Responsibility Modeling for Operational Contributions of Algorithmic Agents

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Abstract

This paper presents an agent responsibility framework that can be used to identify, describe, and analyze many possible roles that algorithmic agents might perform for information systems and other work systems, including those involving robotic process automation. The two dimensions of the framework are 1) a spectrum of possible roles for algorithmic agents and 2) a set of facets of work to which algorithmic agents might be applied in work systems. This paper explains those ideas, applies two examples to illustrate their potential use, discusses alternative ways to use the framework, and identifies areas for future research.

Keywords

Automated agents, facets of work, work systems, robotic process automation (RPA)

Responsibilities as a Lens for Understanding Systems

Many researchers have argued that methods for enterprise and process modeling have not achieved their full potential and need to be extended or augmented to make them more usable by broader user groups. For example, a *BISE* research note by enterprise modeling community leaders (Sandkuhl et al., 2018) encourages moving from an expert discipline towards “grass roots modeling” and "modeling for the masses." Their future research agenda includes “softened requirements to completeness, coherence and rigor”. Alter and Bork (2020) cite many articles that discuss problems related to modeling method usage, model comprehension, misuse of methods, poor fit with modelers’ aptitudes and knowledge, excessive cognitive load, lack of flexibility, and excessive prescriptiveness. Uncertainty and variability due to accidents, mistakes, and workarounds bring further challenges for modeling tools and methods. Part of the problem is that documentation tools and methods that are often considered the core of SA&D (e.g., BPMN and ERD) are often ineffective for visualization and discussion related to system design and evaluation.

This paper’s agent responsibility (AR) framework addresses parts of those problems by providing a different type of lens for the aspects of SA&D that are more concerned with intuitive understanding of systems and less concerned with detailed documentation. The AR framework integrates two sets of ideas that could help in visualizing and evaluating design alternatives. Those ideas are a spectrum of possible responsibilities for algorithmic agents and facets of work to which algorithmic agents might be applied in work systems. This paper explains those ideas and illustrates their potential use through two examples to. Pursuing that emphasis could help in reducing some of the model-related problems encountered by many SA&D efforts. Ideas presented here are equally relevant to both attended and unattended forms of RPA, robotic process automation (e.g., see Hofmann et al (2020) Leno et al. (2021, p. 303)), because both RPA use cases necessarily involve responsibilities related to facets of work in work systems that use RPA.

Goal. Present an agent responsibility (AR) framework that potentially helps in the analysis and design of information systems and other work systems that use algorithmic agents. Provide examples that illustrate the potential use of that framework. Identify areas for related research in the future.

Organization. The next section provides background in the form of four pillars of the AR framework. These include service-related responsibilities, algorithmic agents, the work system perspective, and facets of work (an extension of work system theory). The presentation of the AR framework emphasizes its two dimensions and how they interact. Two examples illustrate potential use of the AR framework, which can be used in other ways and adapted for other uses.

Background

The idea of looking at responsibilities related to systems certainly has existed in informal discussions of systems in organizations and has been covered in more general responsibility frameworks for projects or processes such as RACI (responsible, accountable, consulted, informed). This paper's innovation is the agent responsibility (AR) framework, which focuses on responsibilities of algorithmic agents in relation to facets of work in work systems. That framework is a current product of a research stream that started in the 1990s with a series of IS textbooks. Those textbooks introduced preliminary versions of the work system method (WSM), an SA&D method designed to be useful to both business and IS/IT professionals. WSM provides a broadly applicable way to think about systems in organizations and is based on ideas that were formalized as WST, work system theory (Alter 2006, 2008, 2013). This section discusses four largely disjointed ideas within that research stream that each contributed to the development of the AR framework. These will be called the four pillars that support the AR framework.

Pillar 1: Considering Responsibilities when Seeing Systems as Services

The stream of research related to WST first considered the idea of responsibilities as part of an attempt to visualize service systems as work systems in response to initial articles promoting service science (e.g., Spohrer et al., 2007, Maglio et al., 2009). Ultimately the work system perspective viewed service in relation to product/services produced by most work systems, in contrast with the assumption in service-dominant logic (Vargo and Lusch, 2016) that service is inherently an exchange of service for service between providers and customers, in essence an economic exchange.

