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Introductory editorial

Socio-technics and beyond: an approach to organisation studies and design in the second machine age[1]

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[1] In September 2018, Bjørn Gustavsen passed away. Gustavsen was a major actor in the discourse of Norwegian and European work life reform and innovation, and he was always a spokesperson for "concept-driven development" based on practical experiences. Gustavsen's point of departure was the Norwegian industrial democracy projects in the 1960s, where he worked with Thorsrud and the researchers of the London Tavistock Institute, developing the first generation of STS thinking. His later work went "beyond original STS". A book that he co-edited with the philosopher Stephen Toulmin was titled *Beyond Theory: Changing Organizations through Participation* (1996). When we use "STS and beyond" as the title of this article, and of this special issue in general, it is as a token of remembrance of and respect for the role that Bjørn Gustavsen played in European work reform and work research, and for his development of STS beyond the original STS.

"Over the next decade, AI won't replace managers, but managers who use AI will replace those who don't" (Brynjolfsson and McAfee 2017:11).

"With more highly functional and integrated systems in both the office and the factory high performance is obtained by getting all workers to take on values and prerogatives heretofore expected only from management" (Pava 1983:139).

"Technologies are constituted by unique affordances, but the development and expression of those affordances are shaped by the institutional logics in which technologies are designed, implemented, and used" (Zuboff 2015:85).[2]

Introduction

Socio-technical systems theory (STS) is now almost 70 years old. Its empirically grounded analyses were based on production conditions that have since radically changed, as has society. Previously, we saw ourselves as cogs and wheels of a machine; now, we see ourselves as nodes in digital networks, in a work life characterised by blurred and shifting distinctions. Few of the assumptions about organisations, technologies and environments that form the foundations for the original STS still hold. So why bother with it today?

We think it not only fruitful but necessary to reinvent an STS position to address contemporary and future organisational realities. Although the classical core concepts may have not kept pace with societal change, the *inner vision* of STS has analytical, theoretical and practical potential, even today. However, we must be willing to turn over many stones in order to maintain it as a viable position. This article, taken together with the other contributions to this special issue, is an attempt to do just that, and it is not the first such attempt. Among our forerunners, we want to draw particular attention to the work of Calvin Pava, an STS thinker who has not been widely read in the European STS milieu. Pava's attempts in the 1980s went a long way toward correcting the original position and conceiving a new one founded in a forward-looking analysis of what he saw as radical changes in production conditions and society that were about to take place. This makes it worthwhile to present his thinking more fully.

Perhaps the need for organisational makeover, caused (primarily) by globalisation, digitalisation and new technological platforms, exceeds Pava's concepts and recipes. The opening quote by Brynjolfsson and McAfee indicates that the potential for change in the current technological development is large and revolutionary. There are many different technologies, and because of rapid interconnectivity, the links between different thought-fronts are many and ever-evolving. So, this appears to be a new type of situation. Or are we sure about this? Is what Pava considered new (such as the merger of white-collar and blue-collar work) really fundamentally new? Have the differences ever been absolute or categorical? Perhaps it is precisely a closer look at the faults of Pava's empirical analysis that will restore and save his analytical socio-technical concepts.

This article is divided into three main sections. In the first section, we retrieve and reconsider Pava's works. We find his concepts and approaches to be relevant to and connected with recent developments in society and manu-

[2] "Affordances" are to be understood as available space for manoeuvre, or perceptible degree of freedom or agency; that is, only actions are possible that users perceive as possible. Thus, the room for action when faced with a new technology is dependent on the users' abilities, their goals, previous experiences etc. According to Castells, power can be taken as "the structural capacity of a social actor to impose its will over other social actor(s)" (2007:239). There are always forces and power behind apparently neutral technology horizons.

facturing industry. His approaches break with previous STS approaches[3], and through the use of new concepts he makes STS relevant to the new digital reality. Using his concepts as a point of departure, a new STS approach opens up: "STS-beyond (STS-B)". In the second section, we explore some transformations currently taking place in industrial production, providing a rough overview of the most important changes regarding technology, markets, production, skills and change capability. Building on these first two sections, the final section highlights challenges that STS-B must confront, discuss and find operational solutions for. We use a paradox approach to show that an organisation must be able to handle simultaneously conflicting demands. We conclude by summarising and elaborating the consequences of the position of STS-B. But first, we set the scene with a prologue.

Prologue: globalisation, digitalisation and new technological platforms

According to Brynjolfsson and McAfee (2014), the "second machine age" concerns the development of computational power and how this has allowed for the automation of cognitive tasks, in a somewhat similar manner to how the "first machine age" (the Industrial Revolution) concerned the development of mechanical power and how this allowed for the automation of manual tasks. In both cases, a lot of jobs are made unnecessary and obsolete. In the long run, we might conclude that the first machine age was a positive development. As for the second one, we are in the middle of it, and according to Brynjolfsson and McAfee, it is far from obvious that its outcomes will be beneficial to the general working population. In an analysis preceding both the work of Brynjolfsson and McAfee and the arrival of Google and Facebook, Manual Castells coined the term "network society" to describe societal developments at the millennium, and argued that the present age may be described as "replacing the antiquated metaphor of the machine with that of the network" (2000:3). This fits well with contemporary discourses on the digitalisation of work life and society.

Aside from the network society, globalisation, digitalisation and technological developments, other reconfigurations are also taking place. Consider how some of the traditional distinctions between different forms of business and different sectors of society are transcended or blurred, e.g., when manufacturing industries are "servitised", when service sectors are "industrialised," when public administration takes on governance principles from the business sectors (such as "new public governance" and "lean") in management, and how all this produces distinctive socio-technical problematisations.

The network society, globalisation, digitalisation, technological developments, and the blurring of previously clean demarcations between various societal subsystems: all these have again made organisations and work life a highly focused and debated ground. How can we deal with this as organisation researchers? What comes next? How might a STS approach look now, facing such a dynamic and diverse manifold of challenges? Will STS be a platform for the future or are we facing STS-B?

When massive change happens, people are affected. Organisational processes for the domestication of something new (in the sense of total familiarisation, making it their own), be it new technology, new governance concepts or restructurings, often face organisational resistance in the form of "counter-implementation" (or contra-implementation/resistance). The classic example in the history of manufacturing is the opposition between James Hargreaves and the spinners ("the Luddites") when he introduced the Spinning Jenny (Timmins 1993).

[3] Van Eijnatten (1993) identified four existing socio-technical system design (STSD) positions: (a) participative design, (b) integral organisational renewal (IOR), (c) democratic dialogue (DD) and (d) STSD in North America. In his elaboration of the last position, van Eijnatten refers to Pava's "deliberation analysis for nonlinear work" (1993:76) as an alternative to traditional variance analysis. Deliberation analysis is "especially applicable to non-linear technical system (white-collar work), and fits in nicely with the classical STSD approach" (1983:77). So, although van Eijnatten's analysis included Pava's deliberation analysis (1993:98), Pava's approach has not been much discussed beyond this in European STS.

