Connecting the SMART work design approach to sociotechnical design principles

Peter Oeij, Steven Dhondt & Fietje Vaas

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Abstract

While sociologists have a strong interest in the division of labour, the labour process, and sociotechnical design aspects, in relation to job and work design, psychologists stress the importance of human needs and human satisfaction. Sociologists underline strategic and organisational choices as conditional to the quality of work, whereas psychologists focus on person-environment-fit approaches.

Recently, we observe a rapprochement in the field, with regard to the development of the SMART work design model; individual, team, and organisational elements are integrated into an approach that links human needs, job characteristics and organisational conditions. In Europe (particularly in the Lowlands and Scandinavia) researchers have linked sociotechnical design thinking to organisational design principles for production lay-outs and quality of work criteria into a modern sociotechnical approach. The paper intends to stimulate discussion about how to integrate elements of the SMART work design approach and the 'modern sociotechnical' into an integral approach, in the sense that 'HR professionals meet the engineers'.

Keywords: work design; sociotechnics; quality of work; organisational design; job design

1. Introduction

There has always been a diverging approach to the quality of work between sociological and psychological disciplines with regard to job and work design. While sociologists -who identify themselves with organisation designing engineers- seem to have a strong interest in the division of labour, the labour process, and sociotechnical design aspects, psychologists -who identify themselves with HR-to-the-business professionals- stress stronger the importance of human needs and human satisfaction. Sociologists seem to underline strategic and organisational choices as conditional to the quality of work, whereas psychologists seem to focus on person-environment-fit approaches. Sometimes a controversy is framed between 'objective' and 'subjective' styles of doing research and improving working conditions in practice. Unfortunately, this does not help much to stress the commonalities and convergence between disciplines.

In recent years, however, we can observe an important rapprochement in the field. With the development of the SMART work design model of Parker and colleagues it can be observed that individual, team, and organisational elements are integrated into an approach that links human needs, job characteristics and organisational conditions. We think that the SMART model is different from the more usual person-environment fit models in the W&O psychology discipline. In Europe (particularly in the Lowlands and Scandinavia) researchers have linked sociotechnical design thinking to organisational design principles for production lay-outs and quality of work criteria into a modern sociotechnical approach. Dutch researchers have started to seek to integrate elements of the SMART work design approach and the 'modern sociotechnical' into an integral approach (Oeij et al., 2021, 2023).

The purpose of our paper is to confront and connect the 'psychological individual & team approaches' to work design with the 'sociological organisation approaches' to work design (Figure 1).

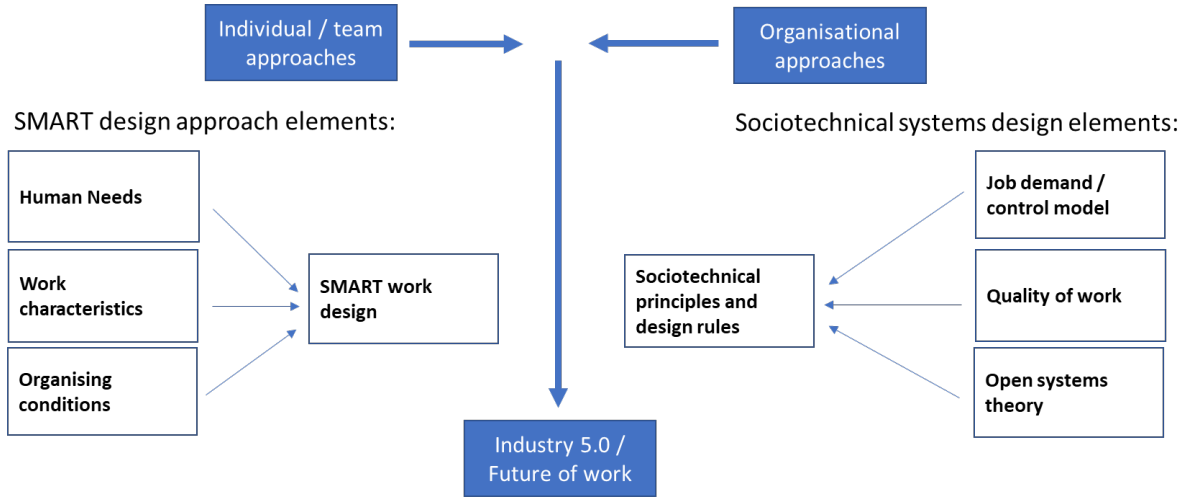


Figure 1: Connecting psychological and organisational approaches to work design

A reason to perform this exercise these days is the present debate to make industries and work environments less technologically deterministic and more human-centric, as in the Industry 5.0 approach, compared to Industry 4.0 (Breque et al., 2021). To design human-centric jobs and workplaces practical guidelines and principles are desired. The SMART work design approach is, for example, related to a variety of streams in work and organisational psychology, such as the study of human needs, job characteristics, job design requirements, job resources, and job / team crafting (Bakker & Demerouti, 2017; Deci et al., 2017; Hackman & Oldham, 1975 and 1980; Oldham & Fried, 2016; Parker & Grote, 2020 and 2022; Parker et al, 2017; Tims et al., 2013; Van den Broeck et al., 2021). The sociotechnical systems design approach is, amongst others, related to models of function analysis (WEBA model), principles to design organisations and production systems (sociotechnical principles, the job – demand / control model of Karasek, the 'complete job' model of Hacker (1986 and 2003), workplace innovation and skills approaches (De Sitter et al., 1997; Govers & Van Amelsvoort, 2019; Karasek & Theorell, 1980; Kuipers et al., 2020; Pot et al., 1989 and 1994; Vaas et al., 1995; Van Amelsvoort & Van Hootegem, 2017).

The sociotechnical researchers (i.e. mainly sociologists and management scientists) state that organisational design is conditional to job design ('primary prevention', causal conditional approach). The implication is that (subjective) job satisfaction of persons is subordinate to (objective) job design criteria, because people differ in preferences but jobs should have quality standards for everyone. HR-practitioners, however, are often trained as psychologists. Their point of departure is more often to intervene in the skills and behaviours of persons ('secondary prevention', combating symptoms approach) and to find an optimised 'person-environment fit'. The sequence of design interventions is therefore significant for their effects: the preference is first primary prevention, then secondary prevention.

