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The Planning Process at a Construction Site

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If you tell people where to go, but not how to get there,
you'll be amazed at the results.

George S. Patton

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ABSTRACT
Planning, coordination and control processes are integral parts of construction project management. Although construction projects are repetitive and their execution is routine, practitioners find themselves at a crossroad deciding whether to specify a detailed course of action or to allow it to develop over the duration of the project. The extensive use of and reliance on subcontractors, the frequent changes made to project descriptions and goals along with the preference for loose control ascribed to site management in Sweden makes planning challenging.

The aim of this thesis is to investigate the planning process as it is practiced at the intersection between planning, coordination and control, and the execution of activities. It is based on a case study in which ethnographic research methods were applied. The study spans 18 months of observations at a construction site, principally in the role of a participant-as-observer.

This thesis demonstrates that it is feasible to allow the detailed course of action to develop over the duration of a construction project by defining activities and deciding upon their timing and sequence using coordination and control processes rather than a planning process. The coordination and control processes in the project were not functions solely of the planning process. This has implications for the definitions of planning found in the conventional project management body of knowledge, and implies that the planning process needs to ensure that the conditions necessary for an efficient utilisation of resources assigned are in place.

Keywords: Planning, coordination, control, construction, site management, practice

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Fredrik Christiansen

CONTENTS

INTRODUCTION

Planning has remained central to management ever since Henri Fayol listed it as a managerial functions along with, among others, coordination and control in 1916 (cf. Blomberg, 2003; Hodgson, 2004; Mintzberg, 1975; Wren et al., 2002). Planning, coordination and control processes are considered integral parts of what is commonly referred to as the conventional project management body of knowledge (see Cicmil et al., 2006; Engwall, 2003). According to Cicmil et al. (2006) and Engwall (2003) the underlying supposition is that the use of these processes will result in the achievement of project goals and the failure thereof is considered synonymous with project failure (Packendorff, 1995). While Globerson and Zwikael (2002) adhered to this view and considered the failure thereof likely to result in project failure Blomberg (2003) saw it as having contributed to the success of several projects. Typical contributions include Kerzner (2003), Maylor (2003) and Meredith and Mantel (2010) (cf. Engwall, 2003; Hodgson, 2002; Jacobsson & Söderholm, 2011).

"Planning lies at the heart of construction project management" and the industry has been described as proficient at planning by Zwikael (2009) (Winch & North, 2006, p. 473). However, the proficiency measure used was based on the presence of planning processes consistent with the conventional project management body of knowledge which has been criticised for not taking the context of the project into consideration by Cicmil et al. (2006) and Dvir and Lechler (2004) (see Zwikael, 2009). The strong emphasis on planning and the prescribed execution of activities in accordance with plans has been criticised by Andersen (1996) and Lenfle and Loch (2010) for failing to seize opportunities when they arise during the project (see Cicmil et al., 2006; Hodgson, 2004). Alternative planning processes that share a common denominator in allowing projects to develop rather than assuming they can be planned in advance in their entirety have been advocated by Andersen (1996) and Ballard and Howell (1998) (cf. Cicmil et al., 2006).

This thesis investigates the planning process endorsed by Winch and Kelsey (2005, p. 149) who stated that "planning remains central to construction project management, and its practice deserves more research attention than it currently receives." Rather than investigating the presence of planning processes consistent with the conventional project management body of knowledge as Zwikael (2009) did, this thesis, investigates planning as it is practiced at a construction site.

PLANNING

A planning process is a process of decision-making (cf. Ackoff, 1970; Laufer et al., 1994; Mintzberg, 1981). Decision-making *per se* should, however, not be equated with

planning (Ackoff, 1970; Mintzberg, 1981). Rather, the decisions made as part of a planning process are distinguished by three characteristics (Ackoff, 1970). Firstly, they are anticipatory and cannot be made at the moment of action without loss of efficiency; since otherwise planning would not be needed (Ackoff, 1970). Secondly, they are interdependent, meaning that the outcome of one decision rests upon the outcome of at least one of the other decisions (Ackoff, 1970). Thirdly, they are directed towards "producing one or more future states which are desired and which are not expected to occur unless something is done" (Ackoff, 1970, p. 3). Furthermore, according to Wildavsky (1973) a planning process is a process of controlling the future. Accordingly, activities not performed in accordance with decisions made as part of a planning process entails that the process no longer qualifies as a planning process (cf. Mintzberg, 1981; Wildavsky, 1973).

Planning, or controlling the future, should involve taking into consideration the context in which activities are to be executed (Dvir & Lechler, 2004). Cicmil et al. (2006) report how studies have shown that projects, in which processes that are a part of the conventional project management body of knowledge have been applied, have failed. The lesson drawn from these studies was that the "the project emerges rather than being entirely pre-planned […] and there is acceptance that the plan cannot be fully prepared because of the influence of the external environment" (Cicmil et al., 2006, p. 683). Whilst Zwikael (2009) appear to have been of the opinion that planning proficiency can be measured by the presence of planning processes, it appears as if the true measure of proficiency is whether planning processes succeed in controlling the future (cf. Wildavsky, 1973). The construction industry has been ascribed characteristics that make planning, or controlling the future, demanding (see Bryman et al., 1987; Bröchner et al., 2002; Lundin & Söderholm, 1995; Modig, 2007; Styhre, 2006; Thiel, 2007). These characteristics may influence the industry's susceptibility to anticipatory decision-making as well as the level of detail at which the future can be controlled.

CONSTRUCTION PROJECT CHARACTERISTICS

Construction projects, and particularly framework supplement work, are characterised by extensive use of and reliance on subcontractors (Bryman et al., 1987; Nordstrand & Révai, 2002). In projects studied by Bryman et al. (1987), site management associated this characteristic with uncertainty since they were rarely able to be certain that subcontractors would appear at the construction site in due time. In many cases the subcontractors were reported to have been held up at other construction projects (see Bryman et al., 1987). It is the subcontractors' home offices that assigns resources to construction projects (Modig, 2007). The uncertainty associated with extensive use of and reliance on subcontractors indicates that site management may experience difficulties in controlling the future actions of the subcontractors' home offices

through anticipatory decision-making or planning. Not only are the home offices external to the project organisation but they seem to make decisions that are not always in line with project goals.

There are also characteristics ascribed to the construction industry that are seemingly in favour of a high level of specificity in anticipatory decision-making. Construction projects are described as repetitive projects and their execution as routine (see Bryman et al., 1987; Lundin & Söderholm, 1995; Modig, 2007). Bryman et al. (1987) attributed the role clarity exhibited by the project organisations studied to the repetitiveness of construction projects. Further support for this view is Lundin and Söderholm (1995, p. 441) stating that the repetitiveness carries with it that project organisations "know what to do, and why and by whom it should be done" which was considered characteristic for routine execution and was attributed to experience by Lenfle and Loch (2010). In Sweden, the description of a construction project is based on a national consensus on how building information should be classified (Bröchner et al., 2002). Modig (2007) associated explicit project descriptions with repetitive projects by. Clearly defined goals are also considered characteristic for routine execution by Lenfle and Loch (2010). The repetitiveness of construction projects and their routine execution implies that they are susceptible to a high level of detail in anticipatory decision-making. That is, assuming that construction projects are explicitly described, goals clearly defined and project organisations have limited difficulty identifying the activities to be performed. Whilst the conventional project management body of knowledge assumes that "goals are simple, stable and are often defined before the project commences" this should not be taken literally (Pollack, 2007, p. 270). Unlike the construction projects studied by Shenhar and Dvir (1996), where the goals were completely defined prior to execution, Tryggestad et al. (2010, p. 696) found that "goals are […] often neither well defined from the onset, nor are they stable throughout the course of the construction project." Hence, the repetitiveness of a construction project and its routine execution only implies that it is susceptible to a high level of specificity in anticipatory decision-making assuming that the description and goals remain stable.

Furthermore, construction project organisations are ascribed characteristics that influence coordination as well as control processes. Subcontractors have been described as autonomous by Olsson (1998) and Thiel (2007). Also, site management in Sweden has been found by Bröchner et al. (2002) to exhibit a preference for loose control. Albeit the conventional project management body of knowledge's assertion that projects should be executed in accordance with plans, alternative approaches to planning have been suggested (see Andersen, 1996; Ballard & Howell, 1998; Blomberg, 2003).

CONTRASTING VIEWS

Andersen (1996) has argued for milestone planning as an alternative to the planning prescribed by the conventional project management body of knowledge. The divide between the two lies in the postponement of decision-making. Whilst Andersen (1996) did not specifically have construction projects in mind, the alternative planning approach advocated is relevant if descriptions and goals are considered to be evolving as opposed to being stable (cf. Tryggestad et al., 2010). The milestones that are identified beforehand are intermediate project results, not activities (see Andersen, 1996). Rather than identifying and defining activities beforehand it is argued that the planning process should progress milestone by milestone thereby postponing the identification, definition and scheduling of activities to be carried out (see Andersen, 1996). The principal argument put forth by Andersen (1996) is that anticipatory decision-making may inhibit a project organisation from seizing opportunities over the course of a project. Andersen (1996), in line with Lenfle and Loch (2010), thus appears to consider uncertainty as a source of opportunities that the conventional project management body of knowledge inhibits project organisations from seizing (cf. Cicmil et al., 2006).

Of course, if the assumptions upon which the conventional project management body of knowledge rests hold, and the descriptions and goals of construction projects remain stable then milestone planning would be less relevant. Even so, the postponement of decision-making recurs in the alternative planning process advocated by Ballard and Howell (1998). Ballard and Howell (1998) were concerned with the conditions necessary for executing activities in construction projects. In contrast to Andersen (1996), Ballard and Howell (1998) did not support postponing identification and definition of activities, but instead favoured assigning activities to construction workers and subcontractors when the necessary conditions are in place, thereby shielding the execution of activities from uncertainty. The alternative planning process certainly has bearing on the uncertainty associated with the assignment of resources to construction projects by the subcontractors' home offices as observed by Bryman et al. (1987).

Also Blomberg (2003) has questioned the desire for anticipatory decision-making with a high level of specificity. As opposed to Zwikael (2009), Blomberg (2003) stated that it was hard to find any correlation between seemingly well planned projects and project success. The critique from Blomberg (2003) centred on the consequences of adhering to plans: the removal of an project organisation's need to think by itself, to solve problems and to deviate from plans. As Blomberg (2003) put it, in projects where the project organisation is working towards precise goals and following a plan with a high level of specificity miracles cannot occur. The problem as seen by not only Blomberg (2003) but also by Andersen (1996), was that project organisations, as a

result of sticking to plans, are unable to seize opportunities that present themselves over the course of a project. Such reasoning resonates well with Lenfle and Loch (2010) who perceived uncertainty as a source of opportunities.

There thus exists not only differing opinions regarding how construction projects should be planned, but also arguments for each alternative that seemingly fit the characteristics ascribed to the construction industry. Whilst the efficiaciy of different planning, coordination and control processes is debatable it is, in practice, a debate settled "over and over again as new houses go up in their millions" (Dubois & Gadde, 2002, p. 621).

AIM

The aim of this thesis is to investigate the planning process as it is practiced at the intersection between planning, coordination and control, and the execution of activities (cf. Mintzberg, 1981; Wildavsky, 1973). According to Wildavsky (1973, p. 152) the "discussion of what seems to work in a particular context is [often] inhibited because it may be inconsistent with 'good planning practice'." This thesis contributes to the debate between those advocating planning processes following the conventional project management body of knowledge and those advocating allowing projects to develop rather than assuming they can be planned in advance in their entirety by investigating what seem to work in practice. Further, as "the focus on what actually happens on construction sites themselves [… has been] limited", this thesis contributes to the understanding of planning and practice by investigating the process of planning at a construction site (Pink et al., 2010, p. 648).

This thesis adheres to the view put forth by Mintzberg (1981) and Wildavsky (1973) that planning processes are to be investigated at the intersection between the anticipatory decisions made and the activities performed. There are, however, alternative ways of investigating planning processes in construction projects. Laufer and Tucker (1988) as well as Winch and Kelsey (2005) have investigated what planners do. The planning processes obtaining in construction projects have been investigated by Zwikael (2009) and in Sweden by Friblick and Olsson (2009). Whilst contributing to the understanding of current practice, these studies still miss that planning is not determined by the processes applied but by the impact that decisions have on activity execution (see Wildavsky, 1973). The correlation between planning and project success has been investigated by Dvir and Lechler (2004), Dvir et al. (2003), Pinto and Prescott (1990), Zwikael (2009) and Zwikael and Globerson (2006), however, the presence of any such correlations have been questioned by Blomberg (2003). At the same times, calls for research into the actuality of projects have been made by among others Cicmil et al. (2006). Furthermore, research contributions on practices on construction sites have been considered promising by Pink et al. (2010).

This thesis builds upon a conceptualisation of the construction planning process based on Laufer et al. (1994) and Laufer and Tucker (1987). This conceptualisation positions coordination and control as functions of the planning process and serves as a frame of reference for this thesis (see Laufer & Tucker, 1987). There are several arguments behind this decision. Firstly, this conceptualisation is consistent with the open-endedness of the aim as it does not limit the investigation to a set of specified processes. Rather, the focus on what planning is and why it is performed enables investigating the impact from decisions made as part of a planning process on activities carried out (see Laufer & Tucker, 1987). Secondly, Laufer et al. (1994) and Laufer and Tucker (1987) build on earlier work by, among others, Ackoff (1970), Mintzberg (1981), Snyder (1982) and Wildavsky (1973) that relate to the definition of planning rather than the specifics of a particular planning process. Thirdly, Laufer et al. (1994) extends the perspective by positioning the construction project planning process as a part of, and an extension of, the construction planning process beyond the construction project organisation.

PLANNING AS A PROCESS

The notion of planning as a process is based upon Laufer et al. (1994) and Laufer and Tucker (1987) and serves as a frame of reference for this thesis. Planning processes are considered by many as hierarchical, and Laufer et al. (1994) and Laufer and Tucker (1987) constitute no exception (see Guinery & MacCarthy, 2009). Thus "decisions made early in the planning process must be taken into account when making decisions later on in the process" (Ackoff, 1970, p. 2). This thesis investigates the planning process at the lower levels of the hierarchy, at the intersection between planning, coordination and control, and the execution of activities.

CONSTRUCTION PLANNING

Laufer et al. (1994), in line with Ackoff (1970) and Snyder (1982), considered planning a process and proposed a definition of construction planning consisting of seven elements. The more of these seven elements are present "the more readily the process is recognised as planning" (Laufer et al., 1994, p. 54). These elements correspond principally to other definitions and descriptions of planning processes, such as that by Snyder (1982). According to Laufer et al. (1994, p. 54) "planning elements comprise the following.

1. A decision-making process.
2. A process of anticipatory decision-making – to decide what and/or how to perform actions due at some point in the future.
3. A process of integrating interdependent decisions into a system of decisions.

4. A hierarchical process evolving from general guidelines to objectives, to the elaboration of means and constraints that lead to a detailed course of action.
5. A process that includes part or all of a chain of activities comprising information search and analysis, development and design of alternatives, analysis and evaluation of alternatives and choice making.
6. The systematic employment of procedures (standardized and formal to varying degrees).
7. Documented presentation, in the form of plans."

This defines construction planning in a comprehensive sense and should be interpreted as including planning for and by the client, the designers, the contractor's home office, site management as well as subcontractors and suppliers (see Laufer et al., 1994). All of these are likely to influence planning on the construction site. As an example, Tryggestad et al. (2010) contested the stability often ascribed to project goals in the conventional project management body of knowledge (see Pollack, 2007). Whilst Laufer and Tucker (1987) regarded the definition of goals as external to the project organisation on the construction site, this does not exempt the organisation from the influence of decisions made at higher levels in the hierarchical planning process.

This thesis, in line with Laufer et al. (1994) and Laufer and Tucker (1987), regards the definition of project goals as external to project organisations on construction sites but does, however, recognise that they are capable of defining goals of their own (see Artto et al., 2008). The project goals relevant for this thesis are those normally specified by the client and the contractor's home office: time, cost and specification. The planning by site management includes the means of achieving the project goals (cf. Ackoff, 1970; Laufer & Tucker, 1987). These plans concern decisions that should lead to a detailed course of action to achieve the intended results (cf. Ackoff, 1970). This detailed course of action corresponds to the lower hierarchical levels of the planning process, at the intersection between planning, coordination and control, and the execution of activities.

PLANNING AT THE CONSTRUCTION SITE

At the lower hierarchical levels of the planning process Laufer and Tucker (1987, p. 244, italics in original) have stated that "planning answers the following questions:

– *What* should be done? (activities)
– *How* should activities be performed? (methods)
– *Who* should perform each activity and with what means? (resources)
– *When* should activities be performed? (sequence and timing)."

