attitude towards work preparations are evaluated, followed by the operative mode of work preparation and the effect of using them. The main objective of each heading is productivity, with only productivity matters beneath the final heading.

## **The attitude towards work preparations**

Throughout the Skanska organisation there is a wide appreciation of the work preparation concept. The experience of the respondents ought not to be questioned, but their comprehension and opinions differ. Their various definitions of work preparation can be summarised as comprising: risk inventory and risk reduction, choice of method for each activity, productivity focus, resource allocation and material deliveries, reduction of waste and avoidance of standstills and capacities. There is a uniform view on these matters, but the respondents all manage to succeed to a varying extent. An important addition mentioned is the phenomenon of oral work preparations, which are claimed to be present all the time.

Since the management staff is the ones responsible for the production of work preparations they are naturally ought to be the ones most familiar with the concept, an assumption which is supported by the questionnaire results where they score the highest. Skanska's management staff and craftsmen mode values are scored the highest value of seven, but the subcontractors score stays at four. The subcontractors' lack of awareness and understanding of the purpose of work preparation might explain their limited desire to participating more in the production of work preparation, as evinced by the questionnaire results.

**Table 3. The average value of the questionnaire answers by project.**

| Total no. of questionnaires from each project;<br>Project 1: 18<br>Project 2: 27<br>Project 3: 7<br>Project 4: 21<br>Project 5: 27 | Project 1 | Project 2 | Project 3 | Project 4 | Project 5 |
|------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------|-----------|-----------|-----------|
| <b><i>My attitude towards work preparation</i></b>                                                                                 |           |           |           |           |           |
| The level of familiarity with work preparation and knowledge of how to use them                                                    | 5.5       | 5.1       | 6.4       | 6.2       | 4.4       |
| The desire to participate more in the production of work preparations                                                              | 4.5       | 5.1       | 5.0       | 4.3       | 4.6       |
| The desire to view and read work preparations in advance (before the activity start)                                               | 4.9       | 5.3       | 5.7       | 5.5       | 4.6       |
| The desire to only have an oral briefing of the most important parts of the work preparation before activity start                 | 5.1       | 4.6       | 5.4       | 4.9       | 5.0       |
| <b><i>How work preparation operate in projects</i></b>                                                                             |           |           |           |           |           |
| Regular use of work preparation is common in this specific project                                                                 | 4.9       | 4.0       | 3.6       | 5.8       | 3.8       |
| Enough activities are work prepared at this specific project                                                                       | 4.6       | 4.1       | 3.7       | 5.6       | 4.0       |
| The work preparations made are accessible well in advance before the activity start                                                | 4.4       | 3.5       | 3.4       | 5.1       | 3.7       |
| There is a high level of participation in the production of work preparations                                                      | 5.4       | 3.2       | 3.2       | 5.2       | 2.9       |
| <b><i>The effect of using work preparation</i></b>                                                                                 |           |           |           |           |           |
| Increased usage of work preparation leads to increased productivity                                                                | 6.2       | 5.4       | 5.4       | 5.7       | 5.4       |
| Bad planning due to inadequate work preparations is common                                                                         | 4.2       | 4.2       | 4.6       | 3.7       | 4.4       |
| The maximum capacity is often reached through the usage of work preparations                                                       | 5.4       | 4.6       | 4.9       | 5.4       | 5.0       |
| Accidents and incidents could have been avoided to a greater extent with a better risk inventory in work preparations              | 5.1       | 5.6       | 5.7       | 5.3       | 5.2       |
| Progress of the daily work is known due to work preparations                                                                       | 5.2       | 4.2       | 5.2       | 5.4       | 5.0       |
| Progress of weekly work is known due to work preparations                                                                          | 5.2       | 4.2       | 5.0       | 5.2       | 4.9       |
| People's viewpoints are taken more in consideration due to work preparations                                                       | 5.6       | 4.9       | 4.0       | 5.7       | 4.6       |
| There is a great focus on safety matters due to work preparations                                                                  | 5.9       | 5.5       | 6.2       | 6.3       | 5.1       |
| There is too much focus on safety matters due to work preparations                                                                 | 3.9       | 2.9       | 3.7       | 4.5       | 4.0       |
| There is a great focus on environmental issues due to work preparations                                                            | 5.1       | 4.6       | 4.3       | 5.3       | 4.6       |
| There is too much focus on environmental issues due to work preparations                                                           | 3.6       | 3.3       | 3.5       | 4.0       | 3.9       |
| Material is always delivered on time due to work preparations                                                                      | 3.8       | 3.9       | 5.0       | 4.3       | 3.6       |
| The right amount of material is always delivered due to work preparations                                                          | 4.5       | 4.4       | 4.3       | 4.3       | 3.7       |
| Material waste can be kept at a low level due to work preparations                                                                 | 5.2       | 4.9       | 4.3       | 5.0       | 4.5       |
| The work activities are always manned correctly due to work preparations                                                           | 4.5       | 4.6       | 3.8       | 5.5       | 4.4       |
| <b><i>Work preparations and productivity</i></b>                                                                                   |           |           |           |           |           |
| Standardised work methods (normal procedures) are useful                                                                           | 5.0       | 5.4       | 5.5       | 5.4       | 5.2       |
| Work preparations are the best tool in order to increase on-site productivity                                                      | 5.4       | 4.8       | 4.3       | 5.4       | 4.8       |