Our expectation is that this exercise can feed into constructive discussions among psychological, sociological, management, and business scholars, and practitioners, in the field of jobs, work and organisation design.

In this paper we shall first summarise the SMART work design model. Subsequently we identify the organisational structural and cultural design criteria. And finally we connect these to integral system

requirements and the sociotechnical design rules. We close with conclusions and recommendations with respect to the future of work and Industry5.0.

2. SMART work design model

Parker & Knight (2023) propose the SMART work design model, that identifies five higher order categories of work characteristics, including stimulating work characteristics (task variety, skill variety, information processing requirements, and problem solving requirements), mastery work characteristics (job feedback, feedback from others, and role clarity), autonomous work characteristics (decision-making autonomy, timing autonomy, and method autonomy), relational work characteristics (social support, task significance, and beneficiary contact), and tolerable work characteristics (low levels of: role overload, work–home conflict, and role conflict). They tested this structure through higher order confirmatory factor analysis, followed by validity tests linking the factors to the theoretically relevant outcomes of job satisfaction and performance.

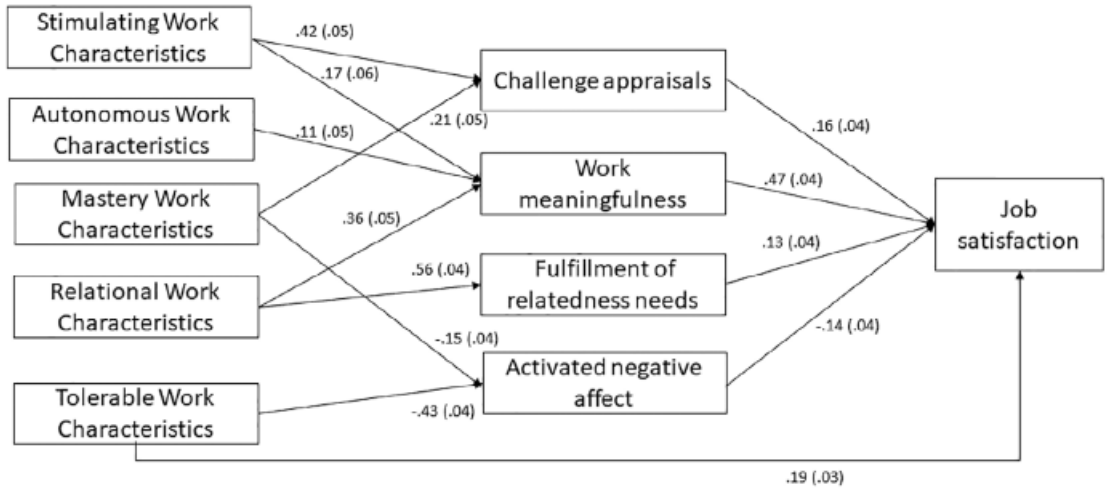
Table 1. Higher-order work design factors, including their definition, theorized links to organizational design and psychological processes, and their work characteristics (Parker & Knight, 2023).

Higher-order factor	Definition	Link to organizing conditions	Link to psychological processes	Perceived work characteristics (dimensions)
Stimulating work characteristics	High degree of mental complexity and variety due to the nature and organization of one's work tasks, activities, responsibilities, and relationships.	Horizontal division of labor	Work meaningfulness and challenge appraisal	• Task variety • Skill variety • Problem-solving requirements • Information processing requirements
Autonomous work characteristics	High degree of autonomy, control, and influence over one's work tasks, activities, responsibilities, and relationships.	Vertical division of labor	Work meaningfulness	• Timing autonomy • Method autonomy • Decision-making autonomy
Mastery work characteristics	Work is organized in a way that one can understand what one's tasks, activities, and responsibilities are, how they fit in the system, and how well they are being executed.	Co-ordination and integration via information	Challenge appraisal and lower activated negative affect	• Job feedback • Feedback from others • Role clarity
Relational work characteristics	High degree of support, connection, and the opportunity to positively impact others arising from one's work tasks, activities, responsibilities, and relationships.	Co-ordination and integration via social processes	Work meaningfulness and meeting relational needs	• Task significance • Beneficiary contact • Social support
Tolerable work characteristics	Low degree of costly quantitative demands arising from one's work tasks, activities, responsibilities, and relationships.	Effort required to achieve shared org. goals	Lower activated negative affect	• Low role overload • Low role conflict • Low work–home conflict

By applying structural equation modelling Parker and Knight (2023) tested the relationships between the five higher-order factors and psychological processes, i.e. psychological human needs, and the outcome of job satisfaction. These relationships proved to be significant, and an additional positive

direct pathway was found between tolerable work characteristics and job satisfaction. Figure 2 displays the final model.

Figure 2. The final structural equation model showing the usefulness of the higher-order constructs (Parker & Knight, 2023).



The third row of table 1 is concerned with a link to organising conditions of the mentioned SMART higher-order factors and human needs. This is where sociotechnical thinking comes in. The Lowlands variant of 'modern sociotechnical systems design' (MST) has developed rules to design organisational conditions that can guarantee excellent organisational and job performance, and holds the assumption that this will result in high job satisfaction (De Sitter et al., 1997), although these sociotechnical researchers state that job design is more fundamental for meaningful work than the job experience of persons, which is a merely a consequence of the quality of work and not a cause of it.

