Complexity and rationality: A material-systemic perspective

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Research paper

Abstract

Purpose. The purpose of this article is to contribute to solving the complexity problem: increased complexity is the main reason why projects fail to reach their goals, and it is unclear what complexity is.

Method. This study employs conceptual development integrating the theories of rationality and complexity, discourse analysis, model constructions, innovations and participatory research.

Findings. To understand complexity, it is necessary to develop a material-systemic process perspective and to distinguish complexity from unwieldy complexity.

The social actors construct a material-systemic process between themselves and nature on the society level and through the organization/project level to handle unwieldy nature-complexity. The material-systemic process creates internal complexity through different kinds of differentiations of materializations.

It is systematic (ideological and structural) blockades that transform internal complexity to unwieldy complexity. The material-systemic perspective reveals how to handle complexity emerging from materializations in outer time and space, from inner time (planning), the interplay between planning and production and the diversity of non-integrated perspectives growing out of specialization.

Research limitations. The practical models of organizing are tested to the highest degree in the construction industry. It is a task to increase the scope of the testing of the models in other types of projects.

Originality/value. This article offers a proposal to a theoretical solution to the complexity problem going back to the roots of modern theory-formation in the Enlightenment. The article at the same time shows through practical models how handling complexity and specialization may be the most important productive force in future projects/organizations.

Keywords: Complexity, rationality, materiality, decisions, communication

1. Introduction[1]

Contemporary projects have taken the character of being complex, multifunctional and highly specialized. Increased project complexity is at the same time recognized as the main reason why projects fail to reach their goals of delivery at the right time, cost and quality (Brady and Davis 2014). An extensive literature review of research on complexity in projects (Rolstadås and Schiefloe 2017: 296) states: "There is no agreement about what complexity is". A

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widespread view, however, is that complexity is about emergent parts: "A system formed out of many components whose behavior is emergent" (Whitty and Maylor 2009: 305). A complex system is composed of reciprocal dependent emergent parts. However, this raises questions about what it is that constitutes the system or the whole and the unit of the process: the whole possesses characteristics or behaviors that are not evident from the characteristics of the individual parts (Snowden 2013). The literature review is summarized thusly: "... project complexity is a function of the characteristics that make a project unpredictable and dynamic" (Rolstadås and Schiefloe 2017: 300). Out of this kind of understanding complexity follows proposals about how to organize like: a "creative-reflective model" based on self-organization and the participants' insight in the value chain.

Knowledge overviews indicate that existing theories are insufficient for understanding complexity as a theoretical problem. In practice, complexity appears as unwieldly complexity. This complex may be called "the complexity problem". It is a hypothesis of this article that the appearance of complexity as a theoretical-practical problem is related to a deficient rationality concept—and that the rationality concept must be developed in order to solve the complexity problem.

The article discusses rationality and complexity in organized production related to four standard positions: The initial position is a classical rationalist decision-making and planning theory based on purpose-rationality. The second position modifies the classical rationalist theories. The third position extends the rationality concept to include communicative action; confer the theory of communicative action and the theories of collaborative planning. The theory of communicative action introduces a distinction between "lifeworld" and system level to analyze how society seeks to solve the complexity problem. The fourth position, the sociological system theory, replaces purpose-rationality with system rationality and brings us closer to the determination of the empirical frameworks of modern complexity through the concept of autopoietic part-systems. The theories are discussed from the distinction in the philosophy of science between holism and methodological individualism and between rationalism and empiricism.

The development of rationality and the growth of complexity as a main problem in projects/organizations are then analyzed in light of the historical empirical change from hierarchical to flatter forms of organization and the promotion of social reciprocity, networking, flexible structures, and polycentric decision-making systems. The analysis reveals how common assumptions of the standard theoretical positions about rationality and theories of complexity reflect changes in social relationships and in the constitution of meaning. The problem to be addressed in the article is how hidden joint assumptions of these theories restrict understanding of rationality and complexity and how these restrictions correlate with the practical appearance of complexity as unwieldy complexity.

The article's foundation refers to the Enlightenment and Immanuel Kant's philosophy of science—in particular Kant's concept of materiality (Kant 1804). The development of this concept is used to reveal the material-systemic process that society creates between itself and nature to handle external natural complexity. The structures of this systemic process are valid as a starting point for determining rationality and complexity at both community and project and organizational levels. The sources of increased internal complexity in the material-

systemic process are highlighted in the section "Work division and emergent materializations in outer time and space" and in "Imaginations and division of labor in inner time." A separate section, "The temporal paradox," illuminates complexity handling at the intersection of planning (inner time) and production (outer time and space). Increased complexity and specialization lead to high number of perspectives related to the individual autonomy of the project actors and disciplines. The section "Structured communication-decisions" determines this form of complexity and how it can be handled. The section "Material-systemic rationality—regulatory and empirical level" determines the material-systemic process as rational complexity.

The progressive clarifications concerning what complexity is, and the ideological and structural-organizational presuppositions about how it can be handled, is developed through a contrast to system-contingent blockages in projects that cause complexity to appear as unwieldly complexity. The article's issue is according to this gradually clarified and discussed.

The historical, empirical change concerning the appearance of complexity and the organizational guidelines to handle it refers to extensive empirical studies of organized work in Norway and especially to development projects in the Norwegian construction industry (Andersen 2016).

2. Rationalistic theories of decision making and planning

The rationalist theories of decision making presuppose that individuals or actors are goal oriented and ruled by reason. The goals are based on values and utility preferences and are realized through chains of goals and means. Ideal rationality is achieved by maximizing the relationship between goals and means in an option field: the option that provides the best achievement is selected. According to Simon (1957), the idea of ideal rationality contains the following: 1. That one identifies and arranges all alternatives, 2. That one determines the impact of each option, and 3. That one compares precision and efficiency associated with the set of consequences mutually.

The rational ideal model for decision making corresponds to the rationalistic synoptic planning theory. The synoptic planner must have a knowledge of alternative solutions and consequences and see the whole of the plan and the relationships between the entities that would be affected. Synoptic planning requires a straightforward sequential process in which the planner seeks control of the situation and exercises professional authority by making diagnoses and prescribing solutions (Sager (2001: 513). Planning and decision making occur from one center and are based on specialized expertise in technological contexts for predicting causes and effects and assume that the empirical reality may be an approximate copy of the ideal plan. Deviations from the plan are explained as individual errors and lack of competence. The concepts of classical rationalism are further recognized in the present-day project management theory (Koskela and Howell 2002), in the idea of management-as-planning (Johnston and Brennan 1996), the dispatching model (description of job execution from plan) (Bhaskaran and Pinedo 1991), and the thermostat model, ensuring that the result is in accordance with given standards (Ogunnaike and Ray 1994).