These questions resemble the definitions of planning commonly found in the conventional project management body of knowledge. Meredith and Mantel (2010, p. 239) have stated that planning "is to establish a set of directions in sufficient detail to tell the project team exactly what must be done, when it must be done, what resources will be required to produce the deliverables of the project successfully, and when each resource will be needed." This was the definition used by Zwikael (2009). Kerzner (2003, p. 380) defined planning as "determining what needs to be done, by whom, and by when." It should, however, be kept in mind that the answers that the planning process will provide are an extension of the answers obtained during the construction planning process external to the project organisation (cf. Laufer et al., 1994; Snyder, 1982).

Laufer et al. (1992, p. 249) stated that "at the site level, construction planning includes developing the following:

1. The production means, such as major equipment and site layout.
2. The work methods, including immediate crew level resources.
3. The work sequence and project schedule.
4. The budget."

A difference between the questions posed by Laufer and Tucker (1987) and the description of planning at the construction site by Laufer et al. (1992) is that the latter does not include the identification and definition of activities. The identification and definition of activities is, however, most often included in descriptions of planning processes. For instance, Kerzner (2003, p. 378) stated that "one of the objectives of project planning is to completely define all work required", Bennett (1983, p. 186) stated that "the crucial project management role given our current understanding of the subject is to identify and clearly define the set of tasks needed to complete the project within a strategic framework formed by the objectives, the project description and the organizational arrangements" and Snyder and Glueck (1980, p. 73) stated that "a planning program is defined as those activities which are concerned specifically with determining in advance what actions and/or human and physical resources are required to reach a goal." There are two plausible explanations for the omission of identification and definition of activities by Laufer et al. (1992). Firstly, the study, similar to studies made by Winch and Kelsey (2005) and Zwikael (2009), dealt with a context where there was a professional planner, normally located off-site, in the contractor's home office (see Laufer et al., 1992). Such planners were not uncommon in Sweden during the 1960's and 1970's, but the role ceased to exist in an attempt to locate planning closer to the construction site (Nordstrand & Révai, 2002). Secondly, Laufer and Tucker (1987, p. 245, italics in original) stated that "*what?* is generally the owner's prerogative and *how? who?* and *when?* are predominantly in the contractor's

domain." It is possible, given the repetitiveness and routine execution of construction projects that Laufer et al. (1992) and Laufer and Tucker (1987) consider these activities as commonly understood in the description of a construction project. Nevertheless, this thesis considers the identification and definition of activities part of the planning process in line with Bennett (1983), Kerzner (2003) and Snyder and Glueck (1980). The decisions that provide answers to these questions are at the intersection between planning, coordination and control, and the execution of activities and are often, in line with Laufer et al. (1994), articulated in plans.

The uncertainty that was considered a source of opportunities by Andersen (1996), Blomberg (2003) and Lenfle and Loch (2010) was, from a planning perspective, considered a challenge by Laufer et al. (1992), Laufer and Tucker (1987) and Laufer and Tucker (1988). According to Laufer and Tucker (1988) it is the accuracy of the anticipatory decisions made that suffers. However, if these decisions are not made as part of a planning process it is said that resources with long lead times cannot be at hand when due, integration of project components becomes extremely difficult and optimisation planning is completely ruled out (see Laufer & Tucker, 1987). Laufer et al. (1992) located these decisions to short-term detailed planning processes involving the foremen.

PLANS

A plan is the articulated result of a planning process (Laufer, 1992; Mintzberg, 1981; Snyder, 1982). It constitutes a "record of a complex set of interacting decisions" (Ackoff, 1970, p. 3). As such, plans are tangible manifestations of planning processes, although, "planning must not be confused with the existence of a formal plan" (cf. Snyder, 1982; Wildavsky, 1973, p. 129). Whilst Zwikael (2009) perceived plans as the outcome of the planning process, this thesis maintains that the impact decisions have on the activities determines the planning (cf. Mintzberg, 1981; Wildavsky, 1973).

While several plans are used in construction projects, schedules may be those that have received the most attention (see Ahuja & Thiruvengadam, 2004; Laufer et al., 1994). They commonly articulate a contractor's plan for completing a project whilst emphasising the timing of activities and the sequence in which these activities are to be executed (Trauner et al., 2009). This thesis deals with two forms of schedules: those that are activity-based and those that are location-based (see Kenley & Seppänen, 2010b, 2010a). Whereas activity-based schedules treat activities as discrete events with time-based relationships, location-based schedules focus "on the relationship between the location of work and the unit of work to be done" and activities are considered as parts of location-dependent sets of activities (Kenley & Seppänen, 2010b; 2010a, p. 50). This has bearing on construction projects as the execution of activities "not only creates the completed facility, but also creates, temporarily, the spaces in which"

activities are executed (see Thiel, 2007; Winch & North, 2006, p. 473). This is a peculiarity the construction industry shares with, among others, shipbuilding (Winch & North, 2006).

According to Friblick and Olsson (2009) Gantt charts, which are activity-based schedules, are the form of schedules found on nearly all Swedish construction sites (Kenley & Seppänen, 2010b). Gantt charts are "graphical representations of the exact timing of all project activities" (De Meyer et al., 2002, p. 65). Activities are identified by the vertical axis and their placement in time are defined by the horizontal axis (Wilson, 2003). Gantt charts thus articulate the timing of each activity, its position in the sequence of activities as well as its duration (see Wilson, 2003). The difference between a linear, location based-schedule and a Gantt chart is that the former uses the vertical axis for identifying locations whereas the latter "do not include this feature except by coding activities" (Kenley & Seppänen, 2010a, p. 52). Schedules can thus articulate the answers to two of the questions that the planning process, according to Laufer and Tucker (1987), shall provide: the what and the when. But coordination and control can also be positioned as functions of the planning process based on the schedule (see Laufer & Tucker, 1987; Van de Ven et al., 1976).

COORDINATION AS A FUNCTION OF PLANNING

According to Van de Ven et al. (1976) coordination is needed in all organisations. It "can be defined as *managing dependencies among activities*" resulting from the use of common resources (Malone & Crowston, 1990, 1994; Malone et al., 1999, p. 429, italics in original). As the resources are both common and limited, the dependencies between them need to be managed since they are used when several activities are being executed (Malone & Crowston, 1990, 1994). Examples of such resources are both time and space (see Malone & Crowston, 1994).

However, coordination processes cannot be assumed present in organisations *per se*. Laufer and Tucker (1987) has positioned coordination as a function of the planning process. Planning was described as "harmonizing and facilitating clusters of construction activities which are characterized by a high degree of interdependence [… which] requires many diverse parties to work in close liaison with each other in terms of time and/or space" (Laufer & Tucker, 1987, p. 248). "By using the word 'harmoniously' [… Laufer and Tucker (1987) imply] that the activities are not independent. Instead, they must be performed in a way that helps create 'pleasing' and avoids 'displeasing' outcomes, that is, that achieves the goals" (Malone & Crowston, 1990, p. 360). Scheduling has been recognised as a coordination process by Malone and Crowston (1994), Van de Ven et al. (1976) and Wilson (2003). As an articulated result of the planning process dependencies managed by a schedule would

position coordination as a function of the planning process as described by Laufer and Tucker (1987).

Three basic types of dependencies were presented by Malone et al. (1999): flow, sharing and fit dependencies. "*Flow dependencies* arise whenever one activity produces a resource used by another activity […,] *sharing dependencies* occur whenever multiple activities all use the same resource [… and] finally, *fit dependencies* arise when multiple activities collectively produce a single resource" (Malone et al., 1999, p. 429, italics in original). It is suggested that all dependencies can be "analyzed as specializations or combinations of" these three (Malone et al., 1999, p. 430). Apart from positioning coordination as a function of the planning process, alternative coordination processes include first-come/first-served, priority orders, budgets, managerial decisions and mutual adjustments "through either vertical or horizontal channels of communication" (Malone & Crowston, 1994; Malone et al., 1999; Van de Ven et al., 1976, p. 323).

CONTROL AS A FUNCTION OF PLANNING

Definitions of control have been described as ambiguous (see Flamholtz et al., 1985; Green & Welsh, 1988; Malmi & Brown, 2008; Ouchi, 1979). A more holistic take on control was presented by Tuuli et al. (2010a, p. 189) who defined it "as all devices and systems employed to ensure that acts, behaviours, outcomes and decisions of individuals, teams and organizations are consistent with meeting organizational or project goals, objectives and strategies" (cf. Flamholtz et al., 1985). According to Nieminen and Lehtonen (2008) management control, especially cybernetic control, is the predominant mode of control described in the conventional project management body of knowledge. As such it is commonly applied as a system for management control which is "concerned with the achievement of overall organizational aims and objectives" (Nieminen & Lehtonen, 2008; Otley et al., 1995, p. S33). Management control differs from organisational control in that it covers only the devices and systems used by managers controlling subordinates whilst in "organisational control anyone in the organisation can act as the controller" (Nieminen & Lehtonen, 2008, p. 64).

Laufer and Tucker (1987) have positioned control as a function of the planning process. Planning was described as the process that "establishes targets and the course to reach them [… and control as] the process that ensures the course of action is maintained and desired targets are reached [… which] involves measuring and evaluating performance, and the taking of corrective action when performance diverges from plans" (Laufer & Tucker, 1987, p. 248). Such a control process corresponds to cybernetic control (cf. Dermer & Lucas, 1986; Flamholtz et al., 1985; Green & Welsh, 1988; Hofstede, 1978; Malmi & Brown, 2008; Nieminen & Lehtonen,

2008). Cybernetic control is based on a negative feedback loop resulting from the comparison of actual performance to a performance standard (Flamholtz et al., 1985; Green & Welsh, 1988; Hofstede, 1978; Malmi & Brown, 2008; Nieminen & Lehtonen, 2008). The cybernetic control process can be illustrated with five steps. Firstly, a performance standard is established based on the organisation's objectives, (Flamholtz et al., 1985). Secondly, actual performance is measured which initiates the third step: comparison between actual performance and the performance standard (Flamholtz et al., 1985; Green & Welsh, 1988; Hofstede, 1978; Nieminen & Lehtonen, 2008). Fourthly, information on unwanted deviations from the performance standard is fed back into the process under control and this finally results in corrective action (Green & Welsh, 1988; Hofstede, 1978; Nieminen & Lehtonen, 2008). Although the description by Laufer and Tucker (1987) of control as a function of planning is not limited to the schedule, it can be used to illustrate the cybernetic control process. Laufer and Tucker (1987) posit plans, such as schedules, as the performance standards against which comparisons will be made, and corrective actions based. The cybernetic control process is based on three assumptions: "there is a standard, corresponding to effective and efficient accomplishment of the organization's objectives", actual performance is measurable and the information from the comparison between actual and planned performance can be used to correct the process (Hofstede, 1978, p. 451). This implies that adhering to the schedule shall, if we interpret the description of control as a function of planning by Laufer and Tucker (1987) in the light of Hofstede (1978), lead to the purposeful attainment of objectives.

Using schedules as performance standards in cybernetic control processes has been questioned, for instance "it seems that [Henry] Gantt did not use his charts as do modern project managers do; and [… that he] may have rejected such a mode of use" (Wilson, 2003, p. 434). Instead, it seems that he preferred rivets driven as a measure of progress in shipbuilding (Wilson, 2003). Whilst shipbuilding is not construction there are similarities and perhaps more importantly, this points to alternative performance standards (see Egbu et al., 1998; Winch & North, 2006).

CASE DESCRIPTION

This thesis is based on a case study of the Kuggen project which involved the new construction a five-storey office building in Gothenburg. The building is a part of the Lindholmen campus of Chalmers University of Technology and the client, that now owns and operates the building, was Chalmersfastigheter AB. The discussions that led to the construction project date back to autumn 2007. Along with the university, Lindholmen Science Park AB and Älvstranden Utveckling AB, the client discussed how Lindholmen could be further developed. Since the closing down in 1976 of a shipbuilding yard, several companies and organisations have been established on that

site. At the same time, there has been a trend of increasing collaboration between academia, companies and organisations which created a need for meeting places.

The new building was to address that need, and in addition it was intended to act as a symbol for academia, Lindholmen and Gothenburg. In line with this intention the architect was given great liberty and this came to be expressed in the building's more striking features: its colourful façade and its circular shape and the cog-wheel design of each floor (see Figure 1). The gross floor area of the building is 5353 m^2. From the first to the fourth floor the number of cogs on each floor increases by two. The additional floor area resulting from the additional cogs is placed in the southern part of the building. The increase in size of successive floors provides shade for floors below. Shade for the fourth floor is provided by the moving screen that follows the position of the sun around the building (see Figure 2).

THE CONTRACT AND THE CONTRACTOR

In competition with five other contractors Peab Sverige AB was awarded the design and construct contract by the client. The client had acted in accordance with the Swedish Public Procurement Act and the procurement decision was contested by one of the other contractors competing for the contract. The appeal was, however, settled in the favour of Peab Sverige AB. The project was considered prestigious and according to Josephson and Christiansen (2012) four of the contractors had invested more time than customary in preparing their offers. The site engineer reported that Peab Sverige AB had spent 50 % more time on this offer than on previous projects of a similar size.

The contract had two parts, a fixed cost part and a target cost part coupled to an incentive. If costs did not reach the target cost, the gain would be shared by the client and the contractor. The fixed cost part covered the contractor's fee, the contractor's fee for alterations and additions, site management and general construction site expenses and the target cost part covered the construction workers, the subcontractors and materials. The contractor, Peab Sverige AB, carries out construction and civil engineering projects in Sweden, Norway and Finland. The company was founded in 1959 and has since the 1980's grown through acquisitions. It has 15 000 employees and a yearly revenue exceeding 40 billion SEK.

THE CONSTRUCTION PROJECT

The period set for the project stretched from November 2009 to May 2011. The contract was worth approximately 90 million SEK. Upon initiation a site manager, two supervisors and a site engineer were assigned to the project. Later on, during the second half of 2010, they were joined by additional supervisors. From mid-January

2011 to mid-April the same year at most five supervisors at a time were assigned to the project. The budgeted cost for the construction workers was 5.3 million SEK.

Figure 1 *The building's exterior. Photo: Tobias Hildorzon*

Figure 2 *The moving screen. Photo: Tobias Hildorzon*

The resources assigned to the project by the contractor's and the subcontractors' home offices varied over the duration of the project. Figure 3 depicts the resources assigned to the project on a daily basis. Work days in Sweden are eight hours. Josephson and Christiansen (2012) provides a detailed account of the resources consumed over the course of the project and includes the briefing and design phases.

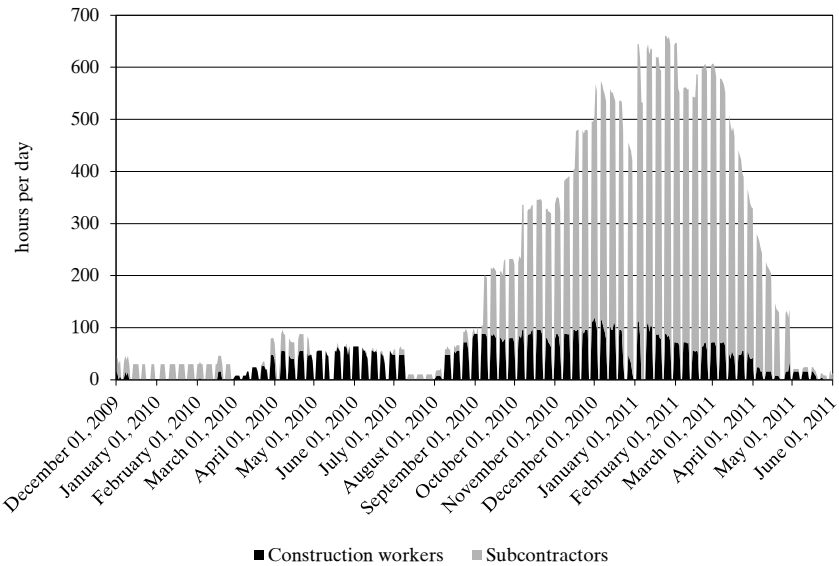

Figure 3 *The resources assigned to the project. Adapted from Josephson and Christiansen (2012).*

The contractor was awarded the contract based on an alternative offer that included a complete redesign of the load-bearing structure and the pile foundation. The redesigned load-bearing structure consisted of pre-cast concrete formwork elements and pre-cast concrete formwork wall panels. The ground conditions where the building is situated are complicated and the building rests on an approximately four meter layer of refilled land consisting partly of dredged material, with between 60 and 80 m of clay below that. With the initial pile foundation, consisting only of cohesion piles, the building's settlement was expected to approximately 60 cm over a period of 100 years. The alternative offer included a redesigned pile foundation which would restrict the expected settlement to between 20 and 25 cm over the same period. This offer included cohesion piles and end-bearing piles. The cohesion piles were driven to 52 m below the base plate and the end-bearing piles were cut off approximately one meter from the base plate and functioned as reversed cohesion piles.