3. Linking human needs to integral system requirements

Modern sociotechnical systems design theory (MST) is an open systems approach to design work processes (the process of producing goods or services) (Kuipers et al., 2020)[1]. The design of work processes of organisations follow from strategic choices that organisation members (often management) make. These choices deal with matters such as markets, customers, products, business models, finance. The mix of those matters results in decisions on how the product can be produced to meet the needs of markets, customers, investors and so on. Thus, we have production criteria for the lay out of the work process. The MST approach not only looks at economic values as an input for the design. Human values play a significant role in the MST principle to minimise the division of labour. In the end this principle contributes to the quality of work by the design of 'complete jobs' (Hacker, 1986 and 2003)in which executive and managing tasks are not split up as in Tayloristic and Bureaucratic organisation designs. This allows to take into account human-centric values that lead to work criteria that enable the inclusion of well-being-at-work criteria, such as reducing stress risks and enhancing learning and developmental opportunities. MST design rules

[1] This sociotechnical variant of the Low countries is often overlooked, even in sociological overviews of the link between sociotechnical systems thinking and quality of work (e.g. Guest et al., 2022). We think it is because it is 'too technical', as it has a strong relation with operational management.

follow a certain sequence, namely to first design the production lay out top-down (called production structure), and second, design the logic of dividing managing and operational tasks bottom-up (called management structure). In line with minimising the division of labour the MST principle is to locate decision latitude at the lowest organisational level where problems occur and where autonomous decisions can be taken. Once these functional requirements of production and management are determined, the design of supporting systems follow, such as technological systems, information systems, management systems, human resources systems. The sequence of the design is crucial. All too often, organisations choose the application of technologies and IT-systems that create a division of labour omitting the quality of work criteria. Instead of a complimentary technology to augment workers in their job (see figure 3; INSIGHTS_EU, a H-EUROPE research proposal, to be submitted in 2024), technologies are steering and monitoring what workers do. Both sociotechnical researchers and work and organisational, and occupational health psychologists care about the well-being of people in their work, and that is the reason why connecting the SMART work design model and sociotechnical design principles is a groundbreaking opportunity to simultaneously improve organisational performance and the quality of work.

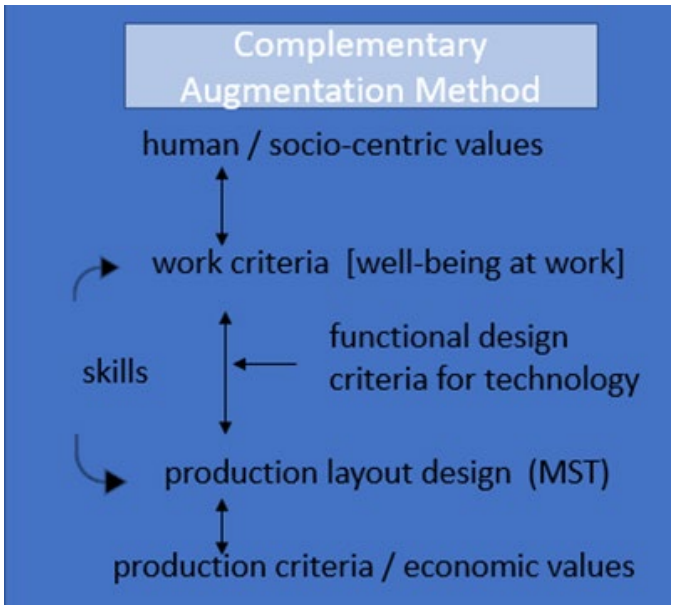


Figure 3: Complementary augmentation method

Table 2 shows the main features of the SMART work design model in column 1 to 4 as discussed in section 2 (Table 1), and sociotechnical features in column 5 to 7: organisational structural design criteria, organisational cultural design criteria and integral system requirements.

SMART model	Work characteristics	Human needs	Link to organising conditions	Organisational structural design criteria	Organisational cultural design criteria	Integral system requirements
Stimulating work characteristics	• Task variety • Skill variety • Problem-solving requirements • Information processing requirements	• Challenge appraisals •Work meaningfulness	Horizontal division of labour	•Minimise division of labour •Maximise learning new skills / job enrichment •Technology to augment work	•Opportunity of learning (new skills)	•Law of requite variety: external variety must be met by internal variety, i.e. internal control options / design active jobs
Autonomous work characteristics	• Timing autonomy • Method autonomy • Decision-making autonomy	•Work meaningfulness	Vertical division of labour	•Decentralisation in division of labour / limited hierarchy / low formalisation •Autonomous teamwork •AI / ML as a choice	•Presence of leadership and mentoring to learn new roles / growth in roles •Shared leadership •Options for self-management and self-selection	•Reduction of structural complexity by reduction of interfaces •Parallelisation of order variety into homogeneous sub-streams •Combine executive, preparatory, and managing tasks supporting of sub-streams, and allocate such 'whole tasks' (self-regulation) to autonomous groups (segmentation) •Decentralisation of authority whenever possible •Minimize critical specification / minimise monitoring and controlling AI and ML
Mastery work characteristics	• Job feedback • Feedback from others • Role clarity	•Challenge appraisals •(Lower) Activated negative affect	Co-ordination and integration via information	•Maximise open information about company results and strategy	•Worker participation in organisational change / renewal •Contribute to innovation •Democratic dialogue	•Teamwork implies control-capacity, coordination, collaboration, social support, uses of talents, enrichment, learning opportunities •Functional deconcentration of information (grouping if required information and data) /access to data / augmenting function of (information) systems
Relational work characteristics	• Task significance • Beneficiary contact • Social support	•Work meaningfulness •Fulfilment of relatedness needs	Co-ordination and integration via social processes	•Maximise external control options •Maximise consultation at work / discussion of work progress	•Cooperation based on human(ist) respect (equality diversity and inclusiveness) / mature employment relationships / labour relations / commitment driven HR system	•Integrate control-cycles to minimise complexity in interactions (nodal network)
Tolerable work characteristics	• Low role overload • Low role conflict • Low work–home conflict	•(Lower) Activated negative affect	Effort required to achieve shared organisational goals	•Maximise internal control options / decision latitude •Workload self-management	•Task / assignments based on achievable (non-exploitative) production goals and human well-being •Fair reward system	•Taking into account the psychosocial and physiological boundaries of human functioning (in and outside work)

Table 2: SMART work design model features and sociotechnical design criteria and requirements

4. Connecting the SMART work design model to sociotechnical design rules

In this section we discuss the design rules that operationalise the sociotechnical design principles and that can be connected to the SMART work design model. The issue we want to address first is the question of why psychological researchers and HR professionals should have an interest in sociotechnical design if all they have to focus on is the job satisfaction of workers. What's in it for them?