As will be argued below, anthropologically speaking, domestication need not be seen as a process of total merger, adoption or synthesis that eliminates the distinction between import and importer. Even once something is "domesticated", its "otherness" may be sustained. This understanding invites us to think of domestication as something that is both an import and a thing from outside: a paradox. There is value, perhaps even necessity, in allowing for paradox: you cannot choose between competing tensions, because either option intensifies the need for its opposite.

Part I. Calvin Pava: reconfiguring the STS perspective

The purpose of the Pava quote at the beginning of this article is to emphasise how the "original STS mantra" (technology ↔ organisation) is still relevant and valid but has to take on a different texture when the technologies are cognitive support tools as much as manual, and when the organisation is required to coordinate cognitive and manual non-routines rather than to control linear routines and "standard operating procedures". One would normally assume that ideas from 1983 about technology and organisation would be rather dated, but this does not seem to be the case with Pava's work. It seems that the conceptual device that he developed to analyse, understand and develop "non-routine office work" (such as leadership, R&D, marketing or product development) is among the most relevant and precise contributions to "organisational theory from within"[4] for addressing contemporary organisational realities. Pava's contribution to the theory of job design, organisational analysis and change is of interest, but has been ignored or overlooked, at least in Europe. He reconceptualised the traditional STS theory and methodology to adapt it to non-routine work. He introduced a whole new set of concepts to capture an organisational reality characterised by certain "organisational characteristics" that are dramatically different from the linear production line that laid the foundation for the traditional STS thinking.

The core of STS is to conceive of organisations as systems that convert inputs from their environments (such as raw materials, information or energy) to outputs fed back into the environment (such as services or physical products). The organisation, then, is seen as a system consisting of a series of transformations, or *conversion processes*, and transactionally linked to its environments. STS at the outset was developed based on the coalmine and the factory floor. Its theorising and conceptual developments drew on organisations with routine work systems where people did mainly manual work to produce mainly physical things. Pava brought the STS devices into (looser) organisations with non-routine knowledge work systems, where people are increasingly processing data and information, developing knowledge and creating value that is not necessarily physical.

In contrast to routine work (such as classic manufacturing, where the conversion processes are linear and sequential and reasonably predetermined), non-routine work systems involve a much higher degree of ambiguity and nonlinearity in the conversion processes; inputs, outputs and transformations are difficult to specify. Unlike routine STS, the non-routine approach emphasises reciprocal understanding rather than a shared goal and coalition formation rather than group identity, as one finds in self-managing teams that are permanent entities in the social system. Examples of non-routine work systems are research and development, market research, management work and professional practice, and such systems often are organised as project teams, matrices and networks.

Furthermore, the meaning of the technology concept, so central to STS, changes with Pava, from "the long-linked technology" (referring to Thompson's 1967 work) to what is called "intensive technology", "information

[4] Organisational theory is a field of study that for the most part develops broadly in the long term and from the outside. This often leads to a different, more detached kind of focus than do close-up studies from within. Compare theory strands such as institutional and new-institutional theory, approaches that have been developed only to a minor extent on the basis of, for example, analyses of changes in specific work processes. This point was made well by Barley and Kunda (2001), who argued that "work has slipped increasingly into the background as organizational theory converged on the study of strategies, structures, and environments as its central and defining interests" (2001:76).

processing technology" and/or "cognitive technology". With so-called knowledge work, it becomes increasingly difficult to maintain the traditional STS distinction between the technical and thesocial subsystems, since both are more directly related to and interwoven with humans.[5]

In Pava's perception, the digital revolution presents such a challenge that neither the pure "soft" approaches of the behavioural sciences nor the "hard" approach in industrial engineering could achieve and maintain the necessary organisational learning and change that was needed. In digitalised non-routine work, demarcations between technology and people become blurred, since they are interlinked and interact in more ways. The workflows become less one-way, less sequential and less predictable. Several of the work tasks done by individuals and teams are technology-enhanced, in more ways. As Trist notes:

> "By saying that the technological system for such work consists of deliberations, Pava has pinpointed the fact that the technology involved has become cognitive. The conversion processes entail the transformation of equivocal, ill-defined, ambiguous, conflicting issues into problems that can be dealt with" (1983:166).

Furthermore, a reconfiguration, or revolution, between what is to be seen as "the structure" and "the cultural fabric" is taking place (1983:164).

Three changes are essential. First, the organisational focus is changing. The traditional line system, mapped as a hierarchical organisation chart, does not capture how an organisation has to work in practice. Second, the technology focus and content is changing. There is no longer any single manufacturing technology that is in focus.[6] The technology system has become something like a developing ecology, where different sub-elements interact with others, inside and outside of the organisation, and develop. Third, the organisation–environment relationship is changing. The boundary between organisation and environment has become much more complex, fluid, fuzzy, ambiguous and temporary, and the environments themselves are of a changing and complex kind. We will elaborate on these changes later in this paper. Two concepts must now be introduced: *deliberations* and *discretionary coalitions*.

Deliberations are discussions and considerations. A deliberation is a unit of analysis in non-routine work, as a unit operation is in a linear process. Pava identified deliberations as the basic analysis unit of non-routine, knowledge-based work, and he defined deliberations as "sequences of reflective and communicative acts employed to resolve problematic issues" (1983:177). Deliberations come in more shapes than just meetings, conversations or decisions. They also include knowledge-generation activities from people working independently, like collecting and analysing data, documenting reflections or getting new ideas (Austrom and Ordowich 2018:11). They are patterns of exchange and communication in which people engage with themselves or others to reduce the equivocality of a problematic issue; the input, conversion and output of these processes move the non-routine work forward (1983:58). Trist's appreciation of the conceptual/analytical strength of this point is worth emphasising:

> "In introducing his idea of deliberation, a generic concept that covers a whole miscellany of unprogrammed activities, [Pava] has identified a dimension of professional and managerial work that has so far gone unrecognized. This dimension has been obscured by a too exclusive concentration on decision making. Deliberations are not in themselves decisions but their hinterland, which constitutes the world

[5] A similar view of "the social vs. the technical" is maintained in a typical or classical Dutch position on STS. De Sitter et al. argue against the distinction between "the social system" and "the technical system": "The isolation of social and technical system elements into separate subsystems blocks the view of the functional relations between the two, which are at the heart of a real production system" (de Sitter et al. 1997:503). For them, the organisation contains several "aspect systems". For instance, there is the operational and the regulatory aspect of a transformation, and these two aspects belong in the operational and the regulatory aspect systems, respectively. Both (sub-) systems are social and technical; they always "constitute a configuration of social as well as technical functions" (1997:503).