According to Simon (1957) and modified rationalism, the idea of ideal rationality ignores human cognitive constraints: the brain has no capacity to receive and evaluate solutions, consequences and information to the degree that an ideal or maximum rationality implies. A decision-maker has resources and time constraints for how much information he or she can afford and time to collect and process before the decision must be made. Perfect rationality also implies clear and precise goals determined prior to the action. According to Simon (ibid.), actions contribute to developing and clarifying goals. Instead of maximum rationality, one must take for one's basis a bounded rationality with a limited ability to predict outcomes and settle for an idea of satisfactory solutions.

Incremental planning conforms to bounded rationality. Incremental planning means that one does not have clear, fixed goals in the first place. The development and selection of goals and means take place simultaneously. In the diversity of alternatives and consequences, only a few are considered. The incremental approach is practice-intensive and makes it easier to consider feasibility. Modified rationalism is also recognized in lean construction (Koskela and Howell 2002: 7). Value generation (cf. customer values as goals) is not determined in advance but is developed through the process, and the process flow is similar to open-ended processes (Koskela 2000). Management is understood as management-as-organizing (Johnston and Brennan 1996). Human action is inherently situated. The terms of action always deviate from the plan and require independent goal-oriented actors and continuous improvements (Koskela and Howell 2002).

The theories of ideal rationality and synoptic planning based on purpose-rationality in the original and modified forms are not arranged to cast light on emergent parts processes and their interplay neither at the cognitive level nor at the level of outer reality. This results in a too simple conceptualization of the relationship between imaginations and plans on the one hand and empirical utterance and reality on the other.

Communicative action and collaborative planning
The linguistic-communicative turn in social studies can be traced back to the 1970s and 80s. The theory of communicative action (Habermas 1981, 1992) plays a central part in this context. This theory creates a sociological distinction between social integration (Durkheim 1933) and functional integration (Parsons and Shills 1951). The determination of social integration takes as its starting point the individual human's lifeworld and meaning horizon (Habermas 1981). In modern society, the lifeworld of individuals is rationalized based on three validity areas: the inner world and social expressions of the person (equivalent to authenticity and credibility), the universalizable norms and validity of justice (ethics-moral), and purpose-rational actions related to external nature and the validity of truth. Communicative rationality and social integration are redeemed through the coordination of individual lifeworlds, consensus formation and common understanding based on "domination-free communication" and "the best argument's force-free force" related to the validity areas.

The purpose-rational field is expanded with the concept of functional integration or system integration (Habermas 1981). On the one hand, human understanding is reproduced through symbolic reproduction. On the other hand, the lifeworld requires a material substrate

based on work and targeted result-oriented action. An increased division of labor results in a complexity that manifests beyond the individual's lifeworld horizons (Nørager 1985) and beyond what can be coordinated through communicative action. Through the dissemination of the purpose-rationality, an autonomous system world is uncoupled from the lifeworld. The economic system in modern society, where money and market reduce complexity, illustrates the uncoupling of a self-governing system kept together by system-integrative mechanisms (cf. money and the juridical system). The political system integrated by power is another example of uncoupling. Specialization and expert competence are an important part of the system world. In modern societies the purpose-rational system, however, turns towards its origins and colonizes the lifeworld, such as when market and purpose-rationality (in the form of instrumental or strategic rationality) takes over and eats into the lifeworld areas and the rationality of communicative actions.

The theory of communicative action and enhanced rationality has been developed into a theory of collaborative planning (e.g. Healy 1992, Allmendinger 2002). In this theory, all participants are involved in the planning process and one-sided expert's influence is reduced. Participants' dialogs, learning, and understanding have increased influence over the framing of the purpose-rationality involved. Collaborative planning may support a collaborative and interactional culture that prioritizes collective flow efficiency at the project level over individual actors optimizing individual or company interests and resource efficiency (Modig and Åhlstrøm 2012).

3. Empiricist approach: Modern sociological system theory

In the rationalist theories discussed above it is assumed (implicitly or explicitly) that an epistemological super-individual unity and objectivity are prerequisites for common societal experience. Empiricist approaches explicitly challenge this assumption of unity and objectivity.

Sociological system theory breaks with purpose-rationality as a basic concept and instead links rationality to the system's autopoiesis and onto the distinction between system and environment. Autopoietic social systems are self-creating, self-sustaining, operationally closed and thus autonomous. They can only be irritated by the outside world and cannot be determined thereby. They are open-ended, emergent (cf. an ongoing growth of qualitatively new levels of order of meaning) and recursive (a process that uses products and results of its own operations as the basis for further operations) and have an unknown future (Luhmann 1984, 2000).

Sociological system theory is closely related to complexity theory. While the sociological tradition studied increasing social differentiation in terms of division of labor and roles (e.g. Durkheim 1933), sociological system theory identifies social system through communication and differentiation of society through differentiations of communication. The social system as a communication system differs from the individual mental system; however, both operate within the medium of meaning. Individuals have freedom and can (as mental systems) connect to and disconnect from social communication systems.

According to the sociological system theory, modern societies are functionally differentiated into seven autopoietic systems separated from each other by means of "binary

codes": in science true-false, legal system legal-illegal, politics, government-opposition; economy, paid-not paid; etc. Each system is an autonomous decision-making system: the modern functional society is polycentric and heterarchichal. System differentiation does not mean that the previous system has been resolved. It is instead recreated as a communicative network system. The community's functioning systems are thematically closed but open in terms of membership (all individuals in society are members). Organizations and projects, however, are thematically open, but closed when it comes to membership (individuals). Organizations and projects develop general decision-making premises, such as conditional programs and goal programs, communication routes and membership.

In this article, we interpret specialization and specialist systems as operatively closed auto-poietic systems in organizations and projects. The organization can accordingly be interpreted as a communication network. Sociological system theory is relevant to defining organizational planning processes (Luhmann 2000, Van Assche and Verschraegen 2008). According to this theory, plans will be emergent so that the forecasts will be transformed continuously to the future and to decision-making principles in the system's autopoiesis (Van Assche and Verschraegen 2008). The plans are designed by combining the perspectives of the internal specialists in the organization/project.

Functional differentiations at the level of society are transferred to the project level by the individual human: all topics in the project have a fact/science aspect, a legal/juridical aspect, etc. (cf. the seven subsystems). The individual can connect the subsystems at the community level to any single topic in the project. In a modern planning team, one finds actors who are specialists from or who derive their competence from functional systems on the community level (ibid). The complexity of both the specialization at the project level and the specialization of the societal level transformed to the project level implies an increased number of specialists in the production process of the project. The process requires a balance between the specialists/experts. There is always a threat of de-differentiation and rationality loss in the project, for example, by one internal system (such as a discipline) overriding another system or because the project lacks competence related to the systems on the community level.