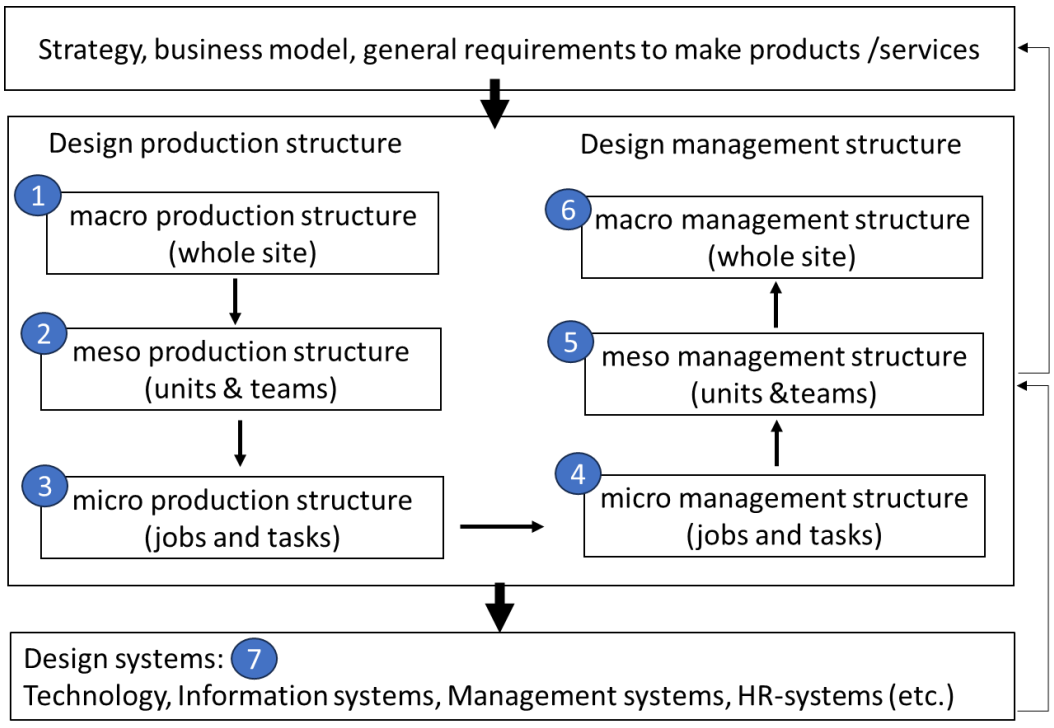
While 'engineers' usually design organisations and their production processes, 'HR to the business' is responsible for ensuring the right personnel. While engineers concentrate on making the production process and the products functionally more effective and cost-efficient, HR-professionals are concerned with the person-environment fit. While engineers use their expertise to design and implement (information) technology to enhance the productivity and the product's competitiveness, HR-professionals are improving the skills match between the present worker skills and new skills requirements of technology. While engineers worry whether they meet the needs of management, operational foremen, shareholders, clients and customers, HR-professionals worry about occupational safety and health, psychosocial risks, musculoskeletal risks and job satisfaction. The salient problem in such instances is that engineers have no expertise in people issues and HR-professionals lack expertise in operational management issues. Consequently, certain options to improve the quality of work are underused (Karanika-Murray & Oeij, 2017).

Can we change this? One option is to enhance the knowledge of engineers with the importance of a good quality of work: better jobs enhance the commitment and involvement of people, which will not only support their job satisfaction, but also their contribution to the quality of the output of the production process and the process of innovation and organisational change in the form of employee innovation adoption. But engineers may reason, why should I care about that as long as

people are replaceable by other people or technology through automatisation, robotisation and digitalisation; as long as costs are controllable and customers are satisfied, who cares?

Another option may be to enhance the knowledge of HR-professionals with insights on operational management. But HR-professionals may reason that this is not their cup of tea, and that their role is 'HR to the business'. In this role HR-professionals have no position concerning strategy, business and operations. Therefore, they have no direct influence on how engineers determine the quality of work with their design of production processes and technology. But we can change this?

With the development of the SMART work design model by Parker and colleagues a bridge can be laid with sociotechnical systems thinking. The SMART work design model captures the main psychological human needs related to work, whereas the Lowlands variant of modern sociotechnical systems design includes operational management design rules that align with good quality of work. The SMART work design model has connected individual person-environment fit models with concepts of team work and organisational design conditions. Modern sociotechnical systems design related the strategic and operational demands of production systems with criteria for good quality job design. While the SMART work design model focuses on human needs the modern sociotechnical systems design stresses functional systems needs. This is where psychological job satisfaction and operational job output requirements meet.



Derived from Kuipers et al., 2020: 222.

Figure 4: the integral design chain

Modern sociotechnical systems design (MST) offers design rules for organisations, based on strategic choices with regard to markets, products and production methods. The principles behind the design are to minimise the requirements for coordination (nodal points) that make organisations unnecessarily complex and to maximise decision latitude to the level where decisions must be taken and problems must be solved. Organisations become less bureaucratic, more resilient (flexible), sustainable (efficient) and human-centric (quality of work) and in line with Industry 5.0 (Breque et al, 2021). The open systems approach of MST leads to principles for design. Such as: (1) design

integrally not partially; (2) apply the sequential order to first design according to the production logic, followed by the design of the management structure, and finalised by designing the needed information and technology; and (3) minimise the division of labour (Kuipers et al., 2020).

We superficially[2] discuss this part or organisation level design rules (1 and 2 in Figure 4), but focus on design rules that enhance the quality of work (3 to 6 in Figure 4); further we will address the design of systems, like technology (7 in Figure 4). Below we summarise the 50 sociotechnical design rules (Peeters & Mossink, 1995), and indicate the number of the steps of the integral design chain (i.e. the seven steps in Figure 4).

