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Steven Alter
University of San Francisco, alter@usfca.edu

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Facets of Work: Enriching the Description, Analysis, Design, and Evaluation of Systems in Organizations

Steven Alter

University of San Francisco
alter@usfca.edu

Abstract:

This conceptual contribution introduces the idea of "facets of work" and explains how it can be applied to challenges in today's IS discipline. The notion of facets of work emerged from earlier attempts to bring more knowledge and richer, more evocative ideas to systems analysis and design (SA&D). Focusing on facets of work when initially discussing requirements could provide guidance without jumping prematurely to details, precision, and formal notation needed for producing testable software. This paper defines facet of work, identifies underlying assumptions and criteria, and uses three examples to illustrate how 18 facets of work can illuminate different aspects of situations that are amenable to discussion as systems. Potential applications of facets of work include supporting SA&D, supporting empirical research, visualizing multiple aspects of digitalization, and identifying some of the knowledge in a body of knowledge for IS. Six lengthy tables in the Appendix identify concepts associated with each facet, evaluation criteria, design trade-offs, sub-facets, and other details that are potentially useful as the basis of tools, methods, and future research.

Keywords: Facet, Facets of Work, Systems Analysis and Design, Work System, Artificial Intelligence, IS Body of Knowledge.

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1 Broadening a Narrow Spectrum of Essentially Mechanical Ideas

Typical systems analysis and design (SA&D) textbooks, coursework, and real-world SA&D practice ignore extensive effort and numerous research publications devoted to facets of work such as making decisions, communicating, controlling execution, coordinating, and creating value. Formal SA&D methods rarely if ever mention those topics despite their relevance and importance in describing and analyzing systems, creating requirements, and sanity checking whether proposed system specifications seem likely to address real-world problems effectively.

Highlighting facets of work is an approach for enriching the description, analysis, design, and evaluation of systems in organizations. The idea of facets of work moves beyond the pervasive and rather mechanical metaphor of documenting bounded sets of interrelated steps in processes. It focuses on a broad spectrum of topics and concerns that are recognized widely but often are downplayed or ignored inadvertently in projects that develop software based on an inadequate understanding of the contexts in which the software will be used.

The idea of facets of work organizes many paths for accessing knowledge from research and practical experience. Convenient and well-organized access to relevant chunks of knowledge might help in creating, evaluating, and improving information systems and other systems in organizations. It also might help researchers describe and analyze organizational routines, IT-enabled systems, AI and machine learning applications (that may address different facets of work), and other processes and activities in real-world settings. That knowledge largely comes from research and experience related to widely studied topics such as decision making, communicating, coordinating, controlling execution, improvising, and so on. Each of these topics can be viewed as a focal point for describing and understanding an important aspect of how work is performed, how well it is performed, and why obstacles occur that reduce efficiency and effectiveness. Discrete chunks of knowledge related to facets of work could be built into comparatively simple tools and methods that could facilitate access to that knowledge, thereby encouraging a richer perspective on work activities that covers much more than typical process-oriented documentation of steps triggered by other steps or by specific conditions.

1.1 Background

The desirability of incorporating something like facets of work into SA&D became apparent during two decades of teaching introductory IS courses, mostly for employed MBA and executive MBA students (and after customer interactions years earlier in a start-up software firm). One of the main student deliverables for most of those courses was a management briefing suggesting how to improve a problematic IT-enabled system in an organization that employed a member of a small student team or a student who worked individually. That assignment used various versions of a work system analysis template that evolved through ongoing efforts to improve on previous versions. The template seemed to work well in focusing MBA and EMBA students' attention on the business issue of improving work systems rather than on IT per se. Most students seemed to find the exercise beneficial, and most of the management briefings seemed satisfactory relative to the limited amount of time that was available during the courses. Eventually, students produced over 700 management briefings, mostly in the United States, (e.g., Truex, Alter, & Long, 2010; Truex, Lakew, Alter, & Sarkar, 2011) but also in China, Germany, India, and Vietnam.

Those assignments generally met their main educational goals, but many recommendations seemed mundane (e.g., collect currently uncollected data or train work system participants who have not received adequate training). Based on that observation, I began to wonder whether an appropriately packaged set of system-related metaphors might help early career business professionals produce more interesting or insightful recommendations. Several attempts to pursue that idea (see Appendix A) ran into roadblocks due to inadequate framing of the problem. Recent research (also mentioned in Appendix A) led to insights that eventually generated the idea of facets of work as the core of an approach for stimulating richer views of IT-enabled systems in organizations.

1.2 Goal and Organization

This paper is a conceptual contribution that explains the idea of facets of work and shows how it might be useful. I developed the idea as an extension to work system theory (WST) (Alter, 2013b), but it can be used totally independent of WST (e.g., in agile development, in describing AI applications, and in other settings). Accordingly, Appendix A mentions WST briefly to establish part of the research context but the body of the paper does not rely on WST to explain the idea.

This paper proceeds in an unusual way because:

- The idea of "facets of work" is suggestive but certainly is not part of the typical IS lexicon. Furthermore, it is distant from the way most the IS community members think and teach about SA&D and is not linked directly to the variables that researchers typically include in research that trying to explain causes of frequent difficulties in system development.
- Efforts to develop the idea addressed an aspect of SA&D that researchers and practitioners rarely view as a major problem. Rather, I pursued it based on a personal belief about possible benefits of searching for a new approach to helping people visualize systems.
- Preliminary literature reviews at several points found extensive sources related to specific facets of work (such as making decisions and communicating) but almost nothing specifically about the idea of facets of work.
- I developed the idea as an extension of WST, but it can be used effectively without reference to WST. That left a quandary about how to explain the idea without lengthy detours devoted to explaining WST and false starts and changes in direction that are best understood in relation to WST.

Despite those issues, the idea of facets of work is potentially valuable in many ways that this paper discusses. For example, aside from its potential use in helping people visualize systems in organizations, it can be used to visualize important aspects of the increasingly visible topic of division of labor between people and automated entities that might be viewed as algorithms, software agents, or even robots.

This paper proceeds as follows: Section 2 defines facets of work and identifies underlying assumptions and criteria for identifying a type of activity as a facet of work. It summarizes how 18 facets of work were identified through an iterative process. Other researchers trying to identify facets of work likely would have identified some of those facets but might have been satisfied with three facets or 15 or 23. Thus, future research might improve on the 18 facets. Section 3 amplifies the abstract presentation of facets of work in Section 2 by presenting three examples that illustrate how all 18 facets could be applied to specific situations. The first two are hypothetical examples that illustrate how facets of work might be useful for describing and analyzing the division of labor between people and automated entities. The third is a published real-world example that illustrates the broad relevance of the 18 facets. Section 4 discusses consolidating basic knowledge about facets of work and organizing that knowledge to make it more accessible. Section 5 identifies possible applications of facets of work in tools and lightweight SA&D methods. Section 6 identifies next steps in this research.

The Appendix is divided into two parts. Appendix A explains how the idea of facets of work is an extension of WST that was developed through disconnected efforts that occurred years apart. It also mentions other uses of the term facet that appear in research in other disciplines. Presenting that background information after the main body of the paper reflects concerns that the paper's main purpose might be diffused by a discussion of the disjointed steps that developed the idea of facets of work. Appendix B presents six lengthy tables that each cover one aspect or another of the 18 facets. These tables appear in the Appendix because including tables in the main body would make the narrative choppy and difficult to follow. These tables have practical importance, however, because they form the basis of the tools, methods, and future research mentioned in Sections 5 and 6.

2 Facets of Work

The term *facet* is often defined as one side of something with many sides. By analogy, a facet of work refers to one side of a work activity that has many sides. A facet of work is a generic aspect of work that applies in many, but not necessarily all, work systems in organizational settings. In that context, work consists of activities performed to produce product/services for internal and/or external customers by using human, informational, physical, and other resources.

The idea of *facets of work* is almost totally absent from the literature even though individual facets such as making decisions, communicating, and coordinating are mentioned frequently. A Google Scholar search for "facets of work" on 19 January, 2021, returned only 3,790 hits, almost all of which concerned other topics such as facets of work value, facets of work-life balance, facets of work autonomy, facets of work support, and facets of work-method ambiguity.

Table 1 identifies 18 common facets of work that can be used to discuss and explore activities, processes, operational systems, and business ecosystems at various levels of depth. Each facet brings related concepts and other knowledge even though some facets overlap to some extent. Basic understanding of how the facets apply to specific situations does not rely on rigorous diagramming tools that belong in subsequent analysis, design, and problem solving. The 18 facets of work in Table 1 are discussed throughout this paper with much more detail in tables in the Appendix.

Table 1. 18 Facets of Work

Making decisions	Representing reality	Learning	Coordinating	Performing physical work	Providing service
Communicating	Applying knowledge	Planning	Improvising	Performing support work	Creating value
Providing information	Thinking	Controlling execution	Processing information	Interacting socially	Maintaining security

The following assumptions clarify the purpose and scope of the idea of *facets of work*:

- **Focus on activity**: Each facet of work is identified using a verb or verb phrase since work in business settings always involves activities that are expressed using verbs.
- **Broad applicability**: The various facets of work can be applied to thinking about specific real-world activities, capabilities, processes, operational systems, and business ecosystems. They can be used in survey research and for coding situations in case study research. They also can be applied in discussions about digital transformation, digitalization, and other phenomena that have little practical meaning unless work is performed.
- **Multiplicity of facets:** Work can be visualized as having many facets. For example, work related to hiring new employees in a specific situation includes activities that may involve many facets that appear in Table 1. People initiating analysis of that situation can explore questions about facets of the relevant work without needing to document operational details, performance levels, or other information that deeper analysis would require.
- **Generic concept**: The concept of facet of work is generic (i.e., the same facets and related ideas can apply to many different situations). The 18 facets in Table 1 apply to work in many situations even though a given facet may not apply significantly to work in some specific situations.
- **Inclusion criteria for facets**: The 18 facets were chosen because they are easily understood, widely applicable, and associated with concepts and other knowledge related to business situations. Table B1 in Appendix B summarizes the frequent importance of each facet.
- **Independence not required**: The facets need not be totally independent. Facets of work may overlap as when making decisions (one of the facets) in a situation involves processing information and communicating (two other facets). People describing, analyzing, or designing systems will not be sidetracked if some concepts related to decision making (e.g., speed, cost, and accuracy) also pertain to other facets. The key issue concerns whether each facet brings important concepts and other knowledge that should be readily accessible for use.
- **Applicability to sociotechnical and totally automated systems**: Almost all facets apply equally to sociotechnical work that people perform and totally automated work that machines perform (see Table B2 in Appendix B). The main exception concerns the facet *interacting socially*, and even that one might be used in some way for modeling a totally automated work system or an ecosystem consisting of automated entities that interact in a quasi-social manner in the future.
- **Facet-related concepts and knowledge:** Each facet is associated with concepts and other knowledge that is associated more directly with that facet than with other facets (see Table B3).
- **Evaluation criteria and design tradeoffs**: Most facets bring or imply widely recognized evaluation criteria and design tradeoffs (see Table B4).
- **Subfacets**: Many facets have broadly applicable subfacets. For example, subfacets of information processing include capturing, transmitting, storing, deleting, retrieving, manipulating, and displaying information (see Table B5).

- **Open-ended questions**: Most facets suggest questions that can be used in initial stages of describing or analyzing activities, capabilities, processes, operational systems, and ecosystems (see Table B6).

2.1 Selection of the 18 Facets

The 18 facets were selected in a largely informal manner starting with some related ideas from earlier research described in Appendix A. An initial small set of facets was expanded iteratively by considering whether personally familiar IS papers and real-world situations might suggest possible facets of work that were not yet included in the evolving list of facets. An aspect of activities in business organizations might be included tentatively in the evolving list of facets if it satisfied four criteria: 1) it is easily understood, 2) it is widely applicable, 3) it is identifiable using a verb phrase (since it is an aspect of an activity), and 4) it is associated with a set of concepts and other knowledge that is more related to that facet than to other facets. Some ideas initially on the list were replaced by synonyms or near synonyms that met the four criteria more fully. The facets idea was discussed at conferences and workshops in 2019 and 2020 and benefitted from comments from conference submission reviewers and conference attendees. It was applied to varying degrees in five papers accepted for presentation at international conferences or workshops (Alter, 2019, 2020a, 2020b, 2020d, 2021a) and was applied subsequently in Alter (2021b).

An improved set of facets might be generated through additional exposure, discussion, and application of the current version or of an updated version of the facets. Deriving a formally justified set of facets in the future might be worthwhile if initial applications of the facets of work prove useful in practice or in future research.

