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(Some Theoretical Reflections)

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Abstract

Following some theoretical reflections are made regarding a comprehensive design of production planning and scheduling (PPS). On the one hand the latest concepts of work and organizational design are considered. These concepts postulate an autonomy-oriented design; i.e. autonomy should not be centralized but distributed throughout an organization in order to provide working conditions that promote motivation, competencies, and flexibility on an individual as well as on a collective level. However, the concepts do not provide concrete support for organizational design, particularly with regard to the question of how to guarantee for the coordination of distributed autonomy. On the other hand, human-centered PPS-approaches are discussed regarding their implication for allocating autonomy. It is argued that these concepts often focus sub-tasks of PPS. On the basis of these reflections PPS-related roles are elaborated for individuals and collectives that primarily have an executing function (i.e. production) as well as for instances with a planning functions (i.e. production control department). These roles are elaborated with the aim to reach an allocation of autonomy that is distributed but coordinated.

1. TECHNOLOGY- VS. HUMAN-CENTERED APPROACHES TO PPS

Corbett's (1987) criteria for distinguishing technology-centered systems from human centered systems focus mainly on the allocation of control. In the former approach control is to be removed from the shopfloor and allocated either to the technology or to the organization (i.e. to specialists). In the latter approach as much control as possible is to be allocated to the shopfloor. Applying Corbett's (1987) distinction on concepts of production planning and scheduling (PPS), it must be stated, that (still) most of the concepts follow a technology centered approach, in research as well as in practice. Of course this has been criticized by many authors (e.g. McKay, 1987; 1992; Sanderson, 1989; Bossink, 1992; Fischer, 1993; Nakamura & Salvendy, 1994; Schüpbach, 1994; Dessouky et al., 1995; Strohm, 1996; Wiers, 1997; MacCarthy & Wilson, 2001; Trentesaux et al, 1998; Vernon & MacCarthy, 1998; Vazquez & Resnick, 1999). These criticisms mainly emphasize the limited capability of technology centered approaches in dealing with PPS complexity, which is caused by characteristics such as (cf. McKay, 1987, 1992; Weth von der & Strohschneider, 1993; Schüpbach, 1994; Zölch, 1997; Wiers, 1997; Crawford et al., 1999; Crawford et al., 2000):

- Information to be processed is incomplete, ambiguous, dynamic and of stochastic nature.
- Information flow follows feed forward and feedback structures as well as formal and informal structures.
- Decisions to be taken are highly interrelated not only in content but also time wise.
- Decisions have to be taken situatively.
- Objectives to be followed may be - even if set clearly - contradictory.
- Information processing and decision-making is distributed among many different (human and non-human) actors.
- Result oriented performance measurement and even more process oriented evaluation of PPS practices are constrained due to temporal delays between actions and effects as well as unclear mutual relations.
- PPS is not a cognitive task only, but involves as well social role behavior.

Not only are technology centered approaches incapable to deal with such complexity, even worse, they can limit also corresponding human capabilities. Bossink (1992) who developed himself a technology based system, states, that technology centered solutions often not only neglect but even obstruct human potentials: "The proposed systems all want to create a satisfactory schedule. Therefore the developed manual adjustment functions to change an existing schedule are poor" (Bossink, 1992, 102). Furthermore Dessouky et al. (1995) state that the choice of a technology centered approach can itself make the PPS problem more complicate: „... many problems that are intuitively simple are actually computationally intractable, which may confine solutions of offline planning.“ (Dessouky et al., 1995, 468). Hollnagel and Cacciabue (1999) ad, that this may influence use strategies in a way not intended by system developers: „New technologies often fail to deliver the promised benefits, and may instead introduce new demands and complexities into already existing fields of