METHOD

This thesis is based upon a case study in which ethnographic research methods were applied. The case studied, the Kuggen project, presented an opportunity to study planning processes in practice. The research design and the research methods applied have allowed for the aim of this thesis to develop over the course of the study. According to Bryman (2008), such open-ended approaches are common in ethnography. In line with classic case studies this thesis is based upon the study of a single case (see Bryman, 2008; Dyer & Wilkins, 1991). Whilst interviews were conducted with site managers in four other construction projects, the validity gained from providing a rich description of the context in which processes were observed outweighed the comparative insight that could have been gained from additional cases (Dyer & Wilkins, 1991; Pink et al., 2010). These interviews were conducted at the early stages of this case study. A comparison with the data collected from the case under study revealed that interviews alone would not provide sufficient information to reach the level of understanding of practice that was sought.

Access to the case was enabled by being hired as an industrial doctoral student by the contractor. The open-ended research design is reflective of how the case constituted an opportunity to study planning processes in practice. In line with "the opportunistic and adaptable nature of ethnographic research in practice" the collected data guided subsequent analysis (Pink et al., 2010, p. 655). Access to the construction site did not equate with access to data. Although the site manager acted as a gate-keeper in providing access to the construction site, this was not sufficient to develop suitable relationships with the supervisors, construction workers and subcontractors for the necessary data collection. One way in which such relationships were formed was through the daily three o'clock walks around the construction site, and striking up conversation with the supervisors, the construction workers and the subcontractors. These relationships were gradually developed over time, and were substantiated by social invitations, e.g. lunch at the restaurant next to the construction site, and by spontaneous conversations initiated by the site manager, the supervisors, the construction workers and the subcontractors. It was considered important to form as many relationships as possible so as to avoid too much reliance on a few key informants, as well as for the acquisition of broad understanding (see Bryman, 2008). Certainly, a good laugh every now and then - as when accidentally stepping into wet concrete right after one of the floor structures had been cast - did not hurt.

PARTICIPANT-AS-OBSERVER

The study spans 18 months of observations, principally while adopting the role of a participant-as-observer (see Gold, 1958). During the first twelve months, it included

participating in the *ex ante* planning of both the structural work and the framework supplement work, assisting site management by e.g. taking-off quantitates from drawings, and in attending meetings. Whilst participation carries with it a risk of influencing the processes being studied, an unwillingness to participate carries with it the risk of ethnocentrism that, according to Gold (1958), hinders the development of understanding. During the last six months participation involved adopting the role of a supervisor which, in turn, carried with it the risk of "going-native" (see Bryman, 2008; Gold, 1958). One of the suggestions by Gold (1958), a cooling-off period, was employed in the study. Subsequent to the period of observation at the construction site, twelve months were spent at the Department of Construction Management, Chalmers University of Technology that enabled looking back while assuming a more critical stance towards the observations. Whilst ethnographic research methods carry with them particular risks, closeness to the collected data can be considered a strength that, according to Eisenhardt and Graebner (2007), helps keep researchers honest and disciplined.

DATA COLLECTION AND DATA SOURCES

According to Bryman (2008), the degree of open-endedness in studies in which ethnographic research methods are used varies. Over the course of the Kuggen project data collection was guided by the aim of the study. Whilst the aim narrowed the collection of data to some extent, it did not limit the amount of data collected. Saturation was reached when sufficient data to describe a process had been collected and further data only served as confirmation. When a process could be adequately described, the data subsequently elicited related to changes to, or incidents affecting that, process. This way, the ethnographic research methods used also guided the data collection in that there was no telling what would come next.

Data was collected from sources consistent with ethnography, such as observations, conversations, semi-structured interviews, documents and photographs (cf. Phelps & Horman, 2010). Observations and conversations were recorded in field notes. During some of the planning processes, such as job planning, and whilst attending weekly meetings held at the construction site they were recorded openly. The field notes developed over the course of the study. Whilst initial field notes focused more on details in a planning process or details of the discussions held during meetings attended, later field notes were more descriptive as patterns and structure had been identified. Conversations and other observations were recorded in field notes afterwards. A peculiarity of ethnography is that data can become available at any moment. On several occasions, field notes were the consequence of conversations with construction workers during the commute to and from the construction site. Excerpts from two field notes, recorded during a meeting held on September 3, 2010 and during a morning brief held by the site manager on September 6, 2010 are included below.

Tape recorded semi-structured interviews were conducted with the site manager on September 21, 2010 as well as with each of the ventilation, electrical and plumbing contractors' foremen on November 15 and 16, 2010. These interviews enabled collecting data not only on the views held by each of the interviewees, but also on processes that had not been amenable to observation, e.g. how the subcontractors decided which activities to carry out. The interviews were based on interview guides prepared beforehand. Photographs to complement the field-notes were taken over the course of the Kuggen project. Documents have, besides being collected during the period spent at the construction site, been available through access to the contractor's intranet afterwards. Schedules, drawings, minutes from meetings and a casting diary as well as other documents have been used as a complement to the field notes.

EXCERPT 1: MEETING HELD ON SEPTEMBER 3, 2010

They're discussing planning. The contractor's foreman says that there is not sufficient time to carry out the activities. He gains the support of one of the supervisors. They feel that they are falling behind because they are not getting material from the floors below to the floor where they are working. The foreman says that he was under the impression that two of the construction workers were going to see to it. Another supervisor says that he was as well until you (referring to the foreman) reassigned them to other activities. They discussion turns to the sheet metal used as sealing around the columns when the site manager in verbatim says: "This is the inventors' construction project." The foreman adds: "It is a bit like that, yes." Returning to the topic of planning the site manager says that whilst it looks tight they won't need the shoring towers on the next floor. One of the supervisors says that they indeed will and that they had made the decisions the day before.

EXCERPT 2: MORNING BRIEF HELD ON SEPTEMBER 6, 2010

The lasting impression from the morning brief was a lack of enthusiasm amongst the construction workers. I am not sure whether it is because it is Monday or whether they are weary. […] The site manager asked if anyone felt called upon to do column underpinning. No one replied. One of supervisors said that one out of two concrete finishers would have to take it upon themselves. It did not look as if one of the concrete finishers were up for it. The site manager noticed. She asked how he felt about it. He said that they had a lot to do already as it was.

ANALYSIS

Principally, the analysis of the collected data began by coding the field notes. Field notes that bore reference to the four questions that the planning process, according to Laufer and Tucker (1987), should provide answers to were coded. The analysis identified the processes that provided answers to these four questions regardless of

whether these were planning processes or not. The analysis carried with it a risk as it required "data to fit into *preconceived* standardized codes", however, coding was not intended to verify the presence of specific processes but rather to identify the processes present (Bryman, 2008, p. 542, italics in original). "One of the most commonly mentioned criticisms of the coding approach to qualitative data analysis is the possible problem of losing the context" (Bryman, 2008, p. 553). Whilst the analysis involved breaking up the field notes, in order to attain an increased understanding of the processes observed in relation to these four questions, care was taken to put data back in a manner reflective of the chronology of events in the written account. Writing an account of the period of observation proceeded in a chronological order, period by period, which involved also taking into consideration the data not subject to coding.

The written account highlighted the discrepancies between practice and the conceptualisation of the construction planning process as described by Laufer et al. (1994) and Laufer and Tucker (1987). Coordination and control theory were applied on the data to further analyse how coordination and control could have been functions of the planning process in the project in question. These theories were also used in analysing how the observed coordination and control processes were dependent upon the planning process.

VALIDITY AND RELIABILITY

In line with ethnographic traditions this thesis includes a written account of the 18 months of observation on the Kuggen project (see Bryman, 2008). According to Phelps and Horman (2010), a written account is important in enabling a reader to judge the validity and reliability of case studies where ethnographic research methods are applied. Whilst a case is not a sample of one reliability can, according to Phelps and Horman (2010), also be judged based on the written acoount (Bryman, 2008). It shall "provide enough context and nuance that others will understand what aspects of the unique situation are generalizable to similar situations" (Phelps & Horman, 2010, p. 61). A tape recorded respondent validation of the written account was conducted with the site manager of the Kuggen project. Minor corrections followed on the respondent validation and the site manager confirmed the representativeness of the written account. Whereas the written account was assessed as representative by the site manager, the judge of this thesis is the reader and whether the case studied has been properly understood is for the reader to decide based partly on how well such an understanding is communicated in the written account (cf. Phelps & Horman, 2010).

THE KUGGEN PROJECT

This chapter is based on my observations of the project in question over a period of 18 months, from December 2009 to May 2011. The observations made are reported chronologically in four sections. The first section covers the *ex ante* planning of the structural work from the time when the contractor had just become established on the construction site. The second section covers the structural work. As the contractor did not separate the activities that were related to the base plate and the basement walls from those that were related to the load-bearing structure, as is sometimes customary, neither have I. The third section, which chronologically coincides with the structural work, covers the *ex ante* planning of the framework supplement work. The fourth section covers the framework supplement work up to the final inspections.

Decisions made outside the observation period are taken into consideration. Even though I was a stranger to the construction site upon arrival, I was not a stranger to the project. I had covered the briefing and design phases of the project in a previous study and knew that the contractor had been awarded the contract based on an alternative offer (see Christiansen, 2010). Decisions made by the contractor while preparing the alternative offer were reflected in the processes that I observed on the construction site. The contractor had suggested a complete redesign of the load-bearing structure, which shortened the period required for the structural work. Shortening the structural work period entailed starting the framework supplement work earlier. While the framework supplement work could be initiated before the building would be weatherproofed, progress would depend on the length of time required for weatherproofing. Weatherproofing the building began with the mounting of curtain walls so the sooner mounting commenced, the sooner the framework supplement work could be initiated.

However, the redesigned load-bearing structure was based on pre-cast concrete formwork elements that required temporary support from below. The prospect of being able to commence the framework supplement work earlier depended on not having to use scaffolding for the temporary support of the overhanging pre-cast concrete formwork elements. Scaffolding would have delayed the mounting of curtain walls by preventing access. Preparing the alternative offer included making decisions such as these, which limited the options available to site management.

Moreover, there were prior decisions made that influenced the project and that were reflected in the processes observed on the construction site. During scheduling periods were set for the structural work and the framework supplement work by the site engineer and a scheduling consultant. These periods, considered realistic at the time,

would provide a basis for later scheduling. A period of five months and two weeks had been set for the structural work with the mounting of curtain walls planned to begin after two months and two weeks.

EX ANTE PLANNING OF THE STRUCTURAL WORK

I joined the project in December 2009 when initial work, excavation and piling, was being carried out by a subcontractor. Site management had recently moved to the construction site, and was engaged in planning the upcoming structural work. I had met the site manager, the site engineer and two of the supervisors previously. It became clear to me that site management considered the structural work less challenging than the framework supplement work. They saw themselves and their colleagues as proficient at managing structural work and described this phase as a customary source of profit for the contractor. Instead, it was while managing framework supplement work that they had encountered difficulties. Particularly, it was difficulties related to the frequent increase in size of the project organisation during this phase. On a later occasion the site manager told me that she, at the time, thought of the building as a large building with limited complexity.

Site management's planning of the structural work consisted primarily of the scheduling process. The site manager had begun scheduling the structural work prior to moving to the construction site. The schedule that she had prepared covered the base plate and the basement walls. The remaining work was to be scheduled by site management when on the construction site. The scheduling of the structural work which began in December was carried out alternately by site management and myself, or by the site manager herself. A few of days into the scheduling the site manager left the construction site for a few of days, and instructed the supervisors and me to continue scheduling the structural work. We were all unfamiliar with the scheduling software used and found it difficult to progress. The many activities already entered into the scheduling software were one source of problems, another being our difficulties in obtaining an overall view of the structural work using the scheduling software. Rather than adjusting the activities in the schedule prepared by the site manager we chose to make a new schedule and enter activities one by one as we progressed. Although the scheduling process focused on the timing of future activities and the sequence in which they were to be carried out, it also provided a forum for decision-making. Several decisions had been made beforehand, including the placement of the tower crane and agreeing to mount the curtain walls from the entrance floor upwards. Furthermore, the site manager had suggested that the activities comprising the structural work on each floor be split in three. It did, however, become apparent during the site manager's short absence that the supervisors did not share this view.

SPLIT-UP ACTIVITIES

The supervisors opposed the site manager's suggestion to split the activities comprising the structural work on each floor into three groups, and dividing the base plate and the floor structures into three corresponding sections. If the suggestion was accepted, activities such as the mounting of pre-cast concrete formwork elements and pre-cast concrete formwork wall panels along with the castings of the base plate and the floor structures would be performed as three separate activities on each floor. From the supervisors' perspective, splitting the activities into three would create extra work, which would otherwise not have been necessary. One such activity was mounting stop end formwork in order to prevent concrete from pouring into adjacent sections during casting.

Whilst the site manager argued for three separate castings, the supervisors argued that the entire base plate should be cast during one extended working day. The site manager's main argument was that splitting activities was required if the structural work was to progress according to plan. Her main reason for splitting the activities was to avoid the risk of having construction workers being idle for periods of time. There were, throughout the structural work certain activities that upon completion triggered the start of several other activities. Such activities included the castings of the base plate and the floor structures. Once cast there were several activities that could be initiated. The site manager and the supervisors reached a compromise wherein the activities comprising the structural work were split into two. A compromise the site manager later admitted regretting. The discussion brought to surface the site manager's concern on progress being made with the load-bearing structure as well as the supervisor's concern for the duration of activities. Once the decision to split the activities comprising the structural work into two had been taken scheduling was resumed.

SCHEDULING

Scheduling was an incremental process by which site management gradually progressed through the structural work. Activities at each step were identified and sequenced before being assigned durations. The scheduling software was used throughout the scheduling process. Site management based their interpretation of the construction project on the building documents. In combination with the decisions made and the estimates prepared beforehand they identified the activities that comprised the structural work. Using the scheduling software, site management sequenced the activities according to their own preferences.

The contractor's policy was to assign durations to activities based on base piece-rates, and the estimates that site management had at their disposal had been made accordingly. However, the estimates had been made by the contractor's home office

rather than by site management which appeared reluctant to use them. Site management was not convinced that the base piece-rates had been correctly applied, and spent time attempting to match the estimated durations with the base piece-rates. Furthermore, site management doubted the validity of the base piece-rates. They were not confident that activities could be carried out within the durations given using the base piece-rates. In the end, the durations assigned to activities by site management during scheduling were based on durations recorded during the site manager's earlier projects as well as on the above estimates. While scheduling was the principal process in site management's planning of the structural work, there were also other concurrent influential processes, such as the procurement of suppliers and subcontractors.

METHODS

Site management needed a method that would temporarily support overhanging pre-cast concrete formwork elements. However, the decisions that had been made prescribed a method that would not, by preventing access, delay the mounting of curtain walls from the entrance floor up. The floor structures would eventually be supported by columns but, until these were sufficiently strong temporary support would be needed. The bulk of the pre-cast concrete formwork elements were to be supported by formwork girders and slab props. Site management called for bids from two suppliers that, in addition to providing the project's wall and column formwork, formwork girders and shoring, would provide a method that would provide temporary support for the overhanging pre-cast concrete formwork elements. The methods offered by the two suppliers were comparable and site management's selection became a matter of price. The method selected included shoring towers and formwork girders. These towers extended beyond the edge of the floor structures on which they were placed and provided temporary support for the overhanging pre-cast concrete formwork elements by transferring the loads further inwards. Once the floor structures had been cast, and were sufficiently strong, these towers would be replaced by slab props which in turn would remain there until the columns had reached sufficient strength. Whilst the method confirmed the feasibility of the decisions made so far, site management still needed to sequence the activities comprising the structural work to fit the set period.

THE PLAN

The period allotted to the structural work was based upon the premise that excavation and piling work were to have been concluded by February 19, 2010. The period's farther limit was set by the commencement of the framework supplement work. The activities comprising the structural work had been sequenced in the scheduling software. However, site management needed to sequence the activities to fit the period set for the structural work. Two options were available to site management:

scheduling activities to be executed simultaneously or shortening the scheduled duration of the activities. This was a process of managing dependencies. A process during which site management, while considering the decisions made and the constraints present, decided which activities could be executed simultaneously. The process was based on site management's knowledge of the activities. As several of the activities were to utilise the tower crane, its capacity constituted one of the constraints that had to be taken into consideration. It limited the number of activities that could be executed simultaneously.

Scheduling up to this point had been a fairly straightforward process by which site management gradually progressed through the structural work. The process of sequencing activities to fit the period set for the structural work was less straightforward. It was an iterative process carried out mainly by the site manager herself. The supervisors' main contributions to the *ex ante* planning of the structural work, were their input into the decisions that were made and on methods that were discussed. The completed schedule reflected the decision made to split activities in two. The activities that were to be done in each section were sequenced to start once the activities in the corresponding section on the floor below had been completed. With the completed schedule site management were ready to commence the structural work as soon as the excavation and piling work had been concluded.

THE STRUCTURAL WORK

The excavation and piling work suffered setbacks and did not progress according to plan. Piles were lost in the clayey soil and cracked when driven through moraine. The structural work was, as a consequence, delayed and re-planned to begin March 11 instead of February 22 as originally intended. The planned commencement of the structural work had been based upon information provided by the subcontractor doing the excavation and piling work. The site manager later stated that, if she found herself in a similar situation once again, she would be certain to schedule a buffer week or two before the commencement of the structural work to accommodate delays in the piling work. Once the excavation and piling work was completed, the construction workers could start their structural work activities.