Table 3. Sociotechnical design rules

Level	**Sociotechnical design rules**
Organisation as a whole 1	*General principles* 1. Parallisation and segmentation of the organisation of production (crude design) 2. Units require a coherent set of management functions (preparing, supporting and controlling) to enable control options into the functions of workers 3. Design production structure top-down from crude to fine 4. Design the management structure bottom-up from fine to crude (see Figure 4) *Production structure* 5. Homogenize the production into parallel streams and segment these into independent, separate units (parallelisation and segmentation fine design) *Parallelisation* 6. Minimise organisational coordination between units by further division into subunits / teams; 7, 8, 9. Segmentation criteria are product variety, order predictability, order volume *Segmentation* 10. Minimise organisational interdependence of units and maximise the interdependence of actions within units 11,12,13,14, 15, 16. Dependency requirements can be sequence of activities, (interval) time, quality, tooling (processing, manufacturing), space, skills; dependency conditions are a balanced flow rate, clear demarcations, work pace sovereignty, communication options between units, skill homogeneity to enable support and task take-over, option to affect product quality *Management structure* 17. Grouping and coupling preparing, supporting and organising staff and operational tasks (functions) at maximum decentralised level (decentralisation, deconcentration). Conditions are independence of production processing, need for control options to deal with control problems, geographical spreading, specialisation of staff, specific procedures, availability of staff expertise 18,19,20. Decentralise decision latitude, demarcate the central and decentralised staff tasks, ensure independence between operational and decentral staff tasks
Teams / units	21, 22. Analyse the option of integral design of a unit, its demarcation, and the need to adapt the design of the production organisation (at higher level); assess the need of a structural design (autonomous groups: team, task group, project-based group, project team), an organisational

[2] Most publications about MST design are in Dutch, but a few good sources in the English language are Govers & Van Amelsvoort (2019 and 2023), Kuipers et al (2020) and De Sitter et al (1997). See Annexe.

2	function design to include organising tasks, or a professional function design to divide executing, preparing and supporting tasks.
5	*Autonomous groups* 23. Design a complete set of group tasks (preparatory, executing, supporting tasks) that is demarcated and measurable 24. Allocate internal and external control options to make groups autonomous and independent 25. Group tasks must be mutually dependent and complementary, but allow individual space (loose coupling) 26, 27. Group size (4-20 persons, ideally 8-12 persons) must enable significant organisational contribution and ensure group flexibility 28, 29. Group members are multi skilled but do not differ too much in status; the group has a (rotating) contact person 30, 31 Allocate management facilities (e.g. budgeting, HR-tasks) and information to allow for autonomous task execution, and means of production (e.g. technology) to meet the requirements of the group task
6	- Analyse the management structure and maximise the decision latitude for lower levels of the organisation ('whole task groups', 'complete jobs'), and minimise the need of decision latitude at the highest organisational level concerning strategy and business decisions
Job & tasks	32. In the case of incidental control problems (e.g. stress risks) reduce the control problems by adaptation and solving immediate, short-term problem causes (combat symptoms) 33. In the case of structural control problems enlarge the control options by improving and solving long-term problem causes (combat causes) via first autonomy, second supporting tasks, third organising task (enlarge learning and developmental opportunities) 34. In the case of incomplete functions allocate executing, preparatory, and supporting tasks systematically
3	
4	*Adaptation – reduce control problems* 35. Analyse control problems per control domain and improve control options. Control domains are: information about the assignment, material (flow), means / resources, (planning of) operations, information / feedback about results, reducing the complexity of the nodal network (interactions, coordination), redefining / lowering the norms (output standards) *Improvement - enlarge control options* 36. Enlarge autonomy of pace, method, sequence, and environment in executing tasks. 37, 38. Improve (functional and social) support by creating overlap between the tasks of workers (internal / external control options) or the possibility of contacting non-team persons to solve control problems *Making functions complete* 39. Integrate executing tasks by task rotation and job enlargement (horizontal enlargement of executive tasks) 40. Integrate preparatory and supportive tasks in the job by job enrichment (vertical enlargement of non-executive tasks)
7	*Design augmenting and complementary technology* 41. Non-standard tasks and unpredictable events remain the responsibility of humans

	42. Technology-implementation and the capacity of technological production means must take into account the possibility of switching in the case of disturbances (modularity of technology, loose coupling) 43. Technology and machines (including AI and ML) and their set-up and adjustment must be possible by humans at the local, operating level 44. Technology design and implementation (automation, robotisation, digitalisation) should be such that work with short cycle times is avoided 45. The work pace of teams should remain independent of other teams (buffering) 46. The work pace of transportation systems (conveyor belt, production line) must be uncoupled wherever possible from executing the work 47. The unit / team disposes of their own means of production 48. Management and information systems must support the decentralised control options 49. Management and information systems must be available for operational users to provide process information (feedback) and anticipatory information (feedforward) 50. Management and information systems must support inter-local communication between units / teams

Having laid out the sociotechnical design rules and connected them to the design steps, we now turn to the question of how these design rules and steps can be connected to the SMART work design model (Table 4).

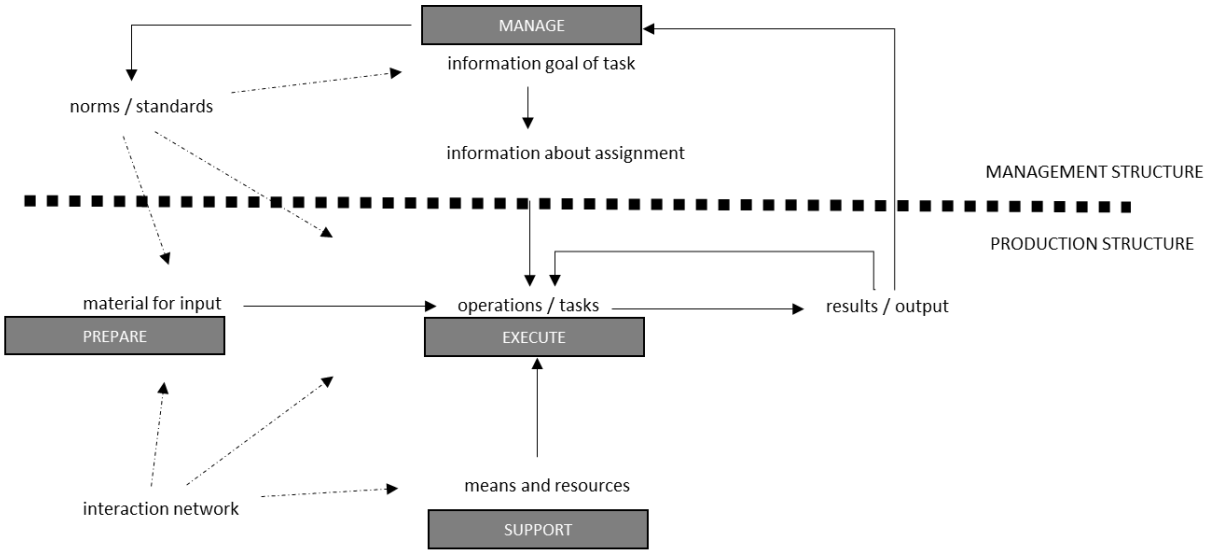
Table 4: SMART work design model features, sociotechnical design criteria and requirements, and the connection with sociotechnical design rules