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Focus	merging the intelligence of T and P-Ind	support for cognitive capabilities of P-Ind	PPS as a market of capacity offer and demand	PPS-specifics of cross boundary cooperation and communication (boundary regulation)	comprehensive understanding of P-Ind's behavior (incl. cognitive task and social role behavior)	design of T design of PPS-task of P-Ind and E-Ind	splitting PPS tasks between P-Kol and E-Kol	3-level model of process regulation splitting PPS tasks between levels	3-level model of PPS-organization interaction between levels; structure within levels	differentiation between production and control process
Unit of Analysis	P-Ind; T	P-Ind; T	T; E-Ind	P-Ind; P-Kol; E-Ind; T	P-Ind	T; P-Ind; E-Ind	P-Kol; E-Ind; T	P-Kol; E-Kol	--- (abstract)	E-Ind; E-Kol
Specifics	T and P-Ind complement one another T learns from P-Ind	P-Ind executes PPS-task T supports P-Ind	auction-like negotiation among E-Ind's T facilitates interaction among E-Ind's T executes PPS-task	P-Ind creates coordination among E-Ind as well as among E-Kol consideration of contingencies regarding regulation requirements	PPS-behavior of P-Ind understood as a mix of cognitive task and social role behavior	P-Ind executes PPS-task T supports P-Ind consideration of contingencies regarding uncertainties; and its consequences for splitting PPS tasks between P-Ind and E-Ind	independency of P-Kol and E-Kol T supports P-Kol as well as E-Kol	heterarchically interlaced collectives, each covering all planning functions executing functions on the lowest level only	hierarchic structure with explicit mutual vertical influencability no consideration of executing functions	reduction of control requirements by the means of a suitable design of the production process; followed by a bottom-up design of control structure aiming at promoting generic control capabilities

Table 1: Overview over human centered PPS-approaches (legend: T: PPS-Technology; P-Ind: Individual with planning task; E-Ind: Individual with executing task; P-Kol: Collective with planning task; E-Kol: Collective with executing task).

practice. In order to cope with this, people often adapt either the technology or the way of using it in ways not anticipated by designers. Technological artefacts, or tools both shape user strategies and are shaped by the users.“ (Hollnagel & Cacciabue, 1999, 3). Such interdependencies of human and technology can cause self-dynamics that lead to developments not intended before the technology has been implemented.

In order to overcome the deficiencies of technology centered approaches some authors have proposed alternatives (see Table 1 for an overview). In these alternative approaches different perspectives on the PPS task are adopted. Hence, different aspects of the PPS task are focused, which leads to different demarcations of PPS subtasks to be considered. Regarding the choice of the units of analysis the following can be stated:

- Most approaches mainly focus on individuals specialized on PPS (i.e. planners, schedulers as smallest unit of analysis) that interact with one or more other parts of the system (e.g. technology, shopfloor operator, other PPS-specialists).
- Only some approaches focus on collectives (i.e. organizational units as smallest unit of analysis). The allocation of PPS tasks within the units is mostly not further specified. With regard to design requirements mostly no distinction is made between organizational units that have an executing task from such that have a planning task.
- PPS-technology is an issue in most approaches. Corresponding design requirements are mostly on a rather high level of abstraction.

In principle it can be stated, that valuable efforts towards a human centered PPS-approach have been made. But these approaches are still to be integrated into a comprehensive concept. Support for that may be provided by human centered approaches from work psychology and organizational sciences. A brief introduction is given in the next section.

2 SOCIOTECHNICAL SYSTEMS DESIGN: THE DISTRIBUTION OF AUTONOMY

In general the latest concepts of work psychology and organization sciences aim at promoting individual and collective autonomy by providing opportunities for local control and self-organization (Grote, 1997). This need for distributed autonomy is postulated on the basis of considerations from:

- action (regulation) theory (e.g. Hacker, 1986; Volpert, 1987; Resch 1988; Dahme, 1997; Ulich, 1998), and its developments regarding collective action regulation (e.g. Gohde & Kotter, 1990; Weber, 1997)
- considerations on opportunistic planning (Hayes-Roth & Hayes-Roth, 1979) and situated action (Suchman, 1987)
- humanistic (work) psychology (e.g. Maslow, 1954; Emery, 1959; Herzberg, 1966; Hackman und Oldham, 1976; Ulich, 1998)
- sociotechnical system approach (e.g. Trist & Bamforth, 1951; Rice, 1958; Emery, 1959; Susman, 1976; Alioth, 1981; Trist, 1981; Strohm, 1996; de Sitter et al., 1997)
- consideration regarding complementary function allocation in man-machine-systems (e.g. Jordan, 1963; Bainbridge, 1982; Corbett, 1985; Sheridan, 1987;

Grote et al. 2000)

There are basically two lines of arguments that substantiate the need for autonomy oriented design: one focusing on the interdependency of job design and personality, the other one focusing on the structural interdependencies of action (e.g. executing) and action regulation (e.g. planning).

The first line of arguments considers the individual to be a subject that – by acting – interacts with its environment, thereby shaping the environment and being shaped by the environment. Hence, the human is not only a component (resp. a resource) of the organization, but also its product. Human resources are not just given to (resp. are not just selected by) the organization. Rather they are produced by the organization. In order to provide opportunities for a 'positive' development (with respect to personality, motivation, technical and social competencies, etc.) it is required to enrich tasks with autonomy.

The second line of arguments focuses on structural interdependencies of planning and doing. On the individual level the reasoning is related on the one hand to interdependencies of action and (psychical) action regulation, which leads to lower performance if planning is separated from doing and allocated to different individuals. On the other hand it is related to effects of automation. The more a process is automated the more the human is remote from it and hence opportunities for human control over the automated process decrease. This can have negative effects, especially when situations occur which the technology is not (fully) specified for. Such situations may require creative human intervention, for which the human is neither prepared nor qualified. On the organizational level autonomy oriented design is substantiated by the notion that an organization needs opportunities for local regulation in order to be able to competently cope with variances and disturbances (i.e. 'only variety kills variety').

It can be summarized that autonomy oriented job and organizational design opens the scope of action and thus promotes individual and collective flexibility. Consequently it empowers an organization to competently cope with uncertainty (cf. Susman, 1976; Alioth, 1980; Schüpbach, 1994; Grote, 1997). Variances and disturbances are not perceived to be mainly symptoms of an inadequate system design. They are rather seen as a reality, which is caused by dynamic environments and conditions, and which can only be handled by a system that is empowered to act reactively as well as proactively. Furthermore, increased opportunities for local regulations do not only promote an organization's flexibility, but are also preconditions of organizational learning (Frei et al. 1993).

On a theoretical level the demand for autonomy oriented design is clearly stated and substantiated: autonomy should be distributed throughout the organization. However, realizing this demand in organizational design turns out to be quite difficult. The problem is that tasks for individuals and collectives are in most concepts considered in a rather isolated way. Corresponding design criteria demand for instance completeness for an individual's task (i.e. a task including planning as well as executing functions) or independence for organizational units' tasks. Such demands can lead to contradictory design requirements because tasks are always interrelated and can therefore not be designed in a way being (fully) complete or independent of each other. Hence *autonomy needs to be shared rather than split up*. For the design

of industrial organizations, which base on division of labor, a simple demand for distributed autonomy is not sufficient when its coordination is not considered at the same time. This is especially true for the PPS-task, which is mainly concerned with (proactive or reactive) coordination.

In the next section the human centered PPS-concepts described in section 1 are discussed regarding their consequences on the distribution and the integration of PPS-related autonomy.