3 Examples Illustrating the Relevance of Facets of Work

This section provides three examples that illustrate how all 18 facets could be applied to specific situations, thereby amplifying the initial understanding of facets of work from Section 2. The first is a hypothetical example used in a conference paper (Alter, 2020b) to help explain the division of labor between people and robots in Industry 5.0. That use of the idea of facets of work sprang from curiosity about what the term Industry 5.0 might mean since it appeared in the name of a conference mini-track but was not defined carefully in the mini-track description. The hypothetical example presented here could be converted into facet-based descriptions of realistic examples related to situations that call for a combination of competence, collaboration, and improvisation (e.g., high-level management processes, crisis response, operation of distributed teams, physical processes that require coordinated effort between people and machines, etc.). The second example is a hypothetical hiring system that includes several AI-based modules provided by a vendor. Alter (2020d, 2021b) use this example to illustrate how to visualize an AI application in the context of a work system without being diverted by AI-related hype and punditry. Later that article shows how many of the 18 facets of work were relevant to five real world examples presented at a local AI conference. The third example illustrates how all 18 facets were applicable to a real-world case study (Gawande, 2018) related to significant issues encountered in using a major electronic medical records system.

3.1 Example: Tennis Lessons from an Imagined Robotic Tennis Instructor

The artificial example of tennis lessons from an imagined robotic tennis instructor was developed for a conference mini-track concerning sociotechnical aspects of Industry 5.0. The content of Figure 1 was produced for a 12-minute remote presentation constrained by the conference's very limited remote format. Explaining the paper and the facets of work in just 12 minutes required an example that described the 18 facets quickly. The 18 slides consolidated into Figure 1 look cartoonish but nonetheless provide a simple way to show that all 18 facets potentially pertain to situations that involve collaboration between people and robots. The example illustrates why a deep look at sociotechnical aspects of almost any Industry 5.0 situation involving collaboration between people and robots would require consideration of many of those facets of work.

Notice that the 18 facets reveal many issues that analysts would ignore or downplay if they relied heavily on typical SA&D tools such as BPMN and entity-relationship diagrams to model the situation. Those tools are best suited to focus on mechanical process steps, such as creating an availability schedule, enrolling students, taking payment, scheduling lessons, recording student progress, and updating a robot's program. BPMN models of those steps would reveal little about important sociotechnical issues related to the person-robot collaboration required in the lessons themselves.

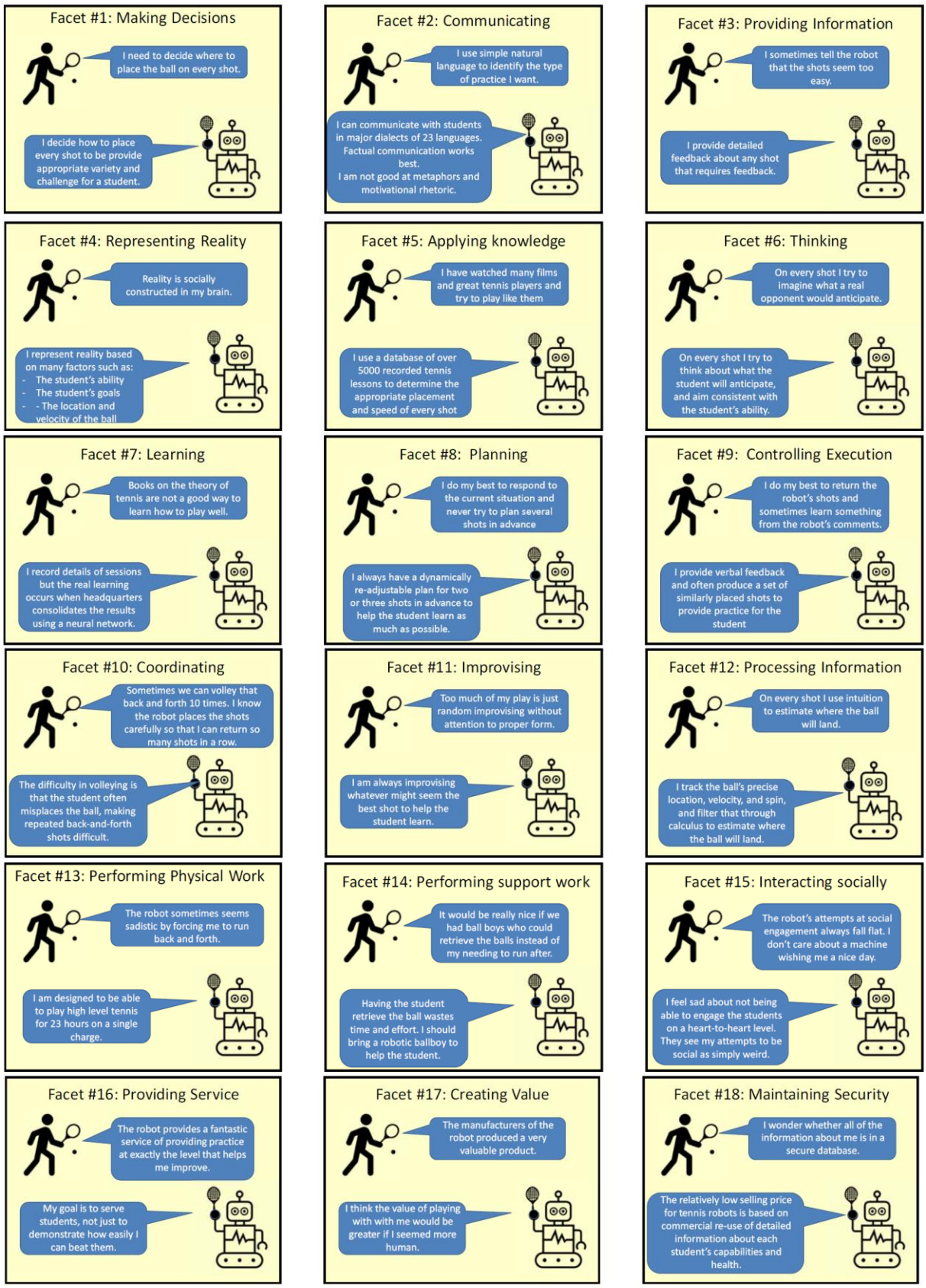

Figure 1. Hypothetical Robotic Tennis Lesson that Illustrates the 18 Facets of Work

3.2 A Hypothetical Hiring System that Uses AI

Table 2 is a formatted summary of a hypothetical hiring system that Alter (2021b) used as an introductory example to illustrate a way to think about AI's role in an operational work system. That example and that paper's other introductory material provided background for comparing five real-world examples presented at an AI conference. For current purposes, this example illustrates a potential way to use facets of work to identify important issues related to a work system that is to be improved.

In this example, PQR Corp implemented a new hiring work system two years ago to improve a previous hiring work system that absorbed too much internal effort and operated so slowly that good candidates sometimes went to other companies before receiving offers. Also, it hired too many candidates who proved unsuitable and left before becoming productive. The new hiring work system used AlgoComm and AlgoRank from a suite of AI-based software tools that AlgoCorp provided. AlgoComm provided capabilities for posting job ads, receiving applications, setting up interview appointments, and performing other communication with candidates. AlgoRank ranked candidates based on job criteria and a neural network application driven by AlgoCorp's extensive database of job qualifications, salaries, and other information. Managers analyzed the situation because some of the original issues persisted and new issues arose.

Table 2. Hypothetical Hiring System that Uses AI

<table>
<tr><th colspan="2">Customers</th><th colspan="2">Product/services</th></tr>
<tr><td colspan="2">• Applicants
• Hiring manager
• Larger organization
• HR manager (who will use the applications to analyze the nature of applicants)</td><td colspan="2">• Applications (which may be used for subsequent analysis)
• Job offers
• Rejection letters
• Hiring of the applicant</td></tr>
<tr><th colspan="4">Major activities and processes</th></tr>
<tr><td colspan="2">• AlgoComm publicizes the position.
• Applicants submit resumes to AlgoComm.
• AlgoRank selects shortlisted applicants and sends the list to the hiring manager.
• Hiring manager decides who to interview.
• AlgoComm sets up interviews.</td><td colspan="2">• Interviewers perform interviews and provide comments about applicants.
• AlgoRank evaluates candidates.
• Hiring manager makes hiring decision.
• AlgoComm notifies applicants.
• Applicant accepts or rejects job offer.</td></tr>
<tr><th>Participants</th><th colspan="2">Information</th><th>Technologies</th></tr>
<tr><td>• Hiring manager
• Applicants
• Other employees who perform interviews</td><td colspan="2">• Job requisition
• Job description
• Advertisements
• Job applications
• Cover letters
• Applicant resumes
• Applicant short list
• Information and impressions from the interviews
• Job offers
• Rejection letters</td><td>• AlgoComm
• AlgoRank
• Office software
• Internet</td></tr>
</table>

Table 2 summarizes the type of information that typically would be compiled and discussed to make sure stakeholders agreed about the nature and scope of the system and the issues that they needed to analyze in more depth (e.g., concerns about different aspects of work system performance, structure, compliance and non-compliance, key incidents, perceptions of IS user satisfaction, etc.). Looking at the facets of work in this situation would help them understand the situation in more depth. Table 3 shows some of the questions that might have been studied. Notice that such questions might not have been pursued without attention to the facets of work.

Table 3. Issues Related to AI that Might be Pursued Concerning the Hiring System in Table 2

Facet	Issues related to potential use of AI in the hiring system
Making decisions	How could AI support decisions more fully in this system? Should AI suggest decisions or make decisions?
Communicating	How could AI explain how it makes or suggests decisions? How can AI help work system participants communicate more effectively?
Providing information	Could AI provide more meaningful information to work system participants than would otherwise be available?
Representing reality	Does AI represent reality in a biased way? For example, what about possible bias or omissions in the dataset used to train a neural network?
Applying knowledge	Could AI identify and provide specific knowledge that would help in evaluating applicants?
Thinking	Could AI beneficially replace or augment thinking that work system participants perform in any area?
Learning	Could AI learn from the success or problems with previous hires in order to support better hiring decisions in the future?
Planning	Could AI help in planning hiring schedules and interview schedules in ways that minimize interference with interviewers' ongoing work?
Controlling execution	Could AI help in controlling interview processes to assure that the strongest candidates receive priority in screening processes?
Coordinating	How could AI support better coordination between interviewers and between applicants and interviewers in terms of convenience?
Improvising	How could AI support any necessary improvising, such as identifying appropriate workarounds when standard processes prove cumbersome?
Processing information	Can AI play any special role in capturing, transmitting, storing, retrieving, deleting, manipulating, or displaying information?
Performing physical work	Using AI to assess physical work would be relevant mainly if job responsibilities involved physical work that could be sampled and evaluated.
Performing support work	How could AI perform support work that might help interviews proceed more efficiently and with fewer interruptions?
Interacting socially	Could AI do more to support social interactions during interviews and evaluation processes?
Providing service	How could AI make the entire hiring experience seem like more of a service to applicants (thereby swaying them in the firm's favor)?
Creating value	How could AI help both applicants and interviewers feel that they receive more value for their efforts across the hiring process?
Maintaining security	How could AI help in maintaining information security for applicants, interviewers, and the firm as a whole?

3.3 Using Facets of Work to Illuminate Important Aspects of a Case Study

One way to test the practical value of facets of work involves examining whether the 18 facets of work appear in non-trivial ways in real-world situations. This section uses a case study called "The Update: Why Doctors Hate Their Computers" (Gawande, 2018) to demonstrate the practical relevance of the 18 facets. In the case study, a surgeon describes his experience related to the $1.6 billion implementation of the EPIC electronic medical records (EMR) system in Partners HealthCare, which has 70,000 employees, 12 hospitals, and hundreds of clinics in New England, USA. Under $100 million was for software, while the rest was for "lost patient revenues and all the tech-support personnel and other people needed during the implementation phase" (Gawande, 2018, p. 62). Gawande's account recognizes the value of the EMR system, but, as implied by its title, does not support aspirational views of EMR as providing complete and accurate patient information, eliminating vulnerabilities of paper, facilitating communication, assuring consistency, and improving evaluation of medical treatments. Instead, he says:

> *Doctors are among the most technology avid people in society; computerization has simplified tasks in many industries. Yet somehow we've reached a point where people in the medical profession actively, viscerally, volubly hate their computers.* (p. 62)

Table 4 uses quotations from the case to illustrate that the surgeon who wrote the case study for a non-specialist audience mentioned all 18 facets either directly or indirectly. The apparent goal was to describe what he saw as the essence of an important real-world situation that mattered greatly to him and his colleagues and that well-informed citizens should know about. He had no prior knowledge of the idea of facets of work, which had not been proposed at the time he wrote the case study.

The use of the 18 facets to organize quotations in Table 4 supports the belief that the facets of work are topics that matter in practice. Some quotations could be moved to other categories, but it is noteworthy that every facet was present at least to some degree. The facets with the least direct quotations in Table 4 include planning (represented by mentioning a treatment plan) and performing physical work (implicit in the fact that the author talks about being a surgeon and, therefore, spending little time entering data into the EMR system). The significance of finding quotations related to all 18 facets should not be exaggerated, but notice how typical SA&D approaches easily could have missed many issues that a tech-savvy surgeon viewed as important for understanding realities that resulted from his organization implementing an EMR system. Discussion of the various facets of work might have helped in anticipating and addressing some problems that led the surgeon to write a paper with the subtitle "why doctors hate their computers".