**Table 4. The average value of all questionnaires sorted by job type.**

| Total no. of questionnaires from each job type<br>Management staff: 34<br>Skanska craftsmen: 41<br>Subcontractors: 25 | Management staff | Skanska craftsmen | Subcontractors | Total |
|-----------------------------------------------------------------------------------------------------------------------|------------------|-------------------|----------------|-------|
| <b><i>My attitude towards work preparation</i></b>                                                                    |                  |                   |                |       |
| The level of familiarity with work preparation and knowledge of how to use them                                       | 6.2              | 5.2               | 4.3            | 5.4   |
| The desire to participate more in the production of work preparations                                                 | 4.3              | 5.5               | 3.9            | 4.7   |
| The desire to view and read work preparations in advance (before the activity start)                                  | 5.5              | 5.6               | 3.8            | 5.1   |
| The desire to only have an oral briefing of the most important parts of the work preparation before activity start    | 4.1              | 5.1               | 5.6            | 4.9   |
| <b><i>How work preparation operate in projects</i></b>                                                                |                  |                   |                |       |
| Regular use of work preparation is common in this specific project                                                    | 5.3              | 3.8               | 4.2            | 4.5   |
| Enough activities are work prepared at this specific project                                                          | 4.8              | 4.3               | 4.3            | 4.5   |
| The work preparations made are accessible well in advance before the activity start                                   | 4.2              | 3.7               | 4.4            | 4.1   |
| There is a high level of participation in the production of work preparations                                         | 5.5              | 3.1               | 3.1            | 4.0   |
| <b><i>The effect of using work preparation</i></b>                                                                    |                  |                   |                |       |
| Increased usage of work preparation leads to increased productivity                                                   | 6.0              | 5.7               | 5.0            | 5.6   |
| Bad planning due to inadequate work preparations is common                                                            | 4.2              | 4.3               | 4.0            | 4.1   |
| The maximum capacity is often reached through the usage of work preparations                                          | 5.2              | 5.0               | 4.8            | 5.1   |
| Accidents and incidents could have been avoided to a greater extent with a better risk inventory in work preparations | 5.7              | 5.5               | 4.7            | 5.3   |
| Progress of the daily work is known due to work preparations                                                          | 4.9              | 4.9               | 4.9            | 4.9   |
| Progress of weekly work is known due to work preparations                                                             | 4.9              | 4.7               | 4.8            | 4.8   |
| People's viewpoints are taken more in consideration due to work preparations                                          | 5.7              | 4.6               | 4.9            | 5.1   |
| There is a great focus on safety matters due to work preparations                                                     | 6.1              | 5.6               | 5.3            | 5.7   |
| There is too much focus on safety matters due to work preparations                                                    | 3.3              | 3.6               | 4.5            | 3.7   |
| There is a great focus on environmental issues due to work preparations                                               | 4.8              | 4.6               | 5.3            | 4.8   |
| There is too much focus on environmental issues due to work preparations                                              | 3.3              | 3.5               | 4.4            | 3.7   |
| Material is always delivered on time due to work preparations                                                         | 4.2              | 4.1               | 3.4            | 4.0   |
| The right amount of material is always delivered due to work preparations                                             | 4.4              | 4.2               | 4.0            | 4.2   |
| Material waste can be kept at a low level due to work preparations                                                    | 5.2              | 4.6               | 4.7            | 4.9   |
| The work activities are always manned correctly due to work preparations                                              | 5.1              | 4.5               | 4.3            | 4.7   |
| <b><i>Work preparations and productivity</i></b>                                                                      |                  |                   |                |       |
| Standardised work methods (normal procedures) are useful                                                              | 5.4              | 5.4               | 5.0            | 5.3   |
| Work preparations are the best tool in order to increase on-site productivity                                         | 5.0              | 5.1               | 4.8            | 5.0   |