3 AUTONOMY AND CONTROL IN HUMAN-ORIENTED PPS-CONCEPTS

Following the human centered PPS-concepts as described in section 1 (cf. Table 1) are discussed regarding their consequences on the allocation of PPS-related autonomy (see Table 2). As the distribution of autonomy should not be realized by splitting autonomy only, but also by sharing autonomy (cf. section 2), it is distinguished between the allocation of autonomy on the one hand and the autonomy related interaction on the other hand. Whereas the former focuses on the splitting of autonomy, the latter is concerned with its sharing. Furthermore the concept of autonomy is considered in a more differentiated way in order to get a clearer picture. Therefore the concept of Grote (1997) is applied. She distinguishes autonomy from control. With regard to the acting individual or collective she sets the following definitions:

- *Autonomy* refers to objectives and rules for the achievement of objectives: An individual or a collective is the more autonomous the more it can – within a concrete situation - determine objectives as well as rule for their achievement.
- *Control* is related to concrete influence on situations: An individual or a collective has the more control the more it possesses the capabilities to influence a concrete situation in respect of certain objectives.
- *Self-regulation* requires autonomy as well as control. Hence, self-regulation corresponds to 'autonomous control'.

With regard to the allocation of PPS-related autonomy and control as well as to the design of a corresponding interaction the following is implied by human centered PPS-concepts (see Table 2):

- *Concepts focusing on the collective*: PPS-related autonomy and control should be allocated in such a way that hierarchically subordinated levels as well as executing levels have an influence on PPS-objectives and -constraints and can act autonomously. With regard to the interaction some concepts demand as much independence as possible regarding vertical as well as horizontal interaction (Strohm, 1996; Schüpbach, 1994; de Sitter et al. 1997). Furthermore bilateral constraints in the vertical line is demanded (McKay, 1992) as well as lateral interaction in the horizontal line (Schüpbach, 1994). All concepts remain rather vague regarding the concrete design of the interaction.
- *Concepts focusing on the individual* (i.e. the PPS-specialist): Remarkably no PPS-related autonomy regarding PPS-objectives is demanded by any concepts. Only one concept (McKay et al., 1989) explicitly demands for PPS-related autonomy regarding PPS-constraints. However, most concepts demand a

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Allocation of Autonomy (PPS-Objectives)	---	---	---	---	---	---	---	---	---	---
Allocation of Autonomy (PPS-Constraints)	P-Ind (influence on constraints)	---	E-Ind (pers. offer of capacity)	---	---	---	---	---	top-down decreasing	---
Allocation of Control (PPS-Task)	T and P-Ind	P-Ind	T	divided between. P-Ind and E- Ind	P-Ind	divided between P-Ind and E-Ind	divided between E-Kol and P-Kol	divided between E-Kol and P-Kol	level specific	E-Ind; E-Kol
Interaction reg. Autonomy (PPS-Objectives)	---	---	---	---	---	---	T supports P-Kol and E-Kol	vertically & horizontally bilateral	vertically bilateral	---
Interaction reg. Autonomy (PPS-Constraints)	---	---	E-Ind's interacting	---	---	---	T supports P-Kol and E-Kol	vertically & horizontally bilateral	vertically bilateral	---
Interaction reg. Control (PPS-Task)	T and P-Ind interacting	T supports P-Ind	---	P-Ind's interacting P-Ind with E-Ind T supports P-Ind	---	T supports P-Ind	T supports P-Kol and E-Kol	vertically & horizontally bilateral	vertically bilateral	E-Ind's/E-Kol's interacting

Table 2: Allocation of PPS-related autonomy and control according to human-centered PPS-concepts (legend: T: PPS-Technology; P-Ind: Individual with planning task; E-Ind: Individual with executing task; P-Kol: Collective with planning task; E-Kol: Collective with executing task).

technical support that empowers the human (PPS-specialist) to control the PPS-process. Only in two concepts the task of the PPS-specialist is (partly) to empower the shopfloor for controlling the PPS-process (Wiers, 1997; Zölch 1997). Quite a different approach is followed by Arai et al. (1999). They allocate control over the PPS-process to the technology whereas the shopfloor operator gets autonomy regarding the capacity he provides (PPS-specialists are not required). PPS-related interaction from the point of view of PPS-specialists is described in detail by Crawford et al. (2000) and by Zölch (1997). However, detailed hints regarding its design are widely missing.

- *Concepts explicitly focusing on PPS-technology:* All concepts unisonous demand a supportive role for PPS-technology, mainly regarding individual or collective human control over PPS-processes, partly regarding PPS-related autonomy (as mentioned above Arai et al. make an exception).