Table 4. Quotations Related to Facets of Work from an EMR Case Study (Gawande, 2018)

Facet	Quotation from the case study
Making decisions	"Perhaps a computer could have alerted me to the possibility of a genetic disorder in [a patient], based on his history of skin lesions and the finding of high calcium." (p. 73)
Communicating	"[Her] in basket…[had become]… clogged to the point of dysfunction. There are messages from patients, messages containing lab and radiology results, messages from colleagues, messages from administrators, automated messages about not responding to previous messages. 'All the letters that come from the subspecialists, I can't read ninety per cent of them. So I glance at the patient's name, and, if it's someone that I was worried about, I'll read that,' she said. The rest she deletes, unread." (p. 66)
Providing information	"From my computer, I could now remotely check the vital signs of my patients recovering from surgery in the hospital. With two clicks, I could look up patient results from outside institutions that use Epic, as many now do." (p. 64)
Representing reality	"[A doctor] manages a large number of addiction patients, and has learned how to use a list to track how they are doing as a group, something she could never have done on her own. [The EMR supports new ways to] identify patients who have been on opioids for more than three months in order to provide outreach and reduce the risk of overdose." (p. 66)
Applying knowledge	"Doctors' handwritten notes were brief and to the point. With computers, however, the shortcut is to paste in whole blocks of information—an entire two-page imaging report, say—rather than selecting the relevant details. The next doctor must hunt through several pages to find what really matters. Multiply that by twenty-some patients a day, and you can see [her] problem." (p. 65)
Thinking	"Our systems are forever generating alerts about possible connections—to the point of signal fatigue. Just ordering medications and lab tests triggers dozens of alerts each day, most of them irrelevant, and all in need of human reviewing and sorting. There are more surprises, not fewer. The volume of knowledge and capability increases faster than any individual can manage—and faster than our technologies can make manageable for us. We ultimately need systems that make the right care simpler for both patients and professionals, not more complicated." (p. 73)
Learning	"There was a column of thirteen tabs on the left side of my screen, crowded with nearly identical terms: "chart review", "results review", "review flowsheet". We hadn't even started learning how to enter information, and the fields revealed by each tab came with their own tools and nuances." (p. 62)
Planning	"Cameron's situation was too complicated for a thirty-minute slot. We'd gone way over time. Other patients were waiting. Plus, I still had to type up all my findings, along with our treatment plan."
Controlling execution	"The chief clinical officer supervised the software upgrade and remained focused on long-term concerns such as maintaining control and quality. He was happy to have change control processes and execution controls that would help the hospitals avoid unsafe medical practices that could not be found in the paper-based world, such as nonstandard treatments of congestive heart failure." (p. 68)

Table 4. Quotations Related to Facets of Work from an EMR Case Study (Gawande, 2018)

Coordinating	"Each patient has a 'problem list' with his or her active medical issues, such as difficult-to-control diabetes, early signs of dementia, a chronic heart-valve problem. The list is intended to tell clinicians at a glance what they have to consider when seeing a patient. [A physician] used to keep the list carefully updated—deleting problems that were no longer relevant, adding details about ones that were. But now everyone across the organization can modify the list, and, she said, 'it has become utterly useless'. Three people will list the same diagnosis three different ways. Or an orthopedist will list the same generic symptom for every patient ('pain in leg'), which is sufficient for billing purposes but not useful to colleagues who need to know the specific diagnosis." (p. 64)
Improvising	"[As a result of change controls] Artisanship has been throttled, and so has our professional capacity to identify and solve problems through ground-level experimentation." (p. 68)
Processing information	"'Ordering a mammogram used to be one click,' she said. 'Now I spend three extra clicks to put in a diagnosis. When I do a Pap smear, I have eleven clicks. It's 'Oh, who did it?' Why not, by default, think that *I* did it?' She was almost shouting now. 'I'm the one putting the order in. Why is it asking me what date, if the patient is in the office today? When do you think this actually happened? It is incredible!'" (p. 65)
Performing physical work	"As a surgeon, though, I spend most of my clinical time in the operating room. I wondered how my more office-bound colleagues were faring." (p. 64) [Thus, the surgeon performed the physical work of surgery but he did not discuss issues related to that work in the case.]
Performing support work	"A longtime office assistant…said that each new software system reduced her role and shifted more of her responsibilities onto the doctors. Previously, she sorted the patient records before clinic, drafted letters to patients, prepped routine prescriptions— all tasks that lightened the doctors' load. None of this was possible anymore. The doctors had to do it all themselves. …She couldn't even help the doctors navigate and streamline their computer systems: office assistants have different screens and are not trained or authorized to use the ones doctors have. …[She] felt sad and sometimes bitter about this pattern of change: 'It's disempowering. It's sort of like they want any cookie-cutter person to be able to walk in the door, plop down in a seat, and just do the job exactly as it is laid out.'" (p. 66)
Interacting socially	"I began to see the insidious ways that the software changed how people work together. They'd become more disconnected; less likely to see and help one another, and often less able to." (p. 66)
Providing service	"A 2016 study found that physicians spent about two hours doing computer work for every hour spent face to face with a patient—whatever the brand of medical software. In the examination room, physicians devoted half of their patient time facing the screen to do electronic tasks." (p. 62)
Creating value	[According to the chief clinical officer] "'We think of this as a system for *us* and it's not,' he said. 'It is for *the patients*. While some sixty thousand staff members use the system, almost ten times as many patients log into it to look up their lab results, remind themselves of the medications they are supposed to take, read the office notes that their doctor wrote in order to better understand what they've been told.'" (p. 66)
Maintaining security	See the quotation on performing support work. The restrictions on accessing information partly concern maintaining security.

4 Consolidating Basic Knowledge about Facets of Work

The three examples in the previous section illustrate different aspects of the potential usefulness of facets of work. The relatively familiar and easily understood nature of the direct quotations in the EMR case study (see Table 4) makes it seem likely that many facets will be relevant in discussions or descriptions of many systems in business and organizational settings. The nature of the list of issues (see Table 3) related to facets of work in the hypothetical hiring system makes it seem plausible that similar issues related to facets of work might apply to many AI applications and to many other ICT applications as well. Applying the facets of work to the hypothetical example about robotic tennis lessons shows that attention to facets of work might be useful in looking at collaboration between people and automated entities, an increasingly important topic as important responsibilities are increasingly assigned to automated entities. More broadly, the example shows how the facets of work can be used for visualizing aspects of many situations that call for some form of organized analysis even though they do not contain highly structured processes.

Consolidating basic knowledge about facets of work represents a step toward developing new tools and methods for describing and analyzing systems in business and organizational settings. To demonstrate that idea, entries in Table 5 illustrate some basic knowledge about the facet *making decisions*.

The entries in Table 5 are illustrative and could be improved and expanded in many ways. The first entry summarizes why the facet *making decisions* has broad significance. The second entry shows that the facet *making decisions* applies to both sociotechnical systems, some of whose human participants use technologies, and totally automated systems that operate autonomously after being triggered by people, by automated entities, by conditions, or by other factors. The third entry identifies a selection of concepts that are associated with making decisions. Many other concepts could have been included. The next two entries identify common evaluation criteria and tradeoffs associated with making decisions. The sixth entry identifies subfacets of making decisions (e.g., typical generic steps in decision processes). The seventh entry identifies typical open-ended questions that might be useful in starting a discussion about how and how well decisions are made in a particular situation.

Table 5. Issues and Ideas Associated with Making Decisions (One of 18 Facets of Processes and Activities)

Significance of the facet making decisions	Treating decisions simply as steps in a process is often inadequate if issues and opportunities related to the rationale or quality of decisions are important	
Relevance to sociotechnical and automated systems	**Sociotechnical**: People use information that supports a decision process. **Example**: Marketing manager decides on allocation of advertising budget	**Automated**: Computer uses software algorithms to make decisions automatically. **Example**: A marketing model calculates automatic allocation of advertising budget
Associated concepts	Decision, criteria, alternative, value, risk, payoff, utility, utility function, tradeoff, projection, optimum, satisficing vs. optimizing, heuristic, probability, distribution of results, risk aversion	
Evaluation criteria	Actual decision outcomes, realism of projected decision outcomes, riskiness, decision participation, concurrence, ease of implementation	
Design tradeoffs	Quick responsiveness vs. superficiality, complexity and precision of models vs. understandability, brevity vs. omission of important details	
Subfacets	Defining the problem; identifying decision criteria; gathering relevant information; analyzing the information; defining alternatives; selecting among alternatives; explaining the decision	
Open-ended questions for discussion	**Open-ended question**: How do the available methods and information help in making important decisions? **Follow-on questions**: What decisions are made with incomplete, inaccurate, or outdated methods or information? How might better methods or information help in making decisions? Where would that information come from?	

The six tables in Appendix B consolidate the same types of knowledge related to each of the 18 facets of work. Section 1 notes that those lengthy tables appear in Appendix B because including them in the body of the paper would make the narrative choppy and difficult to follow. Readers who look at those tables will recognize many common concepts, evaluation criteria, and tradeoffs. They probably will be able to suggest additional ideas as well. Thus, the content of those tables is not meant to be definitive or exhaustive. Rather, the examples in the tables demonstrate the possibility of compiling valuable knowledge that people could use when they try to analyze systems just as compilations of medical knowledge and legal knowledge sometimes are useful for physicians and lawyers and just as checklists are useful in many situations involving established procedures or knowledge (e.g., Gawande, 2010).

5 Potential Applications of Facets of Work

The facets of work are associated with concepts and other types of knowledge that are typically viewed as peripheral to SA&D, to systems in general, and to speculative discussions about digital transformation, digital innovation, and digitalization. This section identifies some among the many areas in which the facets of work might prove useful to practitioners and researchers.

5.1 Supporting Efforts to Analyze and Design Activities, Processes, Operational Systems, and Business Ecosystems

SA&D starts with requirements determination but often is associated with a process of creating rigorously documented specifications of software/hardware used by people or embedded in objects. Emphasis on rigorous documentation increases the likelihood of creating high-quality software but may lead to ignoring

business, social, and conceptual issues that pertain to analyzing and designing systems for efficiency and effectiveness.

The facets of work provide an organized and straightforward way to identify issues that might otherwise be missed when focusing mostly on process specifications and technical requirements. The facet-related concepts, evaluation criteria, design tradeoffs, and subfacets (see Table 5 and the tables in Appendix B) all provide ways to guide discussions without requiring deep theoretical knowledge related to each facet. Facet-specific questions (again see Table 5 and Appendix B) provide a path for going deeper. Aspects of those topics surely are discussed in many SA&D efforts even if they are not traversed in a systematic manner in most widely discussed SA&D approaches. Pre-specified templates or interactive tools related to theoretical concepts, generalizations, and other knowledge for each topic might go much deeper.

The tables in Appendix B illustrate only a subset of the content that could go into online tools or other approaches to provide stakeholders with flexible access to useful knowledge that might support their deliberations. Thus, while parts of the tables might be used directly, the facets of work could be a basis for organizing and providing both non-abstract knowledge such as examples, stories, and statistical data and abstract knowledge such as design principles, frameworks, models, and theories related to specific facets (Alter, 2021a).

Regardless of whether that type of ambition is ever realized, here is a simple, lightweight approach that allows an individual or group to use these ideas. That can be done with the help of a Web-based tool, a PowerPoint presentation, or simple checklists in the general spirit of those used in medical exams or in other procedures where it is important not to overlook important topics:

- Select one or several facets that seem relevant to the situation.
- For each facet:
  - Briefly consider open-ended questions such as the ones in Table B6.
  - If desired, support the deliberations by finding ideas about that facet in checklists, online tools, or other representations of the content in Tables B3 (associated concepts), B4 (evaluation criteria and tradeoffs), and/or B5 (subfacets)
  - Discuss, take notes, or obtain relevant information.
- Repeat for other facets that might seem important in the situation at hand.

A practical feature of this approach is that it can be used independent of formal systems analysis or can be used in conjunction with existing SA&D methods by simply adding new questions about facets of work at whatever level would likely generate insights quickly. Non-experts in any given facet would apply the relevant knowledge less precisely and less deeply than experts, but making those topics visible would be better than ignoring them.

5.2 Supporting or Extending Approaches and Methods Related to Processes, Systems, and Ecosystems

5.2.1 Supporting Agile Development

Agile development is discussed a great deal without much agreement about exactly what it means beyond bearing some relation to parts of the Agile Manifesto (Beck et al., 2001). Ideas related to facets of work could contribute in several ways even though agile development typically does not start with detailed plans and documentation. Identifying and discussing relevant facets of work at the beginning of an agile project would help in maintaining coherence by keeping key issues visible during the project. Looking at facets of work could lead to identifying issues that might be overlooked by focusing too much on software backlogs and the progress of sprints in agile development.