SMART model	Work characteristics	Human needs	Link to organising conditions	Organisational structural design criteria	Organisational cultural design criteria	Integral system requirements	Sociotechnical design rules	
Stimulating work characteristics	• Task variety • Skill variety • Problem-solving requirements • Information processing requirements	• Challenge appraisals •Work meaningfulness	Horizontal division of labour	•Minimise division of labour •Maximise learning new skills / job enrichment •Technology to augment work	•Opportunity of learning (new skills)	•Law of requite variety: external variety must be met by internal variety, i.e. internal control options / design active jobs	1-20 33-36 39 44	1 3 4 6
Autonomous work characteristics	• Timing autonomy • Method autonomy • Decision-making autonomy	•Work meaningfulness	Vertical division of labour	•Decentralisation in division of labour / limited hierarchy / low formalisation •Autonomous teamwork •AI / ML as a choice	•Presence of leadership and mentoring to learn new roles / growth in roles •Shared leadership •Options for self-management and self-selection	•Reduction of structural complexity by reduction of interfaces •Parallelisation of order variety into homogeneous sub-streams •Combine executive, preparatory, and managing tasks supporting of sub-streams, and allocate such 'whole tasks' (self-regulation) to autonomous groups (segmentation) •Decentralisation of authority whenever possible •Minimize critical specification / minimise monitoring and controlling AI and ML	1-20 33-36 40-50	1 3 4 6 7
Mastery work characteristics	• Job feedback • Feedback from others • Role clarity	•Challenge appraisals •(Lower) Activated negative affect	Co-ordination and integration via information	•Maximise open information about company results and strategy	•Worker participation in organisational change / renewal •Contribute to innovation •Democratic dialogue	•Teamwork implies control-capacity, coordination, collaboration, social support, uses of talents, enrichment, learning opportunities •Functional deconcentration of information (grouping if required information and data) /access to data / augmenting function of (information) systems	21-31 41-50	2 5 6 7

Relational work characteristics	• Task significance • Beneficiary contact • Social support	•Work meaningfulness •Fulfilment of relatedness needs	Co-ordination and integration via social processes	•Maximise external control options •Maximise consultation at work / discussion of work progress	•Cooperation based on human(ist) respect (equality diversity and inclusiveness) / mature employment relationships / labour relations / commitment driven HR system	•Integrate control-cycles to minimise complexity in interactions (nodal network)	37-38	4
Tolerable work characteristics	• Low role overload • Low role conflict • Low work–home conflict	•(Lower) Activated negative affect	Effort required to achieve shared organisational goals	•Maximise internal control options / decision latitude •Workload self-management	•Task / assignments based on achievable (non-exploitative) production goals and human well-being •Fair reward system	•Taking into account the psychosocial and physiological boundaries of human functioning (in and outside work)	32-34	3

The foundational idea is how an organisation is designed as a work process that results in the design of jobs with allocated tasks that will include or exclude well-being risks; and, that these risks are a characteristic of the job, irrespective of the experience of a person. But the absence / presence of risks will affect the experience of human needs being fulfilled or not. It is possible to assess control problems at the level of tasks[3]. If a control problem is present, this means that there is a disturbance or a disruption in carrying out a task. In order to solve the disturbance, control options (i.e. decision latitude) are needed at the level of this task. This is a matter of applying a specific design rule. If the control options are absent, and the disturbance cannot be solved at the level of that task, the operator assigned to the task may experience the emotion of feeling incompetent or stressed. In such instances, it can be said that the task is facing an unfavourable 'well-being condition' (Dhondt & Vaas, 2001; Pot, 2017; Pot et al., 1989 and 1994; Vaas et al., 1995).

The diagram below (Figure 5) helps to understand how to identify control problems in relation to the control cycle (Vaas, 1995; see also Oeij et al., 2017).



Vaas et al., 1995: 12, 16.

Figure 5: The control cycle, its tasks and domains

The control cycle is a systems element that contains inputs, throughputs and outputs. The inputs must be processed by a task operator (i.e. the throughput) to achieve the output (e.g. a result like making a product). A distinction can be made between tasks at the level of production (prepare, execute, support) and the level of management (manage or 'solve a problem', 'create a solution')[4]. The domains in the process of a task are operations, material, means and resources, information

[3] A control problem is a disturbance in the work process that can be solved with control options (i.e. decision latitude, regulatory power, autonomy); a control problem can occur at the level of job tasks, for which the operator has or has not the control options to solve the disturbance (this is due to a choice in the job design).
[4] Compare single-, double- and triple-loop learning in the reflective practitioner model and the organisational learning model (Argyris and Schön, 1996; Oeij et al., 2017: pp. 5-6).

about the goal and the assignment (order), interactions with others, norms and feedback (on the result). Each of these domains can be a source or cause for a disturbance or control problem. To be able to deal effectively with control problems (and to learn from them), control options must be allocated to a task. If control options are not present to a sufficient extent, the result can not be achieved and unfavourable well-being conditions are indicators for that. We discuss seven of them, derived from the method of Well-being at work (WAW) (Pot et al., 1989 and 1994; Vaas et al., 1995).

1. The completeness of a job - A 'complete set of tasks' implies the presence of all the grey handling options (execute, prepare, support and manage). This means that the task allows the operator to solve disturbances (i.e. the result / output is not met qualitatively of quantitatively) with allocated control at both the level of the production structure and the management structure.
2. Non-short cycle time tasks – Short cycle time tasks indicate work that is repetitive and monotonous, and contains (physiological) risks. It lacks learning opportunities. Such tasks should be limited.
3. Level of (cognitive) difficulty – Within a job there should be tasks that enable learning opportunities. The combination of high task demands and high autonomy ensures a combination of learning new things and the presence of control to deal with that (e.g. solving a disturbance) without high-stress risks. A balanced mix of 'complex' tasks and 'routine' is desirable.
4. Autonomy – The tasks should allow for forms of autonomy in carrying out the task, with regard to pace, method, (order) sequence and (work) place.
5. Interaction network – The tasks should enable functional and social contacts with other persons and the job station should not be an isolated working environment.
6. Organising tasks - The tasks should allow organising functional contacts, peer review, etc. to arrange assistance and consultancy (by colleagues, staff, and management).
7. Information - There should be sufficient information and data available about goals, the assignment and feedback about the results.