The assumption of sociological system theory that systems are autopoietic implies that steering can only be self-steering (Luhmann 1984). However, planning can be considered to be a form of indirect management of self-steered subsystems (Van Assche and Verschraegen 2008). An organizational system involves developing general decision-making premises; the network of subsystems in the organization may mirror a goal-program: a plan, or a planning system (ibid), making the autopoiesis and self-steering of the other systems possible.

However, this raises the question of how the planning system, as part of a general polycentric and heterarchic decision-making system (and which is an autopoietic system itself) can control and coordinate the autopoiesis of the other systems? It may be inferred that the sociological system theory for epistemological reasons is not concerned with integration or coordination. Coordination, however, is a dominant challenge in organized work that the theory must be able to address.

4. Empirical-historical trends—The construction industry

Project management is traditionally characterized by synoptic planning, hierarchical and centered decision-making and sequential linear processes (see also the decision-making model of ideal rationality). The corresponding organizational form has inhibited the systematic interaction between the experts and has led to plans that do not match the empirical reality (Ballard 2000, Koskela 2000). When plans have not matched reality, there has been a need for ad hoc decision making to ensure process progress. Ad hoc decisions, however, entail a high risk that decision makers do not account for the network of dependence under which the decision is made and consequently do not predict the consequences that the subsequent actions trigger. The current organizational form can be termed oversteering within a tacit work environment (Andersen 2002). On the one hand, this management form hampers emerging forces in production. On the other hand, production appears to be more complex, emergent and unpredictable than anticipated in the plans. Information about the production processes to a limited extent is manifested up through the organization.

There has been a long-term trend of flattening organizations: of increasing emphasis on more flexible processes, on incremental elements in the planning processes, on reciprocal social relationships and on the delegation of decision making to the executive teams. This trend is also found in the theory as in decision-theory based on "limited rationality" (Simon 1957) and "muddling through" (Lindblom 1959), the determination of open-ended processes in lean construction (Koskela 2000, Ballard 2000) and planning theories based on incremental procedures (Ballard 2000) and collaborative planning (Healy 1992, Parrish, K. 2014). These characteristics of flat organizing, however, create a coordination and decision-making vacuum (at slightly higher levels in the organization), which is due to the undeclared status of the planning process and which makes the organization appear to be understeered (Andersen 2016). The flat organization liberates and highlights more of the emergent part-processes, but the collective unitary and common systemic aspects of the process remain underdeveloped and insufficiently determined both in practice and in the corresponding theoretical academic discourse. These process characteristics of flat organizing are due to the fact that the communication system grounded in reciprocal social relationships is not linked to an effective decision-making system. The result is tendencies for fragmentation and disintegration of production. This type of organization can be termed "flat structure with non-committing work environment" (Andersen 2002, 2016).

Empirical studies (Andersen 2002) support that over- and understeering today exists as hybrid forms in different kinds of organized work, for instance, in phases in construction projects—that is, in design and engineering as well as in the building phase (Andersen 2000, 2016). The absence of efficient planning processes both in over- and understeered organizational units and in the hybrid form causes plans with short timeframes in production.

The combination of theories of incremental planning (Ballard) and commitment planning (Searle 1969; Austin 1962; Winograd and Flores 1986; Ballard 2000) is aimed both at oversteered (tacit)- and understeered (non-commitment) work environments. The theories of communicative action and collaborative planning (Habermas 1981, Healy 1992, Parrish 2014) can be interpreted as more in-depth theories in the same vein: communicative action counteracts "internal colonization", reciprocal communication counteracts oversteering, and the development of social integration counteracts the tendencies of fragmentation and social

resolution associated with a non-committal work environment. Sociological systems theory helps us to determine the development of emergent specializations in organized production (confer both differentiations at project/organization levels and societal levels) and to go beyond purpose-rationality to develop a more advanced notion of systemic rationality. However, the theory still only mirrors the development of the flat organization and the uncommitted work environment with a polycentric decision-making system—and the missing capacity to develop the collective process.

What is it with the empirical-historical development from top-down managed organizations to flatter forms that make complexity appear to be an unclear theoretical term and something practically unmanageable, but at the same time as a main source of success or failure in projects? The overall development of the process means a flattening of hierarchy with increased emphasis on reciprocal social relations. The theories of rationality presented above only describe features of this development but do not show the underlying causes of the complexity problem. The academic theories and discourse appear to share common (implicit) assumptions with those underpinning empirical historical development: both are based on notions about the processes restricted to a social-relational level and to a level of meaning, or meaning-constructs, or abstract notions or ideas about materialization. The rationalist theories (explicitly or implicitly) presuppose ontological and epistemological premises about an over-individual unity of reality—such as holism. The empiricist theories presuppose autonomous parts—such as methodological individualism—criticizing the existence of any over-individual unity. Both positions in this antinomy are grounded in subjectivist assumptions contributing to the complexity problem. A determination of the material-social foundation of constructs and relationships in objective outer time and space makes it theoretically possible to demystify complexity and to show how complexity can be handled in practice.

5. The material-systemic process

In the Enlightenment, the portal to modern society, the philosophy of science got its "Copernican turn" through the philosophy of Kant. The growth of a new dynamic society uncovered that humans create through the constitution and construction of an open dynamic material system for their own purposes between themselves and the undetermined external nature. The foundation of this material system can be further interpreted as follows (Kant 1804, Andersen 2016): Humans create a material-systemic process as a common front in outer time and space based on work division to develop their own needs and to subordinate to themselves an unwieldly and non-mediated external nature. For man, this process is grounded first in that external nature appears under the premise of shortage of time. Second it is grounded in the fact that the material-systemic process has the capacity to store problem solving skills and through this to increase "free time," making the further development of the material system possible.

The Copernican turn also implies that the outer material world is both man-made and at the same time, epistemological speaking, absolutely distinct and separated from man's cognitive capacity. Nature appears empirically for the human with the infinity of alternative possibilities and threats that she/he has limited information about (cf. also Simon 1957). The actors use the material systemic process to subsume the arbitrariness of nature underneath the

material systemic process without repealing the arbitrariness. The rule is that cognitive imaginations are biased from materializations—and that the experienced variations are critical variations (Andersen 2016).

This material has a systemic character: the parts are based on and complement each other, making synergies to the joint construction of materiality, and at the same time a process character, through constitutions and constructs by ongoing perceptions and work mediated by perceptions. The materiality takes the character of both noun and verb[2]. Humans manifest themselves through "materializations" pointing beyond the distinction between thing-ontology and process-ontology (Koskela 2000): the material-systemic process implies that material and "thing-functions" are saved in a specialized fixed order in outer objective time-space, but at the same time that the materials are emergent through perceptions and work. The material-systemic process may be considered to be a basic complexity reduction directed against external nature. The notion of materializations described above has same type of relevance for all kinds of materializations, for instance for materializations at the societal level, organizations, projects, etc.