5.2.2 Extending Business Process Management

As with agile development, different scholars have different ideas about what BPM means. Some scholars see it as a combination of six core elements (i.e., strategic alignment, governance, methods, information technology, people, and culture) (Rosemann & vom Brocke, 2015) and tend to focus on process-improvement methods (Bolsinger, Elsäßer, Helm, & Röglinger, 2015), BPM culture (vom Brocke & Sinnl, 2011), and related topics. Others focus more on extensions of workflow software, process models, and process automation, with an emphasis on abstractions, BPM languages, and computerized methods.

Facets of work could extend ideas in Alter and Recker (2017), who suggest expanding BPM's scope by superimposing ideas from WST and its extensions on top of 20 BPM research use cases described by van der Aalst (2013). BPM stakeholders who want to manage business processes should be interested in important issues related to facets of work rather than just details of process models and should find the facets of work potentially useful for visualizing issues related to existing or proposed processes. Researchers interested in extending the formal aspects of BPM might be interested in seeing whether and how the facets of work could extend some existing techniques and notations.

5.2.3 Extending Enterprise Modeling

Focusing on facets of work might help in achieving some enterprise modeling (EM) aspirations described by Sandkuhl et al. (2018), who propose making EM less reliant on modeling experts. Business stakeholders who engage in EM discussions probably could contribute to discussions about facets of work without great difficulty. As with BPM, it seems possible that relatively high-level discussion of facets of work would fit with existing EM practices. Notice how this approach differs from EM research streams that produce EM languages and rigorous modeling environments such as the multi-perspective enterprise modeling (MEMO) capability (Frank, 2014).

5.2.4 Analyzing Business Ecosystems

When considering business ecosystems from an enterprise viewpoint, key questions include what the enterprise contributes to an ecosystem and how that contribution might be improved or extended. Facets and subfacets of work provide a starting point for thinking about many issues without becoming overwhelmed with contributions and interests of multiple participants that play different ecosystem roles. Most of the facets of work apply directly: how will this enterprise participate in important decisions in the ecosystem? How will it communicate with ecosystem partners—mostly through messages in computerized transactions or through relationships and negotiation? Questions such as those lead directly to issues about which capabilities, processes, or systems are required and how the various facets of work will be handled.

5.3 Supporting Empirical Research

The idea of facets of work might be incorporated into empirical research about how requirements determination and SA&D are performed in practice. The facets provide the basis for simple checklists that could be used to analyze meeting notes, formal documentation, recordings of interviews, and other indications of what was or was not considered during the project. Analysis of that type of information would provide empirical evidence about whether systematic consideration of facets of work in IS development projects would likely lead to better business outcomes.

More broadly, the idea of facets of work could be used in case study research to identify topics that a formalized account of the situation does or does not address. For example, facets of work could be used to code statements or concerns of people interviewed. They also could be used as prompts through open ended questions such as the ones in Table B6.

5.4 Understanding Digital Transformations, Digital Innovations, and Digitalization

The increasing frequency of commentaries about the terms digital transformation, digital innovation, and digitalization has done little to establish agreement about exactly what they mean in practice (e.g., Demlehner & Laumer, 2019; Vial, 2019). Looking at those ideas through the lens of facets and subfacets of work could lead to new ways to understand what those terms mean in specific situations beyond just slogans for whatever currently seems new and exciting in the intersection between business and technology. Thinking in terms of facets of work could help in strategizing about digital transformations and digitalization because it could engage business stakeholders' imagination around important aspects of business operations instead of focusing on vague aspirations or emerging technologies that they may not understand or appreciate fully. Even if inspired by abstractions or cherry-picked examples about potential of AI, big data, Internet of things, mobility, cloud computing, and/or social media, the discussion would try to identify and consider key issues related to specific facets of work in the current situation that might be addressed through an IT-based intervention. Delving into facets and possibly subfacets of work in the situation could help many stakeholders appreciate how emerging technologies might bolster their internal and external capabilities or might present difficult threats and competitive challenges.

5.5 Developing a Better Set of Facets

Readers might view the figures and tables presented here as a starting point for a bootstrap process of developing a better set of facets. That process could proceed in several ways. One approach would involve accepting the general characterization of the facets of work in Section 2 and trying more powerful methods to develop a better list. Other individuals or teams trying to identify facets of work based on the same criteria likely would have identified making decisions, communicating, and processing information but might have ignored some others and might have identified other plausible facets of work that Table 1 does not include. An attempt to develop a better list of facets might start by reviewing and possibly sharpening the criteria and then proceeding toward a better list by using various combinations or search methods, experience, and voting.

A fundamentally different approach would involve extending the idea of facets of work beyond activities or groups of activities. For example, elements of various recognized frameworks might have been used for a broader view of facets of work that includes facets of the entities that perform the work, are affected by the work, or that affect the work in some way. Thus, the work system framework (Alter, 2013b) might have provided facets called customer, product/service, processes and activities, and so on. The Leavitt diamond model (Leavitt, 1964) might have provided four facets: people, task, structure technology. CATWOE from soft system methodology (Checkland, 2000) might have provided six facets: customers, actors, transformation process, worldview, owners, and environmental constraints. The main elements in diagrams summarizing activity theory (e.g., Engeström, 1990) might have provided mediating artifacts, subject, object, rules, community, division of labor, and outcome. Submodels in the 4EM language for enterprise modeling might have brought goals, business rules, concepts, business processes, actors, and resources (Stirna & Persson, 2018). At least one element in these approaches refers specifically to activities or groups of activities. Expanding the idea of facets of work to include additional elements of any of those approaches would have resulted in a more complicated scheme that future research might pursue.

To illustrate this expanded approach, Figure 2 shows how the idea of facets of work might be expanded into a broader idea called facets of work systems. Figure 2 associates the facets of the work with the work system element *processes and activities* but also attaches other facets to the other eight elements of the work system framework and to work systems as a whole. For example, facets of the work system element "participant" include agent, technology user, and collaborator. Much knowledge related to participants is more closely linked to those facets rather than to "participant" in general (e.g., computer self-efficacy more related to technology user than to agent or collaborator because many agents and collaborators do not use computers).

Expanding the idea of facets of work to facets of work systems might be useful in various ways even though some facets of work systems would not satisfy all of the assumptions about facets of work mentioned in Section 2. For example, some facets of work systems overlap more than the facets of work as demonstrated by greater overlap involving associated concepts, evaluation criteria, and tradeoffs. Also, many of the facets in Figure 2 do not constitute activities and, therefore, do not have the same type of subfacets even though they may have components or special cases.

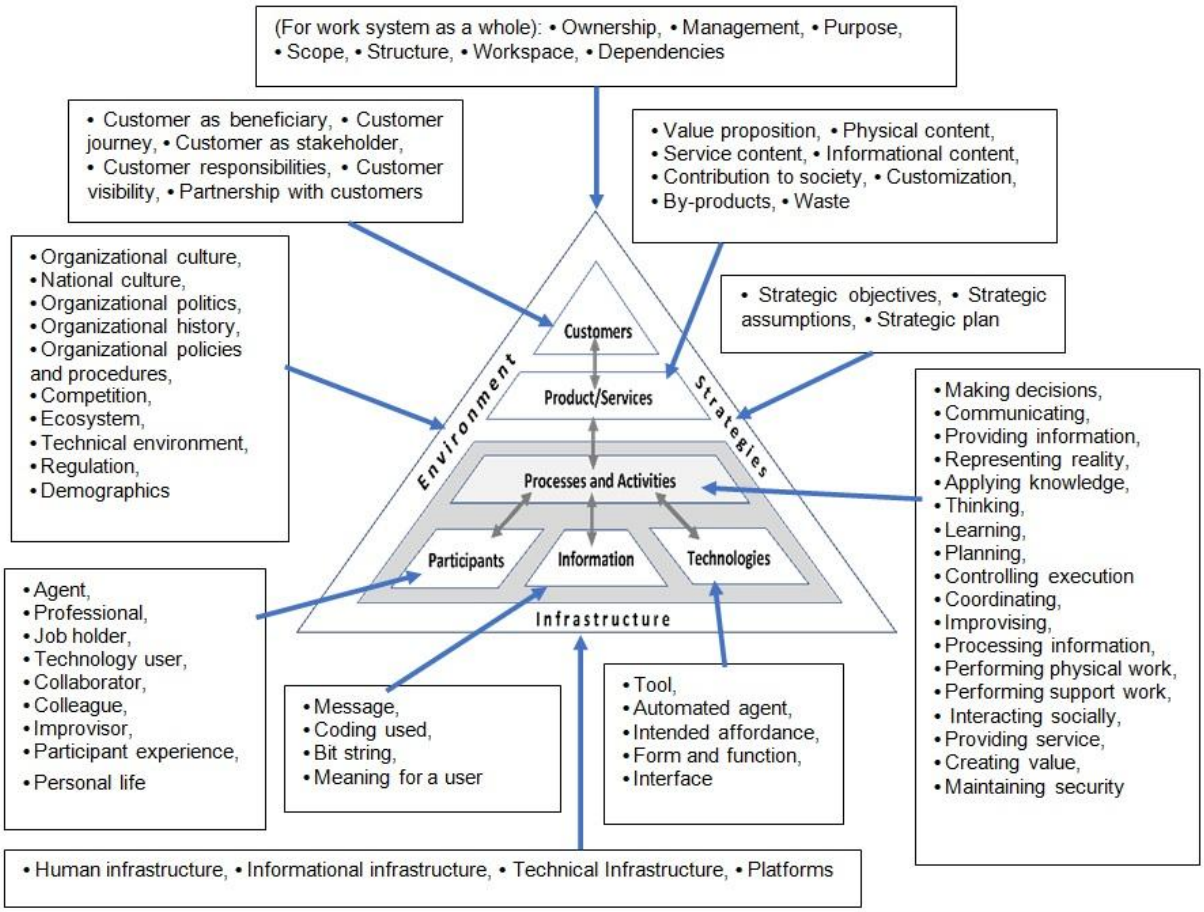

Figure 2. Expanding Facets of Work to Facets of Work Systems

5.6 Developing a Body of Knowledge for IS

Researchers have discussed the need for an IS body of knowledge (ISBOK) or at least a shared language about IS for at least several decades (e.g., Hirschheim & Klein, 2003). An ISBOK would be an organized set of ideas that are useful for understanding, analyzing, evaluating, and communicating about information systems that may be sociotechnical or totally automated. Various initiatives have addressed aspects of an ISBOK. Four examples that help in visualizing possible paths include 1) representation theory, 2) the Association for Information System's (AIS) "Theories Used in IS Research Wiki", 3) compilation and organization of important articles, and 4) constructs for IS research:

1) A set of ideas proposed by Wand and Weber (1990), later called representation theory (Burton-Jones, Recker, Indulska, Green, & Weber, 2017), views an IS as a representation of a real-world system and says that ISs "are primarily intended to model the states and behavior of some existing or conceived real world system" (p. 62). Representation theory applies the Bunge-Weber-Wand (BWW) ontology and energized important research but omits many important IS topics such as how an IS is implemented, used, or managed, as noted by Wand and Weber (1990).

2) The "Theories Used in IS Research Wiki" (Larsen & Eargle, 2018) summarizes many such theories but often does not clarify their domains, possibly because many theories such as the theory of planned behavior are not fundamentally about IS (an observation that also applies to the idea of facets of work).

3) A quite different approach tries to compile knowledge in the form of published papers. Hassan and Mathiassen (2018) relied on classification in proposing an IS development BOK (ISDBOK) based on textual analysis covering 6,643 Senior Scholars' basket of eight

papers between 1978 and 2012. As a result, they identified "466 ISD articles that offer canonical ISD knowledge distinctive to IS and complementary to other disciplines" (p. 175). Using mechanical means to extract knowledge about specific facets of work from those papers would probably be quite difficult.

4) Larsen and Bong (2016) applied natural language processing algorithms to detect whether two behavioral constructs refer to the same real-world phenomenon. Application of the algorithms to 193 papers in two major IS journals between 1983 and 2009 led to a construct taxonomy that included 1,004 constructs in 19 hierarchies—a much more extensive result than the six tables in Appendix B. Perhaps the six tables should not seem as lengthy as they might seem at first blush.

A possible step toward treating facets of work as part of an ISBOK appears in Alter (2021a), which proposes the rationale and structure of a work system knowledge model (WSKM) that constitutes a plausible approach for making progress toward an ISBOK. The WSKM assumes that knowledge objects include non-abstract knowledge such as data, examples, and stories and abstract knowledge such as concepts, generalizations, and methods. The proposed WSKM focuses on an essential part of the IS discipline (i.e., the creation, operation, and evolution of information systems in organizations). Facets of work are an integral part of that proposed WSKM because knowledge about facets of work are a significant part of the knowledge about information systems and other systems in organizations. Table 6 illustrates how the knowledge objects in the ISBOK might be recorded in a spreadsheet. Entries in the first column are knowledge objects. The second column builds on classifications from a taxonomy of knowledge objects in Alter (2020c). The third column refers to special cases of work systems such as totally automated information systems, projects, and open source software projects. Here, "applies to" refers to whether the knowledge object refers to a work system as a whole (which may be a special case such as project), a specific element of the work system framework, or a facet of one work system elements.