There is a grievance from the top management regarding the few work preparations made at the different projects; criticism which in part is justified but also met with scepticism from the different respondents. The slow progress in turning work preparations into an everyday tool and allot time for producing it are the biggest obstacles, despite the recognition of the benefits. The routine of producing work preparation must get a stronger focus, but first the adverse attitude must be dealt with. Explanation of the purpose of work preparations, and the reasons as to why they should be produced and used, as well as emphasising their benefits, are measures suggested to increase the usage of work preparations throughout the projects. It is important, because the belief in work preparation as an important and crucial tool for Skanska is complete. To work structured in order to become a role model for Swedish industry life, is one of the respondents opinion about the purpose of work preparations, before concluding the subject by saying:

*'Miscalculations in projects are very rare, but poor project management can lead to failures'*

The level of satisfaction with the process of using work preparations today varies considerably from 'satisfied' to 'not at all satisfied'. The general opinion is that the ongoing work is planned pursuant to the definition, but not written down according to the work preparation template. What is neglected by not doing so are plenty of matters. According to the questionnaire, the craftsmen are most willing to increase the degree of participation in the produce of work preparations compared to other categories of professionals. They are also eager to see and read the work preparations in advance and prefer this compared to just an oral briefing. Subcontractors are in general satisfied with just an oral briefing regarding the most important matters of the activity they are to carry out.

As to the identification of the activities which are to be included in the written work prepared, the most important ones are those concerning different kinds of risk. Time critical activities which can influence the rest of the project must be carefully planned. Safety risks, such as deep slopes and heights for instance, must, in some way, be work prepared according to regulations. Environmental risks are considered together with heavy economic parts and they, too, are to be work prepared according to the respondents. Simultaneously, as no one is able to mention any activity which does not need to be planned, the impossibility of making work preparation for everything going on at each project must be taken into account. The focus should be on, and the level of detail in each work preparation adjusted to, the activity level, not too general so important information is lost, but not as detailed as a work description either. The general view among the respondents about the percentage of written work preparation Skanska should aim for is slightly higher than the corresponding number which can be ascertained from the questionnaire answers, where the uniform opinion at each project and job type seems to be that 50-65 % is an appropriate level.

The work preparation template, available from Skanska's management system, 'our way of working', is to a great extent already used among the management staff today. Sometimes, the template is not sufficient enough, for example when photos and drawings are necessary, but it serves the purpose most of the times. There is an issue, however, regarding the capacities and calculated statistics when work preparations are handed over to the client, which today is 'solved' by either not completing the template or by omitting to reveal information. The comprehensiveness of the parts



included in the template is more than enough, the fact of which more often results in incomplete work preparation than complaints of its content. The biggest obstacle to their being produced, as mentioned earlier, is lack of time. The insight that time is actually saved by planning is sometimes neglected due to time shortage coupled with the indolence of the staff. Late changes and the actual writing part are factors identified to explain the small number of produced written work preparations. Today, it seems to be the opinion of some respondents that it is easier to just go through the phases in an oral discussion with the people concerned with a certain activity, whereas others have work preparations prepared six months in advance and are revising them as living documents before the respective activities start.