Materializations mediate teleology (Kant 1790 and 1804): they consist of both objectivity (outer empirical determination) and meaning (teleology). Causality appears as part of determined material (determinative judgement) as «causa finalis» or purpose-causes: the result of a materialization is a purpose or motive (teleological judgement) and triggering cause for the action and the subsequent chain of material causes that leads to the result. This can be illustrated and further developed by a ventilation system in a building (Andersen 2016): First the electronics that operate a ventilation system can be seen as a system of internal-effect functions (effects being defined as a result of causes and functions referring to interactions between parts of the system). Second electronics lead to result-effect functions: it creates a certain type of air tightness and pressure, replacing old with new air at a certain speed, to a particular extent and at a certain temperature, etc. Third, the purpose of the effect-purpose or effect function is to create user functions: users apply the effect functions (electronics and air tightness, transport of freshly purified air) for meaningful user experiences: "Fresh and healthy air here, nice temperature there, etc. "—i.e. as user-effect functions. The material user-effect functions are contingent endpoints, motives and triggering reasons for constitution, construction and maintenance of the other actual systemic process of effect-functions. User-effect functions are constructed and work together to create the ground for a unified experience: "fresh air here," "good light," "fine colors," etc., making up a basis for coherent meaning or lifeworld horizons. All effect functions imply material causal effects and thus determining judgment in outer objective time and space. Through this, the materially mediated teleology has been developed to include user-effect functions, result-effect functions and internal-effect functions.

All of the material-systemic reality that humans surround themselves with and that they live into is designed, constructed and operated in this way: first by material user-effect functions, second by result-effect functions and third by internal-effect functions. The parts of

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[2] Weick (1995) determines organizations through a distinction between realities qualified by verbs like act, work, communicate, making decisions and nouns that form a stable basis for the processes through rules, habits and routines like generic subjectivity. Weick's distinction is within subjectivist premises.

the material system don't disappear when we move around. Some of the functions are moveable as when we in a house tap water from a faucet while others are resting effect-purposes. Also the unprocessed but defined materiality mediates teleology as when we rationally move our bodies in nature. Material constitution and constructs take place through perception and work mediated by perceptions. Undetermined causes are still not mediated causes. The phenomenon of meaning is inherent in the definition of material—and there is no meaning beyond its material mediations.

The material-systemic approach indicates an alternative starting point for the concept of rationality: First that purposes is material purpose-causes and effects as parts of materializations. Second that individual object-oriented materialization always operates in and gets its definitions through a material-systemic context. The material teleological rationality of the individuals' lifeworld is coupled to rest of the materially mediated teleology of the material-systemic process (material constructed by perception and work) or field (in addition to what is only perceived as untouched nature).

This Kantian concept of materiality and material systems differs from positivism/the critical theory of socio-materiality based on holistic presuppositions with society and natural phenomena as separate and distinct (Sartre 1972, Østerberg 1977). It is also different from the recent theory of the socio-material presupposing methodological individualism and assuming a unity between meaning and material (Barad 2003, Latour 2005, Orlikowski and Scott 2015). The basic assumptions of these kinds of theories are distinctions inside the material-systemic process. The Kantian approach is on a higher level of abstraction: the starting point for the theory is the distinction between the cognitive imagined materializations and distinct from this is the always socially mediated material-systemic process as such in outer empirical forms of perceptions separated from pure outer forms of perceptions. It is a further examination of the deep structures of the material-systemic process and its preconditions on the one hand and the interaction between imaginations on the cognitive level and outer objective level on the other that make it possible to respond more closely to the complexity problem addressed in this paper.

Materialization and work division—In outer time-space
Work division based on processed materializations is a contributing source of internal complexity. The complexity problem may however now be addressed in an expanded material-social context. This article complies with the phenomenological tradition based on a concept of the lifeworld. The empirical material life-horizon of individuals is ontologically defined always limited in relation to the rest of the material-social process and increased specialization through material-social differentiations increases these limitations. A community of specialists who produce a material-social product imply that no one observes or knows the totality of the product: every specialist knows and materializes a lot that the others do not know anything about. Despite this, the total product or object works in practice.

Complexity as composite and emergent materialization
If we imagine, for example, at the entrance of a hospital, its lighting fixtures are hung in specific places to provide the desired illumination, reception is positioned to "communicate"

with the front door, and further into the building, elevators and stairwells are placed in relation to reception, windows can provide sufficient and desired natural lighting, etc. Each of these elements constitutes a user-meaning function through a specific material. Together the materials constitute a meaningful context or unity for the user of the building, and the unity is realized by materials creating continuity and coherence in time and space.

The description of the entrance is a description of composite materials or a composite object. The individual material meaning may be produced based on special competence and an individual subject discipline. The entrance is the superior idea that, together with its material counterpart, gives direction to the compositions of the items—the parts. This concept of the material may be called the composite material or object on a par with a holistic approach—the whole defines the parts. Such an object-concept leads to a focus on a generalized knowledge (the whole) based on the interaction between different disciplines. An object consisting of a large amount of parts and relationships constitutes a complex composite object.

However, part-technologies constituting an object are not just technologies that complement each other but are also part-technologies, each with its own autopoietic logic. The electrical subject's decision latitude and solutions in "technical room" in a building and incidentally around in the building is largely a closed universe for everyone else (cf. for instance the internal-effect functions). A part of the electrician's decisions and materializations encounter, however, the interface with other subjects and technologies in the joint process (cf. the result-effect functions and user-effect functions). The same applies to all disciplines and subjects; they have on the one hand a separate specialist material-meaning universe corresponding to a conditionally independent technology with its own emergent causal systems and emergent levels of material-meaning. On the other hand, their technologies appear with different types of addictions in the interface with other technologies and other competencies. Each material part is constituted mediated through perception and therefore an open-ended emergent process. This reveals the object as a complex-emergent object.

This gives rise to a further development of the material-systemic process. The individual objects are autopoietic material part-systemic processes connected with closed emergent knowledge systems of specialists held together by interface functions between the objects and between the disciplines' knowledge-domains.

The hallmarks of complexity and specialization are on an abstract level reflected in the sociological system theory where subsystems (i.e. experts) are determined as autopoietic and as operationally closed universes of meaning (Luhmann 1984, 2000; Pikas et al. 2016). However this theory operates on an abstract level of human relationships and free-standing "meaning."