Table 6. Illustration of a Spreadsheet Format for Compiling Knowledge Objects for an ISBOK

Knowledge object	Type of knowledge object	Applies to	Most general type of work system
Scalability	Characteristic	WS as a whole	WS in general
Precision	Characteristic	Information	WS in general
Accuracy	Performance variable	Information	WS in general
Error rate	Performance variable	Processes and activities	WS in general
Techno-stress	Phenomenon	Participants	Sociotechnical WS
Start date	Characteristic	Processes and activities	Project
Escalation of commitment	Phenomenon	Project as a whole	Project
"Do the work efficiently"	Design principle	Processes and activities	WS in general
TAM	Theory	Technology	WS in general
Cognitive load theory	Theory	Participants	Sociotechnical WS
Absorptive capacity	Phenomenon	WS as a whole	WS in general
Agile manifesto	Design principle(s)	Software project	Software project
Understandability	Performance variable	Communicating (a facet)	WS in general
Coordination theory	Theory	Coordinating (a facet)	WS in general
Responsiveness	Performance variable	Providing service (a facet)	WS in general
Capturing information	Action	Processing information (a facet)	WS in general

Regardless of limitations in that approach to an ISBOK, including facets of work in the WSKM raises the question about whether a valid ISBOK could simply ignore many or all of the18 facets, especially when a great deal of IS-related research focuses specifically on most of those facets. The need to include facets such as making decisions and communicating that appear near the beginning of the current list is most obvious, but many of the other facets are also important and are current focal points of research (e.g., interacting socially via ICT, performing physical work involving robots, providing service, and maintaining security).

6 Conclusion

The IS discipline and related disciplines have generated a substantial body of research results related to important topics that are barely mentioned in typical SA&D methods, in everyday IS practice, or in the speculation and hype associated with digital transformation, digitalization, and artificial intelligence. Straightforward application of ideas related to facets of work could make more of that knowledge available for practitioners and managers without disrupting the benefits of existing methods. Other than one preliminary attempt to describe generic subsystems (Alter, 2013a) noted in Appendix A, I am not aware of past attempts to explore, develop, or use an approach similar to facets of work in SA&D methods or practices or related parts of the IS discipline.

6.1.1 Next Steps

This conceptual contribution proposed that facets of work could be useful in many areas where existing knowledge is not applied in an organized and prominent way. An obvious next step would involve incorporating facets of work into empirical research related to SA&D, BPM, or EM to assess the ways in which those ideas might or might not help analysts and stakeholders. Another next step would involve testing the value of the idea of facets of work for practitioners. This could be done by using templates or other tools that could support the type of iterative process that was mentioned in Section 5.1 (i.e., start by identifying several facets of work that might pertain to a specific situation, use content related to Tables B3, B4, B5, and B6 (and possibly other knowledge) to help in exploring those facets, and continue to other facets if that seems useful in the situation). Yet another next step might involve applying a facet-oriented classification scheme to organize published empirical research in order to improve visibility and accessibility of real-world experience that could provide insights.

Facets of work is a new idea that addresses important disconnects in IS research and practice. Results and insights from a great deal of valuable research are not organized in a way that facilitates their use in research or in practice. This paper presents the idea of facets of work, demonstrates its relevance to examples, and provides enough detail to help researchers and practitioners appreciate possible ways to apply the facets of work in tools, methods, and research. Tables and figures in the paper body and in the Appendix should suffice for visualizing whether the overall approach makes sense and is worth pursuing further. It is certainly possible to explore questions such as whether a better set of facets could replace the 18 in this paper and whether a more “scientific” way to select and justify a set of facets would be preferable. The more important issue concerns whether organized packaging of ideas related to some version of the facets of work could support practice and research by making existing knowledge more accessible and, hence, more valuable.

References

Alter, S. (2003). 18 reasons why IT-reliant work systems should replace the IT artifact as the core subject matter of the IS field. *Communications of the Association for Information Systems*, *12*, 365-394.

Alter, S. (2005). Architecture of Sysperanto: A model-based ontology of the IS field. *Communications of the Association for Information Systems*, *15*, 1-40.

Alter, S. (2006). *The work system method: Connecting people, processes, and IT for business results*. Larkspur, CA: Work System Press.

Alter, S. (2008). Defining information systems as work systems: Implications for the IS field. *European Journal of Information Systems, 17*(5), 448-469.

Alter, S. (2013a). Incorporating more system-related knowledge into systems analysis and design. In *Proceedings of the Americas Conference on Information Systems.*

Alter, S. (2013b). Work system theory: Overview of core concepts, extensions, and challenges for the future. *Journal of the Association for Information Systems*, *14*(2), 72-121

Alter, S. (2015). Work system theory as a platform: Response to a research perspective article by Niederman and March. *Journal of the Association for Information Systems*, *16*(6), 485-514.

Alter, S. (2019). How could systems analysis use the idea of "responsible information system"? In C. Cappiello & M. Ruiz (Eds.), *Information systems engineering in responsible information systems* (LNBIP vol. 350, pp. 23-35). Berlin: Springer.

Alter, S. (2020a). Applying facets of work as a source of knowledge and insight for requirements determination. In *Proceedings of the 25th International Conference on Exploring Modeling Methods for Systems Analysis and Development.*

Alter, S. (2020b). How facets of work illuminate sociotechnical challenges of industry 5.0. In *Proceedings of European Conference on Information Systems*.

Alter, S. (2020c). The philosopher's corner: Taking different types of knowledge objects seriously: A step toward generating greater value from IS research. *ACM SIGMIS Database: the DATABASE for Advances in Information Systems*, *51*(4), 123-138.

Alter, S. (2020d). Using work system theory, facets of work, and dimensions of smartness to characterize applications and impacts of AI. In *Proceedings of IFIP WG 8.6 International Conference on Transfer and Diffusion of IT.*

Alter, S. (2021a). An open-ended work system knowledge model for visualizing, organizing, and accessing knowledge about information systems in organizational settings. In *Proceedings of Hawaii International Conference on Systems Science.*

Alter, S. (2021b). Understanding artificial intelligence in the context of usage: Contributions and smartness of algorithmic capabilities in work systems. *International Journal of Information Management*.

Alter, S., & Bork, D. (2019). Work system modeling method with different levels of specificity and rigor for different stakeholder purposes. In *Proceedings of Wirtschaftsinformatik*.

Alter, S., & Recker, J. C. (2017). Using a work system perspective to expand BPM use cases for research. *Journal of Information Technology Theory and Application*, *18*(1), 47-71.

Beck, K., M. Beedle, A., van Bennekum, A., Cockburn, W., Cunningham, M., Fowler, J., Greening, Highsmith, J., Hunt, A., JEffries, R., Kern, J., Marick, B., Martin, R. C., Mellor, S., Schwaber, K., Sutherland, J., & Thomas, D. (2001). *Manifesto for agile software development*. Retrieved from http://agilemanifesto.org/

Bērziša, S., Bravos, G., Gonzalez, T., Czubayko, U., España, S., Grabis, J., Henkel, M., Jokste, L., Kampars, J., Koç, H., Kuhr, J.-C., Llorca, C., Loucopoulos, P., Pascual, P. J., Pastor, O., Sandkuhl, K., Simic, H., Stirna, J., Valverde, F. G., & Zdravkovic, J. (2015). Capability driven development: An approach to designing digital enterprises. *Business & Information Systems Engineering*, *57*(1), 15-25.

Bolsinger, M., Elsäßer, A., Helm, C., & Röglinger, M. (2015). Process improvement through economically driven routing of instances. *Business Process Management Journal*, *21*(2), 353-378.

Bork, D. & Alter, S. (2020). Satisfying four requirements for more flexible modeling methods: Theory and test case. *Enterprise Modelling and Information Systems Architectures*, *15*(3), 1-25.

Broughton, V. (2006). The need for a faceted classification as the basis of all methods of information retrieval. *Aslib Proceedings*, 58(1/2), 49-72.

Burton-Jones, A., Recker, J., Indulska, M., Green, P., & Weber, R. (2017). Assessing representation theory with a framework for pursuing success and failure. *MIS Quarterly*, 41(4), 1307-1333.

Checkland, P. (2000). Soft systems methodology: A thirty year retrospective. *Systems Research and Behavioral Science*, *17*(S1), S11-S58.

Demlehner, Q., & Laumer, S. (2019). Setting the hook——he digital transformation from a manufacturing point of view and what it really means. In *Proceedings of the Americas Conference on Information Systems.*

Engeström, Y. (1990). Developmental work research as activity theory in practice: Analyzing the work of general practitioners. In Y. Engeström (Ed.), *Learning, working and imaging: Twelve studies in activity theory.* Helsinki: Orienta-Konsultit Oy.

Falkenberg, E. D., Hesse, W. & Olive, A. (1995). *Information system concepts: Towards a consolidation of views.* In *Proceedings of the IFIP International Working Conference on Information System Concepts.*

Falkenberg, E., Hesse, W., Lindgreen, P., Nilsson, B., Oei, H., Rolland, C., Stamper, R., Van Assche, F., Verrijn-Stuart, A., & Voss, K. (1998). *A framework of information system concepts.* International Federation for Information Processing. Retrieved from file:///C:/Users/Adam/Downloads/10.1.1.89.1492.pdf

Ferstl, O. K., & Sinz, E. J. (2013). *Grundlagen der Wirtschaftsinformatik*. Oldenbourg, München.

Fettke, P. (2009). How conceptual modeling is used. *Communications of the Association for Information Systems*, *25*, 571-592.

Frank U. (2014). Multi-perspective enterprise modeling: Foundational concepts, prospects and future research challenges. *Software & Systems Modeling, 13*(3), 941-962.

Gawande, A. (2010). *Checklist manifesto: How to get things done right.* New York, NY: Picador.

Gawande, A. (2018). Why doctors hate their computers. *The New Yorker*. Retrieved from https://www.newyorker.com/magazine/2018/11/12/why-doctors-hate-their-computers

Haisjackl, C., Soffer, P., Lim, S. Y., & Weber, B. (2018). How do humans inspect BPMN models: an exploratory study. *Software & Systems Modeling*, *17*(2), 655-673.

Hassan, N. R., & Mathiassen, L. (2018). Distilling a body of knowledge for information systems development. *Information Systems Journal*, *28*(1), 175-226.

Hesse, W., & Verrijn-Stuart, A. A. (2001). Towards a theory of information systems: The FRISCO approach. In H. Kangassalo, H. Jaakkola, & E. Kawaguchi (Eds.), *Information modelling and knowledge bases XII* (pp. 81-91). Amsterdam: IOS Press.

Hinkel, G., Kramer, M., Burger, E., Strittmatter, M., & Happe, L. (2016). An empirical study on the perception of metamodel quality. In *Proceedings of the 4th International Conference on Model-Driven Engineering and Software Development.*

Hirschheim, R., & Klein, H. K. (2003). Crisis in the IS field? A critical reflection on the state of the discipline. *Journal of the Association for Information Systems*, *4*(5), 237-293.

Hudon, M. (2020). Facet. *Knowledge Organization*, *47*(4), 320-333.

Johannsen, F., Leist, S., & Braunnagel, D. (2014). Testing the impact of wand and weber's decomposition model on process model understandability. In *Proceedings of the International Conference on Information Systems.*

Kajonius, P. J., & Johnson, J. (2018). Sex differences in 30 facets of the five factor model of personality in the large public (N= 320,128). *Personality and Individual Differences*, *129*, 126-130.

Karagiannis, D. (2015). Agile modeling method engineering. In *Proceedings of the 19th Panhellenic Conference on Informatics.*

Karagiannis, D. & Kühn, H. (2002). Metamodelling platforms. In *Proceedings of the 3rd International Conference EC-WEB.*

Kendall, J. E., & Kendall, K. E. (1993). Metaphors and methodologies: Living beyond the systems machine. *MIS Quarterly*, *17*(2), 37-47.

Larsen, K. R., & Bong, C. H. (2016). A tool for addressing construct identity in literature reviews and meta-analyses. *MIS Quarterly*, *40*(3), 529-551.

Larsen, K. R., & Eargle, D. (Eds.) (2018). *Theories used in IS research wiki.* Retrieved from http://IS.TheorizeIt.org

Leavitt, H. J. (1964). Applied organization change in industry: Structural, technical, and human approaches. In S. Cooper, H. J. Leavitt, & K. Shelly (Eds.), *New perspectives in organizational research* (pp. 55-71). Chichester, UK: Wiley.

Loucopoulos, P., & Kavakli, E. (2016.) Capability oriented enterprise knowledge modeling: The CODEK approach. In D. Karagiannis, H. Mayr, & J. Mylopoulos (Eds.), *Domain-specific conceptual modeling* (pp. 197-215). Berlin: Springer.