The work system approach to service was articulated through use of the service value chain framework (SVCF) as part of an attempt to bring more of a service mindset into descriptions of systems (Alter 2010). The two-side form of the SVCF is based on assuming that services tend to be coproduced by providers and customers. Coproduction implies shared provider and customer responsibility for outcomes. More broadly, the SVCF combines concepts such as customer and provider responsibilities, service instances, service interactions, and frontstage and backstage. Value capture for both customers and providers is described as occurring during negotiation, set-up, service request, fulfillment, and follow-up phases, and also can extend long after specific service instances conclude. The AR framework builds on the SVCF by emphasizing responsibilities and including coproduction as one of the possible areas of responsibility for an algorithmic agent. The extensive discussion of concepts related to delegation, rights, and responsibilities in Baird and Maruping (2021) might be used at some future point to expand this view of systems as services.

Pillar 2: A General View of Algorithmic Agents[1]

Algorithms are abstract procedures for converting data inputs into data outputs. Algorithms may be as simple as a decision rule or as complex as an advanced optimization method or an integrated algorithm for driving a self-driving car. Given their nature as abstractions, algorithms cannot do anything by themselves and have effect only when human or non-human actors use them to support, control, or perform actions in the world.

Algorithmic agents are human or nonhuman agents that perform activities based on explicit algorithms. Table 1 lists examples involving algorithmic agents that might or might not use AI-related capabilities. Some of those algorithms might be simple decision rules such as allowing no more than 40% of applicants to be classified in category X. Even a simple algorithm like that one can have important and far reaching effects such as favoring one group of people over other groups, as when category X is qualification for employment or acceptance into college. Notice how the issue of bias and favoring one group over another is intertwined

[1] This section is an abbreviated and revised version of a section in Alter (2021b) that discusses algorithms. A subsequent discussion of a hiring system is based on the same source.

with justifications for using alternative algorithms instead of less formalized or unstated subjective perceptions and judgments that frequently have their own biases.

• using facial images to identify people • converting spoken words into equivalent text • deciding which applicants should be hired or accepted by a university • deciding whether to alert medical staff about a change in a patient's condition • deciding whether a person is legally entitled to drive • deciding which is the best target for a missile • deciding a person's salary or bonus • deciding whether an autonomous vehicle needs to stop or swerve	• deciding whether to turn off a machine likely to have a mechanical failure soon • deciding where police should be deployed today • selecting defective items that are being moved on a conveyor belt • combining multiple items in an order to minimize shipping cost • automatically writing stories starting from an initial paragraph • determining the best route for driving from a starting point to a destination • finding the laws that are most relevant to a specific lawsuit • use aerodynamic principles to control the flight of a rocket

Table 1. Application situations for algorithms (that might or might not use AI)

Pillar 3: Work Systems as the Context for Using Algorithmic Agents

The work system perspective (WSP) is a general approach for understanding systems in organizations by treating those systems as work systems as explained in Alter (2006, 2013). The core of the WSP is work system theory (WST), which consists of three components: the definition of work system plus two frameworks for understanding a work system, both shown in Figure 1. The work system framework outlines a rudimentary understanding of how a work system operates. The work system life cycle model (WSLC) explains how a work system evolves through planned and unplanned change. Earlier confusion about the relationship between core ideas and various extensions of the work system approach was clarified when Alter (2013) identified WST as a core of ideas underlying the work system method (WSM) which had been developed over several decades as a semi-formal systems analysis method for business professionals. Various versions of WSM have been tailored to instructional needs of different courses, most of which were for employed MBA and Executive MBA students. Individual students or teams of students used WSM templates to produce over 700 management briefings recommending improvements of problematic IT-reliant work systems during 2003-2017, mostly in their own organizations (e.g., Truex et al, 2010).