The above presentation transfers the concepts of sociological system theory about autopoietic part systems into a world of emergent part material objects. The material mediated teleology of internal effect functions and, in a certain sense, result-effect functions and user-effect functions are integrated in the concept of autopoietic individual material objects. Insofar as the autopoietic individual material objects contribute to the joint material-systemic process, they also contribute to a further definition of material rationality. The definition of

autopoietic individual material objects involves a step in determining the material-systemic processes as a concrete, complex, and emergent phenomenon. The theory is brought to a material level; however, the substrate of the substance that mediates the interfaces between the parts is thus far undefined.

Internal functional differentiation

The notion of material functional differentiation may be contrasted with the theory of "set-based design," which occupies a central position in Toyota and lean philosophy (Singer et al. 2009; Ballard 2000b). Set-based design develops from high complexity to simplicity. In a real design process, however, the designer starts out at a system level (such as a hospital), differentiates the system—for instance in two user-effect function subsystems (treatment and surgery versus the rest of the building), and further each subsystem into, for example, twenty new subsystems. The design of each new sub-function implies a number of alternative designs, and each new feature creates opportunities for the further differentiation of new clusters of sub-functions (in the canteen: kitchen as one cluster and restroom another cluster). For each level of functional differentiation, the amount of complex (composite and emergent) objects increases and thus the amount of alternative design concepts will increase as well. The interfaces on the preceding differentiation level will not disappear but will be further defined in light of the more detailed design related to the subsequent level. The material is constituted as clusters of objects and the clusters together as a united object (cluster) in differentiation from other objects. Each level of functional differentiation increases complexity (amounts of emergent material parts and relations).

Behind each function/equipment and behind each complex object, there is usually a manufacturer or series of manufacturers and as part of this, a series of specialists that make it possible to produce the equipment. Each piece of equipment requires a specialist for it to be installed. Each sub-function is the starting point for new clusters of features and specialists. Generally, functional differentiation and construction, and the corresponding development of human needs, is the driving force behind the creation of each special competency and each new expert (this does not prevent technological jumps that simplifies the process). In the elucidation of the material-process perspective, the open dialectic of differentiation and integration goes on in each phase of the process—in construction: in design, engineering and so on.

Differentiations of functions inside each project may be defined as project internal differentiation. These differentiations are developed in interplay with differentiations of material products or services delivered to the project from other producers (supporting internal project differentiations). The sociological system theory's functional systems on the level of society may be differentiated into substantial and reflexive systems (Andersen 2016). A substantial system, like natural science, produces groundwork for technological innovation on the basis of material production and reproduction systems. The reflexive systems on the level of society do regulate material production and reproduction without even producing anything into the material production and reproduction process, such as the judicial (legal-not legal), the political (position-opposition), and the economic system (paid-not paid) (*ibid*). In projects and organizations, the reflexive systems do affect both the constitution of the

planning processes and the constitution of properties of the material objects and the materialization processes.

All the differentiation processes mentioned above are internal to the joint material-societal process and imply an enormous complexity. For the individual, increased complexity and specialization may appear to be complicated and unwieldy. Further analysis of the deep-structure of the material-systemic process shows some dimensions about how to disconnect unwieldy complexity from complexity as such.

Structuring material

The unity of different user-effect-functions in a building is part of a material order and of structuring material. In a building process, lighting, ventilation, piping, etc. are fastened, built into or laid down on/in the floor, walls and ceiling (Andersen 2016). The floor, walls, ceiling, etc. comprise the building's "skeleton," the construction elements (concrete, wood and steel-structures) that make it possible to give the other materials and individual functions a fixed order, coherence and continuity in space and time. Structural material logically and in time precedes the other materials and functions in the construction process. One cannot attach the ceiling to the cables. The structuring material provides the object-world with a necessary stable order in outer space and time safeguarding a main or leading interface with other types of materials. Structuring material connects both functions in single clusters (a hospital bedpost, a hospital operating room, etc.) and the clusters on a project level. The constitution of structuring material is in itself an autopoietic process and constitutes the material order as an autopoietic order of autopoietic part-systems.

In a building project, it is first and foremost the architect's task, responsibility and specialty to develop the unit of material user-effect functions (the unit of the users' lifeworlds) in the building through structuring material and to link this to the effect-functions of materiality. It is the architect's specialty to coordinate user-effect functions and result-effect functions of structuring material with user- and, in particular, result-effect functions connected to the contribution of the other disciplines. Furthermore, it is the structuring consultants (SC), structural engineers (on-site) and normally the concrete subjects and carpenters who are specialists in and responsible for structuring material. When architects and SCs, etc. (the "structuring subjects-axis" or "structuring-axis") perform their ideal role in the construction process, they create by realizing the purpose and tasks of their own subject at the same time primarily coordinating guidelines for the other subjects such as the technical subjects. All subjects have their specialist expertise; the structuring-axis also has a general building-structuring competence integrated into their own specialist expertise. This expertise is about coordinating interfaces between the structural-axes and other subjects (this role-competence is normally most explicitly developed by the architect subject).

The notion of structuring material contributes to the solutions to the complexity problem. In a specialized process like a building process, the individual specialist discipline can create their emergent sub-products based on earlier materializations and in interaction with the design of the structuring material. The structuring material is the substrate that makes it possible for the contributions of the single disciplines to function autonomously in a fixed order in a specialized and complex context of meaning.

The empirical-practical development in organized labor is characterized by a complexity that increasingly overloads the individual's lifeworld horizon and the individual's opportunities for rational decision making. However, increased internal differentiation and complexity do not necessarily mean increased complexity in the individual's decision-making situation. Individuals operate in and further develop sections of material which is supported by the structuring material. When using or working in one part, the other material is put on hold and processed later if necessary (cf. different forms of material such as construction, design processes, writing, etc.). The material order anchors the individuals' lifeworld: the individual actors can walk around in structured material with their limited perceptual-materialization lifeworld horizons. They can move around in a building knowing that other parts of the building and its substantive order will be there when they return to places they cannot observe here and now. This characteristic of materiality and, in particular structuring materiality as concern reductions of inconvenient complexity, has the same validity on the individual level, the discipline level, etc.

This step in the solution of the complexity problem supports going beyond the antinomy between the system and action theories and furthermore between holism and methodological individualism. The sociological system theory (Luhmann 1984) criticizes holism for its old-European thinking because in practice it can't fail to assume that one of the parts (majores partes) exalts itself to stand hierarchically over and determine the other parts. Action theory and methodological individualism is criticized because the benefit of individual independence can jeopardize the whole, the collective and the unity. However, in the light of the material-systemic perspective, structuring material ensures the unit and a concrete "totality" and is a public-collective possibility condition for the development of autopoietic subsystems and individual autonomy. The subject's autonomous lifeworlds and materializations are based on an already materialized object-world. This material object-world has a significant collective reality beyond the individual lifeworlds and actions. For instance, the "boundary objects" in the theory of "knowledge communities" (cf. methodological individualism) could advantageously and in light of the material-systemic perspective be replaced with structuring material.