[6] Has this ever been the case? See Nuvolari (2000).

> of cognitive technique. Deliberations provide a new unit of analysis, the equivalent for the intensive technology of unit operations for the long-linked technology. They involve determining the full range of pertinent topics, analyzing their components and ensuring their examination through a series of forums (structured, semi- structured or unstructured), in which all the relevant parties present their various perspectives so that optimum trade-offs can be achieved" (Trist 1983:166).

Discretionary coalitions are alliances of interdependent parties formed to make intelligent trade-offs that enable attainment of overall objectives; in other words, collaboration among heterogeneous parties. Different coalitions are associated with different deliberations. Thus, the social system is defined in terms of discretionary coalitions that are needed to conduct deliberations effectively. These coalitions make the important trade-offs in creative work that are made necessary by the presence of useful but inherently divergent values and perspectives. As observed by Trist, one of the merits of the concept of discretionary coalitions in relation to deliberations is that it offers an "operational approach to the analysis of managerial and professional work in a nonhierarchical perspective" (1983:169).[7]

With the concepts of deliberation and discretionary coalition, Pava offers a new model for a flexible and scalable organisational architecture based on self-regulation. It provides a layout for how to combine self-managed work teams (in production lines, with the stamp of routine work), project teams of "hybrid work" (partly routine and matrix-organised) and the discretionary coalitions of non-routine work, coexisting within a "network organisation". Pava also acknowledged that our increasingly turbulent environment requires us to look at organisational change less as an event and more as a continuous dynamic of iterative design.

Pava's model of workers in interaction is that "disparate people" should work together and that tensions, disagreements and conflicts are thus not only inevitable and necessary but useful and therefore desirable, because this improves ideas, calls attention to the risks of the issues and solutions involved, and strengthens trust between people. This invites us to consider a "a paradox approach", and we will come back to this matter below. This interpretation is contrary to an interpretation of deliberations and discretionary coalitions as drivers for consensus-making and unity. This may be a source of different interpretations of Pava's text, since Trist and others (such as Austrom and Ordowich) seem to pay little attention to or downgrade the importance of preserving contradictions within a workable arrangement. Would deliberations and discretionary coalitions need renewal in order to face such contradiction between consensus destroying the dynamics of paradoxes and the preservation of paradoxes without paralysing decision-making and workable arrangements? Does this challenge us to go beyond the prevailing interpretations of STS? We think so.

As well as developing new organisational scripts, Pava also took on organisational change, finding that traditional approaches to managing change were unable to deal with ill-defined, complex problems that may require change in both behaviour and values. He therefore identified a 2×2 matrix to illustrate various types of issues that had to be addressed to ensure that the chosen change strategy would be viable. The matrix uses a social axis to highlight the degree of conflict between different parties and a technical axis comprising the level of complexity in relation to a contemplated change (Figure 1).

[7] "However much the hierarchical scaffolding may still be in the background, it is the unprogrammable sequences of coalitional formations that must become salient at the higher levels of any organization if it is to succeed in coping with substantial degrees of complexity, interdependence, and uncertainty" (Trist 1983:169).

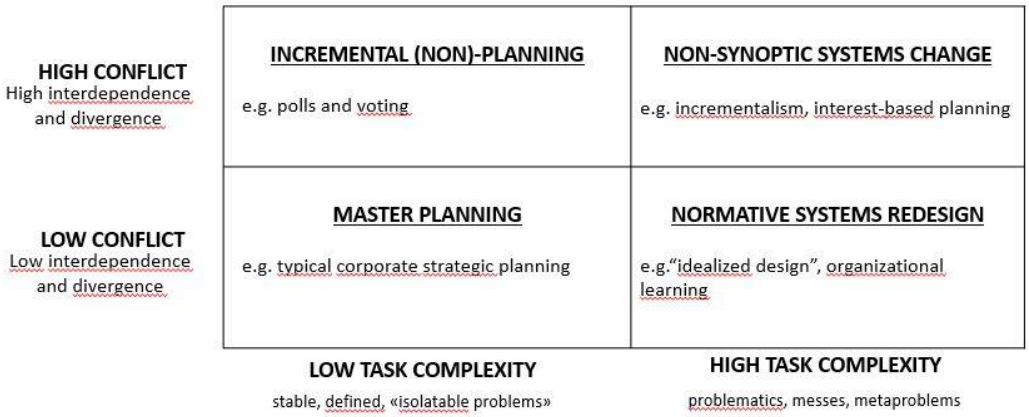

Figure 1. Strategies for organisation change (based on Pava 1986a:617).

On the basis of these two factors, Pava described four types of change: (1) master planning, i.e., low conflict and low task complexity (typically corporate strategic planning); (2) incremental (non-) planning, i.e., high conflict and low task complexity (typically polls and negotiations); (3) normative systems redesign, i.e., low conflict and high task complexity (like idealised design and organisation learning); and (4) complex system change ("non-synoptic systems change"), i.e., high conflict and high task complexity (more like a mission or vocation rather than a strategy, where all contributors are informed and very "change conscious") (Pava 1986a:617).

Trist, commenting on Pava, makes an interesting observation of a paradox: "The paradox is that greater technological sophistication will give more rather than less weight to how the human side performs, albeit that there will be fewer humans around" (Trist 1983:172). This was written 35 years ago, but it seems highly relevant today; regardless of how accelerating or exponential the technological developments may be, organisations will continue to be socio-technical puzzles to solve (although we have some hesitations about the latter part of Trist's observation: are we sure that there will be fewer humans joining the universal workforce?).

On the same issue, consider also a reflection by Austrom and Ordowich:

> "Pava was remarkably prescient regarding the potential impact of microprocessors and related technologies on the world of non-routine knowledge work. He recognized that the distinctions between blue-collar and white-collar work were decreasing due to increased reliance on knowledge work in both the office and the factory, especially given the emergence of "smart" equipment and advanced manufacturing. His influence on the theories and practices of STS […] and organizational change would arguably have been much more significant had he not passed away at a very young age. In fact, we believe that the full impact of his contributions to the design of knowledge work systems and contemporary enterprises is yet to be realized" (Austrom and Ordowich 2017:3).

We agree with the observation about the foresightedness concerning technological disruptions, but, as hinted already, the issue of the interrelationship of blue-collar and white-collar work, whether seen as a distinctive boundary or as a merger in the making, deserves special attention, and we will return to it below. In the next section, building on this discussion of Pava's work, which is rooted in what he at the time saw as revolutionary technological disruptions, we will provide an overview of the present day's disruptions, i.e., the most important recent and upcoming changes in manufacturing industry.