Mendling, J., Reijers, H. A., & van der Aalst, W. M. (2010). Seven process modeling guidelines (7PMG). *Information and Software Technology*, *52*(2), 127-136.

Mendling, J., Recker, J., Reijers, H. A., & Leopold, H. (2018). An empirical review of the connection between model viewer characteristics and the comprehension of conceptual process models. *Information Systems Frontiers*, *21*, 1111-1135.

Morgan, G. (1986). *Images of organization*. Thousand Oaks, CA: Sage.

Oates, B. J., & Fitzgerald, B. (2007). Multi-metaphor method: Organizational metaphors in information systems development, *Information Systems Journal*, *17*, 421-339.

Opdahl, A. L., & Sindre, G. (1997). Facet modelling: An approach to flexible and integrated conceptual modelling. *Information Systems*, *22*(5), 291-323.

Priss, U. (2008). Facet-like structures in computer science. *Axiomathes*, *18*(2), 243-255.

Rosemann, M., & vom Brocke, J. (2015). Six core elements of business process management. In J. vom Brocke & M. Rosemann (Eds.), *Handbook on business process management: Introduction, methods, and information systems* (2nd ed., vol. 1, pp. 105-122). Berlin: Springer.

Sandkuhl, K., Fill, H. G., Hoppenbrouwers, S., Krogstie, J., Matthes, F., Opdahl, A., Schwabe, G., Uludag, Ö., & Winter, R. (2018). From expert discipline to common practice: A vision and research agenda for extending the reach of enterprise modeling. *Business & Information Systems Engineering*, *60*(1), 69-80.

Simões, D., Antunes, P., & Carriço, L. (2018). Eliciting and modeling business process stories. *Business & Information Systems Engineering*, *60*(2), 115-132

Stirna, J., & Persson, A. (2018). Enterprise modeling: Facilitating the process and the people. Cham: Springer.

Truex, D., Alter, S., & Long, C. (2010). Systems analysis for everyone else: Empowering business professionals through a systems analysis method that fits their needs. In *Proceedings of 18th European Conference on Information Systems.*

Truex, D., Lakew, N., Alter, S., & Sarkar, S. (2011). *Extending a systems analysis method for business professionals*. In *Proceedings of the European Design Science Symposium.*

van der Aalst, W. M. P (2012). What makes a good process model? *Software & Systems Modeling, 11*, 557-569.

van der Aalst, W. M. P. (2013). Business process management: A comprehensive survey. *ISRN Software Engineering*. Retrieved from https://www.hindawi.com/journals/isrn/2013/507984/

Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *The Journal of Strategic Information Systems*, *28*(2), 118-14

vom Brocke, J., & Sinnl, T. (2011). Culture in business process management: A literature review, *Business Process Management Journal*, *17*(2), 357-378.

Wand, Y. & Weber, R. (1990) Towards a theory of the deep structure of information systems. In *Proceedings of the International Conference on Information Systems.*

Wild, P. J., Giess, M. D., & McMahon, C. A. (2009). Describing engineering documents with faceted approaches. *Journal of Documentation*, *65*(3), 420-445.

Winter, M., & Szczepanek, T. (2009). *Images of projects*. Farnham, UK: Gower.

Appendix A: Background and Related Literature

This section summarizes the somewhat disconnected steps that led to the current version of the facets of work. It also mentions some other uses of the term "facet" that appear in research in other fields. This section was placed in an Appendix in order to make the discussion about the background more understandable and because the false starts and obstacles encountered as the ideas developed might not matter to many readers.

The idea of facets of work was developed as one of many extensions to work system theory (WST) but is useful regardless of whether WST is being used, as was shown by the three examples in Section 3 and the proposed applications in Section 5. The development of facets of work as an extension to WST that tried to address a long-standing shortcoming of the work system method (WSM) led to a quandary about how to explain the development of the ideas. On the one hand, most research publications are expected to explain the motivation for research efforts and the provenance and development of ideas that are used or developed. On the other hand, repeating discussions of WST, WSM, and related ideas that have been presented many times (e.g., Alter, 2003, 2008, 2013b, 2015) seems redundant, especially since the facets of work can be used independent of WST and WSM.

The compromise pursued here started with using several paragraphs in the introduction to establish the paper's motivation. This Appendix continues from that point, identifies issues that became clearer during several intermediate efforts that did not meet their own goals, and finally summarizes how the idea of facets of work emerged in subsequent research.

Trying to Extend WST

The idea of facets of work extends work system theory (WST) and was developed to address a major gap that was not articulated clearly until the idea of facets of work was developed recently. The gap was that WST did not differentiate adequately between activities of different types even though it highlighted work systems that necessarily included activities of many types. The content of numerous management briefings that MBA and Executive MBA students produced between 2003 and 2017 hinted at the desirability of producing a WST extension that somehow might help them produce more interesting and insightful recommendations.

A prematurely ambitious proposal (Alter, 2005) suggested a possible architecture for an IS ontology called Sysperanto, a play on the purported universal language Esperanto. The proposed ontology tried to build on results of a series of information systems concepts (ISCO) conferences sponsored by IFIP 8.1 in 1989, 1992, 1995, and 1999. Those conferences attempted to identify the basic concepts of IS but ultimately produced reports (Falkenberg, Hesse, & Olive, 1995; Falkenberg et al., 1998; Hesse & Verrijn-Stuart, 2001) that did not satisfy many participants in the effort. The architecture of Sysperanto was organized around the elements of the work system framework and the assumption that information systems, projects, supply chains, e-commerce, and many other important types of systems can be modeled as work systems. That assumption remains as the basis of the current work system perspective, whose core consists of the three components of WST: the definition of work system, the work system framework (the triangular framework in Figure 2 minus the facets), and the work system lifecycle model, which is not shown here. The work system perspective builds on WST by including extensions and use cases. The extensions include WS axioms, WS design principles, a theory of workarounds, a system interaction theory, a set of WS metamodels, and ideas about the inheritance of WS properties by special cases such as information systems. The use cases include the work system method (Alter, 2006), a related SA&D toolkit, and applications of WST and its extensions for understanding many topics in the IS discipline.

While basic assumptions underlying Sysperanto remained, its architecture included the awkward idea of a "slice" that tried to build on the way people "understand business and organizational reality by slicing it in a variety of ways. In Sysperanto a 'slice' is a related set of properties that can be applied when trying to understand or analyze a particular work system. Although slices may overlap, each slice provides a particular set of concepts, associations, and understandings." (Alter, 2005, p. 11). The idea of slices was not developed further at that time but turned out to be a precursor of the idea of facets explained here.

A subsequent effort (Alter, 2013a) was inspired by earlier publications that applied metaphors for understanding complex management or system topics (e.g., Morgan, 1986; Kendall & Kendall, 1993; Oates & Fitzgerald, 2007; Winter & Szczepanek, 2009). That effort identified eight subsystem types such as decision subsystem and communication subsystem (rather than typical categories such as ICT, MIS, or

DSS), each of which suggested potentially useful metaphors that might provide insights in SA&D. The subsystem approach proved limited because subsystems are typically viewed as being contiguous, whereas activities related to decision making and communication may not be contiguous in a system (e.g., decision making might be important in the second, third, and ninth steps of a process but not in the fourth to eighth steps).

A third effort from the domain of enterprise and process modeling (Alter & Bork, 2019; Bork & Alter, 2020) focused on a different set of problems but eventually led to an insight about facets of work. That effort suggested ways to "relax" some of the formal requirements on enterprise and process modeling suggested by Karagiannis and Kühn (2002). It was inspired by researchers from various backgrounds noting frequently that modeling methods related to processes and enterprises need to be extended or augmented to make them more usable by broader user groups and for broader purposes (e.g., Sandkuhl et al., 2018; van der Aalst, 2012; Karagiannis, 2015). The idea of a two dimensional design space for modeling methods (Alter & Bork, 2019, p. 6) came from reviewing research on modeling method usage (e.g., Fettke, 2009; Mendling, Reijers, & van der Aalst, 2010), model comprehension (e.g., Haisjackl, Soffer, Lim, & Weber, 2018; Johannsen, Leist, & Bruannagel, 2014; Mendling, Recker, Reijers, & Leopold, 2018), and misfit between modeling methods and modelers' aptitudes, knowledge, and purposes (e.g., Hinkel, Kramer, Burger, Strittmatter, & Happe, 2016; Simões, Antunes, & Carriço, 2018). That design space suggested that different user purposes (e.g., identifying systems, describing capabilities, describing system scope and operation, etc.) call for models with different degrees of rigor and specificity organized around a single "overarching modeling metaphor" (Ferstl & Sinz 2013), which was the idea of work system in that research.

The "user purpose" of describing capabilities initially came from awareness of capability-driven development (Bērziša et al., 2015; Loucopoulos & Kavakli, 2016). Trying to express capability-related ideas in a work system metaphor led to consideration of multiple facets of capabilities. Thinking about that topic led to recalling previous attempts to apply system-related metaphors in SA&D, and that inspired the possibility of using the idea of facets of work as a path toward achieving unmet goals of the earlier research. The iterative process of identifying the current 18 facets of work started by renaming the subsystem types from Alter (2013a) as a set of capabilities in Alter (2019). In a work system perspective, those ideas could be presented more naturally as facets of work rather than facets of capabilities.

Faceted Organization of Knowledge

Researchers have used the idea of *facet* with quite different meanings and connotations in psychology, library science, information science, computer science, and other disciplines. Preliminary literature searches identified uses of facet that will be mentioned here for the sake of completeness even though they did not provide insights for this paper's use of that idea.

In psychology, each factor in the widely used five-factor model of personality (neuroticism, extraversion, openness, agreeableness, conscientiousness) has been expanded into six facets. For example, facets of conscientiousness include self-efficacy, orderliness, dutifulness, achievement, self-discipline, and cautiousness (e.g., Kajonius & Johnson, 2018). In library science, Ranganathan introduced the term facet in a series of books in the mid-1900s. A lengthy paper (Hudon, 2020) in the *Library of Knowledge Organization* notes that facet became somewhat of a buzzword in knowledge organization, knowledge management, and information architecture. Broughton (2006) says that "faceted classification in some form or another now plays an integral part in most methods of information retrieval" (p. 68). Nonetheless, observers such as Wild, Giess, and McMahon (2009) note theoretical and practical issues such as "differing interpretations of the facet notion; confusion between faceted analysis and faceted classification; lack of methodological guidance; the use of simplistic domains as exemplars", and so on (p. 420).

A paper on facet-like structures in computer science identifies the following facet-like structures: facet, database field, view (table), class, aspect, scale, situation, context, and channel (Priss, 2008). In facet modeling, "facets are intended to represent numerous and highly diverse kinds of aspects, ranging from the informal to the formal, from the soft to the hard, from the general to the special, from the whole to the parts, etc." (Opdahl & Sindre, 1997, p. 302). Those kinds of aspects apply to the use of facets in visualizing and analyzing work systems. Importantly, since the work system perspective provides guidance without imposing too much structure on users, the use of facets in conjunction with work systems does not need to satisfy Opdahl and Sindre's expectations of rigorous facet modeling, such as a "powerful and flexible mechanism to accurately specify the structure and content types of a particular kind of facets" (p. 302) as in programming languages.

In contrast with past uses of the term facet, this paper uses that idea as a way to address the major limitation of WST that has been mentioned several times. WST and its previous extensions did not link directly to a great deal of knowledge about frequently relevant topics such as decision making, communication, and coordination. Articulating *facets of work* as a new extension to WST appears to be a new path to relate a great deal of existing knowledge more directly to the operation of systems in organizations. Strengthening that relationship could help business stakeholders and technical experts as they try to visualize, describe, and analyze those systems.

Appendix B: Tables Showing Knowledge Related to Facets of Work

This Appendix presents six tables that contain potentially valuable ideas for SA&D and other purposes. They appear in the Appendix because their appearance earlier would have made this paper's main narrative choppy and difficult to follow.

- Table B1 summarizes why all 18 facets of work are significant in many situations.
- Table B2 shows that almost all 18 facets of work apply to both sociotechnical systems and totally automated systems that operate autonomously.
- Table B3 shows that each facet of work is associated with concepts and other knowledge that is associated more directly with that facet than with other facets.
- Table B4 shows that all 18 facets bring common evaluation criteria and design tradeoffs that can be used when analyzing, designing, or evaluating systems in organizations.
- Table B5 shows that most of the 18 facets have subfacets that might provide guidance for looking at specific facets of work in greater depth in some situations.
- Table B6 shows that all 18 facets imply open-ended questions that can be used to start discussions related to specific facets. Those facet-specific questions build on two simple questions: 1) "Where is this facet important for this real-world situation or research area?" 2) "What are important issues or opportunities related to this facet?".