## **Work preparations in projects**

There is a shared sense awareness of what a work preparation actually is and whether it is a natural feature in Skanska's all infrastructure projects. For some respondents, the work preparation is more of a check list they are completing because they have to do so due to their manager, while others view work preparation as a central part of the day and use them frequently. The questionnaire does not present any high numbers regarding regular usage of work preparations, and there are clear and distinct differences of opinion between management staff and craftsmen, respectively, and between the different projects. Closely related to this divergence is the question whether enough work preparations are made, and here a pattern can be discerned from the questionnaire answers which confirms that low reliance on work preparations generates a low satisfaction level insofar this matter is concerned. Regarding the already produced work preparations, no project can flourish with delivering them for distribution well in advance before activity start. The average numbers of days in advance work preparations are finished is two, but with a significant reservation for individual deviations.

The process of producing a work preparation, as intended by Skanska, is explained on page eight, but the actual procedure is as follows. In case of a new or hazardous activity, the head of production decides on the choice of method and safety measures. Usually the team leader starts out by envisaging what is to be built by using maps, drawings and the specification of requirements. The calculations from the contract offer are consulted and modified if possible or compelled. This process is often started several weeks before the activity start, in order to gain a sense of the expected result. The draft is then reviewed together with all the workers which are to perform the job about one week before the activity start. Input from this meeting is incorporated and the work preparation is completed.

This interpretation is not completely reflected in the questionnaire, where the accessorial question is very poorly graded by the workers. Projects two, three and five all received a low average score on this question and have a mode value of just one. Notably, the lowest mean value comes from the project with the lowest proportion of management staff. This is a question of interpretation with many variables and potential explanations, and is at least somewhat counterbalanced by a result in excess of five for the question whereas the personal standpoints are taken into considerations in work preparations.

The time aspect has been mentioned as the strongest obstacle to the production of written work preparations. The advantages of producing a written work preparation is

that it provides an opportunity to identify risks and prevent accidents from occurring, keeping the labour active, and making sure the right things are made at the right time. Some employees are too stressed to find time for planning and work preparation, which may be characterised as an instance of poor priorities. Reconstruction is costly, in terms of both time and money. Looking at the questionnaire results from the management staff, the mean value of standstill hours mounts to half an hour per day-time which could be spent doing work preparations. The corresponding figure for the workers is about one hour a day, i.e. one hour of pure standstill due to shortage of something in the production.

The general impression from all the interviews and reviews of old work preparations is the absence of experience documentation. Follow-ups on choices of method and outcomes, actual capacity compared to the calculated, and general documentation after completed work-prepared activities is very rare. Instead of complementing the work preparation with such information, it is replaced by meetings and oral briefings. The direct benefit of adding this sort of information cannot be identified and is therefore often neglected. Feedback and project specific information stays within the project itself and is confined to the people involved, which leads to missed opportunities of completely successfully reusing or communicating a work preparation outside the specific project.

### **The effect of using work preparations**

The effect of using work preparations is multifaceted. Involvement of co-workers is an important aspect, according to Skanska's guidelines. It has been shown that additional workers among Skanska's own personnel want to participate more in the production of work preparations. They are also the ones who most frequently consider bad planning, originating from inadequate work preparations, to be common.

As to the on-site production, a steady flow of work tasks must be generated to keep the work force busy. According to the questionnaire result, the work preparation support the daily and weekly planning sufficiently. There are standstills in all projects, which, however, from time to time, to some extent can be linked to the usage of work preparations. After the work preparation is finished and distributed to all concerned with the activity, changes of work methods are avoided. Changes in conditions are a concern; otherwise the work preparation is to be followed. For reasons of vocational pride, some parts of the thinking process should be left to the individual worker. There are great challenges involved when making the delicate decision of how strict a work preparation should be, with the common goal of producing as much as possible always in mind. The expectation to reach maximum capacity is substantial in all projects and established among all job types. Reaching the target capacities from the contract bid and finding opportunities to avenge it is a returning subject of how work preparation can be and are used throughout the organisation today.

Disadvantages associated with regular usage of work preparations are few, when they are performed right. The most frequent comment is the time required to produce them, followed by a growing concern regarding requests from Skanska's top management for the production of a specific number of work preparations for a certain size of a project. One of the respondents summarises the general opinion in the following way:

*'Turning the production of work preparations into a bureaucratic thing for the sake of statistics is a completely wrong development'*

For questions of production and productivity however, none of the respondents identifies work preparations as anything but a resource.