Still lots of 'blanks' remain especially regarding the autonomy-related interaction of the different parties that (implicitly or explicitly) participate in carrying out the PPS-task (see Table 2). In the following section it is tried to fill these blanks. For that purpose roles for executors (individuals or collectives) as well as for planning instances are elaborated that allow for a distributed, but coordinated autonomy.

4 PPS AS SOCIOTECHNICAL SYSTEMS

The characteristics of the PPS task as specified in section 1 indicate that PPS cannot be considered as a task that can be isolated and allocated to a clearly defined agent be it an individual (e.g. a human scheduler), an organizational unit (e.g. a scheduling department), or a sophisticated technology (e.g. an ERP-system). It must rather be considered as a process that takes place within a complex system consisting of humans, organizational structures and technology. The PPS-system as a whole is a network of information flow and decision-making. Within this system human-computer-interaction as well as human-human-interaction take place. Hence PPS-systems themselves can be considered sociotechnical systems (cf. Emery, 1959) that perform a cognitive task. A sociotechnical PPS system is a human-computer network that penetrates the organization. It consists of people working in different organizational units (e.g. production departments, planning departments). Together these people (e.g. planners, supervisors, and operators) supported by technical devices (e.g. ERP-systems) actually perform PPS.

It was proposed to term sociotechnical PPS-systems *secondary work systems* (Wäfler, 2001). That way they can conceptually be distinguished from the sociotechnical concept of the *primary work system*, which are the formal organizational units. Whereas primary work systems can easily be demarcated within the organization, secondary work systems penetrate an organization, by overlapping primary work systems. Figure 1 illustrates the relation between primary and secondary work systems. It shows four primary work systems that are interrelated by a network of people and technical devices. It is this sociotechnical network that constitutes the secondary work system. Within it both, information flows as well as decision-making take place in technical (full lines) as well as in social (dashed lines) relations.

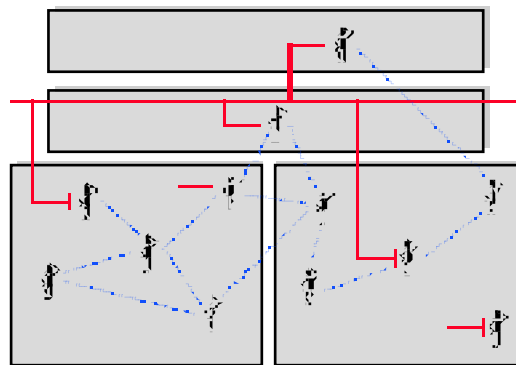


Figure 1: A secondary work system that interrelates four primary work systems

Demarcating PPS-systems as secondary work systems aims at overcoming the deficiencies of 'traditional' sociotechnical design, where the PPS-task needs to be split into sub-tasks that are allocated to separate primary work systems. In contrast designing secondary work systems is not aiming at demarcating but rather at integrating primary work systems.

Sociotechnical design concepts mostly focus on separated primary work systems they do not provide much hints of how to design secondary work systems. However, within the sociotechnical design approach individuals have been successfully integrated into teams. Hence, lessons can be learnt from there. Consequences for the design of PPS-related roles will be outlined in the following section. Thereby concepts regarding both are considered, a team's operation as well as a team's evolution. The former concerns the relation of divided autonomy of individuals and shared autonomy of collectives when the team operates. The latter concerns the process of dividing autonomy into individual and collective parts when the team (re-)constitutes itself.

5 PPS-RELATED ROLES IN SECONDARY WORK SYSTEMS

Following PPS-related roles are outlined that allow for a distributed but coordinated autonomy. The outlines are made for individuals and collectives that have an executing function as well as for organizational instances (individuals or organizational units) that have a planning function. A summary can be found in Table 3.