The site manager delegated the responsibility for these activities to the supervisors. Each supervisor was responsible for several activities, such as the castings of the base plate, the reinforcement of the base plate, and the column formwork. Their responsibilities included setting out, providing the construction workers with the materials, tools and machinery needed to carry out these activities and the quality assurance of the completed activities. The supervisors also called in subcontractors as needed throughout the structural work. The supervisors spent most of their work days on the construction site.

OUT OF LINE?

Most, but not all, of the activities comprising the structural work were sequenced to commence once the activities in the corresponding sections on the floor below were done. This was a decision made by site management with the progression of structural work according to plan in mind and applied to the activities related to the load-bearing structure. There were also activities that were not subject to this decision, which were sequenced to allow for and to support progress made on the load-bearing structure. Amongst these were those activities concerning the slabs that would encircle the building just below ground level. These slabs were placed close to the steps leading from the ground level up to the entrance floor, and were intended to reduce the difference in settlement that occurs over time between the steps and the building. The schedule stipulated that activities that were related to these slabs were to commence on May 11 and that all the slabs would be cast by June 8.

On the construction site, the second casting of the base plate was done two days ahead of schedule on April 12. After the first casting of the base plate on March 29, the schedule prescribed that the activities related to the first casting of the entrance floor should start so that the castings would be completed on May 5. However, on the construction site, activities related to the slabs encircling the building were brought forward by the supervisors and done ahead of schedule, so that the castings for the slabs were ready by May 21 instead of June 8. This delayed work on the load-bearing structure. As a result, the castings of the entrance floor slipped from the scheduled May 5 to May 31.

Having noted that activities were performed out of sequence, the site manager repeatedly rescheduled the structural work. However, after re-evaluating the decision made to split the activities comprising the structural work on each floor into two, the site manager ceased to reschedule the structural work. It was decided that once the castings of the entrance floor had been made, the activities were to be split into three instead of two. The ambition was to speed up progress on the activities related to the load-bearing structure. There were two reasons behind the site manager's decision to cease rescheduling the structural work. Firstly, since activities were performed out of sequence and no longer in accordance with the schedule, she did not see any point in rescheduling. Secondly, the site manager described the schedule as being too detailed to reschedule to better reflect the actual sequence of activities carried out on the construction site. Thereafter the schedule was used during site meetings with the client to communicate the progress being made on the structural work and the planned remainder thereof at a general level. It did not express site management's planning of the activities comprising the structural work. However, other schedules were used: one covering periods of eight weeks and one covering single weeks; and these better described site management's planning of the structural work.

SCHEDULES FOR EIGHT WEEK PERIODS

The schedules covering periods of eight weeks were primarily delivery schedules presented on a pair of A3 sheets. They articulated the timing of deliveries of pre-cast concrete formwork elements and pre-cast concrete formwork wall panels. But the timing of some of the activities, such as the casting of the floor structures and the mounting of shoring towers, were also articulated. The first weeks were often covered with greater specificity and more activities were included for these than for the later weeks. Activities were frequently defined by reference to the sections that the floors had been divided into. Whilst the schedules were a result of the site manager's efforts rather than anyone else's, the timing of the deliveries of pre-cast concrete formwork elements and pre-cast concrete formwork wall panels, as well as castings was frequently discussed by site management during meetings held on Wednesdays. The site manager described the process as a balancing act, a balancing act between not making sufficient progress on the load-bearing structure and there not being sufficient time to complete activities. Whilst the site manager often argued for bringing activities forward in the schedule, the supervisors were often sceptical and seemed less confident about there being sufficient time to carry out the activities. Whereas site management used the estimates prepared beforehand and data from the site manager's earlier projects during the *ex ante* planning of the structural work, the timing of deliveries and activities included in these schedules was based on rough estimates by site management. A problem was that the activities carried out between the castings of the floor structures were not identical. It was not until the floor structure of the second floor had been cast that activities became identical for the rest of the load-bearing structure, and previous durations were able to provide a viable basis for assigning durations to the remaining activities.

SCHEDULES FOR ONE WEEK PERIODS

The schedules covering periods of one week, as opposed to the schedules covering periods of eight weeks, resulted from the joint efforts of the site manager, the supervisors and the foreman. Scheduling the activities for the following week was a part of the Wednesday meetings. The site manager and the supervisors along with the foreman assigned activities to the construction workers one by one. The timing of activities was based on their rough estimates of when the preceding activities would be finished. The schedules were presented on A3 sheets that were placed on view for the construction workers. Whereas the schedules covering eight week periods often made reference to the sections that the floors had been divided into, these schedules did not. A common observation made at these meetings was that the last construction workers in these schedules were not scheduled to carry out activities towards the end of the following week. However, this should not be interpreted as construction workers being left idle towards the ends of the weeks, but rather that they were not assigned any specific activities in these schedules on these days.

At the beginning of the structural work attempts were made to render the schedules covering periods of one week more visual. Tabular schedules with a floor plan and space for a written description of activities in each cell were used. The rows corresponded to the construction worker or the construction workers that were to carry out one or more activities. The columns covered the work days, Monday through Friday, and the planned progress for each activity was to be marked on the floor plans day by day so as to enable daily follow-up of the progress being made. These schedules were only momentarily used. The supervisors found them difficult and unnecessary. They often discussed how the planned progress was to be marked on the floor plans in the cells of the tabular schedules, and often criticized the level of detail required for the written descriptions. The supervisors frequently pointed out that this was unnecessary as the construction workers were already familiar with the activities.

The schedules for eight week periods and one week periods articulated site management's continuous planning of the structural work. This planning process was described as a balancing act by the site manager; to me it seemed different from the *ex ante* planning of the structural works. Fitting the structural work or what remained of it, to the period set appeared less explicit. The explicit utterances seemed to occur during discussions between the site manager and the supervisors observed during the Wednesday meetings. But there were also indications of site management not being at terms with the project. For example, the frequent changes of timing of deliveries and activities made by the supervisors, frequently without including the site manager and at times within hours of a meeting, as well as the discussions during the Wednesday meetings. Matters did improve, and by early June the sequencing of activities to be carried out once the casting of the floor structures was completed had stabilized.

A STABLE SEQUENCE

During the Wednesday meetings site management together with the foreman assigned activities to the construction workers. However, rather than assigning construction workers to the activities they assigned activities to the construction workers. The activities that had been assigned to each of the construction workers had, according to the site manager, remained fairly consistent. In other words, the construction workers had been engaged in recurring activities albeit in different sequences throughout the structural work. The changes to the activity sequence was attributable to the uncertainty present in the durations assigned to the activities, and further evidenced by the frequent changes made to the timing of deliveries and activities. The initial decisions that had been made regarding the timing of activities related to the base plate and the basement walls had been made on a day to day basis. The sequence in which activities were carried out was seen to become more consistent as work on the

load bearing structure progressed. By early June a list was made formulating the sequence in which activities were to be carried out after floor structures had been cast. The list also named the construction workers assigned to each of the activities.

The supervisors pointed out that there were activities that were missing from the schedules and the above list. According to the site manager this constituted common practice and the activities in question were such that construction workers were engaged in frequently. In other words this was part of construction workers' and site management tacit knowledge. These were activities that the construction workers divided between themselves, an ability that the site manager attributed to their professional capabilities. During the initial structural work there had not always been sufficient time to carry out these activities. The sequence in the list was based on how activities were executed on the construction site. It epitomised site management's understanding of the relationships between the durations of the activities rather than the durations and/or timings of the specific activities and deliveries. The site manager felt that the carrying out of activities seemed to have become more consistent after the formulation of the list. However, it remains unclear whether it was a consequence of the list. Regardless, the difficulties with the timing of activities and deliveries remained.

DURATIONS

Several of the activities were not completed within their assigned durations. This was not necessarily due to the activities themselves, which were similar to those in earlier projects, but rather to the conditions prevailing on the construction site. Such activities included the form erection that was done from underneath the pre-cast concrete formwork elements. Whereas the thickness of most of the floor structures of the first and second floors had been set to 265 mm and 250 mm, the edges of these floor structures were to be 100 mm thicker. Hence, the outermost pre-cast concrete formwork elements were positioned 100 mm lower than those further in. The gap that was created between the outermost elements and the adjacent inner elements needed to be covered. The site manager had initially considered the building to be spacious, but when the construction workers fastened wooden boards to cover these gaps from underneath the floors were full of shoring making them appear substantially smaller than initially. The shoring made moving a ladder and wooden boards around the floors time-consuming. When the activity durations had been assigned these conditions had not been taken sufficiently into account and consequently activities were not completed within their assigned durations.

The site manager described the castings of the floor structures as the most important structural work activities. The termination of each casting triggered several activities and represented progress being made with the load-bearing structure. Similarly,

casting required that several prior activities had been carried out in advance. This pre-requisite applied also to the mounting of pre-cast concrete formwork elements. The form erection done from underneath the pre-cast concrete formwork elements was of importance for the casting of the floor structures of the first and the second floors only. However, it, along with the other activities not completed within their assigned durations affected the timing of the castings as well as the mounting of the pre-cast concrete formwork elements. Neither site management nor the construction workers were in favour of keeping the truck with the pre-cast concrete formwork elements waiting on the construction site if the preceding activities had not been completed within their assigned durations. Nor did they like temporarily off-loading the pre-cast concrete formwork elements at the construction site, but preferred to mount them directly from the truck upon delivery at the construction site.

While the list showed the sequence in which the activities were to be carried out after a casting of a floor structure was completed, past durations were not yet, according to the site manager, reliable predictors of future progress. The activities carried out on different floors were not identical. An example being the form erections underneath the pre-cast concrete formwork elements which were carried out before the floor structures of the first and the second floors were cast. The activities following the castings of the floor structure for the second floor were identical except for floor sizes. Besides being indicative of the difficulties experienced, the changes made by the supervisors to the timing of deliveries and activities were, also a representation of flexibility. The site manager later commented on the situation stating that it was the state of the market that enabled the flexibility. During a building boom it might not have been possible to change the timing of deliveries. But flexibility was not restricted to the timing of deliveries and activities, also methods experienced change.

FLEXIBILITY

On several occasions the site manager referred to the project as the “inventors’ project”. She was referring to the frequent changes of methods throughout the structural work. These changes were often instigated by the construction workers. A method that was changed was the attaching of slab props to the overhanging pre-cast concrete formwork elements (see Figure 4). These were the slab props that, once the floor structure had gained sufficient strength for the shoring towers to be removed, were to transfer the loads inwards until the columns were sufficiently strong. The construction workers had initially transported the slab props in a boom lift and then attached them to the overhanging pre-cast concrete formwork elements while standing in the boom lift.

Figure 4 *Column formwork on the third floor, shoring towers and slab props hanging from the overhanging pre-cast concrete formwork elements on the second floor, slab props attached to the floor structure below on the first floor and formwork girders, shoring and slab props on the entrance floor.*

This method was not liked by the construction workers who considered it cumbersome. The method adopted instead was one suggested by a construction worker: the slab props were attached when the pre-cast concrete formwork elements were lifted off the truck by the tower crane. This meant that when the pre-cast concrete formwork elements were lifted and positioned on the formwork girders the slab props had already been attached and could be left hanging from the overhanging pre-cast concrete formwork elements until the shoring towers were removed. The slab props were then attached to the floor structure below.

RIGIDITY

Though many of the processes observed throughout the structural work were flexible, rigid practices were observed as well. On the construction site most of the construction workers worked in pairs, and I have understood this is common practice. Activities were often assigned to pairs of construction workers throughout the structural work, and most often they were regarded as pairs rather than individuals. Several of the construction workers had been working together in the same pairs for years and were assigned to one project after another as intact units. This affected the processes as well as the decisions made throughout the structural work. The durations that were assigned to activities were often based on the supposition that the activities were to be carried out by pairs of construction workers. At one point splitting up a pair was contemplated. The site manager believed that it might speed up the progress being made. Although the site manager stated that it was possible to split up pairs, it appeared to have been a charged issue that had to be handled delicately. This was an example of a rigid practice. Not only did it appear to be a sensitive matter to separate pairs, but most activities were planned to be carried out by pairs, rather than by three or five construction workers. It also reflected the care with which site management handled some of the questions that seemed to have been important to the construction workers.

The number of construction workers remained fairly constant throughout the structural work till the end of August. With the framework supplement work approaching, two more carpenters joined the project. Construction workers were assigned to the project by a personnel coordinator who was a part of the contractor's home office. The site manager requested these two carpenters, as well as others later on, from this personnel coordinator, even though it became clear upon their arrival that she had not known which activities they had prior experience of. They were assigned to the activity that, at the time, was in the greatest need of additional resources: shoring. As it turned out the two carpenters had only limited experience of shoring and it became clear that the other construction workers were not happy with the decision. The other construction workers were uneasy, and on one occasion one of them told me that it would have been better if other carpenters with more experience

of shoring and thus more productive, would have been chosen. The construction worker told me he was not criticising the carpenters but rather the way in which construction workers were assigned to projects without taking into consideration what kind of activities they had experience in.

BASELINES

Apart from the castings - considered the most important activities by the site manager - the supervisors and the construction workers appeared to attach great importance to the mounting of pre-cast concrete formwork elements. These were activities that once done triggered other activities. While it was possible, and did indeed occur on a few occasions, neither site management nor the construction workers favoured temporarily storing the pre-cast concrete formwork elements on the construction site. They preferred mounting the pre-cast concrete formwork elements immediately upon delivery at the construction site. Also, keeping the truck waiting at the construction site incurred additional costs. Any delay in these activities pushed back subsequent activities and could leave other construction workers standing idle waiting the release of activities.

On the construction site the supervisors and the construction workers appeared to show little concern for the timing of many of the activities, as, for instance, the mounting of shoring towers. It was important that these and other activities were carried out in the time allotted so as not to delay the casting of the floor structures and the mounting of pre-cast concrete formwork elements, but whether two or three shoring towers were mounted in one day was of lesser importance. Naturally, if all of these activities were delayed then the casting of the floor structures and the mounting of pre-cast concrete formwork elements would also be delayed. The difference to the previous case is that if one of these activities, such as the mounting of shoring towers, was delayed it would not necessarily mean that the construction workers were left standing idle waiting the release of activities. At least not, unless it delayed the casting of the floor structures and the mounting of pre-cast concrete formwork elements. There was greater flexibility in timing these activities.

This notion was further justified in September when one of the supervisors had marked the deliveries of pre-cast concrete formwork elements on a floor plan and placed it on a sign next to the construction elevator on the third floor landing. There was no further information on the sign than the timing of deliveries of pre-cast concrete formwork elements so it may very well have been the case that just that information was needed by the construction workers and supervisors. This was most certainly the case when the sequence of activities had already been set, and it can be safely assumed that the construction workers, as well as the supervisors, were aware

which activities were to be carried out as well as which construction workers would be involved.

EXERTING INFLUENCE

Throughout the structural work site management remained flexible regarding the methods applied as well as the timing of deliveries and activities, however, there were also rigid structures in place that limited the flexibility available to site management. The construction workers were mainly carpenters and concrete finishers. These tradesmen do not engage in the same activities. Before the construction workers begin working, agreements are made between the contractor and the construction workers, via their union, regarding the activities that they are to be involved in. The agreed upon activities are assigned to the construction workers and site management cannot easily bring in subcontractors for these activities. Furthermore, the construction workers' perception of the contractor's policy was that all activities they were competent in were to be executed by construction workers rather than subcontractors. This limited the amount of flexibility available to site management. An example was the cutting and placement of plastic insulation on the base plate. As a means of raising the floor level, concrete would then go over the plastic sheet. This activity was scheduled for the end of November. This was a period during which site management was not certain that sufficient time would be available. Site management discussed calling in a subcontractor for this activity at a meeting held on September 22. While appearing eager to do this, they said that they would have to talk with the construction workers before making any decision. Keeping the activity in-house might lead to increase in the construction workers' piece-rates. As it turned out, the construction workers were not willing to let the activity be outsourced and carried it out themselves.

FINISHING THE STRUCTURAL WORK

The structural work neared the end during the second half of October as the final activities related to the load-bearing structure were carried out. The final casting of the roof was done on October 15. The initial delay caused by the set-backs encountered by the subcontractor undertaking the excavation and piling work, could not be recovered. During the initial structural work, while the site manager was still rescheduling the structural work, the final casting of the roof was planned for September 13. Whilst casting was carried out as late as in January and even March 2011, the end of October marks the end of the structural work. From then on, site management's focus was on the framework supplement work.

The processes observed over the course of the structural work were not the same as those initially observed. The initial schedule was not used as had been intended. Site management had been more flexible than first planned but had also learnt from the

structural work. The site manager thought that it might be sufficient for her to focus on keeping track of the important deliveries and the casting of the floor structures, and that it might be better to leave the rest of the activities to the supervisors and the construction workers. The exact timing of the other activities was less critical if satisfactory progress was being made with the load-bearing structure.