According to Skanska, the main purpose of work preparations, the rationale for their existence, is to increase on-site productivity. Everything they contain is meant to ensure that the production work flow stays consistent. This, however, is not the case at any of the projects visited and it is most likely not practicable anywhere. Instead, the ambition is to minimise disruptions in order to reach the capacities and stay productive. The main sources of disruptions, reappearing at all projects, are: errors and changes in documents; material shortage; weather conditions; tools and machine shortage.

All these reasons for standstills, along with others less frequently occurring reasons, are meant to be reduced with more and better work preparations, in order to achieve ambitious targets of productivity. Material deliveries are relatively poorly graded, as far as deliveries being made on time are concerned. This is remarkable among the projects with a high amount of craftsmen and lumbers, confirmed to be a general issue, see *Table 4*. Slightly better results are presented in regard to the question whether the right amount of material is delivered, but there is still room for improvement.

The projects visited have not suffered any severe accidents or other major incidents with a lot of absence from work ensuing, according to the respondents. Many of the respondents testify that safety matters are the basis for the work preparations' existence, and constitute the foundation when producing them. For all projects a risk inventory is made during the procurement, which, however, is rarely consulted by the work preparation producers. Instead they identify safety risks on-site and thereafter decide which activities to work prepare. Accidents due to unidentified risks very rarely, instead negligence and unforeseen events are the most common causes for accidents.

The risk inventory can be a cumbersome document, with more than two hundred identified risks for some projects, and is therefore often neglected. However, accidents can, and will, take place nonetheless, and all questionnaire answers speak in favour of work preparation as a potential tool to avoid accidents and mishaps. Fall in production, due to accidents and such, are killing productivity when focus is moved away from the production. Severe accidents are rare and the work preparation really puts focus on safety matters, as the respondents testify and questionnaire result shows. Deviations between the answers in the present case regarding if safety to have too high focus, can be interpreted as some are experiencing safety as unnecessary. The mode for Skanska's management staff on this issue is one, for the craftsmen three, and for the subcontractors seven. The answer span is here the broadest possible, amply that opinions differ as to the importance of the safety issue.

## **Work preparation and productivity**

It is not possible to use work preparation in order to directly measure productivity. In fact measuring productivity in the diverse construction business is very complicated.

What work preparations can provide is a way of facilitating the construction process and thereby a means to reducing different types of waste, resulting in a more economical process and reduced building time. Disrupters generating standstills is the one reason all interview subjects mention when benchmarking work preparations as a concept. Planning is everything, but all contributing parameters are crucial to maintain a steady production state, and this is where work preparations are useful. From the questionnaire, the conclusion can be drawn that many employees want to participate in the production of work preparations to a greater extent. Given this, in combination with the opinion that work preparations do not cover enough on-site activities, and the fact that the average for standstill hours is almost an hour, the belief in more elaborate and thorough work preparation as the best tool for increasing productivity is widespread and seems justified.

A useful aiding tool, and a source of inspiration, when producing work preparations can be found by consulting the 'normal procedures', available at Skanska's intranet. The normal procedures are video-documented on-site activity performances, illustrating the best known way of performing particular activities which take place at an infrastructure project site. The videos are supplemented by many good pieces of advice and potential capacities. Relatively recently' developed normal procedures are not yet widely used within Skanska's organisation. The responses from the respondents diverge as few use them on a regular basis. There is a widespread faith in the concept, but thus far too few normal procedures recorded for them to be applicable to the current jobs, resulting in incongruent application and difficulties of comparison. However, in spite of its limited usefulness, there is a widespread support for normal procedures at all projects and job types.

## Analysis and discussion

One of the most experienced respondents expressed his thoughts of work preparations in:

*“A work preparation is not a work preparation until it is written down”*

This quote clearly demonstrates his viewpoint in this matter. Skanska believe in work preparation as the best tool for increasing on-site productivity and, according to the results of the current survey, this view is supported by the people on site. The construction sector are good planners, but sometimes enough time is not devoted employees to planning by the construction project managers, according to Zwikael (2009), an allegation confirmed by the respondents identifying time as the biggest obstacle to performing work preparations. At the same time, everyone seems to realise that time is saved in the end if time is invested before the activity start and by making the work preparation. This is a contradiction, which perhaps can be explained by the slow learning process within the construction industry (Lê & Brøn, 2007).