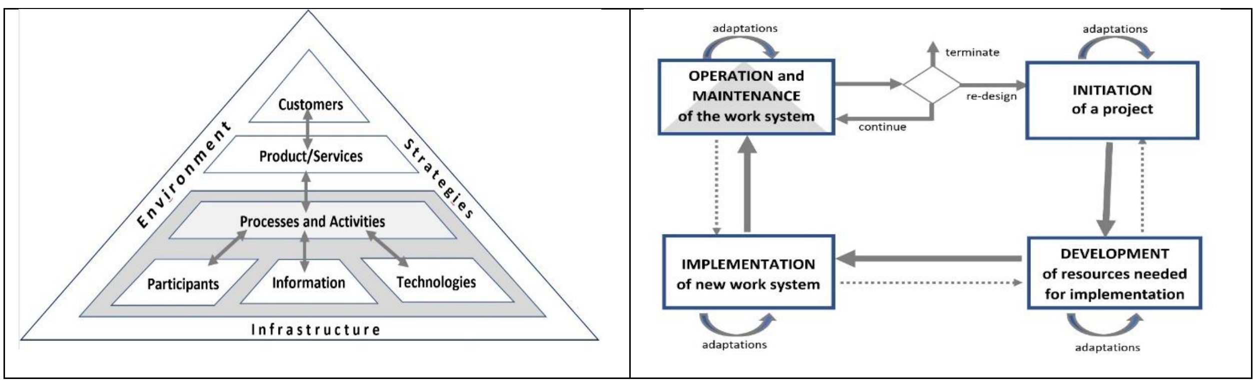

Figure 1. Work system framework and work system life cycle model

Definition of work system. A work system is a system in which human participants *and/or* machines perform work (processes and activities) using information, technology, and other resources to produce specific product/services for internal and/or external customers. Terms in that definition are stated in relation to work systems rather than in relation to other discourses. C*ustomer* refers to any entity using the work system's outputs; *product/service* avoids distinctions between products and services that are not helpful when discussing work systems; *processes and activities* recognizes that activities in a work system may or may not be structured enough to call a business process. The first *and/or* in the definition addresses trends toward service-orientation and automation by saying that work systems may be sociotechnical (human participants perform some of the work) or totally automated (machines perform all of the work).

Information systems and projects as special cases of work systems. Instead of seeing an IS as a tool, like a laptop or a hammer, the work system perspective treats information systems as work systems most of whose activities are devoted to capturing, transmitting, storing, retrieving, deleting, manipulating, and/or displaying information (Alter, 2008, 2013). An IS may be sociotechnical (e.g., financial analysts creating economic projections with the help of modeling software) or totally automated (e.g., computers generating economic projections automatically by using algorithms developed by people). Projects are another important special case, i.e., work systems designed to produce specific product/services and then go out of existence. Software development is a type of project that can be executed in many ways.

Work system framework: elements of a basic understanding of a work system. This framework identifies nine elements of a basic understanding of a work system's form, function, and environment during a period when it retains its identity even as incremental changes may occur, such as minor process changes, personnel substitutions, or technology upgrades. *Processes and activities*, *participants, information*, and *technologies* are completely within the work system. *Customers* and *product/services* may be partially inside and partially outside because customers often participate in activities within a work system and because product/services take shape within a work system. *Environment, infrastructure*, and *strategies* are external to the work system even though they have direct impacts on its operation.

Work system life cycle model (WSLC): how work systems change over time. This says that work systems (including ISs) evolve through a combination of planned change via projects and unplanned change via adaptations and workarounds. Significant changes typically affect multiple elements of the work system framework, not just technology. Projects that pursue planned change traverse three main phases: initiation, development, and implementation. Much the WSLC remains valid even with nominally agile approaches, e.g., the emphasis on work system changes rather than just software development, the focus on evolution over time rather than one-time projects, the simultaneous importance of planned and unplanned change, and the relevance of key responsibilities within each phase. Those same issues apply to projects involving work system-related AI applications because it is necessary to determine requirements (at an appropriate level of detail), acquire or produce any needed software, test and debug software, decide how to implement work system changes, identify implementation problems, and train work system participants.

Customers	Product/services
• Applicants • Hiring manager • The organization (where a new employee will be a colleague) • HR manager (who will use the applications to analyze the nature of applicants)	• Applications (which may be used for subsequent analysis) • Job offers • Rejection letters • Hiring of the applicant

Major activities and processes	
• **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.	• **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.

Participants	Information		Technology
•Hiring manager •Applicants •Other employees who perform interviews	•Job requisition •Job description •Advertisements •Job applications •Cover letters •Applicant resumes	•Applicant short list •Information and impressions from interviews •Job offers •Rejection letters	•AlgoComm •AlgoRank •Office software •Internet

Table 2. Work System Snapshot of a Hypothetical Hiring Work System

A Hypothetical Work System that Uses AI-Based Algorithmic Agents. Table 2 is a work system snapshot (a tool from WSM) summarizing a hypothetical hiring system that illustrates a work system perspective. PQR Corp implemented a hiring work system to improve a previous hiring work system that absorbed too much effort inside PQR Corp and operated so slowly that qualified candidates took other jobs before receiving offers. Also, it hired unsuitable candidates who left before becoming productive. AlgoCorp provided two *algorithmic agents* for the hiring system, AlgoComm and AlgoRank. 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 machine learning application driven by AlgoCorp's extensive database of job qualifications, salaries, and other information. AlgoRank can be seen as an AI application, whereas AlgoComm seems more like typical information processing even though certain parts of it apply AI technologies such as a chatbot and other capabilities involving natural language processing (NLP). A quick glance at Table 2 shows that the hiring work system involves much more than AlgoComm and AlgoRank. That work system uses AI but should be viewed as a hiring system (i.e., a name based on its purpose) and not as an AI system (a description of some of its components).