Part II. Industrial production in transformation

Over the last decades, industrial production has changed radically. Nevertheless, the end of the transformation is far from being reached. This process has gone under different labels, with Industry 4.0 being perhaps the most widely used.[8] The transformation is taking place not only in the form of technology developments but also in areas where new technology opens up new opportunities. We may call attention to some areas that are affected without claiming that this overview is comprehensive.

1. Technology

Socio-technical theory was conceived in another industrial era or setting. At that time, STS technology was the technology of the manufacturing industry organisation. Today, to gather all industrial technology into a shared frame would be a gross simplification, both because concepts such as Industry 4.0 cover a broad range of rather different technologies, and because a fixed demarcation between technology and "non-technology" is increasingly difficult to operate. Orlikowski (1993), for instance, observes a more dynamic and fluctuating boundary between (what is understood as) technology and (what is understood as) organisation. How a technology is deployed and appropriated depends on many social and economic forces, which lie beyond managerial control, and "the ongoing interaction of technology with organisations must be understood dialectically, as involving reciprocal causation" (Orlikowski 1993:423).[9] Technology and "the social system" are causes of one another and are sustained by their interaction. Nevertheless, we think it worthwhile and perhaps necessary to develop an adequate typology of various typical technology concepts. The realisation that technology is ascribed in and partly a product of external forces and sensemaking does not remove the usability a more diversified concept. Particular emphasis will be placed on Pava and his distinction between routine work and non-routine work (Pava 1983). The distinction between white-collar and blue-collar work may be regarded as an expression more of a traditional pre-industrial focus on work. On this basis, it is possible instead to indicate a future merger, or fluidity, between "manual and intellectual (cognitive) work" (Table 1).

[8] Industry 4.0 is a name given to the current trend of automation and data exchange in manufacturing technologies. It includes cyber-physical systems, the Internet of Things, cloud computing and cognitive computing. Industry 4.0 is commonly referred to as the fourth industrial revolution. The term, often shortened to I4.0 or simply I4, originates from a project in the high-tech strategy of the German government to promote the computerisation of manufacturing.

[9] A similar argument is also found in so-called actor-network theory, well captured in this Latour quote: "Society and technology are not two ontologically distinct entities but more like phases of the same essential action" (Latour 1990:127). See also the Zuboff quote (and note) in the Introduction.

Table 1. Technology: types, roles and descriptions.

Concept (type, role)	Details and description
Physical reinforcement	Solving physical tasks such as transport, lifting, machining and mass production.
Control purpose	Communication technologies, ERP systems, HRM systems[10].
Conceptual platforms	Structural design concepts such as Taylorism, supply chain design, lean, production systems and total quality management.
Automation	Applies not only to manual production tasks but to even greater extent to cognitive work (administrative, commercial, technical). The use of AI and machine learning will accelerate this development.
Digitalisation	Information in product and service production is digitised, opening up new ways of communicating, handling and making information (globally) available (see the contributions by Govers & Amelsvoort and Haga in this issue).
Social technologies	Facebook, Snapchat, Instagram, blogs etc., and the World Wide Web.
Human extensions	Cyborgs, where technology is integrated into humans; conversely, avatars, when the human is integrated into the machine. Also includes artificial body parts and exoskeletons (external skeletons that support and protect the body). (Lawson 2010).
Cognitive technologies	Technologies that carry out perception and cognition (Brynjolfsson and McAfee 2017); that handle text, speech, sound, vision and can "learn" (AI, machine learning, based on pattern recognitions and also other paths); that move from descriptive to prescriptive analysis; may streamline decision-making like programmable computing streamlined manufacturing. Cognitive technology takes process automation one level up.

2. Markets and environments

There has also been a noticeable change in how companies relate to the market. From having customers within a specific market, there has been a change towards companies acting flexibly in accordance with a number of different markets (Table 2). (There have obviously been deviations from this stereotypical image, such as the traditionally family firm.)

[10] ERP: Enterprise resource planning; HRM: Human resources management

Table 2. Markets and environments: roles and descriptions.

Concept (type, role)	Details and description
Flexible market orientation	Whereas companies previously specialised in specific market segments, we now see a stronger diversification. Companies are oriented towards different markets, and part of their strategy is to move quickly between different market segments while maintaining competitiveness and effectiveness. Such moves are extremely demanding for the organisation and require understanding of how the different markets work, different contracts and contract formats, different quality standards etc. Staff expertise is also required.
Changing organisational environments	A major contribution of Emery and Trist is their analysis and prediction of increasing turbulence in organisational surroundings (1965). Today this is everyone's experience. The flexible market approach, with other factors, causes changing surroundings. The surroundings are not static but increasingly dynamic, and they cannot be broken down into parts (because they interact with each other). This may increase turbulence in how to relate to the surroundings. For example, the set-up of partners and sub-contractors may vary within and between different markets.

3. Production/business process reconfigurations

New technology, more flexible market interactions and the continuous changes in the division of work between different suppliers will open up major changes in the way goods and services are conceived and produced. Changes in technology and in markets may lead to rapid and fundamental changes in the structure of industrial production (Table 3).

Table 3. Process reconfigurations: roles and descriptions.

Concept (type, role)	Details and description
Flexible production set-up	Technology allows a flexible production set-up, which in turn allows for a flexible interface between what the company produces and what it procures. The flexibility also lies in the fact that the partners in the various projects will vary.
Changing "economic laws"	With purely digital products (like apps), the cost of producing one unit is the same as cost price of producing one million units. For products that are not entirely digital, the industrial thesis that unit price drops with increasing volume appears less obvious (Brynjolfsson and McAfee 2014). Physical, serial mass production seems a less viable option.
Less routine work	Because of new technology, new market set-ups, digitalisation and automation, there is less routine work to be done.
Replacement of classical organisation recipes	• Lean production has removed buffer stocks, once the premise for the semi-autonomous work group. • Manufacturing industries are "servitised" (service offerings accompany or replace the physical product). • Service offerings are "industrialised" (and sometimes replaced by "apps"). • Public administration is governed by productivity principles.
Fluctuation/weakening of boundaries	Boundaries between different types of production and different tasks are less visible. Production of goods and services are likely flow into one another.

4. Skills and skills needs in transition

There is a lot of research and many white papers on requirements for new skills (see Øyum et al. in this issue). The changes outlined above will make other demands on individual employees as to the company's personnel. Without being able to predict the total change, it is difficult to list changes in skills requirements. It is nevertheless possible to anticipate a number of features (Table 4).

Table 4. Skills needs: roles and descriptions.

Concept (type, role)	Details and description
Operational skills	Individual employees require knowledge of an increasing proportion of the production process, knowledge of planning, and both technical and practical knowledge to take on varying tasks. They also need to be flexible and be able to move between different "project settings", where the assumptions are different, the division of roles is different (more non-routine work; see Pava 1983) etc.
System skills	It is reasonable to expect that systems must increase in their capacity to coordinate and communicate. The ability to consider system set-up in fluctuating project settings also becomes vital. Fluctuating settings demand communication skills on the part of individuals.