If these well-being conditions are not met, and results cannot be achieved, this will also affect the achievement of human needs. MST is however less concerned with human job satisfaction, but with the absence of risks in tasks. The WAW method is a bridge between these two. Therefore, the SMART work design model can benefit from the sociotechnical design rules to identify risks in the design of the organisation and jobs in order to enhance the options to optimize human needs and job satisfaction.

5. Example of a job: Operator production line

To show the connection between the SMART work design model and sociotechnical design rules we present an example of a WAW-analysis of a concrete job, the operator on a production line (Oeij, 2023). This was part of a research into the health and safety risks of short cycle time labour. Based on an expert-assessment of the seven well-being conditions a 'well-being profile' can be generated (Table 5).

Table 5. Well-being profile of 'operator production line'

Assessment	Unsatisfactory	Limited satisfactory	Satisfactory
1.Job completeness			
2.Non-short cycle time tasks			
3.Cognitive difficulty			
4.Autonomy			

5.Interaction network			
6.Organising tasks			
7.Information			

Overall, the job profile of this operator does not look too bad, but can be improved by enhancing cognitive difficulty to improve learning opportunities. To prevent, reduce and preferably structurally eliminate the risks that lead to unsatisfactory scores the WAW method – based on sociotechnical design rules- suggests adaptation measures, improvement measures and restructure measures (i.e. redesign). Adaptation measures are mainly measures that solve the control problems, for example by clearer work instructions, provision of more or better resources and materials. Note that this is 'only' an adaptation: it reduces the stress risks, but it also reduces the opportunities to learn from solving the problem in case. Improvement measures are aimed at improving task composition and introducing control opportunities as (social) contacts without requiring production-organisational and/or production-technical measures (i.e. restructuring measure): task rotation, task expansion, task enrichment (as examples of improving the horizontal division of labour), work consultation (functional dialogue).
The machine operator in the studied plant rotates across various work stations on the production line. At these work stations the operator has to carry out preparatory tasks and quality controlling tasks. As a result, the job contains less short-cycle times as in the case of isolated work stations. This contributes to the job 'completeness'. Task enrichment here has little effect on cognitive difficulty (i.e. learning opportunities) or functional contacts because most tasks on the line are of an equally low cognitive level and the work stations are isolated (the operators do usually work there in pairs). A useful task enrichment in this job would be to have the machine operators (in rotation) make the daily schedule or introduce self-scheduling.
Introducing work meetings (functional consultation) for all operators on this production line would enable the machine operators to jointly address control issues in areas such as material supply or working conditions. A restructuring measure could be to make all operators on the production line function as a 'task group' or 'autonomous team'. Such a team is responsible for the daily planning and mutual distribution of work, does as much of the preparation, execution and support tasks in the work process as possible, establishes contacts with colleagues inside and outside the department independently when control problems arise, meets regularly for work consultations involving planning and logistics, product and process specifications, materials (i.e. what is processed by the machines), equipment, technology, working conditions, clean policy requirements, etc.
The formation of a task group /team requires a rearrangement of tasks and competences, i.e. a change in the production structure and in the management structure of the work organisation.

In Table 6 we connect the SMART factors with the WAW conditions and the MST design rules from a general perspective, not per se from the operator job that we just discussed. The point we want to make is that the results of a job analysis with the WAW method (as in Table 5) lead to insights into control problems. These problems can be combated by measurements based on MST design rules. And, finally, these design rules can be related to the five factors of the SMART work design model.

Table 6: Connecting SMART factors, the WAW criteria and conditions, and MST design rules

SMART factors	**WAW criteria and conditions**	**MST design rules**
Criterion: Fulfill Human needs	Criteria: 1.No stress risks 2.Provide opportunities for learning and development	General principles: First: design the production structure (top-down); Second: design the management structure (bottom-up); Third: design ICT, technical and other systems.
1.Stimulating work characteristics: Task variety, skill variety, problem-solving requirements, information processing	WAW conditions: 1.Job completeness 2.Reduction of short cyclic work 3.Level of cognitive difficulty	A. Design the production structure: 1. Create divisions along the line of product groups or client groups or regions 2. Parallelilise within the divisions independent product streams (parallelisation) 3. Provide for segmentation within the parallelilised streams. 4. Create autonomous teams within the segments (dependency within a segment (i.e. team) must be strong, between segments must be weak) 5. create jobs by combining executive tasks with the connected preparatory and supporting tasks (complete jobs). B. Design the management structure 1. Allocate as much decision latitude as possible to lowest levels in the organization (i.e. to teams or jobs). 2. Allocate remaining decision latitude to the next higher level 3. Continue to the top level. C. Design the information structure and system 1. To provide the workers and the teams at each level with information they need to do their job and respond to their clients and responsibilities. 2. Make general information about results, plans future technologies etc. available.
2.Mastery work characteristics: job feedback, feedback from others, role clarity	WAW conditions: 5. Interaction network (opportunities to have contact with colleagues and supervisors) 7. Information supply	In the design of the production structure isolated jobs must be avoided. Preferably the work should be done in teams where workers can support and help each other and share information. In the design of the management structure information supply contains clear information and data (e.g. on quantity and quality requirements) at job and team level (AI and ML are amendable).
3.Autonomous work characteristics	WAW conditions: 2.Reduction of short cyclic work 4.Autonomy in method, order, time and place	In the design of the management structure (bottom–up) add decision latitude on: time, method, order and place to the job. Create autonomous teams that can divide tasks among team members and can operate independently within the boundaries of the result criteria.

4.Relational work characteristics: task significance, beneficiary contact, social support	WAW conditions: 5.Interaction network (Contact opportunities) 6.Organising tasks	In the design of the production structure isolated jobs must be avoided. In the division of tasks on the shop floor there should be sufficient connection or overlap in tasks to enable help from direct colleagues (and avoiding too many nodal points).
5.Tolerable work characteristics: Low role overload; Low role conflict; Low work–home conflict	WAW conditions: 4. Autonomy 6. Organising tasks	In the design of jobs workers should be able to regulate the workload and eliminate ambiguous assignments .