Pillar 4: Facets of Work

The idea of facets of work grew out of research attempting to bring richer and more evocative concepts to systems analysis and design to expand its scope and to facilitate interactions between analysts and stakeholders, as explained in Alter (2021a, pp. 342-344). The notion of facet is an analogy to how a cut diamond consists of a single thing with many facets. The idea of facet has been used with quite different meanings and connotations in psychology, library science, information science, and computer science.

Most activities in work systems can be described as consisting of activities of common types, such as making decisions, communicating, and coordinating. For current purposes, those types of activities can be considered facets of work if they are easily understood and widely applicable and if they satisfy a series of criteria: They apply to both sociotechnical work systems and totally automated work systems; they are associated with many concepts that are useful for analyzing system-related situations; they are associated with evaluation criteria and typical design trade-offs; they have sub-facets that can be discussed; they bring open-ended questions that are useful for starting conversations. Table 3 illustrates how the facet *decision making* satisfies those criteria. Alter (2021a) includes tables providing the same types of information for 18 facets of work while recognizing that other researchers might have identified 15 or 23 facets of work that satisfy those criteria. This paper uses only six of those facets, both for the sake of simplicity and due to this paper's ten page length limitation. Importantly, there is no assumption that the facets of work should be independent. To the contrary, the facet *making decisions* often involves other facets such as *communicating* and *processing information*. Also note that specific facets of work are not subsystems of a work system because the activities related to the facet may be distributed across different noncontiguous parts of a process. The main point is that each facet serves as a lens for thinking about where and how algorithmic agents might have responsibilities in a work system.

Type of qualification	Example related to making decisions
Applies to sociotechnical and automated systems	Sociotechnical work system: Marketing managers allocate an advertising budget. Totally automated: An optimization model allocates a corporate advertising budget.
Association with many concepts that can be used for analysis	Decision, criteria, alternative, value, risk, payoff, utility, utility function, tradeoff, projection, optimum, satisficing vs. optimizing, heuristic, probability, distribution of results, risk aversion
Association with evaluation criteria	Actual decision outcomes, realism of projected decision outcomes, riskiness, decision participation, concurrence, ease of implementation
Association with design tradeoffs	Quick responsiveness vs. superficiality; Complexity and precision of models vs. understandability; Brevity vs. omission of important details
Existence of sub-facets for detailed description	Defining the problem; identifying decision criteria; gathering relevant information; analyzing the information; defining alternatives; selecting among alternatives; explaining the decision
Related open-ended questions	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?

Table 1. Why *making decisions* qualifies as one of 18 facets of work

The Agent Responsibility Framework

The hiring example summarized in Table 2 illustrates that algorithmic agents can contribute to some of the activities in work systems. That straightforward observation says little about how to understand roles of algorithmic agents in greater depth. A designer, engineer, or manager trying to decide whether or how to produce and apply an algorithmic agent that serves a work system could benefit from a framework that helps in identifying and visualizing potential design choices related to algorithmic agents.

Shneiderman's (2020a, 2022b, 2022) HCAI (human-centered AI) framework is a step in that direction. Its two dimensions, low vs. high computer automation and low vs. high human control distinguish between many situations in which both computer automation and human control are design variables:

- Low computer automation, low human control: Examples include a music box and a landmine.
- High computer automation, low human control: Examples include a pacemaker and an airbag.
- Low computer automation, high human control: This is where human mastery applies. Examples include playing the piano and riding a bicycle.
- High computer automation, high human control: Safe, reliable, and trustworthy examples include elevators and digital cameras.

The HCAI framework explains why a frequently imagined contradiction between computer automation and human control is based on a false assumption that computer automation and human control coexist in a zero-sum game, where more of one necessarily implies less of the other. Despite expressing a key insight, the HCAI framework's two dimensions say little about how or why an algorithmic agent might affect a work system's operation or might affect stakeholders such as work system participants or customers.