Eighteen Common Facets of Work

Table B1 briefly comments on the frequent importance of each of 18 facets, all of which could be the topic of a complete literature review. They also could be the topic of at least two open-ended questions at the beginning of a description or analysis process regardless of whether a version of the work system method was used:

- Where is this facet of work important in this situation?
- What are important issues or opportunities related to this facet?

Those open-ended questions could be considered a starting point, with some facets more important than others in any specific situation. Facets that seem unimportant initially could be set aside so that stakeholders could focus on the facets that seem most relevant in the current situation for a combination of description, management concerns, and speculation. Table B6 identifies typical open-ended questions that directly relate to each facet of work.

Table B1. 18 Common Facets of Work

Facet	Importance of considering this facet
Making decisions	Treating decisions simply as steps in a process is often inadequate if issues and opportunities related to the rationale or quality of decisions are important.
Communicating	Inadequate communication is a common complaint in business situations. Often the problem does not concern specific steps but rather clarity, involvement, terminology, and other issues.
Providing information	In many business situations, people complain that they are not informed adequately about information or situations they should know about.
Representing reality	Many information systems represent reality in incomplete or misleading ways (e.g., by providing inadequate options for recording or coding problems or incidents).
Applying knowledge	Significant business situations typically require the application of general and/or specialized knowledge which may be tacit or explicit and codified or uncodified.
Thinking	While artificial intelligence and related topics receive a great deal of attention, many work situations simply require ability and time to think carefully and sometimes creatively.
Learning	Adaptations and workarounds in business activities often contribute to learning. Trends toward applying AI bring new attention to methods by which machines or systems might learn.
Planning	Inadequate planning often leads to disappointing results even though there are some situations where improvisation is more important than planning.
Controlling execution	Controlling the execution of work often calls for finding an appropriate balance between inadequate control and excessive surveillance.

Table B1. 18 Common Facets of Work

Coordinating	Efficient and effective operation of an organization calls for coordination between people and groups performing related tasks and/or sharing resources.
Improvising	Understanding the reality of how work is performed in many settings requires considering improvisations and workarounds that occur when work is relatively unstructured and when exceptions and other conditions require deviation from established practices.
Processing information	Most business situations involve some form of information processing by people and/or machines. Digitalization increases reliance on information processing by machines.
Performing physical work	Trends toward digitalization coexist with the continuing importance of creating, modifying, moving, or adjusting physical things.
Performing support work	Process documentation often does not include support work (also called articulation work) that helps in coordinating documented work steps, overcoming transient obstacles, and obtaining needed resources in a timely manner.
Interacting socially	Inadequate social interaction may degrade work performance by lessening cooperation, whereas excessive social interaction may generate inefficiencies such as absorbing too much time.
Providing service	The purpose of most work activities is to produce things, actions, or conditions that facilitate benefits for others, implying that considering service aspects is often important.
Creating value	Direct attention to value is important because attempts to produce things for others or with others (e.g., value co-creation) do not guarantee that value is created either for intended beneficiaries or people or organizations that perform the work.
Maintaining security	Many threats have emerged related to accessing and transmitting inadequately protected digital information. Privacy concerns compound those issues.

Relevance to Sociotechnical and Totally Automated Systems

Table B2 shows that facets of work apply to both sociotechnical work systems and totally automated work systems. In sociotechnical systems, human participants perform at least some activities that produce product/services for customers. In contrast, machines typically controlled by software perform all of the work in totally automated systems. Relevance of the facets of work to both sociotechnical and totally automated systems is increasingly important as digitalization and automation play increasingly important roles in business and society. Note that the people who create and maintain automated systems perform that work as participants in other work systems that are devoted to creating and maintaining the automated systems.

Table B2. Relevance of Facets of Work to Both Sociotechnical and Totally Automated Systems

Facet	Sociotechnical work performed by people	Automated work performed by machines controlled by software
Making decisions	People use information that supports a decision process. **Example**: Marketing manager decides on allocation of advertising budget.	Computer uses software algorithms to make decisions automatically. **Example**: A marketing model calculates automatic allocation of advertising budget.
Communicating	People communicate with other people as part of collaboration. **Example**: Sales managers meet to discuss issues, problems, and tradeoffs.	Computer communicates an alert to human users. **Example**: A computer creates a message highlighting last week's key performance gaps.
Providing information	People provide information upon request or on a periodic basis. **Example**: An employee submits a progress report before meeting with manager	A computer provides information, either by subscription or on demand. **Example**: An internet-based news service provides a customized daily newspaper.
Representing reality	People create a representation of reality. **Example**: Accountants perform financial analysis and create financial reports.	A computer uses software and data to create a representation of reality. **Example**: A facial recognition system identifies people in a location.

Table B2. Relevance of Facets of Work to Both Sociotechnical and Totally Automated Systems

Applying knowledge	People use expert knowledge to perform a complex diagnosis. **Example**: A physician determines that a patient has an unusual medical problem.	A computer uses a neural network to perform a complex diagnosis task. **Example**: A computer uses thousands of cases to create a neural network that is used to identify a patient's problem.
Thinking	People think about a situation, decide what is important, and make decisions. **Example**: A doctor considers medical evidence and decides what to prescribe.	A computer analyses the same situation and uses an algorithm to suggest an approach. **Example**: A computer uses an algorithm to consider evidence and decides what to prescribe.
Learning	Human workers learn as they perform their work. **Example**: A manager learns by experience about what is effective.	A computerized tool identifies changing conditions and adjusts accordingly. **Example**: A computer adjusts a trading algorithm based on changes in a market.
Planning	People use information and knowledge to create plans. **Example**: A manager plans factory production to satisfy existing orders.	A computer uses information and algorithms to create plans. **Example**: A computerized algorithm plans factory production for current orders.
Controlling execution	Managers use information and incentives to motivate employees. **Example**: Daily incentives push employees to meet daily goals.	A computer uses business rules to control execution of processes. **Example**: BPM software enables the next step after a previous step completes.
Coordinating	People coordinate activities and resource use for mutual benefit. **Example**: Two teams coordinate work to share resources needed by both.	Computers use algorithms to coordinate activities and resource use. **Example**: Two autonomous machines take turns using a resource needed by both.
Improvising	People decide how to proceed based on intuition and resources that are available in the situation facing them. **Example**: A police team responds to an unfolding public safety threat.	A computer decides how to proceed based on search algorithms and a representation of the current reality. **Example**: An autonomous vehicle identifies and avoids obstacles.
Processing information	People capture, transmit, store, delete, retrieve, display, or manipulate data. **Example**: A researcher collects, filters, and summarizes information.	Computer or other device captures, transmits, stores, deletes, retrieves, displays, or manipulates data. **Example**: Information processing via RFID system, MRI system, or digital camera
Performing physical work	People perform physical activities beyond processing information. **Example**: People move packages from one location to another.	Machines perform physical activities beyond processing information. **Example**: Machines move packages from one location to another.
Performing support work	People assure that others have resources they need to perform their work. **Example**: Support staff assures that computers are working properly.	Automated linkages assure that people have resources they need to perform their work. **Example**: Automated update services assure that users' software is up to date.
Interacting socially	People enact everyday social relations while participating in organizations. **Example**: People chat during work breaks or during meetings.	Interacting socially does not describe how current machines operate. At some point "social-like" interactions might help machines coordinate within or between enterprises.
Providing service	People perform activities for the benefit of others. **Example**: "Super users" help others understand software features.	Machines perform activities that respond to a user request. **Example**: A computer uses a search algorithm to compile search results.
Creating value	People produce product/services that matter to customers or users. **Example**: An artist produces a painting that a buyer values.	Machines produce product/services that matter to customers or users. **Example**: An automated alarm system produces a feeling of safety.
Maintaining security	Undisciplined computer usage generates opportunities for crime. **Example**: A firm trains its employees to recognize data security threats.	Computerized systems enforce data standards and access restrictions **Example**: Digital rights management (DRM) systems restrict access based on role-related access rights.

Concepts Related to Each Facet of Work

Table B3 identifies common concepts related to the 18 facets. Importantly, these terms are only tangentially associated with established techniques of SA&D, BPM, and EM even though the facets often could provide important clues for requirements determination. Literature reviews for each facet would find that many concepts and generalizations related to each facet have been articulated and researched in great depth.

Table B3. Common Concepts related to Each Facet of Work

Facet	Related concepts
Making decisions	Decision, decision criteria, alternative, value, risk, payoff, utility, utility function, tradeoff, projection, optimum, satisficing vs. optimizing, heuristic, probability, distribution of results, risk aversion
Communicating	Comprehension, one-way vs. two-way, messages, utterances, encoding, transmitting, decoding, interpreting, communication channel, media, media richness, wired, wireless, signal-to-noise ratio, attenuation
Providing information	Inclusion, exclusion, accuracy, conciseness, focus, filtering, outlining, textual vs. graphical presentation, types of graphical displays, personal style related to information usage, information deficiency, information overload
Representing reality	Entity, event, state, inclusion, exclusion, filtering, summarization, precision, bias, characteristic, measure of performance
Applying knowledge	Tacit vs. explicit knowledge, codified vs. noncodified knowledge, domain of knowledge, know-how, rules of thumb, knowledge base, neural network, expert system, cognitive computing, artificial intelligence
Thinking	Thoughts, concepts, images, perceptions, memories, recall, awareness, consciousness, reasoning, realizations, imagination
Learning	Learning curve, retention, forgetting, skills, experimenting, observing, practicing, assimilating, experiential learning, rote learning, active learning, testing
Planning	Plan, feasibility, needs, goals, forecasts, resources, dependencies, capacity, slack resources, planned resource utilization, strategic vs. tactical vs. operational planning, rational choice, planned capacity utilization, planned fulfillment, planned versus actual results
Controlling execution	Goal, evaluation method, evaluation criteria, positive and negative feedback, standardization, rationale, business rules, chaotic behavior, informal vs. formal feedback
Coordinating	Managing dependencies, interdependent tasks, coordination mechanisms, synchronization, alignment, standardization, bidding, assigning resources
Improvising	Resources at hand, bricolage, adaptation, workaround, trial and error, merger of thinking and acting, extemporaneous action
Processing information	[Nouns] entity, relationship, data item, class, method, object, event, state, process, pre-condition, post-condition, business rules, [Verbs] capture, transmit, store, retrieve, delete, manipulate, display, initialize, initiate, update, back-up, restore, roll back
Performing physical work	Manual labor, blue collar work, ergonomics, movement, physical abilities, physical stress, work environment, repetitive stress, exposure
Performing support work	Providing support, facilitating workflows, improvising, filling in, fixing breakdowns, maintaining continuity of shared or distributed work, working to help others work
Interacting socially	Social relationships, groups, teams, social cohesion, trust, group membership, shared culture, social conflict, virtual teams, presentation of self
Providing service	Service provider, service customer, service interaction, value proposition, resource integration, co-production, service logic, service-dominant logic,
Creating value	Value, value added, economic value, value-in-use, value capture, customers creating value for themselves, customers assessing value for themselves
Maintaining security	Vulnerability, threat, assurance, accountability, authorization, access rights, confidentiality, authenticity, trustworthiness, auditability, non-repudiation

Evaluation Criteria and Design Tradeoffs related to Each Facet

Table B4 shows that each facet is associated with typical evaluation criteria and design tradeoffs. Some criteria and design tradeoffs are common to many activities, processes, and systems, but others are mostly associated with specific facets. For example, cost, efficiency, and effectiveness are criteria that can be used in relation to most of the facets. In contrast, accuracy, riskiness, and social cohesion apply to specific facets and do not apply directly to most others. Notice how many other evaluation criteria and design tradeoffs might be mentioned.