5. Change orientation

Above, we have outlined a change agenda that most industrial companies will have to deal with. Basically, external circumstances will force companies to become change-oriented to maintain their competitiveness (Table 5).

Table 5. Change orientation: roles and descriptions.

Concept (type, role)	Details and description
Change capability	Companies have to be capable of quickly adopting new production technologies and new organisational solutions, and of constantly searching and checking new opportunities and interacting with the external knowledge environment. The ability to translate new solutions into their own business becomes vital (see Govers and Amelsvoort, Putnik et al., Landmark et al. and Haga and Ravn in this issue).
Exploiting the environment	To be able to search for sources of improvement/innovation outside the company to a higher degree than before, one must increase the ability to make assessments/choices of such "external innovation offers".

As indicated in Part I, company configuration is changing in terms of organisational focus, technology focus and the organisation–environment relationship. Companies are expected to relate to the trends outlined above and to other similar trends. As indicated, not all of the trends are visible yet but will most likely appear sooner or later. In particular, we anticipate that the change capacity of companies will be challenged. Consequently, companies' ability to handle change will be of crucial importance (see Ravn in this issue). Relevant questions include how new changes will appear and whether they will be perceived as adaptations or as revolutionary new solutions.

The future: new circumstances, new concepts, new solutions

The different traditions within STS have had different innovation focuses. As articles in this issue show, the Dutch tradition has had a strong *system design focus*, while the Scandinavian tradition has had a strong *contribution and dialogue focus* (see Govers and Amelsvoort, and Haga in this issue). The different STS traditions have developed their distinct approaches over time, but their positions have not been fundamentally challenged or changed. On the other hand, there are fundamental changes in the terrain, as indicated above. It may look as if there is a mismatch. In this issue, inspired by the thinking and approach of Pava (1983), the introduction of new technology, new concepts and new approaches has been used to challenge the traditional STS approaches and to suggest how they may become relevant for present transformations, but how this happens is crucial. Thus, it may be appropriate to introduce the paradox perspective, which allows for an alternative approach to tensions by exploring how organisations can attend to competing demands simultaneously.

The changes that are part of the transformation take place quickly, and various change processes are often activated in parallel. Consequently, both the change capability and the change capacity of companies are challenged. As indicated above, the areas of change are almost all-inclusive, and the solutions will largely be found outside companies, from different competence environments. Thus, making these new solutions and concepts understandable for companies, and making them part of a company's own solutions or ways of operating, have become significant processes that need continuous attention. However, relevant concepts are needed to study and discuss their introduction to and adaptation to companies' way of operating. These processes have been captured through various concepts, such as *sensemaking* (Weick 2001) and *domestication* (Silverstone and Hirsch 1992); the literature considers various aspects of these concepts and discusses their content and practice (see also the contribution by Haga &Ravn in this issue).

In general, organisational set-ups implemented to utilise new technology and simultaneously exercise commercial flexibility efficiently require increased width and depth of expertise among staff. Developing such skills is demanding, because the knowledge that is required is a mixture of practical professional experience and communicative, social and theoretical competence. It is knowledge that cannot be developed through traditional means; a mixture of different forms of learning have to be utilised (see Øyum et al. in this issue). The skills and knowledge needed are also closely linked to the set-up of the company, its technology, market, production etc. The Industry 4.0 transformation can thus hardly be separated from the development of staff skills and expertise.
Traditional organisational set-up will probably be challenged, too. Many organisations are still hierarchical, in that communication follows a (vertical) line, and interaction and communication between different layers or functions are insufficient. New technology, new ways of communicating and new ways of distributing competence and skills will allow for and even require new organisational models. The traditional STS answer to organisational issues has been autonomous work groups. Pava pointed in a different direction, through his concepts of deliberation as basic unit for analysis of non-routine, knowledge-based work (1983), and his
conception of hybrid constellations of self-managing teams, project teams, discretionary coalitions (non-routine) into the reticular organisation (Figure 2).[11]

[11] Reticular organisation: "a network configuration for predominantly nonroutine office work, involving multiple linkages among professionals and executives that complement the existing line organisation" (Pava 1983:179).

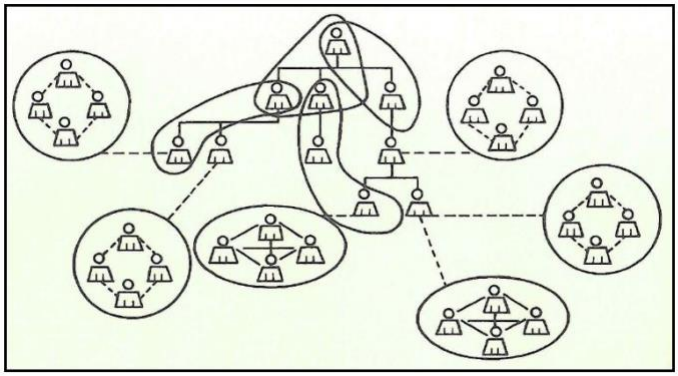

Figure 2. Template for a socio-technically designed high-performance office (Pava 1983:130).

Traditionally, industrial production has been closely linked to quality systems and quality assurance systems. Achieving efficient standardisation of operations and accurate reporting has been an important organisational goal. Detailed tools, such as procedures, have been developed for employees to obey, so as to avoid spending unnecessary time on repetitive operations. A procedure or recipe is established to avoid mistakes and misuse of production time. Standardisation has thus been regarded as a tool for reducing the need for personnel to solve production issues, plan operations and accomplish them. Problem-solving was reserved for production planners and management. The concept of *minimal critical specification* (Herbst 1993) builds on the fact that competent professionals need only a minimum set of required specifications to perform a job. Their skills and knowledge will enable them to solve problems, plan and perform the tasks in the most effective ways. This is particularly relevant in light of the knowledge promotion that companies must make as a consequence of market diversification and the implementation of new technology. Skills and knowledge are also prerequisites for making sensible and well-considered choices. At the same time, making choices based on knowledge and skills is a prerequisite if knowledge workers are to regard a job as challenging and interesting. Choice-making, at the operational level, is thus a key concept in the Industry 4.0 transformation.

STS has in general been concerned with achieving good working conditions for employees, focusing on job content, job requirements and the work environment. Employee participation or deliberation has been regarded as a prerequisite for achieving good conditions (Pava 1983). The mixture of developing professionals able to carry out larger parts of the preparation and implementation of work operations, and who have the competence to make well-considered choices and to create a culture in which participation is cultivated, opens up the issue of operational management based on trust and, to a lesser extent, on control (see Dvergsdal and Haga in this issue). Pava has discussed various aspects of this in terms of operational skills, procedural enhancements, structural factors and cultural fabric (Pava 1983). The way this is done depends on the company's operations, and consequently the way to do it most efficiently must be explored. However, there is no doubt that in this field of excellence there are obvious effectiveness gains for bold and skilled companies.