Roles and Responsibilities. The AR framework in Figure 3 addresses that limitation by pointing toward more detailed characterizations of responsibilities of algorithmic agents. It identifies six roles that an algorithmic agent might perform in relation to its responsibilities regarding any of six facets of work. Clarity about those roles and responsibilities in specific work systems requires attention to whether and how an algorithmic agent supports specific facets of work, such as making decisions, communicating, and processing information. Figure 3 says that the usage of an algorithmic agent occurs when it plays one or more roles (the horizontal dimension) related to one or more facets of work (the vertical dimension). The brief description of the hiring example implied that AI-based algorithmic agents contributed to hiring by playing roles such as providing information and executing activities related to facets such as making decisions, communicating, and processing information.

<<< Facets >>>							
	Making decisions						
	Communicating						
	Processing information						
	Coordinating						
	Creating value						
	Maintaining security						
		Monitor work system	Provide information	Provide capabilities	Control activities	Coproduce activities	Execute activities
		<<<<<<< **Spectrum of responsibilities** >>>>>>>					

Figure 3. The agent responsibility framework

The AR framework's horizontal dimension identifies six different approaches for supporting specific facets of work in a work system. Those six approaches were identified based on many iterations of trying to expand the horizontal dimension of the HCAI framework to make it more specific. E.g., one of the early iterations involved only three roles, i.e., support, control, and perform. The AR framework's six roles represent a spectrum from lowest to highest direct involvement in the execution of activities within a work system. The 6 facets in the vertical dimension are selected from the 18 facets of work identified in Alter (2021a), which showed that all 18 facets of work were often worth considering but did not provide an explicit rationale for placing them in a sequence. Combining those two dimensions leads to pinpointing issues such as the extent to which an algorithmic agent should have responsibilities such as monitoring security, providing capabilities used in making decisions, or executing information processing activities automatically.

Before saying more about the two dimensions in Figure 3 it is worth noting that using the AR framework does not rely on an exhaustive search of all possible combinations of roles and facets. Simply thinking about different facets of work could encourage designers or managers to wonder about needs to enhance specific facets of work in specific work systems. Similarly, the spectrum of roles along the horizontal dimension encourages designers or managers to consider different possible roles that algorithmic agents might play and related responsibilities that they might have. There is no reason to consider all or even many of the 36 possible combinations of 6 facets of work and 6 types of roles and related responsibilities. Instead, practicality implies that designers and managers should look carefully only at the combinations that are potentially important for a specific work system.

Designers and managers also might consider some of the other 12 facets of work that are mentioned in Alter (2021a) but not discussed here. Those other facets in include learning, planning, improvising, interacting socially, providing service, and seven others. Two of the additional facets, providing information and controlling execution, appear as topics in the AR framework's horizontal dimension. That overlap exists because the development of the original 18 facets occurred before Shneiderman's HCAI framework inspired the development of the AR framework.

The Horizontal Dimension: Different Types of Responsibilities that Might Be Assigned to an Algorithmic Agent

The horizontal dimension of the AR framework identifies six types of roles for algorithmic agents (AAs) in the execution of different facets of work within work systems. Those roles might be consistent with human-centered values and aspirations or might oppose those values and aspirations (e.g., supporting micromanagement or surveillance capitalism). The following comments about the six roles mention some of the possibilities while recognizing that many others might be mentioned:

- **Monitor a work system**. AAs might monitor and measure aspects of work to assure that a work system's processes and activities are safe and appropriate for work system participants. In other situations, AAs might monitor work in a way that feels like micromanagement. In either case, AAs might generate alarms when aspects of work seem to be going out of accepted bounds.
- **Provide information**. AAs might provide information that helps people achieve work goals safely and comfortably without infringing on privacy and other rights of people whose information is used. AAs also might provide information in a way that is inappropriate or even illegal.
- **Provide capabilities**. AAs might provide analytical, visualization, and computational capabilities that help work system participants achieve their assigned goals safely and with appropriate effort. In other cases, AAs might provide capabilities that are inadequate for the goals at hand.
- **Control activities**. AAs might control work activities directly to make sure that specific activities do not go out of bounds related to worker safety, time on the job, stress, and other variables that can be measured and used actively to control the work system. In other cases, AAs might limit the autonomy of human participants and might make them feel like cogs in a machine.
- **Coproduce activities**. AAs might be deployed in a division of responsibility in which both AAs and people have complementary responsibilities for performing different parts of the work. Either humans or AAs might take the lead in human-computer interactions related to coproduction activities. Alternatively, the initiative in human-computer interactions might go back and forth between people and AAs depending on the status of the work.
- **Execute activities**. AAs might execute activities that should not or cannot be delegated to people. For example, AAs (or devices controlled by AAs) might perform activities that are difficult, dangerous, or impossible for people perform as the work system's produces its product/services. In other cases, AAs might seem like a cost-saving approach for executing activities that work system participants could perform at higher cost or should perform despite the higher cost because human judgment is needed.