Table B4. Typical Evaluation Criteria and Design Tradeoffs Related to Each Facet

Facet	Typical evaluation criteria	Typical design tradeoffs
Making decisions	Decision outcomes, riskiness, participation, concurrence, ease of implementation, reliance on method or data	• Quick responsiveness vs. superficiality. • Complexity and precision of models vs. understandability • Brevity vs. inclusion of all important details • Local optimization vs. global optimization
Communicating	Clarity, understandability, conciseness, accuracy of the perception of a message, extent of empathy and warmth, signal to noise ratio	• Insufficient vs. excessive communication • Richness of multiple communication channels vs. confusion about which channels to use when. • Focusing on message production versus impact of the communication
Providing information	Information quality, completeness, accessibility, usefulness, timeliness, accuracy, understandability, source, comparability, bias	• Informing vs. under-informing or over-informing. • Insufficient information vs. information overload • Predefined information vs. ad hoc specification • Focusing on informing and information transfer vs. human abilities to perceive and process information
Representing reality	Completeness, accuracy, objectivity, clarity, bias, omissions, confounding, intersubjectivity, shared understanding	• Precision/ granularity vs. big picture issues and understandability. • Focusing on objective data that can collected automatically vs. reflecting reality more fully by including subjective information.
Applying knowledge	Accuracy of knowledge, ability to discriminate between cases, appropriateness of application of knowledge	• Using too little knowledge vs. waiting until more knowledge can be obtained and filtered • Relying on human knowledge and intuition vs. relying on computerized techniques
Thinking	Clarity, precision, flexibility, insight, originality, focus, imagination	• Maintaining control versus freedom to think • Maintaining focus vs. out-of-the-box thinking
Learning	Mastery of content, retention, errors, confusions, rate of knowledge acquisition	• Small increments vs. large leaps • Supervised vs. unsupervised learning • Theory-based vs. experiential learning
Planning	Feasibility, alignment with strategy, goal achievement, planned capacity utilization, actual capacity utilization	• Under-utilization vs. allowing too little slack • Predictability of outcomes vs. risk of shortfalls • Inclusion vs. exclusion of possible responses to known contingencies
Controlling execution	Extent and duration of deviations from goals, delays, cost of monitoring, effectiveness of corrections, likelihood of overshooting control targets	• Micromanagement vs. risks of non-compliance • Quick responsiveness vs. instability. • Focusing on control targets vs. minimizing negative impacts on participants or customer
Coordinating	Quality of resource sharing, quality of synchronization, effort absorbed by coordination	• Cost of coordinating vs. cost of excess resources • Using rules vs. using negotiations
Improvising	Task accomplishment, response time, resource utilization	• Compliance vs. non-compliance with norms • Control vs. freedom to act
Processing information	Efficiency, cost, accuracy, precision, error rate, rework rate, downtime, vulnerability	• Cost and efficiency vs. completeness and detail. • Focusing on processing data vs. producing useful information that fits task or decision needs

Table B4. Typical Evaluation Criteria and Design Tradeoffs Related to Each Facet

Performing physical work	Task completion, conformance, speed, physical stress, impact on workers, workplace injuries	• Automating tasks vs. performing tasks manually • Efficiency vs. overload • Considering vs. ignoring impacts on people performing physical work
Performing support work	Continuity of supported work, elimination of obstacles	• Tightly assigned resources vs. slack resources • Individual task focus vs. support of shared work
Interacting socially	Social cohesion, loyalty, social capital, social intelligence, degree of engagement, role conflicts	• Appropriate cooperation vs. groupthink • Individuality vs. group identity • Maintaining work relationships vs. absorbing time and interfering with work
Providing service	Efficiency, effectiveness, reliability, responsiveness, cost, convenience	• Ease of production vs. customer satisfaction • Relationship-based vs. transaction-based • Produced vs. co-produced
Creating value	Efficiency, effectiveness, reliability, responsiveness, cost, convenience	• Value for provider vs. value for customer • Cost to provider vs. cost to customer or society • Produce and transfer vs. work together
Maintaining security	Number of incidents, Extent of losses, Time to recover from incidents	• Attention to security vs. attention to work • Restrictions vs. ability to satisfy customers

Common Subfacets

Table B5 illustrates how most facets bring subfacets that are often useful when exploring a facet of work in depth. As with facets, subfacets are activities or groups of activities. Thus, people discussing the facet making decisions might start by identifying and discussing consequential decisions in the relevant situation. They might build on that by looking at subfacets (i.e., focusing on how problems are defined, how criteria are identified, how relevant information is gathered, etc.). That type of attention to specific facets and subfacets usually is not included in typical descriptions of SA&D, BPM, and EM. Similarly, guidelines about how to perform case study research or action research that tries to understand a business situation usually do not pay attention to many of the subfacets.

Table B5. Subfacets Related to Each Facet

Facet	Related subfacets
Making decisions	Defining the problem, identifying criteria for making the decision, gathering relevant information, analyzing the information, defining alternatives, selecting among alternatives, explaining the decision to stakeholders.
Communicating	Formulating the message, encoding the message, conveying the message, receiving the message, decoding the message, verifying that the message was received and understood.
Providing information	Identifying alternative ways to provide information that might be needed, identifying the most appropriate way to provide required information, packaging information for conveyance to the recipient, transmitting and/or displaying the information.
Representing reality	Identifying key aspects of reality that matter in the situation at hand, identifying ways to represent those aspects of reality, selecting the most acceptable representation in terms of usefulness versus cost, capturing and manipulating whatever information is needed to produce the desired representation of reality.
Applying knowledge	Determining the domain, collecting relevant data if any, distilling data into knowledge, identifying relevant knowledge, applying knowledge to the situation.
Thinking	Identifying the topic, visualizing the situation, identifying issues or concerns, considering knowledge or evidence, considering alternatives, iterating.
Learning	Determining learning goals, determining learning strategy, recognizing content to be learned, engaging with content, practicing, receiving feedback, demonstrating mastery, evaluating limits of understanding.
Planning	Identifying scope and timeline, identifying objectives, identifying relevant resources, producing a plan, evaluating feasibility, likely goal attainment, and risks for a possible plan, iterating.

Table B5. Subfacets Related to Each Facet

Controlling execution	Identifying control points and goals, collecting information related to the degree of goal achievement, using the information to stay on track.
Coordinating	Identifying dependencies, deciding on methods for addressing dependencies, executing coordination mechanisms, monitoring coordination effectiveness.
Improvising	Identifying goals of improvisation, deciding how to start improvisation, initiating improvisation, monitoring progress of the improvisation, deciding how to proceed.
Processing information	Capturing information, transmitting information, storing information, retrieving information, deleting information, manipulating information, displaying information.
Performing physical work	Grasping, moving, lifting, pushing, pulling, transporting, combining, transforming, sorting, filtering, mixing, constructing, cleaning.
Performing support work	Identifying transient obstacles, deciding how to help, obtaining needed resources, providing resources, performing improvised tasks.
Interacting socially	Communicating, welcoming, initiating conversations, establishing relationships, creating social capital, resolving conflicts, maintaining loyalty.
Providing service	Identifying beneficiaries, determining beneficiary needs, identifying ways to serve beneficiaries, executing service activities, monitoring service activities, monitoring benefits for customers.
Creating value	Defining relevant aspects of value, deciding how to create value, performing activities that add or deliver value, monitoring whether value is captured, monitoring to assure providers and customers both benefit.
Maintaining security	Identifying security goals, identifying threats and risks, defining countermeasures against threats, training staff, executing countermeasures.

Bringing Facets of Work into Systems Analysis

The various facets of work can be applied in systems analysis checklists or analysis tools to explore issues beyond the content of use cases, activity diagrams, and typical summaries of problems, processes, information, and constraints. Table B6 shows a starting point for that type of tool. The tools or checklists could provide typical open-ended questions and follow-on questions that support consideration of the scope and content of each facet of work in a situation.

The questions in Table A6 are straightforward and can be pursued without deep theoretical knowledge in each area. Many surely are pursued in some way in some current systems analysis efforts. Using something like Table B6 might reduce the likelihood of overlooking many important issues. A possible application in research takes the form of checklists for identifying types of issues that were pursued or ignored in real world settings.

Pre-specified templates or interactive tools related to theoretical concepts in each area might go much further. For example, relevant questions for making decisions might use concepts such as utility, risk tolerance, and local versus global optimality.

Table B6. Open-ended Questions Related to Different Facets of Work

Facet	Open-ended questions for starting a discussion plus follow-on questions
Making decisions	**Open-ended question**: How do the available methods and information help in making important decisions? **Follow-on questions**: What decisions are made with incomplete, inaccurate, or outdated methods or information? How might better methods or information help in making decisions? Where would that information come from?
Communicating	**Open-ended question**: In what ways is communication effective or ineffective in this situation? **Follow-on questions**: Where and how does ineffective communication degrade performance or cause problems interpersonal issues? Where is information garbled in communication? Where does inadequate communication of information between locations cause problems?
Providing information	**Open-ended question**: How does the available information succeed or fail in helping managers understand what is going on? **Follow-on questions**: How do managers figure out what is going on (e.g., through standard information systems, spreadsheets, or face-to-face discussions)? What important information is unavailable? What important information is missing or difficult to obtain?

Table B6. Open-ended Questions Related to Different Facets of Work

Representing reality	**Open-ended question**: What are examples of important information that does not exist in available information systems or is not represented well? **Follow-on questions**: Is information recorded or presented in a way that requires manual workarounds to figure out what is going on? Is the information from official or corporate information sources as accurate or timely as information from local spreadsheets? What is the impact of shortcomings related to how available information represents reality?
Applying knowledge	**Open-ended question**: To what extent is it necessary to use explicit knowledge that is codified and computerized? **Follow-on questions**: In what ways is the knowledge and intuition of people in the setting inadequate for the purposes at hand? What data might be used in a computerized approach to compiling and formalizing the knowledge? In what ways could that data have biases that would skew the results of decisions? What are the knowledge-related limitations of current or proposed information systems?
Thinking	**Open-ended question**: Are there situations where people seem not to have enough time or liberty to think carefully about what needs to be done? **Follow-on questions**: Does performance pressure or attention to minute details drive out the ability to think about important issues? Are people frustrated about how the work environment affects their ability to think creatively? Do people feel that they lack opportunities to think through problems with the help of their colleagues?
Learning	**Open-ended question**: In what ways is learning important for successfully performing responsibilities in this situation? **Follow-on questions**: What learning occurs before this activity or system is considered operational? What learning occurs during operation and through feedback? How is that learning supervised?
Planning	**Open-ended question**: How effective are planning processes in this setting? **Follow-on questions**: Are plans taken seriously in this setting? What happens when it becomes apparent that current plans will not be achieved? How well do plans consider risks and uncertainties about what needs to be accomplished and what is feasible to accomplish?
Controlling execution	**Open-ended question**: How well do existing methods and information help the organization meet its short-term and long-term targets? **Follow-on questions**: Is information related to controlling execution ever inaccurate or misleading enough that it causes management or execution errors? What changes in existing methods and information would help the organization control execution more effectively?
Coordinating	**Open-ended question**: What are common situations where coordination between people or departments is challenging? **Follow-on questions**: What kinds of dependencies lead to coordination challenges? What kinds of methods are used to establish and maintain coordination? In what ways is coordination monitored or rewarded?
Improvising	**Open-ended question**: What kinds of situations occur where it is necessary to improvise in the short term based on whatever resources are available? **Follow-on questions**: What are common situations where noncompliance with established practices is necessary in order to complete work or meet customer needs? Describe the extent to which management supports improvisation that seems appropriate to the people who are doing the work.
Processing information	**Open-ended question**: What are situations in which capturing, transmitting, storing, retrieving, deleting, displaying, or manipulating important information is ineffective, prone to errors, or costly in time and effort? **Follow-on questions**: What information is captured or transmitted inaccurately? What information is difficult to store or retrieve? What information would be more useful if it could be refined further through calculations or visual display?
Performing physical work	**Open-ended question**: What kinds of physical work are important in this situation? **Follow-on questions**: Are there any significant challenges in performing that physical work? Are there ways in which better processing of information might replace or facilitate some of that physical work?

Table B6. Open-ended Questions Related to Different Facets of Work

Performing support work	**Open-ended question**: Is any of the recognized work in the situation related to helping other people perform their work? **Follow-on questions**: Do people have assistants whose job is to help them perform their work? In what ways do people in this work situation help each other by eliminating minor obstacles, sharing time and other resources, and making sure that everyone succeeds in doing their work in a timely and convenient way?
Interacting socially	**Open-ended question**: In what ways is social interaction important in this work setting? **Follow-on questions**: Are social interactions viewed as important in this setting? Does social interaction present any significant challenges in this setting? Are there ways in which work methods or availability of information have negative effects on social interactions? What are possible ways to strengthen social relationships and cooperation?
Providing service	**Open-ended question**: How do the available methods, information, and other resources help people perform service for internal or external customers? **Follow-on questions**: Is information readily available about what customers really want or need? How well do customers take responsibility for indicating what they want? How good is the balance between what the customer sees during service provision versus what only the provider sees?
Creating value	**Open-ended question**: What do the customers of this work perceive as the most important aspects of the value that they receive? **Follow-on questions**: How do providers obtain information about whether customers are receiving what they want or need? Are there important tradeoffs between providing value for customers and meeting internal goals related to costs, efficiency, employee satisfaction, and other internal concerns?
Maintaining security	**Open-ended question**: What important security-related threats exist or could emerge in this situation? **Follow-on questions**: Are the threats internal or external? Are the threats related to awareness of security issues? What security related training has occurred? To what extent was that training taken seriously?

About the Author

Steven Alter is Professor Emeritus at the University of San Francisco. He served as vice president of a manufacturing software start-up that was acquired by Applied Materials. After returning to academia, he wrote four editions of a major IS textbook. That effort led to research focused on developing systems analysis and design methods that business professionals could use for their own understanding and to help them collaborate more effectively with IT professionals, consultants, and vendors. The result was various versions of the work system method (WSM), which focuses on the business problem of creating or improving a sociotechnical work system rather than the more limited technical challenge of creating or improving software that satisfies requirements. Most of his papers in journals and conference proceedings relate to articulating and applying the work system perspective, which includes WSM, work system theory (WST), service systems, and extensions of WST such as a theory of workarounds and a service value chain framework.