Over the course of the structural work site management's, and especially the site manager's, changed comprehension of the project became apparent. Activities were not completed within their assigned durations and the conditions prevailing on the construction site were not those expected. There was more uncertainty associated with the carrying out of activities than initially thought. In a sense, all of this was reflected in the processes observed. The list with the activity sequence did not focus on the timing of activities but on the relationships between the activities relating to the load-bearing structure, on assuring that progress was being made with the load-bearing structure, and on assuring that construction workers were not standing idle waiting the release of activities. By remaining flexible, being willing to change the methods applied and by being able to adapt to their changed perception of the project, site management may not have recovered from the initial delays but did take control of the project. Activities were not carried out according to schedule. However, some parts of the planning process were reflected in the activities underway. The list was an example of this and the split activities another. The split of activities was reflected in the deliveries of pre-cast concrete formwork elements making it harder to deviate from the planned sequence. Furthermore, by allowing the activities to sort themselves out to some extent, site management was able to learn from the activities and the project and be able to control it better.

EX ANTE PLANNING OF THE FRAMEWORK SUPPLEMENT WORK

The planning of the framework supplement work began in spring 2010. The supervisors were spending most of their work days on the construction site and became less involved in the planning process than the site manager and myself. The planning process, like the *ex ante* planning of the structural work, was principally represented by the scheduling process. However, preceding the scheduling process there were other influential processes that influenced the scheduling and splitting of activities.

Over the course of the framework supplement work the schedule was expected to accommodate adjustments made to the floor plans. These were anticipated running adjustments that would be made as the client secured tenants. The contractor's agreement with the client stipulated that there would be a period of at least five months between adjustments being made to a floor plan and the final inspection of

that floor. The site manager expected these adjustments to fall within the range of adding, removing and moving some of the interior partitions on each floor. Besides accommodating adjustments that were to be made to the floor plans, the schedule was intended to provide a basis for follow-up.

One aim was to reduce the inclusion of buffers in the durations assigned to activities. This aim was based on the supposition that the durations assigned to activities by subcontractors included buffers. These buffers could be reduced by eliminating the disturbances activities were subject to. The idea was that a sufficiently specific schedule would enable site management to identify the causes of disturbances by follow-up. One such disturbance, identified early by the site manager occurred when two or more activities were being carried out in close proximity to each other. An increase in the size of the project organisation at the beginning of the framework supplement work was not likely to reduce the occurrence of this disturbance. Not only was there an increase in the size of the project organisation following the initiation of framework supplement work, but the subcontractors were to gain a majority. The means chosen to eliminate the disturbance occurring when two or more activities followed each other too closely was to divide each floor into sections and split-up the activities concerned so that not more than one activity would be carried-out in each section at any given time.

SPLIT-UP ACTIVITIES

The decision made to split-up the activities comprising the structural work on each floor was based on the argument that it was needed for the structural work to progress according to plan. The argument behind splitting-up the activities comprising the framework supplement work was eliminating the disturbance occurring when two or more activities followed each other too closely. The decision made was to divide the floors into sections rather than it was splitting the activities comprising the framework supplement work. Nevertheless, dividing the floors would result in split activities and this would result in extra work. Divisions that would create the least amount of extra work were sought which required taking the subcontractors into consideration, as they would be performing many of the activities.

The first, second, third and fourth floors were to be leased to tenants. Offices on these floors were principally located along the external walls. Beside the adjustments that were to be made to the floor plans over the course of the framework supplement work, the client expected that continuous adjustments would be made to the floor plans throughout the service life of the building. As a means of reducing the effort required to add, remove and move interior partitions separating offices along the external walls many of the fixed installations were located above a suspended ceiling parallel to these offices. From the construction workers' and the installation

contractors' perspectives this constituted a natural section on these floors. However, carrying out no more than one activity at a time in each of these sections would not have utilised the available space very well. Each of these sections needed to be divided into two sub-sections. Neither the site manager nor I were certain of the effects of division upon the activities comprising the framework supplement work and additional assistance was sought from an installation coordinator hired by the contractor during the design phase. The installation coordinator, having the knowledge required, assessed the extra work that would be created by the divisions. He recommended dividing these sections into two in line with two ducts on these floors. This division was expected to create the least amount of extra work.

The first, second, third and fourth floors were further divided into three additional sections: the staircase, the two ducts and a large section comprising the remainder of the floor. Besides these floors the basement and the entrance floor were also divided into sections. With the floors divided into sections, the *ex ante* planning of the framework supplement work could proceed. Activities still remained to be identified, defined and sequenced. According to the site manager this work normally fell on site management and the installation coordinator. But, rather than adhering to common practice, the intention was to involve some of the subcontractors to a greater extent than customary thus providing them with an opportunity to participate in the planning process.

COLLABORATIVE PLANNING

The subcontractors that were provided with an opportunity to participate in the planning process were considered to be of decisive importance for the framework supplement work. This included the electrical contractor, the plumbing contractor, the ventilation contractor and the sprinkler contractor. The opportunity consisted of a workshop held on April 13. Besides providing these subcontractors with an opportunity to participate in the planning process, the workshop was intended to provide site management with an opportunity to take advantage of the knowledge held by these subcontractors. The workshop was led by the site manager, accompanied by the supervisors, the foreman, myself and the installation coordinator. The subcontractors were represented by their supervisors and foremen. There were three items on the workshop agenda: agreeing upon the sections that the floors had been divided into, identifying activities and sequencing activities.

Agreeing upon the sections that the floors had been divided into was the first item on the agenda. If they were going to be adhered to, it was important for the site manager to gain the subcontractors' support for the divisions. The divisions could, at this time, be changed as scheduling had not yet started. The subcontractors did not oppose the divisions as much as the very idea of dividing the floors into sections. They preferred

to be given full access to the floors and were, as they expressed it, used to dividing the floors between themselves over the course of the framework supplement work. The site manager was reluctant to give in and argued that it would be beneficial to divide the floors into sections beforehand, thereby eliminating the disturbances occurring when two or more activities were performed too close to one another. The subcontractors, in due course, accepted the divisions.

As the second item on the agenda the site manager instructed the supervisors and foremen to identify the activities that were to be performed in the offices along the external walls on the first, second, third and fourth floors. The offices along the external walls were chosen as the activities that were to be performed in these sections would be repeated on four floors. At their disposal the supervisors and foremen had the building documents as well as a three-dimensional model of the building. Activities were listed on post-it notes. The site manager stressed that activities carried out separately were to be listed separately. She did not want the supervisors and foremen to list activities comprising two or more activities that would be carried out separately. The idea was that by listing activities with sufficient specificity site management would be able to identify the causes of disturbances through follow-up. Whilst it did not appear particularly challenging for the supervisors and foremen to identify activities based on the building documents, it was evident that they were not used to separating the activities in this manner. It was further evident that at the time, April 13, they had not yet familiarised themselves with the project.

As the third and final item on the agenda the supervisors and foremen were instructed to sequence the activities that had been identified. The sequence that the subcontractors agreed upon would be reflected in the changing appearance of the workplace and would therefore affect the activities that were to be carried out. The supervisors and foremen were instructed to stick their post-it notes on a whiteboard and collaboratively sequence the activities whilst discussing the effects of different sequences. Additional activities were identified during the discussion. Activities carried out by others, such as setting out, as well as activities carried out by the construction workers and the subcontractors. It was a straightforward process and the supervisors and foremen appeared to have little difficulty agreeing upon the sequence of activities. The site manager, before bringing the workshop to an end, gave each subcontractor a homework assignment. The subcontractors were instructed to assign durations to the identified activities and to provide the site manager with information on the amount of resources that these durations were based upon.

SCHEDULING

The construction workers and some of the subcontractors were provided with an opportunity to carry out the activities that had been sequenced during the workshop

well ahead of the planned commencement of the framework supplement work in a mock-up of an office at the construction site. The mock-up enabled the client to inspect the materials, the colours as well as some of the fittings and furniture. Although no changes had to be made to the sequence following from the activities in the mock-up some changes were made to the building documents. Furthermore, it became clear when the mock-up activities were being carried out that changes could be made to the sequence without resulting in extra work for the subcontractors. Scheduling would commence towards the end of May.

The scheduling was an incremental process by which the site manager and I gradually worked our way through the framework supplement work section by section. The progress that we made, section by section, differed from that observed on the construction site. On the construction site progress with the structural work could be likened to a spiral moving upwards along the load-bearing structure. The scheduling process itself, however, greatly resembled that observed during the *ex ante* planning of the structural work. Scheduling began with the offices along the external walls on the first, second, third and fourth floors. More activities were to be scheduled in these sections than in any of the others. Even though the supervisors and foremen had identified many of the activities belonging to these sections during the workshop, activities still remained to be identified in these and in the remaining sections. Activities were identified by the site manager as we progressed through the sections. As in the workshop and the *ex ante* planning of the structural work, activities were principally identified on the basis of the building documents. In addition to these the site manager's knowledge of framework supplement work provided a basis for the identification of activities that were commonplace and expected.

The section by section advance through the framework supplement work entailed assigning durations to activities. After a reminder or two the site manager had gotten the subcontractors to hand in their homework assignments. The durations assigned to the remainder of the activities either came from subcontractors, those that had been procured at the time, or the site manager herself. The latter durations were either roughly estimated by the site manager or based on records of her earlier projects. A uniform period was not set for the framework supplement work. Rather, the framework supplement work was planned to commence on one floor after another as the structural work ended on the respective floors. The farther limits of the periods were set by the final inspections and periods for adjustments. The final inspection of the basement, the entrance floor, the first floor and half of the third floor was planned for March 21, 2011. The second floor, the other half of the third floor and the fourth floor were planned to be inspected on May 6, 2011. As the periods set for the framework supplement work were not uniform some of the floors were more challenging than others to schedule. The period set for the framework supplement

work on the first half of the third floor was shorter than that for the others. Given that the same activities were to be carried out on that half of the third floor as on the first and second floors it was particularly challenging to fit the framework supplement work into the assigned period.

ITERATION

Sequencing the activities to fit the periods allocated for framework supplement work was an iterative and time-consuming process. The scheduling software was used throughout the process as a means of expression that allowed and enabled frequent iteration. I took an active part during the *ex ante* planning of the framework supplement work and did most of the iteration in the scheduling software, assisted by the site manager who made the decisions concerning the resources that were assigned to activities and the scheduled sequence. An even consumption of resources over the course of the framework supplement work was not only considered worth aiming at but necessary. It was unlikely that the subcontractors would assign the resources required for progress according to plan unless the resource consumption over the course of the framework supplement work was even or within their capabilities. Initially, as a means of making scheduling easier, attempts were made to even out the durations of activities by adjusting the resources assigned to each activity. However, the periods set for the framework supplement work entailed that the activities would have to be performed in three days, which was not considered feasible. While several of the activities identified during the workshop and assigned to subcontractors could and were scheduled to be carried out in three days, there were others where this was not possible, such as painting that required drying time.

The iterative process included adjusting the resources and, hence, the durations and sequencing of activities. Adjustments were made both to activities assigned to the subcontractors and to the construction workers. When adjusting the resources that were assigned to a subcontractor activity the site manager appeared to take into consideration the resources that a subcontractor could be expected to assign to such an activity. If it was commonplace for an activity to be carried out by a pair of electricians then that activity would be assigned a pair of electricians or multiples thereof, but not three or five electricians. Initially, the activities that were to be carried out in the offices along the external wall on the first, second, third and fourth floors were scheduled in accordance with the sequence defined in the workshop. The remaining activities on these and other floors were sequenced at the discretion of the site manager. It did, though, prove impossible to adhere to the sequence from the workshop if resource consumption was to be kept even. However, the mock-up had shown that it was feasible to alter that sequence without it resulting in extra work or, for that matter, prolonging activities.

The scheduling software had a linear, location-based scheduling feature that provided a general view of the framework supplement work and that made it easier to detect the periods during which no activities were scheduled in the sections. The goal of no more than one activity in each section at any given time had to be given up during the framework supplement work if resource consumption was to be kept even. However, the site manager did not think that this would prolong the durations of the activities concerned. Even though some activities had been scheduled to be carried out in the same sections simultaneously this had been avoided when possible. The structural work had not been progressing according to plan. As a consequence the periods set for framework supplement work were adjusted, but not by as much as the structural work had been delayed. In the schedule from August 23 the framework supplement work had been re-scheduled to start on the first floor on September 8. Some activities in the basement were scheduled to be completed by September 8 but these did not affect the commencement of the framework supplement work in the same way.

THE PLAN

As scheduling neared its end, meetings were held with all subcontractors, except the electrical contractor, that had participated in the workshop. The intention behind these meetings was to provide the subcontractors with an opportunity to share their thoughts on the schedule and to assure the site manager and myself that the schedule was realistic. The supervisors were given similar opportunities throughout the *ex ante* planning of the framework supplement work. Neither the supervisors nor the subcontractors provided feedback that resulted in anything other than minor changes to the schedule. Although scheduling did not definitively end there, the scheduling process neared its end in August. The schedule in Figure 5 was distributed to the subcontractors on August 31 and changes made thereafter were minor.

Whilst only minor changes were made to the schedule from August onwards, the linking of activities in the scheduling software so that dependencies among activities would be represented still remained to be done. The schedule was intended to provide a basis for follow-up that, if the activities were linked, would provide site management with a comprehensive view of progress made with the framework supplement work and the effect from delays. Assigning links to activities that would accurately represent the dependencies among activities was perceived as difficult. While the discussion on how we were to assign links to the activities marked the end of my own participation in the scheduling process, it also marked the beginning of the installation coordinator's participation who, together with the site manager, would continue scheduling. As we saw it at the time, there were two alternatives. We could either link activities based on how they had been sequenced in each section or link all the activities comprising the framework supplement work based on how they had been scheduled.

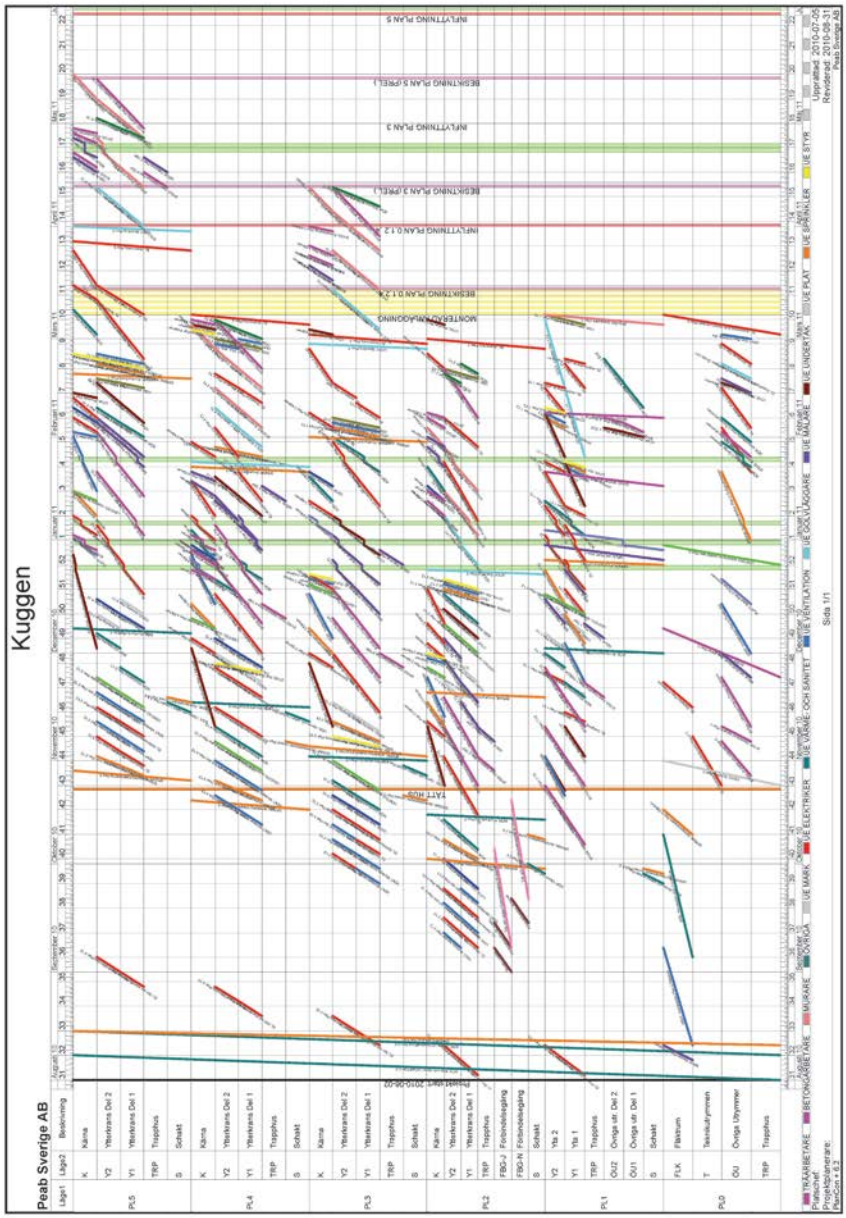

Figure 5 *The schedule covering the framework supplement work dated August 31, 2010.*

The first alternative was chosen as it did not exaggerate the consequences upon the framework supplement work from delays to activities, although, it likely underestimated them. It underestimated the consequences since, although it took into consideration the sequence in which activities had been scheduled to be carried out it did not take into consideration the even consumption of resources. Furthermore, assigning links to the activities in the scheduling software section by section was in line with the section by section scheduling process used earlier. After having assigned links to the activities in the scheduling software site management was ready to commence the framework supplement work on September 8.