The respondents responsible for producing work preparations claim to involve and engage the workers in the planning of the work activities and the production of work preparations. However, there is a desire from the workers to become even more involved, and to increase the number of work preparations made, which implies a certain degree of dissatisfaction with today's procedure for work preparation production. This result is linked to the reported time of standstills, which shows indicates a significant amount of production time being lost due to bad planning. These hours of standstill are a pure loss, referred to as waste by Josephson & Saukkoriipi (2005). Hence, there is a lot left to do and increasing the quality and usage of work preparation might help decreasing this waste of time.

### **How can work preparations be used and improved for the purpose of increasing on-site productivity?**

According to the research result, there is a high degree of faith in work preparations among the employees when it comes to the possibilities to increase on-site productivity. The recognition of inadequate work preparations indicates that the organisation is considering the situation as unsatisfactory. Productivity is defined as in the relation between input and output, where reduction of input effort results in increased profitability. As stated earlier, measuring productivity in construction is very complicated, but reducing the activities on-site which are not adding any value must be considered as increasing productivity. An increasing number of construction productivity journals written lately, according to Panas *et al.*, (2010), clearly show the importance of working on this issue. It is suggested poor productivity of construction workers is one of the major causes of cost overruns and schedule slippages in construction projects today, but with better on-site planning tools, such as work preparation, the possibility of keeping the labour force active at all time is emended. To achieve this improvement, the management staff is forced to reconsider and produce the work preparations earlier and include everyone concerned even more.

To fully meet the standards and requirements of Skanska's opinion regarding work preparations, the employees must be reminded why they are doing work preparations and convinced to carry them out. It is not environmental risks or other risks in general

which is the main reason for performing a work preparation, but rather it is a tool for eliminating all kinds of possible disruptions and thereby work more efficiently. Consequently, the other positive aspects of producing work preparations, i.e. aspects other than the elimination of risks, are not to be overlooked. If work preparations are prepared in advance and in collaboration with everyone involved in the specific work to be performed, the best conditions for a successful performance are secured. Material deliveries are on time; the right amount of material is delivered; the waste of material can be reduced; activities are manned correctly; employees are more involved and standstills are reduced, the aspects of which all can be improved according to the questionnaire results, and which must be improved if on-site productivity is to be increased. This, however, will not be achieved as a result of Skanska's top management forcing the organisation to produce a specific number of work preparations based on the size of the project, but rather by manifest and emphasises on work preparations, if the participants in the study are to be believed. Too much focus on productivity gains impedes the organisation flexibility and innovativeness (Adler *et al.*, 2009).

With increasing demands of more efficient and faster building from the construction business, voices have been raised in favour of longer working hours. The committee of productivity in Sweden is working on this proposal, which advocates the position that the construction workers should; work all days in a week in order to use machines on-site more efficiently and thereby save time and money (Bergling, 2012). With an estimated 15 % increase in productivity in construction within five years, the demand on the constructors is high. The purpose of this proposal is not to increase the work day for the individuals on-site, but to keep the machines more active. With a workforce already put under high physical stress with high mortality compared to other sectors (National Safety Council, 2003) and with only 40 % of the workforce working until retirement age in Sweden (Josephson & Saukkoriipi, 2009), this poses a great challenge. In order to successfully introduce longer working days and working in shifts, the demands on the planning process and the performance of work preparations will be of great importance.

Although the number of work preparations produced today is not sufficient and even though they are often produced too late in order to effectively reduce waste as in the way previously mentioned, the work preparations produced are considered as well performed in all aspects but one: experience feedback. The absence of this part is lacking consistently, and is often intentionally neglected among the respondents. Both Ribeiro (2006) and Desouza & Evaristo (2004) discuss the shortage of experience feedback in construction, while Liker (2004) claims knowledge management and standardisation to be the basis for continuous improvements and increased quality. The normal procedures available are seldom adhered to, which to some extent can explain the low knowledge management in Skanska in general terms. Consistently, in both risk identification and activity performance, reliance is placed upon individual worker's own experience rather than the company's knowledge. Knowledge dissemination does not reach its potential if no one adheres to it, and here there is a great opportunity, and challenge, to work more efficiently within the organisation. Successful and unsuccessful performances should be carefully evaluated and committed on the pertaining work preparation, spread in the organisation in a way which allows everyone to take part of well executed performance and also information on what methods or similar things to avoid.