Above, we have explored recent and likely changes and trends in manufacturing industry. A revitalisation of STS may make a difference in the transformations facing industrial production systems. *How* to do this may be a matter for STS-B to explore and exploit. In the remaining sections we intend to raise issues that demonstrate the relevance of STS for future change dynamics. Such relevance will require a reframed STS, or STS-B as it is termed here.

Part III. STS as a framework for organisational paradox

STS explores and guides identification of change processes where organisations are faced with technology options. Action research and participation are essential when choices are made to explore and exploit certain of the available options. Knowledge and capacities (exploration) are necessary preconditions for the process of exploitation. On the other hand, new knowledge and capacities are achieved through the exploration process. Here, both preconditions (knowledge and capabilities) are required in advance simultaneously as new knowledge and capacities are explored through the exploitation process. Exploration and exploitation are among the key paradoxes appearing in change processes where technological systems are introduced in organisational systems.
A paradoxical approach considers differences that appear incompatible, like exploration/exploitation. One major characteristic of the paradoxical approach is that it copes with apparently conflicting features by converting them into supportive configurations in a change process. Paradoxes can create tension, destructive conflicts and resistance to change; paradoxical approaches aim to configure paradoxes into dynamic drivers for change. In an effort to sketch a theory of dynamic equilibrium model of organising, Smith and Lewis (2011) put it this way:

> "Paradox studies adopt an alternative approach to tensions, exploring how organizations can attend to competing demands simultaneously. Although choosing among competing tensions might aid short-term performance, a paradox perspective argues that long-term sustainability requires continuous efforts to meet multiple, divergent demands" (Smith & Lewis 2011:381).

Smith and Lewis note some examples explored by contingency theory:

> "contingency theory explores the conditions that drive choices between exploratory and exploitative (i.e., Tushman & Romanelli 1985), cooperative and competitive (Deutsch 1968), mechanistic and organic (Burns & Stalker 1961), and centralized and decentralized (Siggelkow and Levinthal 2003) (Smith & Lewis 2011:381)".

In his classic article, Cameron examines the concept of effectiveness as opposed to efficiency utilising a paradoxical approach (Cameron 1986). Pava offers the following elaboration of this distinction:

> "Effectiveness is the capacity to 'do the right thing' against a backdrop of changing conditions […] Efficiency and effectiveness are achieved under vastly different circumstances. Efficiency entails perfecting internal operations under conditions of stability. According to Burns and Stalker (1961), stable organization is mechanistic, providing a high level of routinization and lower immediate costs. Effectiveness entails bettering the match with one's surrounding environment under conditions of change. Fluid organization is dynamic, possessing the ability to adjust to external conditions, maintaining a large repertoire of adaptive behaviors and requiring extensive coordination" (Pava 1983:141).

The efficiency/effectiveness paradox illustrates the shortcomings of a static organisation that depends on a set of stable and given environmental conditions. Change is necessary in order for an organisation to respond with effectiveness and independence when the environment changes. Changing environmental conditions are the *raison d'être* of the modern capitalist economy and its business environment.

Building on this short introduction to the paradoxical approach, we intend to address the following question: how does a paradoxical approach collide with challenges that occur in current and future STS applications and beyond (STS-B)? Introduction of new company-specific production systems face existing organisation systems. Technology systems appear in the external organisational environment as "other" to the existing acknowledged operations and solutions that the organisational "we" regard as "theirs" (Luhmann 2000).

Domestication has been referred to as a way to make sense of the introductions of a company-specific production system, from being external and unfamiliar to being internal and known. This domestication implies that the external is acknowledged and owned by the organisational culture and embedded in its practices (Haga & Ravn in this issue). Such a process of domestication pinpoints something essential within STS: the remaking of externally introduced changes so that they are embedded and acknowledged as the organisation's own, in *their* ownership. The external becomes included as part of the internal creations and responsibilities. Remaking has to take place, both of the external and of the internal capabilities.

The concept of domestication has been applied in anthropology (Goody 1973, Keesing 1972). As a key concept, it covers how external resources in the environment are utilised within specific local entities (families, segments/moieties, villages, districts etc.). Examples are found in the villages surrounding the Sahel belt in Africa, where cattle farmers and agricultural producers operate in a symbiotic relationship (Barth 1964, Durkheim 1933[1893]). Mutual relationships are constantly recreated and renewed through such domestication processes. In the Sahel belt, domestication implies nurturing and solidifying the mutual dependencies among the different production systems (livestock and agriculture). These mutual dependencies include no options for substitutions, flexibility or alternative arrangements. Their mutual dependencies are reinforced by domestication of their respective cultural practices in order to reinforce a community of different practices within a specific local social arrangement. How does this apply to STS and today's industrial environment?

The modern industrial environment fostered standardisation as a means to negotiate wages (Taylor and the piece rate system). Common ground was thereby found on which workers and unions could negotiate wages to create a mutual acknowledgement of the piece rate. Standardisation was the baseline on which to build a common agreement and where industrial relations could be acknowledged. For many scholars, this is regarded as the first Industrial Revolution, as argued in the Introduction: standardisation was necessary in order to create a common ground on which conflicts could be resolved. This was one of the objectives of Taylor's scientific management. Science-based production systems should both enhance efficiency/effectiveness and prepare for dialogue and commitment to the distribution of the surplus created by the changes introduced. Prior to Taylor, diffusion of new technology faced resistance, and even "machine-breaking", as with the first introduction of the Spinning Jenny and the threshing machine (the Captain Swing riots of 1830–31).

Standardisation had no relevance for such hostile forms of resistance. On the other hand, those forms could paradoxically smoothen the introduction and diffusion process of innovations. In a working paper on the machine-breakers and the Industrial Revolution, Nuvolari (2000) cites the historians Rule and Randall and builds on their arguments:

> "Randall shows that in the wool-textile industry the workers' resistance to innovation was highly successful in postponing the adoption of different types of machines for a remarkable period of time. In this respect, Noble has suggested that in some cases one of the aims of machine breaking was simply to gain time and to achieve a slow introduction of the new technologies in the economic system, minimizing the possible negative economic and social consequences of a too rapid change" (Nuvolari 2000:8).

What at first seemed to be a destructive machine-breaking consequence of resistance in fact generated the opposite result. The outcome of the resistance was that time was gained, minimising negative economic/social consequences and providing a more suitable domestication of the new technology. Additionally, the delay through resistance was able to produce flexibility in order to enhance increased capability in the organisation, making it more receptive to new technology. Such capabilities as efficacy, skills and operational/organisational capacities were developed through the greater flexibility and "slack" created by some of these forms of resistance. These remarks on this

resistance paradox could have implications for STS domestication and adjustments between the technological and social systems.