THE FRAMEWORK SUPPLEMENT WORK

The framework supplement work was principally initiated on September 8. The electrical contractor and the ventilation contractor were scheduled for activities on the first floor. The construction workers were, at the time, occupied with structural work and had finished the third concrete casting of the floor structure of the third floor the day before. The structural work had been and kept on presenting a challenge to the supervisors who had not yet found the time to engage in the planning of the framework supplement work. The structural work had taken its toll on both the construction workers and site management and the site manager had hoped for a clear break for the construction workers before starting the framework supplement work.

One aim, at the outset of the framework supplement work, was to diminish the size and number of buffers in the durations assigned to activities by eliminating the disturbances that activities were subject to. Besides being specific enough to enable site management to identify causes of disturbances through follow-up, the schedule was intended to eliminate the disturbance occurring when two or more activities were carried out too closely to each other. However, achieving this aim depended upon the activities comprising the structural work being carried out in accordance with the schedule. While the ventilation contractor that had been working in the basement moved to activities on the first floor on September 8 in accordance with the schedule, the electrical contractor did not. Along with the plumbing contractor, scheduled to begin in the basement on September 6, the electrical contractor failed to appear at the construction site when scheduled. According to the respective supervisors the electrical contractor and the plumbing contractor had been held up at other projects.

OUT OF BOUNDS?

The initial delays that resulted from the two contractors' failure to appear at the construction site on time were considered minor and the site manager believed that they would be able to make up for the lost time. During the *ex ante* planning of the framework supplement work it had become clear that the resources that the electrical contractor would be required to assign in order to progress according to plan far

exceeded those required by the other installation contractors. However, it did not seem that the electrical contractor was assigning the resources required nor making up for the time that had been lost. To resolve the matter the site manager summoned the supervisor and the foreman representing the electrical contractor to a meeting on September 20. The site manager requested a plan detailing how they intended to make up for the time lost and how they planned to assign the resources required in order to progress as scheduled. Furthermore, until the matter had been resolved the two were instructed to account for the progress made with the framework supplement work on a weekly basis during meetings with the site manager.

Rather soon it became obvious that, apart from the ventilation contractor, the installation contractors were not performing activities in accordance with the schedule nor did they adhere to the assigned floor sections as planned. The plumbing contractor, as an example, was on the first floor on September 22 when scheduled to be carrying out activities in the basement. Whilst the initially incurred delays provide a partial explanation to this, there appeared to have been more to it than that. On September 24 the site manager iterated that subcontractors that had been scheduled to carry out an activity in a section had precedence to that section. Subcontractors that had fallen behind the schedule were to adapt to those carrying out activities in accordance with the schedule. While I did not observe any of the subcontractors exercising the right of precedence given to them by the schedule, I did observe them making fun of the schedule while talking to one another. It appeared to me as if they had fallen back to, or never left, the common practice of dividing the floors between themselves as they had expressed it during the workshop.

As it turned out there was no clear break for the construction workers before commencing the framework supplement work. Two of the construction workers began activities on the first floor on October 12, three days before the final casting of the roof had been scheduled. The contractor had been scheduled to begin activities on the entrance floor on October 7 and on the first floor on October 25, hence, the contractor was not either carrying out activities in accordance with the schedule. Over the course of the framework supplement work the site manager changed her approach and gradually adapted to the processes that I observed on the construction site. Later, these processes came to complement each other. Decisions were reached in several ways. One of the first decision-making processes that I observed was informal meetings during which decisions concerning the sequences in which activities were to be carried out, the timing of the activities as well as the assignment of resources to activities were made.

CONCURRENT PLANNING

Informal meetings were observed throughout both framework supplement work and structural work, and were described by the site manager as a common feature of construction projects. While the informal meetings differed in several ways from the weekly meetings (no one was summoned and minutes were not kept), the decisions made were not necessarily different. To me it appeared as if these meetings were held when it became clear that unless certain matters were resolved the progress of the framework supplement work would be negatively impacted. Often problems related to an upcoming activity, had to be solved so they would not delay the activity and potentially cause construction workers and subcontractors to idle waiting the release of activities.

Most often these activities had been identified and scheduled beforehand. However, as far as my understanding goes, these meetings were not initiated based on the articulated timing of a scheduled activity but rather on something that was seen in the activities being carried out on the construction site. Further, there were activities related to deliveries and subcontractor activities that had been planned in advance and that could not be postponed without negatively affecting the progress of the framework supplement work. There was a difference between activities being carried out by the construction workers and the installation contractors normally at the construction site during framework supplement work, and those subcontractors that were called in as needed and would only be at the construction site for a limited time. One such subcontractor was the roofing contractor. During an informal meeting held on October 19 the site manager and the supervisors were discussing calling in the roofing contractor. However, to prevent having the roofing contractor called in to the construction site several times they had to ascertain that a foreign subcontractor had made sufficient progress mounting the curtain walls. At the same time progress with the framework supplement work depended on it not taking too long until the building would be weatherproofed.

The timing of the activities to be carried out by the roofing contractor was based on the progress made by the foreign subcontractor in mounting curtain walls. Other decisions taken to resolve similar situations included activity sequencing, activity timing as well as the assignment of resources to activities. Further, supplying the construction workers with the materials, tools and machinery needed to carry out activities was often initiated when it became apparent that unless this was done progress with the framework supplement work would be negatively affected. There were, however, occasions when materials, tools and machinery were not supplied to the construction workers in time and this occasionally resulted in the postponement of activities. These informal meetings could be held anywhere on the construction site but I observed most often them in the room where the building documents were kept

and around the coffee table. These meetings could be initiated by the site manager, the supervisors, the construction workers as well as the subcontractors. Site management was always represented, more often by the supervisors than the site manager. It was not unusual to observe construction workers and subcontractors taking part as well. As no one was summoned to these meetings, those that took part had initiated the discussion themselves, overheard it or walked by. Neither the site manager nor the supervisors that had not taken part were necessarily informed of the decisions that had been made. Besides these informal meetings during which decisions concerning upcoming activities were made, decisions on current activities were continuously made.

OFF-THE-CUFF DECISION-MAKING

Over the course of the framework supplement work, as well as the structural work, site management continuously made off-the-cuff decisions as a response to matters that were brought to their attention. These matters were similar to those dealt with during informal meetings with the difference that these were often related to activities that were being or were about to be done. Unless the problems were quickly dealt with, there was a risk that construction workers and subcontractors would be standing idle awaiting the release of activities, which would negatively affect the progress made with the framework supplement work. Often it was a subcontractor that brought up these matters usually by informing one of the supervisors that spent most of their work days on the construction site. The customary response from the supervisors in these situations was to assign resources to the activity in question.

Usually, rather than idling and waiting both the construction workers and the subcontractors were engaged in other activities, activities that they would have to suspend. In comparison to the activities that resources were assigned to during both the informal and the weekly meetings these activities were often limited in duration, seldom more than a few hours. The construction workers were not found of these activities. The intention had often been to carry out these activities in a sequence one or several floors at a time rather than singly one at a time. The opposition was grounded on that set-up times could be the same for one activity as for a sequence of several activities. Furthermore, the construction workers risked losing parts of the run-in time effect that they might have accumulated whilst working on the suspended activity. One of the construction workers told me that whilst he would not object to suspending an activity to sweep floors he would not willingly go and get the materials, tools and machinery needed for these activities given the set-up times involved.

Caution was necessary when these off-the-cuff decisions were made. On occasion some of the subcontractors did not reveal the full extent of the problem while simultaneously claiming that unless the construction workers or another subcontractor

acted promptly they would be left standing idle. At times the subcontractors preferred one activity over another and at times they had caused the problem themselves by not having ordered materials in time. Needless to say, the subcontractors were not always entirely upfront with this information. Besides the informal meetings and the off-the-cuff decisions there were other processes, such as job planning, during which the construction workers were provided with an opportunity to take part in the planning of activities they would be engaged in.

JOB PLANNING

Job planning was commonly held about a week before the activity being planned. It took between 15 minutes and an hour and was reserved for extensive activities, activities associated with occupational hazards and activities that were considered challenging. It was a process that was observed throughout both structural work and framework supplement work. Job planning was led by the supervisors and provided the construction workers with an opportunity to take part in the planning of the activities they would be engaged in. Whilst the contractor's home office had issued two forms, that were intended to provide a basis for job planning, it was not a uniform process. Instead each supervisor had their own way of leading job planning. One of the forms covered the execution of the activity and the other its discretionary control.

The supervisors and the construction workers usually began by studying the building documents and discussing such matters as measurements and quality requirements related to the activity being planned. Matters subsequently covered included how the activities were sequenced. The construction workers were commonly provided with the opportunity to make decisions related to the materials, tools and machinery needed for activities being planned. Whilst the sequences in which activities were to be carried out could be covered during job planning the timing of the activity being planned was of marginal interest in comparison to the execution of the activity.

FOLLOW-UP

On October 22 the site manager said that they were not really seeing the consequences of what was happening. Whilst the schedule may not have articulated the consequences of what was happening on the construction site it did provide the site manager with a general view of the progress made with the framework supplement work through weekly follow-up. Except for the ventilation contractor, activities were not performed in accordance with the schedule at this point. The site manager and the installation coordinator used the schedule as a basis for the weekly follow-ups. The site manager and the installation coordinator inspected the progress of the framework supplement work by requesting information from the construction workers and the subcontractors as well as by their own observations made on the construction site. As a result of the follow-ups the scheduled timing of the activities

was adjusted in the scheduling software to reflect the progress made with the framework supplement work. As the activities had been assigned links in the scheduling software based on how they had been sequenced in each section, the timing of the activities remaining in each section was adjusted. However, the adjustments made in the scheduling software did not take into consideration an even resource consumption and thus did not show the consequences of what was happening on the construction site.

After each follow-up the schedule showed the progress of the framework supplement work in each section in relation to the periods set and, hence, indicated the relative need of progress in each section and on each floor. On October 27 the site manager departed from the schedule and postponed framework supplement work on the fourth floor and concentrated on the floors below. This was the day when framework supplement work had been scheduled to commence on the fourth floor. The sprinkler contractor scheduled to begin activities on the fourth floor was instructed to prioritise making progress with the framework supplement work on the floors below. Similar priority changes concerning floors, sections and rooms as well as activities, would become more common over the course of the framework supplement work. Besides providing a basis for follow-up, the schedule or the specificity thereof, were to the site manager's advantage during the Friday meetings with the foremen representing the subcontractors.

WEEKLY MEETINGS

Each week three meetings were held at the construction site, one on Wednesdays and two on Fridays. The site manager chaired all three meetings accompanied by the supervisors and the foreman. The subcontractors were represented by their foremen during one of the Friday meetings. The items covered at these meetings remained fairly constant over the course of the framework supplement work. A reoccurring, and often the first item on the agenda, was general matters pertaining to the project. These were e.g. large deliveries planned for the coming week and which could affect activities and limit access to the construction site. Unlike the informal meetings, these meetings incorporated the schedule. This was more so during meetings with the foremen representing the subcontractors when the results of the latest follow-up were presented than during the other two meetings. The activities that were to be carried out by the subcontractors received more coverage at this meeting than at the other two meetings.

The progress made with the framework supplement work, the activities being carried out and the activities that were to be carried out were an item on nearly all meetings. Starting at the October 29 meeting the site manager began using the floors plans to a greater extent while covering this item. The framework supplement work was covered

floor plan by floor plan. The subcontractors reported the progress they had made with the activities and when they expected to be done with the activities. The specificity of the schedule provided the site manager with information on which activities remained to be carried out by each of the subcontractors in each section and, hence, an understanding of the relative need of progress by each subcontractor in each section and on each floor. The floor plans also served as a pin board for matters still to be settled. Post-it notes listing activities in need of progress or other matters needing attention would be attached to the floor plans. These matters were then dealt with during subsequent meetings as floor plan by floor plan was covered and the post-it notes were left attached to the floor plans until the matter had been resolved.

The decisions made during these meetings were not necessarily different from those made during the informal meetings. As an example, on a meeting held on November 5 site management discussed the sequence in which two of the concrete finishers were to tackle their activities. The decision made by site management was that the two concrete finishers were to execute activities in the room where the electrical distribution board was placed before continuing to activities in the entrance and some of the smaller rooms. This was representative also of the decisions made during the informal meetings. The decision made was to enable the electrical contractor, waiting the release of activities in the room where the electrical distribution board was placed, to make progress with the framework supplement work. Besides decisions concerning activity sequences, timings and resource assignment the site manager could also inform the supervisors, the foreman and the foremen representing the subcontractors of deliveries and subcontractor activities that had been decided upon in advance and would not be postponed. They would then have to enable these deliveries and activities by carrying out the necessary activities. An example of such an activity was floor screeding. Whilst site management demonstrated flexibility that enabled the construction workers and subcontractors to make progress with the framework supplement work it was necessary to adapt to some of the adjustments made to the floor plans.

ADJUSTMENTS

When the client secured a tenant for the second floor the site manager expected adjustments to the floor plans would follow. Whilst the adjustments that the site manager expected were similar in scope to adding, removing and moving some of the interior partitions the adjustments that actually followed were more comprehensive than that. A new floor plan for the second floor was issued on November 12. The adjustments included the addition of a sound insulated visualisation studio and two smaller meeting rooms. This resulted in new activities being added to those identified during the *ex ante* planning of the framework supplement work. As activities were not being carried out in accordance with the schedule this was not a matter of scheduling

as much as a matter of executing the activities during the period set. Nevertheless, the fulfilment of the declared ambition of no more than one activity in each section at any given time seemed considerably less likely. Besides the additional activities resulting from the adjustments to the floor plans, additional activities were also identified by the contractor over the course of the framework supplement work.

Whilst it did not appear difficult for site management to identify the activities comprising the structural work and the framework supplement work it became apparent that the general quality requirements placed on workmanship by the contractor did not match those placed on the workmanship of a foreign subcontractor. The wallboards mounted on the inner side of the external wall by the foreign subcontractor made it clear that two different yardsticks had been used to define the quality requirements placed on workmanship. According to plan once the external wall was mounted the painter would start activities along by spraying the wall with sand filler. However, contrary to the opinion of the foreign subcontractor, neither the contractor nor the painter was of the opinion that the wallboards had been properly joined. Before the painter could spray the inner side of the external wall with sand filler additional activities had to be carried out. The wallboards that stuck out beyond the adjacent wallboards had to be trimmed and metal corner beads had to be mounted. Initially, the foreign subcontractor was instructed to trim the corners of the wallboards but as the contractor did not approve the methods used carpenters were assigned to this activity. The mounting of the metal corner beads could was able to get underway on December 12.

SUBCONTRACTORS

The installation contractors, apart from the ventilation contractor, had not executed activities in accordance with the schedule, and by November 16 this subcontractor could no longer either due to the other subcontractors and the contractor. The activities performed by the subcontractors were subject to the decisions made during the weekly meetings, the informal meetings and by site management's off-the-cuff decisions. In addition activities were subject to decisions made by the subcontractors themselves.

In line with the intention to have only one activity per section any time, the electrical contractor's foreman preferred to operate where no other activities were on-going. But even if he had precedence to a section he chose to postpone activities there and move to another section when some other activities were on-going in the section he was assigned to. The electrical contractor's foreman described it as staying away from the others. Many decisions made by the ventilation, electrical, and plumbing contractors were based on a mutual understanding between the subcontractors and the construction workers. They described that these decisions were mainly reached

after conferring with other subcontractors and construction workers rather than with site management.

In addition to the decisions made in this manner, the information exchanged between them on the construction site influenced the priorities given to activities. The ventilation contractor's foreman described how he prioritised activities when the schedule could no longer be followed. Both the ventilation and the electrical contractor's foremen candidly described how their prioritisations and thus the sequencing of their activities were based on the contractor's progress with the framework supplement work. The electrical contractor's foreman said that as long as they did not delay the construction workers there would not be any demands placed by the contractor until closer to the final inspections. The ventilation contractor's foreman described how he, at this point, looked at the construction site and realized which activities needed to be carried out to enable the construction workers and the other subcontractors to progress with the framework supplement work.