Skanska is in possession of a great tool for increasing their on-site productivity, but fails to take advantage of its potential by its not being consistently used throughout the organisation and enough knowledge experience not being spread from one specific project to the whole organisation.

### **How can the next generation of work preparations be designed to be applied at all times?**

It follows from the interviews, that the design is regarded as sufficiently comprising as to its content and focus. The reason as to why work preparations are considered unsatisfactory is more of an attitude issue. The obstacles must be overcome, starting with the time issue which is identified as the biggest one. Good planning does take time; performing construction projects with excellence takes even more time, but can never be considered as waste of time. As some of the respondents explained, time shortage, should not be acceptable as an explanation for the lack of work preparations. The benefits of doing everything right from the beginning must outweigh the highly temporary loss of time while planning, considering that the costs of visible and hidden defects, together with the inefficiency of resource usage, accounts for approximately 20 % of the total production cost (Josephson & Saukkoriipi, 2005). For Skanska's management, the challenge is to influence the employees to reserve time for producing work preparations by emphasising the potential of this tool from a productivity point of view.

Work methods and calculated data regarding quantities are also reckoned as obstacles, when the information is to be shared with the client. Instead of making two separate work preparations, the information is left out in order to not reveal this information. With the current template, this may seem like an empty work preparation to the client. It would be preferable to have a separate template adapted to the information relevant to the client. To avoid making work preparations for this reason must be prevented in order to stimulate the production of work preparations.

Since the opinion among the respondents is diverging as to the definition of work preparation and as to its content and purpose, a standardised procedure specifying its content and performance should be established. Since it is not efficient to have everyone doing it his own way, efforts to form common way should be promoted by Skanska's management. However, according to Waddell & Sohal (1998), more than half of the organisational changes fail and change resistance is considered a main factor. Simultaneously as demands from Skanska's top management on the reporting of produced work preparations are generally considered bad, thus undermining the purpose and creating a pessimistic relationship with the phrase 'work preparation', they should set high standards to drive the development forward.

## Conclusions and recommendations

- Skanska has come far in their work with work preparations.

*Although improvements can be made, work preparations executed are a great help in the daily work on-site, the conclusion of which is supported by both the respondents and the questionnaire answers. The most important thing is that the organisation, and its employees, believes this tool to be a factor for success in Skanska's work to reduce waste and increase productivity.*

- Work preparations are a good tool to increase on-site productivity in construction.

*The uniqueness of each project rules out the possibility of making direct comparisons between different projects, but highlighting and reducing the obstacles in time and before activity start will generate a more efficient production and this is possible through increased work preparation usage. Time spent in advance planning each activity is always regained in the end due to fewer errors being made, saved time and more satisfied clients and co-workers.*

- The top management within Skanska ought to focus more on supporting and encouraging their employees to produce more work preparations.

*Work preparations should not be produced for the sake of reporting something, based on a specific size of a project. Rather than just making demands, design and undertake selective measures within the organisation and supply information about the way in which work preparations are to be performed within Skanska. Continue to promote work preparation and demonstrate how projects can take benefit from increasing the daily routine of working with work preparations.*

- Comprehensive work preparations are the desirable for the purpose of realising the aim of successfully sharing knowledge between projects and thereby be more efficient and productive in the future.

*Both positive and negative outcomes from production should be included in the work preparation, and explained in detail so that the activity can be utilised anew with the same result. Performing this in a uniform way, and creating a platform for the gathering and distribution of best practice performances and important suggestions of what to avoid, will facilitate the work with increasing productivity.*

Skanska should continue working with work preparations, creating an environment where it is a natural element in the daily work for everyone. A central system for storing and passing on knowledge within the organisation is fundamental in order to maximise the efficiency on-site. To find out how efficient work preparations really are, and create a presumed additional incentive for its use, measurements and comparisons ought to be undertaken.



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