Standardisation also emerged as an important prerequisite for substitution. Necessary replacement of parts required spare parts to be made available according to specific standards. Abundant units conforming to exact measures had to be produced in order to replace required parts, and production systems and human capacities had to be standardised accordingly to fulfil these obligations. Substitution implies replacement of identical parts, but the same concept also covers possible new systems and technologies to replace the existing ones with something improved, new or revolutionary. If substitution is to operate as an alternative to standardisation and replacement, R&D resources are required for innovation and creativity.

Adjustment and domestication proved to be mutual dependencies based on *existing* differences (livestock/-agriculture, external production systems/local practices and theories). Innovations that provide (revolutionary?) changes and development require independence in order to create new organisational arrangements, new technologies, new services and new resources (Schumpeter 2017). These new innovative features are themselves necessary in order to make specific substitutions for change possible.

Domestic human capacities and organisational production systems might lack the capability to meet new demands for substitutions and innovations. On the other hand, external demands not domesticated could be experienced as unfamiliar. Requests to domesticate and familiarise could face resistance. Resistance could, however, pave the way for domestication and familiarisation. For most externalities, such domestication and familiarisation is a prerequisite of the creation of acknowledgement and ownership introduced through change and innovation. This domestication paradox implies both obstacles and conditional opportunities to overcome challenges related to change and innovation processes. This reflection provides us with the following paradox/dilemma:

- On the one hand, flexibility and substitution of existing production systems/technologies requires independence from existing standardisation and human/organisational arrangements in order to create change (revolutions). This is contrary to domestication and adjustment, which interrelate with the existing industrial and human organisational environment.
- On the other hand, domestication to existing industrial and human organisational arrangements must be observed. In order for ownership, engagement and domestication to be complied with, the existing arrangements have to be handled as options for change.

The contradiction between the dependence of existing preconditions and the independence of the same conditions is basic to a paradoxical approach. Resistance can, paradoxically, provide space and coping capabilities for a creative and constructive exploitation process to take place. Straightaway, we are faced with two questions that have to be addressed: how can we make sense ("from label to lens") of paradoxes/dilemmas,[12] and how can we enhance coping capabilities (Lüscher and Lewis 2008)?

STS faces such paradoxes and dilemmas. They are apparent in many of the contributions in this issue. It is important to take account of both the necessity and the ability to reflect on and make sense of these and similar paradoxes/dilemmas. It is important, too, to direct attention to ways of enhancing coping capabilities. Organisations can face tension where there is defensiveness and resistance, reactions brought about when actors are faced with opposing demands and choices. Choosing one option could imply a problematic outcome, with unpredicted or negative impacts from the options not chosen. An alternative to the defensive reaction is to try to incorporate both elements of the paradox. This is the goal of the dynamic equilibrium model mentioned earlier, which tries to

[12] Paradoxes and dilemmas as an approach in organisational science have been examined by a number of social scientists, including Quinn & Cameron (1988), Quinn (1986), Clegg et al (2002), Weick (2001), Smith and Lewis (2011) and Lüscher & Lewis (2008).

demonstrate how paradoxes can be used to stimulate a creative and innovative outcome. Instead of paradoxes being solved or eliminated, they are preserved and developed to facilitate attention to new opportunities and outcomes. Adopting paradoxical thinking opens up the prospect of considering possibilities in the form of both/and, rather than in the form of either/or. This effort thereby offers a way out of vicious circles of tension and destructive resistance to change.

Alternatively, a kind of virtuous cycle is portrayed in accordance to this dynamic model:

> "The dynamic equilibrium model explicates a more positive response to paradoxical tensions. It depicts a virtuous cycle, with awareness of tensions triggering a management strategy of acceptance rather than defensiveness. Acceptance entails viewing tensions as an invitation for creativity and opportunity" (Smith & Lewis 2011:391).

> "by immersing oneself in the opposing forces, it becomes possible to discover the link between them, the framework that gives meaning to the apparent contradictions in the experience" (Smith & Berg 1987:215, quoted by Smith & Lewis 2011).

> "In their action research Lüscher and Lewis (2008) show that helping managers accept tensions as paradoxical enabled their sense making. Initially managers experienced tensions as a dilemma. However, by recognizing that they could never choose between competing tensions, because either option intensified needs for its opposite, they began to adopt paradoxical thinking and opened discussions to consider both/and possibilities" (Smith & Lewis 2011:391).

Such possibilities could be associated with "career success (O'Mahony and Bechky 2006), exceptional leadership capabilities (Denison et al. 1995), high-performing groups (Murnighan and Conlon 1991) and organisational performance (Cameron and Lavine 2006; Tushman et al. 2010)" (2011:393). Tensions inherent in paradoxes may create stress in organisations. Sensemaking and knowledgeable coping with paradoxes can be beneficial:

> "underlying tensions are not only normal but, if harnessed, can be beneficial and powerful. The juxtaposition of coexisting opposites intensifies experiences of tension, challenging actors' cognitive limits, demanding creative sensemaking, and seeking more fluid, reflexive, and sustainable management strategies" (2011:395).

This could be a beneficial approach to moving beyond traditional STS:

> "How would our research and theorizing across the Academy differ if we assumed that for every thesis there is an antithesis? Such an assumption introduces the possibility of seeking opposing views of even our most well-established organizational theories" (2011:397-398).

Paradoxical thinking could, in addition, make us aware of possible trends in modern (post-) industrial society towards merging some essentially founded dichotomies, such as those between white-collar and blue-collar work/workers, between manual and cognitive/intellectual work, between routine and non-routine work, and between theory and practice.

Conclusions

On the basis of the overview of present transformations (Part II), it is reasonable to claim that both technology and social systems/organisation are in transformation. As a consequence, the relationship between technology and social systems is also in transition. STS has developed to focus on this relationship and to develop practical, operational

approaches. However, the major changes or transitions substantiate the need to look at whether established STS positions are capable of meeting the challenges that come with the transformation.

Changes generally generate fundamental and practical contradictions and conflicts of interest. Fundamental contradiction is often referred to as a paradox. Several paradoxes have been identified above; from the overview in Part II, more paradoxes may be added:

- centralisation of decisions vs. decisions at the lowest possible level (digitalisation vs. STS)
- permanent fluctuating partnerships (fixed contract types vs. alternate contract types; flexible forms of cooperation vs. standardised forms of cooperation)
- (implied by the previous item) fluctuations in system vs. environment boundaries (what is "inside" and what is "outside")
- floating work tasks vs. fixed/permanent work tasks.