The activity sequences were also reflective of other factors such as the subcontractors' aversion to reassigning resources engaged in recurring activities to other activities. The electrical contractor's foreman described how he had preferred to have carried out activities in the basement at a certain stage, but having been told by the electrical contractor's supervisor that additional resources were to be assigned to the project he had chosen to postpone these activities in favour of not reassigning resources performing activities in the offices along the external wall on the first, second, third and fourth floors to the basement. Furthermore, the foremen representing the ventilation, the electrical and the plumbing contractors all stressed the importance of cooperating with each other on the construction site. For example, the electrical contractor's foreman described that the construction workers did not always carry out activities in accordance with the decisions made by site management, but rather according to a mutual understanding reached by the construction workers and the subcontractors.

During a meeting held on December 1 the site manager instructed the supervisors to prioritise the activities on the half of the third floor where a final inspection was scheduled to be held on March 21, 2011 rather than those on the other half. The client had not signed a tenant for this half and the site manager said that if it became necessary the tenant after having moved in would have to accept that activities were being carried out on the other half of the floor. At the same meeting the supervisors, upon being asked by the site manager, declared that they were not looking at the schedule. Whilst I had observed that many of the decisions made during meetings as well as the off-the-cuff decisions and the decisions made by the supervisors had in common was the importance given to assuring that the framework supplement work

was progressing and that subcontractors and construction workers were not idling waiting the release of activities, I had not discerned how the supervisors made their decisions.

TAKING PART

In December, after having spent a year at the construction site I was asked by the site manager to take on the role of a supervisor during the next six months. The project was in need of an additional supervisor and I accepted. The site manager had divided the responsibility for the subcontractors between the supervisors and herself. Each supervisor had the responsibility of ascertaining that the subcontractors they were responsible for were able to make progress with the framework supplement work and in addition to represent and speak for them, as well as look after their interests. The supervisors were also responsible for the construction workers. This also meant that each supervisor was to assure that the subcontractors were not left standing idle waiting the release of activities but that they had activities to perform. I was made responsible for the painter and later, closer to the final inspection each supervisor was made responsible for one of the installation contractors. I became responsible for the ventilation contractor. The site manager had been responsible for the installation contractors during the greater part of the framework supplement work.

The method I adopted, in line the other supervisors, was to prioritise the activities carried out by the subcontractor for which I was responsible. This meant that I had a list of sequenced activities which I wanted the painter to follow. My prioritisations were in turn conditioned by other decisions. The site manager could have prioritised a floor or a certain activity, which would then have to be reflected in the listed sequence of activities. If the site manager had informed us of an activity that were to be carried out on one of the floors, then it was our responsibility to ascertain it was feasible. This meant that it was our responsibility to get the subcontractors and the construction workers to execute these activities in due time. A similar way of prioritising activities also existed on the construction site between the supervisors. It could be that a subcontractor that I was responsible for was waiting the release of activities upon completion of a certain activity. Then I would talk to the other supervisors in an attempt to get them to prioritise that activity so as to avoid having the subcontractors idling or performing other less prioritised activities. In a sense, it was a queue in which activities were lined up waiting to be performed. The same applied for construction workers; I would talk to the supervisor responsible for the construction workers that I needed to carry out a certain activity.

This was not a process solely reserved for supervisors. The construction workers and the subcontractors operated in similar ways. It was not unusual to observe them agreeing upon the distance that they wanted to keep between themselves as to avoid

disturbance or to make decisions on the timing of certain activities. This became particularly evident once when I was approached by the foreman asking me to instruct the sprinkler contractor that he needed to carry out a certain activity at a certain time to enable the foreman and the construction workers with whom he was collaborating to be able to progress. However, it took me some time to get in contact with the sprinkler contractor by which time the two had come to an agreement.

FINISHING THE FRAMEWORK SUPPLEMENT WORK

The prioritisations observed by the site manager, the supervisors and the subcontractors throughout the framework supplement work permeated the processes leading up to the final inspections. The site manager had changed her approach over the course of the framework supplement work and gradually adapted to the prevalent processes in that she came to prioritise floors, sections and activities. These prioritisations had an impact upon the decisions made by the supervisors as well as the subcontractors as activities were carried out in alignment with these as opposed to the schedule. Examples during the period leading up to the final inspections include the site manager instructing the painters on January 21, 2011 to postpone activities to be performed in a footbridge leading to an adjacent building to benefit the activities on the one half of the third floor that was due for final inspection on March 21 and the site manager instructing the supervisors, myself included, on February 17 to ascertain that a subcontractor could make progress mounting sound insulation boards. The site manager's prioritisations were integrated by the supervisors, the subcontractors and the construction workers with their own prioritisations.

However, the permeability and the integration of these prioritisations were not exempt from difficulties. As an example, on the morning of January 22, two carpenters could no longer continue working with framed plasterboard partitions on the second floor since they were dependent upon the electrical and the plumbing contractors doing their part. Whilst they had been able to progress up to this point, they had waited for the electrical and plumbing contractors for a few days. Whilst the two carpenters believed that the electrical contractor may have completed the necessary activities they had not been informed and were reluctant to take it for granted. The plumbing contractor performed the activities needed during the afternoon.

The final inspections came closer each week, and this was felt by site management as well as the construction workers and the subcontractors. The electrical contractor's foreman described how each passing week brought them closer to the point of no return when the framework supplement work would have to have been completed. The foreman also described how nowadays fewer resources are assigned at project start than in the past. Whilst he preferred carrying out activities as early on as possible

so that he would be at the construction worker's heels this had not been possible. The electrical contractor was the one that had the greatest number of activities remaining prior to the final inspections. The specificity of the schedule gave the site manager an advantage, enabling her to ask better informed questions and to avoid getting falsely reassuring answers. Besides this advantage it also made it easier to prioritise the floors, sections, activities and subcontractors most in need to advance with the framework supplement work.

FINAL INSPECTIONS

Two final inspections were held. The first final inspection; parts of the basement, the entrance floor, the first floor and half of the third floor, was held on March 21. The second final inspection, of parts of the basement, the second floor, the other half of the third floor and the fourth floor was held on May 6. The first final inspection only covered parts of the basement as adjustments had been made to the other parts which were covered by the second final inspection. During the weeks leading up to the final inspections the construction workers and the subcontractors carried out several activities that had not yet been carried out and activities needed to reach the general quality requirements placed on workmanship. Prior to the first final inspection a period for adjustments had been planned in. Amongst the installations that were to be adjusted was ventilation. The period was planned to commence on March 8. A requirement when adjusting the ventilation was that there were not any activities active that generated dust. However, as there still were, the adjustment of the ventilation was postponed by a week. Whilst the first final inspection was held on March 21 it might have been better to have postponed it. There were more remarks in the contractor's inspection report than anticipated and the client's representative was dissatisfied. The site manager regarded the adjustments made to the floor plans as a large contributing factor to the delays and the negative remarks. The client's project manager acknowledged that the client had been vague on the adjustments that were made to the floor plans once tenants had been signed, but had at the same time expected the contractor to have been more upfront with the difficulties that this had caused.

The ventilation contractor's foreman described the atmosphere prevailing at the construction site in positive terms. Whilst the plumbing contractor's foreman was not pleased with the progress that they had made with the framework supplement work, partly due to the materials used; he said that he had never been at a construction site with better site management. He described how he was used to projects where the site manager was accompanied by only one supervisor and that he preferred there being several supervisors as in this project. Furthermore, he said that it felt good coming to the construction site in the mornings without anticipating conflicts with site management. The second final inspection held on May 6 was considered an

improvement compared to the first. The client's representative said that whilst he had only taken part in one project where all activities had been completed by the final inspection, almost all activities in this project had been completed in time of the second final inspection. Except for the inspection report from the first final inspection, the client was very satisfied with the project. The client's representative described that cooperation between the client and the contractor had continued to improve over time and that it was a shame that project was now over. As of the second final inspection, the project was completed consistent with project goals. The changes made by the client, principally to the floor plans, resulted in a 10 % cost increase. This was primarily due to adaptations resulting from tenant wishes that had been expressed after the contract had been signed. These adaptions included labs on the first floor, a sound insulated visualisation studio on the second floor, and a fan room on the roof. The budgeted costs for construction workers, after adjustment for the changes made by the client, was exceeded by 200 000 SEK. However, these costs were compensated by savings elsewhere, and hence do not indicate that the contractor did not achieve the project goals. The construction project did not result in any incentive payments made to the contractor or the client. The resultant cost structure of the target cost part (with incentive) of the contract can be seen in Figure 6.

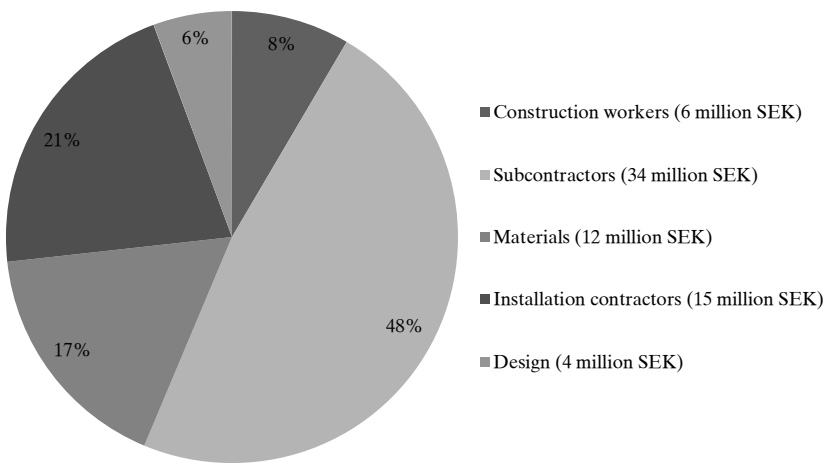

Figure 6 *The cost structure of the target cost part (with incentive) of the contract.*

DISCUSSION

The aim of this thesis is to investigate the planning process as it is practiced at the intersection between planning, coordination and control, and the execution of activities. This aim is partly achieved by an account of observations during the Kuggen project. Coordination and control were not confirmed as functions of solely the planning process in the project in question (cf. Laufer & Tucker, 1987). Rather, the observations opened up for an inquiry into the conceptualisation of the construction planning process based on Laufer et al. (1994) and Laufer and Tucker (1987) and the development of the detailed course of action over the course of the project as opposed to it being specified beforehand.

The analysis is limited to the framework supplement work that confirmed several of the characteristics that have been ascribed to the construction industry (see Bryman et al., 1987; Bröchner et al., 2002; Lundin & Söderholm, 1995; Modig, 2007; Styhre, 2006; Thiel, 2007). The heavy engagement of and reliance on subcontractors was confirmed by the subcontractors becoming a majority in the project organisation after the commencement of the framework supplement work (cf. Bryman et al., 1987; Nordstrand & Révai, 2002). In the construction projects studied by Bryman et al. (1987), site management associated the reliance on subcontractors with uncertainty. The apparent uncertainties and the influence that subcontractors' home offices can exert was manifested by the failure of the electrical and plumbing contractors' home offices to assign resources in accordance with the schedule at the outset of the phase. Furthermore, the increase in size of the construction project organisation following the phase's commencement, in combination with the delays incurred over the course of the structural work, is likely to have increased rather than decreased the need for coordination (cf. Bryman et al., 1987; Josephson & Christiansen, 2012). Also, the autonomy ascribed to subcontractors by Olsson (1998) and Thiel (2007) and the preference for loose control ascribed to site management in Swedish construction projects by Bröchner et al. (2002) in combination makes planning challenging. The correspondence between the characteristics ascribed to the construction industry by researchers and the framework supplement work observed in the Kuggen project warranted further inquiry into the conceptualisation of the construction planning process based on Laufer et al. (1994) and Laufer and Tucker (1987).

This thesis investigates the planning process at the lower levels of the hierarchical planning process. The basis for this inquiry and analysis is provided by the schedule. It is the tangible manifestation and the articulated result of the planning process closest to the activities that are carried out (cf. Snyder, 1982). Furthermore, the *ex ante* planning of the framework supplement work concerned mainly the scheduling

process. As opposed to other tangible manifestations of the planning process, such as the forms issued by the contractor's home office and which were intended to provide a basis for job planning, the schedule covered most of the activities comprising the framework supplement work. That neither the contractor nor the subcontractors, except for the ventilation contractor, carried out activities in accordance with the schedule clearly reveals the discrepancies between the conceptualisation of the construction planning process based upon Laufer et al. (1994) and Laufer and Tucker (1987) and the planning, coordination and control processes in the project in question. A schedule should articulate the decisions made and provide the answers needed to position coordination and control as functions of the planning process (cf. Laufer & Tucker, 1987).

This inquiry explains the coordination and control processes, proceeds and examines the planning process before moving on to a discussion of allowing the detailed course of action to develop over the course of construction projects. The Kuggen project was completed, in accordance with project goals, after the second final inspection on May 6, 2011. This is used as the evaluation criteria for the presence of coordination and control processes. The definition of control as "all devices and systems employed to ensure that acts, behaviours, outcomes and decisions of individuals, teams and organizations are consistent with meeting organizational or project goals, objectives and strategies", by Tuuli et al. (2010a, p. 189) supports the presence of control processes. According to Malone and Crowston (1994) project completion aligned with project goals supports the presence of coordination processes.

COORDINATION PROCESSES

The schedule articulated the timing of activities and the sequence in which these activities were to be executed. It managed the dependencies resulting from the use of common resources. In addition to the evaluation criteria, Malone and Crowston (1990) listed three components of coordination: actors, activities and dependencies. The schedule described whether activities were to be carried out by construction workers or one of the subcontractors, but did not articulate the resources assigned to the activities. Although resources were assigned to activities during scheduling, it remained a prerogative of the subcontractors' home offices to assign resources to the project. Most, but not all, of the activities comprising the framework supplement work were articulated in the schedule. Activities were defined by reference to the sections that the floors had been divided into. The schedule did not articulate the dependencies that were managed.

According to Malone et al. (1999), three basic dependencies - sharing, flow and fit - are sufficient to analyse all coordination processes. The schedule was a linear location-based schedule, i.e. it managed the dependencies among activities that were the

consequence of how space was used over time (see Kenley & Seppänen, 2010a). Construction workers and subcontractors use space when executing activities but, as the space changes as activities are performed; the performance of activities also creates the space in which activities are performed (see Thiel, 2007; Winch & North, 2006).

The activities comprising the framework supplement work were interchangeably subject to sharing, flow and fit dependencies resulting from the use of space over time. The schedule managed the sharing and flow dependencies by articulating the sequence of activities in each section. It did not manage the fit dependencies as activities subject to these were not articulated in the schedule. However, the activities were also subject to sharing dependencies during the periods set for the framework supplement work. These dependencies were managed by the durations assigned to activities articulated in the schedule. The execution of activities in accordance with the schedule implied that the project would be completed as planned.

However, activities were not executed in accordance with the schedule. Thus, neither the sharing and flow dependencies nor the fit dependencies were managed according to the schedule. Two coordination processes were observed, both concerning dependencies between activities resulting from the use of space over time: one managed flow and fit dependencies, the other sharing dependencies. A coordination process corresponding to the durations assigned to activities was not observed.

OBSERVED COORDINATION PROCESS 1

The first coordination process managed the flow and fit dependencies among activities. The supervisors as well as the electrical, plumbing and ventilation contractors' foremen prioritised the activities to be executed. The prioritisations reflected the need to release activities for execution. If activities were not executed, either the construction workers or one or several of the subcontractors would be left idle waiting the release of activities. Both the electrical and ventilation contractors' foremen were explicit about taking particular care to avoid delaying the progress being made by the contractor.

These dependencies were identified in several ways. The ventilation contractor's foreman described how he looked at the construction site and understood which activities needed to be executed. This was considered characteristic of repetitive projects, such as construction projects, by Lundin and Söderholm (1995, p. 441) who described how project organisations "know what to do, and why and by whom it should be done." Lenfle and Loch (2010) associated this with routine execution and attributed it to experience. On the construction site the site manager, the supervisors, the construction workers and the subcontractors all talked to each other and made

each other aware of the activities that needed to be carried out so that succeeding activities could be released. The coordination process resembled what Van de Ven et al. (1976) described as a process of mutual adjustments where the supervisors and the subcontractors' foremen were attentive of the priorities of the others. The coordination process also integrated the ad lib decisions and the setting of priorities by site management as well as the decisions made during the weekly and the informal meetings. The site manager prioritised floors, sections and rooms as well as activities and subcontractors.

OBSERVED COORDINATION PROCESS 2

The second coordination process managed the sharing dependencies among activities. The electrical, plumbing and ventilation contractors' foremen described how they, by themselves, decided which activities to carry out. Whereas activities were defined by reference to floor sections defined in the schedule, these foremen continuously defined activities based on the availability of space.

The coordination process resembles both what Malone et al. (1999) described as first-come/first-served and what Van de Ven et al. (1976) described as a process of mutual adjustments on a horizontal level. The resemblance to the former comes from the consideration the foremen exhibited for use of space by the construction workers and the other subcontractors. None of the subcontractors were observed exercising the right of precedence accorded to them by the schedule. Rather, these decisions were made based on the availability of space. However, the autonomous decision-making exhibited by the foremen was not only unselfish but was also in their own interest as it helped avoid the disturbances created by two or more activities being executed too close to one another (cf. Olsson, 1998). The similarity to the latter comes from observing construction workers and subcontractors deciding, without the involvement of site management, on the distance that should be kept between them whilst carrying out activities.