The common failure of the rationalist and empiricist theoretical traditions is that they are subjectivist social meaning and social relation theories, missing the determination of the empirical material substance in outer empirical forms of perceptions that 1) make the connection between autonomous individual lifeworlds and the common social level possible and 2) support the development of emergent autopoietic parts and also making their unity possible.

Work division in inner time

The construction of the material systemic field is largely taking place step by step in sequential chains of targets and means. The nature of duration and continuity of the material makes it possible to build material on material. The actors create advanced sequences using imaginative abilities like planning. Through this, they create a complexity used to reduce external complexity.

Modern time philosophy distinguishes between a linear objective and a teleological understanding of time (Krogh 2006). A tool used in the lean approach is a flow chart (Wig 1996). A flow chart shows a sequential linear process in any time window without defining a present time. The flow chart demonstrates a process seen from the point of view of an observer standing outside the process and making an objectification of it. A teleological understanding of time places the observer as a creative subject "here and now" in the center of the process. From this position, the subject has cognitive imaginations about plans, goals, and conditions about a future outer now. All before "here and now" is past.

As the philosopher Husserl has taught us, perceptions are not limited to series of consecutive points but rather constitute meaningful objects in coherent time (Krogh 2006). The intuitive forward- and backward-perception is, however, violated through a primeval impression "now" that constitutes the objects as an open process or "genesis." Talking about objects and materials in this way also means talking about material processes. Luhmann (1982, 2000) supplements the concept of time with decision making: the decisions are the core of the now-experiences and what is decided immediately becomes a decision premise. Both Luhmann and Husserl define the processes of constitution as open; however, it is Husserl who primarily deals with the constitution of objects as open processes. Kant (1787) invites us to distinguish between both cognitive processes and outer perceptual materialization as open-ended processes. According to this, we will distinguish between ideas (plans) through inner perceptions and outer perceptual materializations as two emergent recursive and open-ended processes (Andersen 2016).

Plans are about imagined future now. Construction projects create comprehensive notions about future empirical now's through building plans for several years to come. There are planning intervals at 1 week before production, 2–3 weeks before productions, 4–8 weeks before production and there are project plans, delivery plans, logistics plans, master plans, etc. All this is about cognitive imaginations about future now in an outer empirical sense. Although developed to a limited extent, there are different actors operating in the different time windows of the plans, corresponding to a huge specialized imaginative world into the future (Andersen 2016).

A plan traditionally developed (e.g. project management) uses the work-breakdown structure: the plan is divided and sequenced in smaller parts based on a given target hierarchy (Koskela and Howell 2002). In light of the material-systemic perspective, the plans are systemic. The human subjects integrate autopoietic material parts with the help of (an also autopoietic) structuring material into a concrete unit. The plan does not consist of one common plan oriented towards a common goal but emerges from a number of autonomous subplans and separate goals with dependencies integrated through the plan of the structuring subjects-axis. The plan of the structuring subject-axis is developed through dialogues with the other subjects, but the plan of the subject-axis is in the end a decision-making premise for the subplans. In light of the material-systemic perspective, it is necessary to increase work division in inner time to meet increased work division and functional differentiation in outer time-space at the project/organizational level and at the societal level.

The temporal paradox

The temporal paradox is about the connection between the two types of division of work: First, emergent work division and materializations in outer time-space (cf. composite emergent objects, emergent internal functional differentiation and emergent structuring material) and second, emergent work division in inner time like in a planning process. A system conditional (ideological and structural) failure connected to the attuning of plans and what is designed/engineered with the outer empirical reality is a main source of the complexity problem. In earlier parts of the article, the problem is illustrated by the ideological development from ideal rationality and synoptic planning to empirical-sensitive bounded rationality and incremental planning. The problem is also background for the philosophy of planning in lean construction (Koskela 2000) and for the methodology of the last planner system (Ballard 2000). The empirical-historical part of the article illustrates how the complexity problem evolved under the organizational structures of top-down management up to today's modern, flattening, highly complex and specialized forms of organization wherein the complexity issue is the greatest challenge that needs to be addressed to achieve project success. The material-systemic approach offers an ideological shift in how to understand this main part of the complexity problem and also offers an alternative organizational structure that creates a basis for a solution to the problem in practice.

The problem can be understood in light of the temporal paradox and formulated as follows: plans are ahead in time of and give a background for the interpretation of what is going on in production. However, the experience from work execution is that of an emerging reality in the production process creating a new level of meaning that is different from and ahead of the level of meaning in the plan. This is about precision in meaning and concreteness according to alternatives and consequences of materializations; cf. definitions of composed object complexity, functional differentiations and interfaces between disciplines and between disciplines and structuring subject axis. In light of the material-systemic approach, the paradox is grounded in that the cognitive inner reality and the outer perceptual reality are each emerging, operatively closed processes. The material-systemic approach ontologizes the distinction between the cognitive and the outer perceptual level (Andersen 2016).

A meeting structure based on a rationalist or rationalist modified plan-theory will normally consist of the following characteristics: first there is a meeting on an overarching level discussing the project plan, then follows a meeting at an intermediate level and then one at the level closest to the work performance (such a structure is provided in lean construction—more specifically in the last planner system) (Ballard 2000).

Based on the material-systemic approach, an inverted meeting structure has been developed to deal with the temporal paradox (Andersen 2016) and for the solution of this part of the complexity problem. The following illustration of the structure is taken from the physical construction process. For example, a cyclic repeating meeting structure in the building process begins with a planning meeting for the work crew who will perform the physical work during the first week. Immediately afterwards follows a meeting for the crew leaders from all subjects planning for 2–3 weeks ahead in time, and then a construction/operation manager meeting planning for weeks 4–8, then follows a project meeting, and then a builders meeting. All meetings are scheduled closely in time. The craftsmen have first-hand experience and knowledge about ongoing material emergence in the

outer empirical production and they base the work plan (week 1) on this knowledge. Meetings and plans closest to production make up decision-making premises for meetings and plans further ahead in time so that these plans are updated and mirror the emerging reality of production. In light of the material-systemic perspective, the emerging autopoietic materializations in the production play the role of being decision- making premises of an ongoing decision-making process on the cognitive level, defining the imagined future materializations in empirical outer here and now. The material-systemic perspective imply a dynamic process: The outer materializations have to be interpreted in light of emerging plans and design/engineering (drawings and models), which should be used as decision-making premises for the decision-making in the production. Opposite: plans and design/engineering (drawings and models) always have to be interpreted and further developed in light of the emergent complexity growing out of the physical building process. The emergent complex materializations in production are in last instance ultimate decision-making premise and ground for this process of interpretations by virtue of constituting reality.