We have pointed to the relevance of the work of Pava in the contemporary transitions and have considered the introduction of a paradox approach to bring out conflicting trends and interests that have to be accepted as such if an organisation is to be able to develop viable solutions for production and personnel. It therefore makes sense to read paradox into Pava's figures. One point addressed by Pava's commentators is the supposedly fading distinction between white-collar and blue-collar work. This is related to an increase in knowledge work in both offices and factories, and ICT technology is an important influencer in this. As Trist puts it:

> "Several lines of future development are already in their early stages […], such as the dedifferentiation of the factory and office as both become increasingly characterized by computerized tool stocks. This fusion will tend to phase out the distinction between blue- and white-collar work" (1983:174).

One might ask whether this distinction is justifiable or workable. It could be that the concept of manual routine work in a pure form does not cover cognitive aspects of human labour already present in the early stages of industrialisation. Our discussion of the possible constructive outcomes of resistance indicates that even routine work needs "deliberations" to be adjusted to the existing organisational system, in addition to the organisational systems' need for "deliberations". For further elaboration on this point, it would be fruitful to apply Pava's approach to non-routine office work, as opposed to routine manual work. Consider Trist's observation about what may become of the hierarchy:

> "However much the hierarchical scaffolding may still be in the background, it is the unprogrammable sequences of coalitional formations that must become salient at the higher levels of any organization if it is to succeed in coping with substantial degrees of complexity, interdependence, and uncertainty" (Trist 1983:169).

What if "hierarchical scaffolding" was substituted by "linear manual routine conversion process"? Is it not also possible that there are non-linear conversions, non-routine and cognitive aspects in all work? To some extent, this is the core in the concept of "job crafting" proposed by Wrzesniewski and Dutton (2001). They define job crafting as "the physical and cognitive changes individuals make in the task or relational boundaries of their work" (2001:179). Jobs are not only designed by management to fulfil the organisation's purposes; they are also redesigned by the workers. Armed with the concept of job crafting, it is easier to acknowledge that there is also organisational space for paradox engraved in the dichotomies of routine/non-routine, linear/non-linear and manual/cognitive.

Paradox as a source of creativity and sensemaking

Pava reconceptualised the socio-technical organisation. His concept put less emphasis on fixed structures and regularities. Hierarchical structures and linear fixed processes move into the background, and deliberative interactions and temporary task-oriented work coalitions enter the centre of the picture. Perhaps this is less an observation of a change than a shift of perspective. Nevertheless, it allows us to adopt a different socio-technical outlook. To say that structures, linear processes and fixed routines move into the background is not to take them out of the socio-technical organisation equation, but it allows for a different kind of analysis. Focusing deliberations does not obliterate chains of command, nor do discretionary coalitions imply that the hierarchy is gone. Inside of the deliberations there are immanent organisational structures and chains of command, and the principal possibility of going beyond both of these. Seen in this way, deliberation nurtures paradox. It is a process instrument for an organisation that enables both maintenance and transgression.

Allowing for diversity by way of reticular organisations

"It may be that diversity of voices and experiences is an important characteristic of successful organizations".

This quote from Greenwood (1991:88), taken from a gentle and appreciative critique of Donald Schön as a reflective practitioner, captures another important aspect of a reconfigured socio-technical theory that is grounded in Pava's concepts but goes beyond them. Greenwood's study of the Basque Fagor cooperatives in Spain, recast in Pava's vocabulary, is a series of deliberations about the well-being, or otherwise, of the cooperatives. Reflecting on these reflections (or deliberations, as we would suggest), Greenwood endorses reflective practice, but rejects Schön's singular form:

> "Focusing on diversity inside of organizations is a very specific way of bringing this anthropological vision to bear on organizational behavior. The lesson that, within an organization, there is more than one valid view of what is going on is important. Managers and workers alike tend to treat each other's visions and experiences as defective or even duplicitous. The realization that there is room, and perhaps even an organizational requirement, for a diversity of views and experiences of an organization is an essential step in the direction of reflective practice and organizational learning" (Greenwood 1991:88).

The main reason for Pava's proposal that non-linear conversion processes are not fit for the classical semi-autonomous work group is that they tend to be accomplished by a "vocationally separatist workforce" (1983).[13] Elsewhere, he referred to this as "individualistic professionalism (extensively trained specialists)" (1986b:204). In non-routine office work, work is accomplished by individual professionals who cannot come together as a team in the same sense as manual work groups. They are too specialised to be able to substitute for one another and too individualised to have an interest in substituting for one another. Paradox thinking is an option here. Greenwood's argument is that diversity, not homogeneity, is what organisations are made of, even semi-autonomous groups in linear conversion processes. At the same time, diversity is not without limits:

> "Just as equality, in anything but its most mindless form, does not mean that everyone is equal, a respect for diversity does not involve respecting each and every way individuals differ" (1991:102).

[13] Pava defines vocational separatism as "an orientation […] that stresses the individuals and their occupational identity more than a specific collective enterprise" (1983:180).

The general tendency of theories of organisations is to offer a perspective that homogenises the organisation. A revised STS perspective (STS-B) takes account of the many interests and parties in an organisation and their fluctuating and changing interests. At the same time, these diversities and dynamics carry within themselves their own contradictions, in that they are inscribed in an organisation with set values and goals.

Power and paradox

STS theory was perhaps never the best organisation theory to address power structures and power plays. Pava's reconfiguration addresses intra-organisational conflicts but offers little inter-organisational analysis. This is no minor issue. Zuboff's critical assessment of the challenges confronting us from the present day's technologies and "the big other" confirms this (2015). How can we deal with power issues entangled in the rich and multiple transitions taking place?

As we have implied above, digitalisation is ambivalent with regard to steering and decision-making capability. On the one hand, new information systems allow for systematic monitoring and power-related control; on the other hand, they allow for decentralised decision-making and trust-based control. This paradox has been around for a long time,[14] but new digital solutions actualise it in a radical way. While the paradox was previously more of a choice of management principle, the situation following the implementation of new technology is fundamentally different.

Implementation of new technologies implies expected efficiency gains. Technology, either standard or customised systems and solutions, has a cost, and investments made are expected to yield interest through increased competitiveness and higher efficiency. Thus, the steering paradox appears more complex than previously; finding acceptable solutions will require the paradox to be accepted as such and a solution to balance the two extremes.

Closure

Faced with a paradox, you cannot simply choose between the competing tensions, because either option intensifies the need for its opposite. Present-day and future transitions will present organisations and people at work with ambiguity, complexity, uncertainty and volatility, thus bringing to new levels of intensity the need to handle paradox. In the remaining articles in this issue, several such topics are addressed and discussed. For the times ahead, we need new concepts and theories to analyse and understand work systems under different circumstances, beyond the theory that has proven itself so far. Here, we have argued that a remaking of Pava's discursive theory of socio-technical design provides a promising starting point.

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[14] See Dvergsdal & Haga in this issue discussing trust-based management and its success prerequisites.

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