CONTROL PROCESSES

The schedule constituted the performance standard used in comparing planned and actual performance in the cybernetic control process positioned as a function of the planning process by Laufer and Tucker (1987). Cybernetic control processes rest upon the supposition that executing activities in accordance with plans is consistent with project goals (Hofstede, 1978). While there are several plans, a cybernetic control process with a negative feedback loop comparing actual performance with the schedule is limited to the articulated timing of the activities, their sequence and their duration. The execution of activities according to the schedule corresponded to project completion within the periods set.

The site manager and the installation coordinator used the schedule as a basis for weekly follow-up. It provided the site manager with a general view of the progress being made with the framework supplement work in each section, and specified whether activities were being executed in accordance with the schedule. However, corrective actions to ensure that this was actually the case, in line with a cybernetic control process, were not observed. Two control processes were identified based on the definition of control by Tuuli et al. (2010a, p. 189) as "all devices and systems employed to ensure that acts, behaviours, outcomes and decisions of individuals, teams and organizations are consistent with meeting organizational or project goals, objectives and strategies." The decisions made as parts of the control processes superseded decisions made as parts of the coordination processes. These control processes continuously ensured that progress was being made with the framework supplement relative the periods set.

OBSERVED CONTROL PROCESS 1

The aim of the first control process was to ensure that neither the construction workers nor the subcontractors were left idle waiting the release of activities. The control process was manifested in the responsibilities held by the supervisors, the off-the-cuff decisions made by site management as well during weekly and informal meetings. The control process can partly be considered a response to failures to manage the flow and fit dependencies among activities by the first coordination process. Decisions made as part of this control process led to resources being reassigned to activities that, once completed, would release other activities.

OBSERVED CONTROL PROCESS 2

The purpose of the second control process was to ensure that progress was being made relative the periods set. Weekly follow-ups provided the site manager with a general view of the progress being made with the framework supplement work. Additionally, the follow-ups provided the site manager with an overall view of the amount of work remaining in each section and on each floor as well as by the construction workers and by each of the subcontractors. The site manager prioritised floors, sections and rooms as well as activities and subcontractors on basis of the progress being made relative the periods set.

These prioritisations were integrated by the first coordination process and were reflected in the prioritisations made by the supervisors and the foremen. Examples include the postponement of the framework supplement work on the fourth floor on October 27, 2010 so as to ensure that progress would be made with the framework supplement work on the floors below. Reasons for prioritising activities included the amount of work remaining after the completion of an activity in relation to the remaining periods as well as prior arrangements made with subcontractors.

REFLECTIONS

The schedule ensured the efficient use of resources by keeping resource consumption over the course of the framework supplement work even. The first control process superseded the schedule by ensuring that neither the construction workers nor the subcontractors were idle waiting the release of activities. A cybernetic control process could have compared the durations of activities to the durations articulated in the schedule but no such comparisons were observed. Further, no coordination process that corresponded to the durations that were assigned to the activities was detected.

The schedule ensured the effective use of the resources by articulating the sequence in which activities should be executed for the project to be completed within the periods set. The second control process superseded the schedule by continuously ensuring that progress was being made relative the periods set. Whether the second control process ensured project completion within the periods set is not clear. The process involved comparing the amount of work remaining to be performed to the periods remaining. However, aside from the prioritisations made no control process has been discerned targeting this specifically.

THE PLANNING PROCESS

Laufer and Tucker (1987) has have coordination and control as functions of the planning process. Analysis of the Kuggen project showed this to be so, but also that neither of these processes were functions of solely the planning process. According to Laufer and Tucker (1987, p. 244, italics in original) the planning process should provide answers to "the following questions:

– *What* should be done? (activities)
– *How* should activities be performed? (methods)
– *Who* should perform each activity and with what means? (resources)
– *When* should activities be performed? (sequence and timing)."

The schedule provided answers to two of these questions: what and when. It did so by articulating the timing and the sequence of activities to be carried out. In the schedule activities were defined by reference to the sections that the floors had been divided into. There were discrepancies between the studied case and the conceptualisation of the construction planning process by Laufer et al. (1994) and Laufer and Tucker (1987) as well as the conventional project management body of knowledge. The main discrepancy was that the decisions that provided answers to the what and the when and that resulted in the detailed course of action were not made as parts of the planning process (cf. Kerzner, 2003; Meredith & Mantel, 2010). Instead, they were made as parts of the coordination and control processes. Hence the detailed course of action did not correspond to the decisions made as part of the planning process and

that were articulated in the schedule. It follows, adhering to Wildavsky (1973), that the schedule, as a detailed a course of action at the lower hierarchical levels of the planning process, was not a part of the planning process. These decisions were continuous as opposed to the decisions made as part of a planning process that are, according to Ackoff (1970), distinguishable by being anticipatory.

Several researchers, rather than assuming that projects can be planned in their entirety in advance have argued for alternative planning processes that allow projects to develop (see Andersen, 1996; Ballard & Howell, 1998; Cicmil et al., 2006). Though at the outset site management in the project in question did not intend to allow the detailed course of action to develop over the course of the project it did, in fact, do so. The detailed course of action followed on decisions made as parts of the coordination and control processes. Laufer et al. (1992), Laufer and Tucker (1987) and Laufer and Tucker (1988) recognised that decisions with a high level of specificity made as part of a planning process cannot be made far in advance of the activities they refer to. Nevertheless, they maintained that these decisions were to be made as parts of a planning process (see Laufer et al., 1992; Laufer & Tucker, 1988). The project in question differs from this in that the answers to what and when and the resulting detailed course of action were a consequence of decisions made as parts of the coordination and control processes. These did not include corrective actions to ensure that activities were carried out as prescribed in the schedule. According to Laufer and Tucker (1987) decisions that are not made as part of a planning process, such as the decisions made in the project in question, carry with them several deficiencies. They contend that resources with long lead times cannot be expected to be at hand when due, integration of project components becomes extremely difficult and optimisation planning is completely ruled out (see Laufer & Tucker, 1987).

ALLOWING THE DETAILED COURSE OF ACTION TO DEVELOP

Unlike the projects that Andersen (1996) had in mind when arguing for milestone planning, the identification of activities did not constitute a challenge for the project organisation. This was considered characteristic for construction projects as repetitive projects by Lundin and Söderholm (1995) and for their routine execution by Lenfle and Loch (2010). Activities with long lead times were among those activities that were identified. The prioritisations of activities made by the site manager as part of the second control process shares resemblance to the milestones argued for by Andersen (1996) with the difference that they were not intermediate results but activities. These prioritisations enabled activities to be carried out using resources with long lead times whilst decisions related to the sequence and the timing of activities were made continuously over the course of the framework supplement work as parts of the coordination processes.

According to Dubois and Gadde (2002), activities in construction projects are subject to strong dependencies. This view is shared by Laufer and Tucker (1987, p. 248) who have stated that these activities "are characterized by a high degree of interdependence." According to Van de Ven et al. (1976, p. 325), "intensive interdependence causes mutual adjustments." Further support is provided by Olsson (1998, p. 504) who states that "it is the only means that can be relied upon under extremely difficult circumstances." Besides the similarities with what Van de Ven et al. (1976) described as mutual adjustments, the coordination processes that managed the dependencies resulting from the use of space over time were decentralised. Dubois and Gadde (2002, p. 622) saw this to be symptomatic of the dependencies between activities in construction projects and stated that "the nature of these interdependencies seems to favour local rather than centralized coordination." Nevertheless, Ballard and Howell (1998), Laufer et al. (1992) and Laufer and Tucker (1988) maintained that the decisions pertaining to the integration of activities should be made as parts of a planning process. As with the coordination processes in the project in question, they allocated these decisions to foremen (see Ballard & Howell, 1998; Laufer et al., 1992). The difference lies in that the decisions made are either anticipatory or continuous. Making continuous decisions as parts of the coordination processes is, however, supported by Dubois and Gadde (2002), Olsson (1998) and Van de Ven et al. (1976). This thesis demonstrates that it was possible to integrate these decisions by means of the coordination and control processes.

Optimisation planning is completely ruled out at the lower levels of the hierarchical planning process if decisions are not made as part of a planning process (cf. Laufer & Tucker, 1987). The issue of optimisation can nevertheless still be discussed. In this inquiry and analysis, for which the schedule provides a basis, efficiency is understood to entail maximising "the performance that can be attained with the resources that [… were] available" (Ackoff, 1970, p. 5). In terms of efficiency, the schedule ensured that the resources assigned were utilised by keeping the resource consumption even over the course of the framework supplement work. Project descriptions and goals do, however, often change over the course of construction projects as they did in the project in question (see Tryggestad et al., 2010). It is thus questionable whether it is possible to optimise the sequence and timing of activities by specifying a detailed course of action in advance through anticipatory decision-making. These concerns were also voiced by Laufer and Tucker (1987) who stated that due to uncertainties it may not be justifiable to optimise planning in construction. A consequence of the strong dependencies that activities in construction projects are subject to is that delays incurred during one activity can affect many other activities (Dubois & Gadde, 2002; Laufer & Tucker, 1987). An alternative, in line with Ballard and Howell (1998) and Winch and North (2006), is to ensure that the necessary conditions for the efficient utilisation of the resources assigned to the construction project are in place. Whereas

Ballard and Howell (1998) were in favour of a back-log of activities Winch and North (2006) argued for a space buffer. Such approaches entail not attempting to make optimal anticipatory decisions regarding the sequence and timing of activities but rather by ensuring that there are constant activities to be carried out and consequently ensuring the efficient utilisation of the resources assigned to the construction project. This corresponds to the first control process that ensured that neither the construction workers nor the subcontractors were left idle waiting the release of activities. It follows, that decisions made to ensure the efficient use of resources by making sure that there are activities to be carried out are elevated to a higher hierarchical level of the planning process where the conditions on the construction site rather than the sequence and timing of activities is in focus. Furthermore, such decisions would qualify as planning decisions as they, in line with Ackoff (1970), relate to the efficiency of activities and cannot be made at the moment of action without loss of efficiency. Another alternative, when attempting to optimise the sequence and timing of activities by specifying a detailed course of action in advance would be to forbid changes to be made to the project description and project goals. However, this would entail that opportunities might not be seized (see Blomberg, 2003; Lenfle & Loch, 2010). According to Ackoff (1970) being awake to opportunities is a part of planning.

In addition to the negative aspects discussed by Laufer and Tucker (1987), the conventional project management body of knowledge, according to Cicmil et al. (2006, p. 683) regards project failure as "indicative of inadequate attention to the proper project management procedures" (cf. Globerson & Zwikael, 2002). Apart from not applying planning, coordination and control processes consistent with the conceptualisation of the construction planning process based upon Laufer et al. (1994) and Laufer and Tucker (1987), the changes made to the project description by the client led to a 10 % increase in costs and resources consumed over the course of the project. "These methods contradict the underlying emphases of conventional approaches: the project emerges rather than being entirely pre-planned; the management style is much more co-operative, recognizing that the plan prepared pre-project is fallible and incomplete, and there is acceptance that the plan cannot be fully prepared because the influence of the external environment" (Cicmil et al., 2006, p. 683). Nevertheless project completion was consistent with project goals; as of the final inspection held on May 6 the project was completed on time, within budget and in conformance with specifications. "It might well be that management techniques that improve performance in other industries are not readily transferable to this context" (Dubois & Gadde, 2002, p. 622).

CONCLUSIONS

The aim of this thesis is to investigate the planning process as it is practiced at the intersection between planning, coordination and control, and the execution of activities. The conclusions and contributions of this thesis are based on a case study of the Kuggen project. This thesis contributes to a better understanding of planning and practice through an analysis of observations made during the project. This account corroborates several of the characteristics that have been ascribed to construction projects. This thesis concludes that the answers to the what and the when of project activities as well as the resultant detailed course of action could be attributed to the coordination and control processes. These processes prevented resources with long lead times being unavailable when needed, integrated the activities that were carried out, and facilitated the efficient utilisation of the assigned resources. Furthermore, despite neither coordination nor control being functions of solely the planning process, the Kuggen project was completed in line with project goals.

This thesis contributes to the debate between those advocating planning process following the conventional project management body of knowledge and those advocating allowing projects to develop organically. This thesis demonstrates that it is feasible to allow the detailed course of action to develop over the course of a construction project and postpone answering the what and the when. In light of the frequent changes made to project descriptions and goals over the course of a construction project, this thesis questions the suitability of attempting to specify an optimal, detailed course of action beforehand (see Tryggestad et al., 2010). In the Kuggen project these changes resulted in a 10 % increase in costs over the course of the project. Combined with the strong dependencies among activities, attempts to specify an optimal detailed course of action is deemed fragile (see Dubois & Gadde, 2002). There seem to be two alternatives - either attempting to specify an optimal detailed course of action beforehand and preventing the client from making changes to the project description and goals, or making anticipatory decisions aimed at ensuring that the conditions necessary for an efficient utilisation of assigned resources are in place.

The results of this study warrant further research into the practices on construction sites. For instance, how can the fact that construction project organisations “know what to do, and why and by whom it should be done” be utilised in planning, coordination and control processes (see Lundin & Söderholm, 1995, p. 441)? How can the autonomy ascribed to and exhibited by the subcontractors in the case project become an asset rather than a source of uncertainty (see Olsson, 1998; Thiel, 2007)? Studies have been made in other industries, such as the one of the film industry by

Bechky (2006), where role clarity similar to that ascribed to project organisations in the construction industry by Bryman et al. (1987) contributed to the coordination of activities. These are questions related to characteristics that were important for the coordination and control processes in the case project but that are not part of the processes consistent with the conventional project management body of knowledge.

The cybernetic control process positioned as a function of the planning process by Laufer and Tucker (1987) is based on the assumption that "there is a standard, corresponding to the effective and efficient accomplishment of the organization's objectives" (Hofstede, 1978, p. 432). It follows, that for coordination and control to be functions of the planning process this must specify a detailed course of action corresponding to project completion in line with project goals. By demonstrating that decisions made as parts of the coordination and control processes superseded decisions made as parts of the planning process, this thesis has shown that neither coordination nor control need to be functions of solely the planning process. In keeping with Ackoff (1970), this implies that the conventional project management body of knowledge definitions of the planning process at the lower hierarchical levels of the construction planning process do not necessarily hold (cf. Kerzner, 2003; Laufer et al., 1992; Laufer & Tucker, 1987; Meredith & Mantel, 2010). This because if decisions can be made continuously without the loss of efficiency then these are not decisions made as parts of a planning process (Ackoff, 1970). More specifically, this implies that answering the what and the when as well as describing the detailed course of action are not justified if the detailed course of action is allowed to develop over the course of the project. It should, however, be noted that in regard to the answers to the what, the identification of activities was important in the studied project.

This thesis contributes to the understanding of planning and practice by explaining the crossroad at which practitioners can find themselves to either specify a detailed course of action and "ensure the course of action is maintained [… by] the taking of corrective action when performance diverges from plans" or to allow the detailed course of action to develop over the course of construction projects (Laufer & Tucker, 1987, p. 248). Either choice should be reflected in the control processes applied. If the latter alternative is chosen and regardless of whether the detailed course of action results from detailed short-term planning - as argued for by Ballard and Howell (1998), Laufer et al. (1992) and Laufer and Tucker (1988) - or whether decisions are integrated and dependencies managed through coordination processes resembling those in the studied project there are implications for the control process. In the studied project the identification of activities to be carried out beforehand was of significance. Each follow-up provided the site manager with a general view of the progress being made with the framework supplement work and, perhaps more important, the amount of work remaining. The site manager prioritised floors, section

and rooms as well as the subcontractors and the activities. The understanding of dependencies between activities and the identification of milestone activities was important (cf. Andersen, 1996). If decisions are integrated and dependencies managed through coordination processes resembling those in the studied project this thesis does, however, suggest that the planning process should ensure that the conditions necessary for an efficient utilisation of assigned resources are in place.

The two identified control processes ensured that the resources assigned to the project were utilised and that progress was made with the framework supplement work relative the periods set. The first control process shared resemblance to the progress measure used by Henry Gantt in that it ensured a continuous reduction of the amount of work to be carried out rather than ensuring that activities were being carried out in accordance with the schedule or the detailed course of action (cf. Wilson, 2003). This thesis argues that planning processes both provide the necessary answers and include the decisions that need to be made beforehand for the control process to be successful. Control should not be based on the planning process but instead planning based should be based on the control process in question. However, neither coordination nor any control process that managed the durations of activities was observed. This may imply that there were not any such processes present but it may also imply the existence of a reliance on self-control amongst the construction workers and subcontractors (see Kirsch, 1996). Regardless, the combining of studies such as those performed by Tuuli et al. (2010b) and Tuuli et al. (2010a) of organisational control and the planning process could open up for improvements of current planning processes in the construction industry.

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