The distribution of autonomy basically aims at providing individuals that have an executing function with opportunities to act flexibly and self-determined. Hence a role must be assigned to the planning instance that is different from producing plans that stipulate the executors actions. This different role may consist in creating such prerequisites that allow the executor to act autonomously thereby taking into account situative demands. Therefore the planning instance needs to empower the executor to realize actual demands of the situation, to estimate consequences of different decisions, and to act in a situated way.

Nevertheless in organizations based on the division of labor there will always be some kind of separation of planning and executing tasks. Hence, the question is how to achieve this separation without having the negative consequences as described in section 2. To deal with this the concept of *higher-level autonomy* can be applied

(Grote, 1997). It postulates that the negative consequences of a loss of autonomy is smaller, if the autonomy is ceded voluntarily, i.e. when there is (higher-level) autonomy regarding the amount of autonomy to be given away. Thus, when the executor voluntarily hands over part of his autonomy to the planner it can be assumed that he will not perceive himself to be externally controlled. Consequently the planner and the executor should negotiate on the division of PPS-related autonomy. This division should (ideally) not be fixed, but remain a subject of negotiation. That way the planner as well as the executor keeps (higher-level) autonomy even though the autonomy is divided. The same goes for the allocation of autonomy between different executors.

Collective self-regulation is possible when the collective holds a *core task* (Gohde & Kötter, 1990; Weber, 1997), for which it is collectively responsible. The core task is a part of a collective's whole task. It consists of those sub-tasks that are not assigned to individual group members, but to the collective as a whole. The right design of the core task is crucial for successful implementation of self-managed work teams. The existence of a core task in respect of which the collective acts flexibly and self-determined is an indicator of distributed autonomy on the collective level. As higher-level autonomy can compensate for a loss of individual autonomy all members of a collective should participate in the definition of the core task.

On the inter-collective level it is the task of the planning instance to create such prerequisites that allow the executing collective to autonomously perform its core task, taking into account situative demands. Furthermore the collective must have influence on the allocation of autonomy between itself, other collectives, and the planning instance to compensate for a loss of autonomy.

A summary of the different roles can be found in Table 3. They have been derived from the objective to increase the executor's capabilities for opportunistic planning (Hayes-Roth & Hayes-Roth, 1979) and situated action (Suchman, 1987). The roles are in a hierarchical relation as far as the realization of a certain role on a higher organizational level is a necessary but not sufficient prerequisite to realize a role on a subordinated organizational level.

All PPS-related roles have an operational as well as a constitutional part. Whereas the former refers to the autonomy assigned to the role while carrying out the PPS-task, the latter refers to the process of assigning autonomy to the different roles. Following the roles are concretized from these two perspectives (see Table 4 & Table 5). These concretizations base on the following considerations:

- The concept of the core task is applied to the collective as well as to the inter-collective level. The former application corresponds with the original aim of the concept, i.e. to integrate several individual tasks into one collective task. The latter is a further development of the concept. Thereby it is assumed that a secondary work system as a whole must have a core task too, which has to be carried out in joint responsibility of all primary work systems (i.e. organizational units). Hence, this overall core task has the function to integrate the primary work systems' tasks.
- In the same way the concept of higher level autonomy is not applied to the inter-individual level only, but also to the inter-collective level. The aim to do so is to provide individuals as well as collectives with a measure that helps compensating

for a loss of autonomy. Hence, all collectives should be participating in defining the secondary work system's core task.

- The concretization of the role of the planning instance mainly bases upon the sociotechnical concept of *boundary regulation* (Emery, 1959). It means that the function of a planning instance mainly lays in stabilizing the system's boundary and in empowering the executors to act self-regulated.

Org. Level	PPS-related Roles Under the Condition of Distributed Autonomy
individual	The executor (individual) has the opportunity to act autonomously thereby taking into account situative demands.
inter-individual	The planning instance creates such prerequisites that allow the executor to act autonomously thereby taking into account situative demands. The executor (individual) has the possibility to influence his own amount of autonomy (with regard to autonomy shared with planning instances as well as with other executors (individuals)).
collective	The executor (collective) holds a core task for which it is collectively responsible. The executor can act autonomously in respect to the core task thereby taking into account situative demands. All members of the collective participate in the definition of the core task.
inter-collective	The planning instance creates such prerequisites that allow the executor (collective) to take collective responsibility with regard to the core task. The executor (collective) has the possibility to influence his own amount of autonomy (with regard to autonomy shared with planning instances as well as with other executors (collectives)).