6. Conclusions and recommendations

This paper investigated how the SMART work design model could be connected to sociotechnical systems design in order to improve the quality of work from two angles: the design of jobs from psychological human needs and from operational functional requirements of the organisational business goals. The conclusion is that this is possible, at least in theory. The SMART work design operationalised the human needs into five factors and into organisational conditions. The MST approach translated production requirements into tasks that meet well-being conditions, for which design rules were formulated.

Our contribution is in the first instance directed at supporting practitioners to develop organisations and jobs that simultaneously enhance good organisational performance and good quality of work. In doing so, the approach is in line with the concept of 'workplace innovation' (Oeij & Dhondt, 2017, p. 66; Parker & Boeing, 2023: 92). A next step is to translate our ideas into a concrete action plan with concrete steps. This is foreseen to be undertaken in the INSIGHT_EU research, once its proposal is granted.

A limitation of our contribution, therefore, is the lack of testing our approach empirically. That is to say, the elements about human needs have been researched extensively and the SMART work design model did stand its first tests (Parker & Knight, 2023). Concerning the MST design rules and the WAW method there is quite some qualitative research carried out in the Lowlands (the Netherlands and Flanders in Belgium) which supports the viewpoints, but a systematic, quantitative evaluation has not been performed. Nonetheless, there are numerous qualitative case descriptions available[5]. Moreover, there is serious concern that individual-level interventions (read psychological interventions) do not engage with working conditions (read organisational redesign), and that such interventions are not providing additional or appropriate resources in response to job demands (Fleming, 2023).

We would like to express the importance of collaboration in the field to further develop this approach, between different scientific disciplines (for the sake of science), and across different countries and industries (for the sake of practice). The future of work is one with more digitalisation, robotisation, artificial intelligence and machine learning. From Industry4.0 we learned that technological progress and its application and implementation tended to neglect the human factor too much. This has to change, according to the next policy initiative of Industry5.0, which intends to make humans more central (Breque et al., 2021; Oeij et al., 2023). "Industry 5.0 is characterised by going beyond producing goods and services for profit. It shifts the focus from the shareholder value to stakeholder value and reinforces the role and the contribution of industry to society. It places the wellbeing of the worker at the centre of the production process and uses new technologies to provide prosperity beyond jobs and growth while respecting the production limits of the planet" (European Commission, 2021).

[5] See for example the Knowledge Bank Workplace Innovation (https://www.workplaceinnovation.org/).

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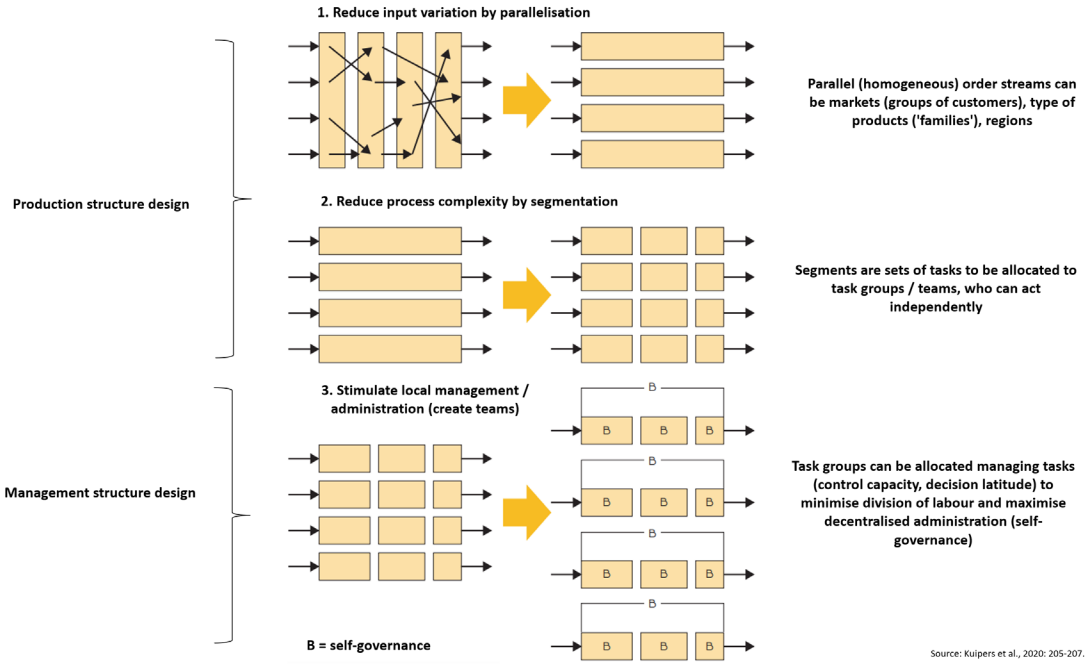
Annexe: Basic MST design rules



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Short bios of presenter(s) and/or author(s)

Presenter/Author: dr. Peter Oeij is senior researcher at TNO Innovation for Life (the Netherlands), and has been trained as work & organisational psychologist and work & organisational sociologist. His field of research is workplace innovation, quality of work, organisational design and Industry5.0. Contact: peter.oeij@tno.nl

Co-author: prof. Steven Dhondt is organisational sociologist and his field of research is new technology and work, workplace innovation and Industry5.0. He is affiliated as senior researcher at TNO Innovation for Life (the Netherlands) and professor at KU Leuven (Belgium).
Contact: steven.dhondt@tno.nl

Co-author: dr. Fietje Vaas is researcher at TNO Innovation for Life (the Netherlands), and has been trained as work & organisational psychologist. She was involved in the development of the WAW method in the late eighties and the beginning of the nineties and is now manager of the knowledge bank on workplace innovation: www.workplaceorganisation.org.
Contact: fietje.vaas@tno.nl

Paper to be found on ResearchGate (https://www.researchgate.net/profile/Peter-Oeij)
Powerpoint presentation to be found on Slideshare (https://www.slideshare.net/PeterOeij)