The traditional rationalistic planning process and corresponding decision-making structure lack adequate organizational instruments to handle the transition from planning to empirical reality. This causes the emergent empirical reality to appear as unwieldy complexity. The development of the modern highly specialized work increases the strength of this source of unwieldy complexity.

Structured communication-decisions

The material-systemic perspective implies an element of structured material communication-decisions that points beyond the sociological system theory (Luhmann) and the theory of communicative action (Habermas). According to the sociological system theory decision-communication requires reconstruction: "The key factor in the interaction between these autopoietic, operationally closed systems, [is] 'reconstruction.' Reconstruction translates and re-signifies social meaning engendered in other systems in terms of their own system" (Van Assche and Verschraegen 2008: 270). The systems' reconstruction of the other systems' perspective is never more than approximated because the system, on its own premises and its own emergence, reconstitutes the perspective of the other system. In the sociological system theory, communication and decisions are connected. When someone decides to express an offer for a subsequent joint action, others may decide to join. In order to be organizational decisions, the decisions must be communicated (Luhmann 2000).

Transferred to the material-systemic perspective, "reconstruction" means the subjects create and re-create their own and others' materializations. The epistemology of the material systemic perspective presupposes that the single subject has operationally closed perspectives. It also presupposes a formable substance "out there" in pure outer forms of perceptions whose reality-status is only of transcendental ideality (Andersen 2016). The re-creation of the other subjects' materializations is basically based on the subject's own perceptual materializations. All communication is mediated by materializations—or objectivations—and, as far as they concern the material-systemic process in empirical objective forms of perceptions, are inter-objective. The most extensive communication is through the re-creation of the "here and

now" in the outer sense of other actors' earlier materializations and without their presence. Symbol-based communication may be disconnected from outer "here and now" perceptions.

The material-systemic perspective also offers an alternative way to integrate communication and decision theory. A starting point is disciplinary-subjects in an organization that takes each other's perspective (reconstruction). When someone makes a materialization explicit as a message, this implies a decision about expressing this precise message. The message may imply a suggestion that others should decide to join an actual subsequent materialization. In this way, material, communication and decisions are linked together and can be termed material communication-decisions.

According to the notions of structuring material and structuring subject-axis, as illustrated by the construction industry above, it is necessary for the other specialists especially to take the perspective of structuring subject-axis in order to contribute to the joint coordination. The competence of the structuring subject-axis is itself a specialist competence and the coordination of the other subject's materializations is part of this e specialty. When proposals for coordinated materializations and communication or dialogues between the experts do not lead to acceptance, then the structuring subject-axis decide based on their special competence involving the coordination of the other subjects (Andersen 2016). The notion of structuring material thus makes it possible (beyond the sociological system theory's decision communication) to determine a notion of structured communication-decisions and an expert-based system for integrated or joint decisions.

Projects and organizations can, in their entirety, be developed as self-directed expert systems because the decision-making and coordination system based on structuring material is subject to the experts themselves. The self-directed expert system means that leader is released from the coordination function and instead can concentrate on the role of a reflexive leader—that is, a leader who facilitates and ensures that the system of structured communication-decisions works. This concept of reflexive management based on a self-directed expert system and on structured communication-decisions can be seen as a development, for example, of lean construction's theory of management-as-organizing (Koskela and Howell 2002).

The validity criteria for authenticity, normatively correct behavior and truth (Habermas 1981) are relevant in the material-systemic perspective—albeit in a rewritten form. This applies, for example, to truth that has to be modified according to the notions of the material-systemic process and interobjectivity for the criterion of validity. In light of the material-systemic perspective, the individual's world does not stand in contrast to the specialist's functions; on the contrary, these functions are prerequisites for the development of lifeworlds. This also implies a rewriting of the criteria of normative behavior. The materially determined lifeworld has a universal basis: everyone may be familiar with using the same material structure regardless of cultural or subcultural origin. In view of the material-systemic perspective, the process of forming and gaining access to material structures must be regulated by norms, ethics and morals. The expansion of the concept of rationality with communicative rationality is a hallmark for the theory of communicative action. A similar expansion is important for the material-systemic perspective.

The release of creative-emergent individuals that reconstruct each other's perspectives on an only approximated level implies in and of itself an infinitely unwieldy complexity. The growth of material systemic differentiations in projects (outer work division: internal project differentiation, supporting internal project differentiations and societal functional differentiation—inner work division: planning and projecting) means an immense amount of emergent part-perspectives and apparently unwieldy complexity. As mentioned, the characteristics of materials in general and structuring materials in particular, relieve some of the unwieldiness of the complexity. Beyond this, the project actor's competence in structured communication-decision making (perspective taking in general, structured perspective taking, etc.) and possibilities to practice this competence in informal and formalized situations in the project process is crucial to handling the complexity.

An inverse formalized meeting structure is discussed in order to handle the temporal paradox. This meeting structure also coordinates the complexity stemming from the division of the labor in outer time and space (specialization connected to composite emergent objects, functional differentiation, etc.). This means that the formal meeting structure must consider complexity at the discipline level (internal-effect functions) and complexity connected to the interface between the disciplines (result-effect functions and user-effect functions). The formal structure, however, only includes the frames of the process: it is the structured communication-decision making that occurs in the meetings (and the informal structured communication-descision making) that provides the contents of the process and that is necessary for handling of complexity. Both an appropriate formal meeting structure and a high communication-decision making competence among the participating actors is necessary to handle the complexity growing out of the work division in outer time and space and inner time.

The relevance of the material-systemic rationality, including the structured communication-decision making process (with communicative rationality), is in general relevant for organized work; it is, for instance, relevant to all phases of the construction process: design, engineering and building.

6. Material-systemic rationality—Regulatory and empirical level

The material-systemic perspective integrates (as the sociological system theory) purpose-rationality on a more comprehensive material-systemic level. It is imagined empirical states of future materializations in the outer her and now (materialized goal or purposes) that cause (causa finalis) constitution and constructs of material chains of causes (causa efficiens) that realizes the final result or purpose as purpose-cause. All individual materializations happen in a material-systemic context. The structured communication-decisions rationality is integrated in the material-systemic rationality. The entire material-systemic process is teleological-causal mediated and defined. Also the unprocessed nature appears as is material-teleologically defined.

In light of the material-systemic perspective, the systemic processes are emergent and open ended. When the design concept is constituted at the most abstract empirical level ("we are building a hospital!"), further design, engineering, construction, planning and execution are all constructs that gradually provide more accurate content and concrete meaning for the

customer and other parties during the process. The constructs are based on perception and ongoing imagined or real materializations evolving from one level of imagined or real material meaning to a more developed level of imagined or material meaning.