Table 3: PPS-related roles of executors (individuals and collectives) and planning instances under the condition of distributed autonomy.

Following the operational as well as the constitutional roles are concretized (cf. Table 4 & Table 5).

Operational PPS-Roles	Indicators
1. Executor (individual)	
<p>is responsible for:</p> <ul style="list-style-type: none"> • optimization of own task • bilateral coordination with pre- and succeeding tasks • active participation in core task • active cooperation with planning instances 	<p>executor:</p> <ul style="list-style-type: none"> • knows individual PPS-related objectives • knows PPS-processes (micro level) • has extended decision latitude • decides in cooperation with pre- and succeeding operators as well as with planning instances • is informed regarding the situation of pre- and succeeding operators • seeks actively for corresponding information • provides corresponding information
2. Executor (collective)	
<p>is responsible for:</p> <ul style="list-style-type: none"> • collective optimization of core task • bilateral coordination with pre- and succeeding collectives • active participation in super-collective core task (super-collective decision making) • active cooperation with planning instances 	<p>executor:</p> <ul style="list-style-type: none"> • knows collective PPS-related goals • knows PPS-processes (macro level) • has extended collective decision latitude • decides in cooperation with pre- and succeeding collectives as well as with planning instances • is informed regarding the situation of pre- and succeeding collectives • seeks actively for corresponding information • provides corresponding information
3. Planning Instances	
<p>is responsible for:</p> <ul style="list-style-type: none"> • stabilization and predictability of the boundary of the secondary work system • support for self-responsible acting of executors • support for mutual coordination of executors • controlling the secondary work system's working • maintaining the secondary work system's infrastructure • training the secondary work system's members • promoting the executor's self-responsibility 	<p>planning instance:</p> <ul style="list-style-type: none"> • monitors external trends • 'controls' external demands • promotes transparency regarding PPS-processes • optimizes PPS-processes • communicates and coordinates PPS-related objectives • monitors objectives • creates decision-making basis for executors • support executors in complex decision-making • trains PPS-related competencies • maintains and develops PPS-infrastructure

Table 4: Operational PPS-related roles in secondary work systems.

Constitutional PPS-Role	Indicators
1. Executor (individual)	
participates in: <ul style="list-style-type: none"> • definition of cooperation rules between executors (individuals) and planning instances • assignment of autonomy within own collective • definition of core task of own collective 	executor (individual) takes part in: <ul style="list-style-type: none"> • definition of his own autonomy • definition of rules regarding the coordination with other executors of the same collective as well as the cooperation with planning instances • delegation of autonomy regarding the coordination with other collectives • definition of PPS-processes (intra-collective)
2. Executor (collective)	
participates in: <ul style="list-style-type: none"> • definition of cooperation rules between executors (collectives) and planning instances • assignment of autonomy between collectives • definition of super-collective core task 	executor (collective) takes part in: <ul style="list-style-type: none"> • definition of its own autonomy • definition of rules regarding the coordination with other collectives as well as the cooperation with planning instances • definition of PPS-processes (inter-collective)
3. Planning Instances	
negotiates the allocation of PPS-related autonomy with executors (individuals and collectives) with regard to: <ul style="list-style-type: none"> • task assignment among executors • task assignment among executors and planning instances 	planning instance takes part in: <ul style="list-style-type: none"> • definition of its own autonomy • definition of rules regarding the coordination between executing instances definition of rules regarding the coordination between executing instances and planning instances <ul style="list-style-type: none"> • definition of PPS-processes

Table 5: Constitutional PPS-related roles in secondary work systems.

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