Even though the systemic levels are emerging levels, goals and performance-goals are still important for the process. On the one hand, we have a regulatory idea regarding an ideal rationality and an abstract goal orientation (a "kingdom of purposes"), implying that the empirical systemic level is something that can always be more perfect. The collective productive forces can be continuously developed so that they create more value (for the customer) while reducing the use of human resources (including the producers' working hours). The regulative idea provides a foundation to understand the joint material-systemic process and the individual project as a common interest.

On the other hand, the materializations must be determined on a concrete, empirical level. We always have specific concrete systemic goals and specific frames of reference. A plan will always be part of an emergent systemic process in which the imagined future immediately becomes a bygone future. If a person plans a partial sequence of a job starting with an understanding of the problem, a specific goal (a composite target image), and an established timeframe, then when she/he carries out the plan and reaches the end of the established timeframe, she/he will discover that the process of materialization has created a new target image and an unforeseen new situation. When the person experiences a new level of emergence, she/he experiences an extended understanding of the empirical underlying problem, of what is actually materialized, and of the context and consequences that the current materialization is part of. What one can now measure (performance goal) is the new situation with a new basic problem statement. This again assumes new specific goals and new measurement parameters. The old problem, target and estimated performance goals are included as concrete frames of reference to interpret the new situation. The comparison of the old and the new situation provides the basis for analysis and learning. It is the regulative idea that is, together with the material functional differentiation, the driving force behind the development and the ongoing increasing complexity.

7. General theory
In the article, the material-systemic perspective is illustrated by building projects, but the perspective is supposed to be valid as a general project and organization theory. Organized production is by definition material-systemic and thus composite and emergent—and the human relationship with the external natural environment is always in a non-mediated form of unwieldy complexity. This implies that there must always be internal differentiation and structuring material, that planning as a coordination mechanism is necessary and that the temporal paradox and inter-objectivity must be addressed. This can be seen in contrast to contingency theory (Thompson 1967; Mintzberg 2009) where the individual organization is adapted to different types of tasks and social environments.

8. Discussion and conclusion
Studies indicate that inability to handle complexity appears to be the main reason why projects do not reach their goals (cf. the complexity problem). The literature on the topic

indicates that the definition of complexity is unclear. There is, however, a need for the rational handling of complexity. The article's approach is, given this background, to highlight what complexity is through developing the concept of rationality. A theoretical clarification of what complexity is also provides a basis for understanding why complexity can be a key source of success in projects. However, it requires deconstructing why complexity appears as unwieldy—and how one in practice can organize the project so that increasing complexity can be handled.

The article begins with a presentation of four prominent, standard theoretical approaches to rationality and discusses the explanatory power of these theories in relation to the complexity phenomenon. The discussion is done in light of the distinction in philosophy of science between holism and methodological individualism and between rationalism and empiricism. Theories that operate within these distinctions operate under a common subjectivist epistemological assumption. The solution to the complexity problem, however, seems to assume a theory based on a level of objective empirical reality (empirical forms of perception) and of materiality separated from the cognitive level.

The Kantian notion of materiality is an alternative point of departure for developing notions about rationality and complexity. The presentation of this approach both repeals and preserves the four previous theories. The starting point is the rationale of humans creating a joint material-systemic process (constituted through perceptions and work) between themselves and external nature in order to enable the development of needs and to reduce external nature's (unwieldy) complexity via a basic complexity reduction. The development of this material-systemic process takes place through differentiations and increased internal complexity. This internal complexity appear as unwieldly complexity because of system conditional (ideological and organizational structural) failures.

In light of the material-systemic approach, unwieldy complexity may be disconnected from complexity in projects in the following ways: 1) The informed actors can, based on structural material, walk around in parts of an extremely complex material-systemic world with their lifeworlds using the rest of the world as latent systemic context. The objects are composite emergent objects: the actors only need knowledge about user-effect functions and partly result-effect functions. 2) The actors may construct materiality step by step and by selections. When they plan and build in this context, they should take structuring material as a point of departure, not only the usual work breakdown structures. 3) The interplay among design/engineering, plans and executions must take the temporal paradox as its point of departure. The traditional decision-making structures (top-down management and flattened forms or organizations) must be substituted with the inverted decision making and meeting structure based on the guidelines from emergent projecting and planning and those from emergent production—giving the creation of reality in production a conditional primacy. 4) The inverted meeting structure also makes it possible to coordinate the complexity stemming from the division of labor in outer time and space (specialization connected to composite emergent objects, functional differentiation etc.). It can also be arranged to take into account complexity at the level of discipline (internal-effect functions), complexity connected to the interface between the disciplines (result-effect functions and user-effect functions) and complexity on the project level. It is, however, the structured communication-decision making

that takes place in the meetings and at informal arenas in the project that provides content to the process and that is necessary for the proper handling of complexity. In addition to a suitable decision structure (meetings, roles and procedures) high communication-decision making competence among the participating actors is necessary to handle the complexity. 5) The individual specialist experiences the complexity which originates from the diversity of specialists with reciprocal and equal-valued perspectives as unwieldy complexity. The material-systemic approach offers an expert-based self-steering process understanding based on the structured communication-decision making in order to handle this kind of complexity.

The material-systemic approach decouple unwieldy complexity from complexity and demystifies and solves through this the complexity problem.This open up for an apparently enormous potential for the development of complexity as a productive force in modern projects and organized work.

As it may seem, the dominant theories about rationality and complexity are based in the old antinomy between rationalism and empiricism. The classical transcendental philosophy (especially as established by Kant) exceeded this contradiction through the Copernican turn in philosophy of science. The turn implied that the material field was determined as a possibility-condition for expanded recognition and growth. This article has developed Kant's "material system" into a material-systemic process approach consisting of basic complexity reduction and the development of internal complexity. The potential of Kant's philosophy for social and organizational theory has long been hidden because of a confusion of this philosophy with the dualism of the father of modern rationalism—Descartes.

The most pressing subsequent research tasks are based on paragraph four above. First, we need to clarify further how to determine the interaction between the diversity of disciplines and their tasks associated with user-effect functions, result-effect functions and internal-effect functions. Second, the power of this interaction needs to be developed through heretofore unestablished organizational structures.

The empirical studies of the causes of the complexity problem and the corresponding organizational imperfections are generally done in the private sector in Norway. The practical models are primarily tested in the construction industry. The building processes are studied for a long time, but design and engineering processes are now under full exploration as well. In addition, it is an urgent task to test the practical organizational models in projects outside the construction industry.

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