The Vertical Dimension: Different Facets of Work in which an Algorithmic Agent Might Have Responsibilities

Table 4 identifies some of the ways in which algorithmic agents might contribute to 6 facets of work in the hiring case. While some of the examples are similar to others, the general point is that the idea of facets of work could help in identifying different forms of usage for algorithmic agents in a specific work system. Other possibilities are easy to imagine but are not mentioned here.

Facet of work	Ways in which an automated agent (AA) might contribute to specific facets of work in a hiring work system
Making decisions	An AA might produce a data-driven ranking of applicants, thereby coming very close to suggesting a decision. Also, in AA might identify ways in which current or past hiring processes demonstrate inappropriate bias.
Communicating	An AA could support or perform communication between the firm and applicants (possibly via chatbots)
Processing information	An AA could translate resumes and cover letters to conform with a template that makes the interviews more efficient and could show that result to the applicants.
Coordinating	An AA could support better coordination of interviews to minimize the disruption experienced by interviewers and greater convenience for applicants.
Creating value	An AA could enhance the value of feedback in order to make the hiring experience seem more like a service to applicants.
Maintaining security	An AA could help in maintaining information security for applicants, interviewers, and the firm as a whole.

Table 2. Examples of ways in which algorithmic agents might be applied to various facets of work in the hiring system in Table 2

Application of the AR Framework to a Medical Example

This example is based on "The Update: Why Doctors Hate Their Computers," a case study by a well-known surgeon (Gawande, 2018) that explained difficulties in the $1.6 billion implementation and subsequent use of the EPIC electronic medical records (EMR) system in a large healthcare organization. The case study was discussed in several existing papers for other purposes, but will be used here to illustrate how the two dimensions of the AR framework help in understanding aspects of an important real world situation. The case study fully recognizes the importance of immediate access to patient information, and the fact that EPIC became an integral part of the organization's medical practices and therefore might seem successful. Nonetheless, the author said, "something's gone terribly wrong. Doctors are among the most technology avid people in society; computerization simplifies 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).

The chief clinical officer who supervised the upgrade saw important benefits in standardization and in benefits for patients. In contrast, the author says, "I've come to feel that a system that promised to increase my mastery over my work has, instead, increased my work's mastery over me." The case mentioned "signal fatigue" and said that "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." A primary care physician described erasing EMR-generated alerts and emails that had become overwhelming. Those included automated email reminders that previous emails had not been answered. Contrary to expectations about better communication, the author "began to see the insidious ways that the software changed how people work together. They become more disconnected, less likely to see and help one another, and often less able to [help]" as in a situation where a medical assistant who formerly organized information to help physicians work more efficiently no longer had access rights to patient information.

Roles of algorithmic agents in relation to facets of work in the case. For each of the 6 facets in the AR framework, Table 5 shows in parenthesis one of the six roles in the AR framework's horizontal dimension and then summarizes how an algorithmic agent (AA) playing that role might be applied to the facet of work. Table 5 applies the roles in the AR framework in the same sequence in which they appear in Figure 3. Associating roles with facets in that way has no significance other than showing that roles can be assigned to facets. Most of the roles can be applied to most of the facets even in this single case study. A more detailed exercise of assigning each role to all 18 facets that were discussed in Alter (2021a) would make basically the same point using a table with 108 entries.

Facet	Illustration of how a specific algorithmic agent (AA) role (***in parenthesis and italicized***) might be applied to a specific facet of work in the medical case study
Making decisions	(*monitor*) The AA might <u>monitor</u> clinical <u>decisions</u> to make sure that hospital standards are followed and to make sure that people from different socioeconomic classes are treated equitably.
Communicating	(*provide information*) The AA might <u>provide information</u> that would expedite <u>communication</u> between overscheduled medical staff members.

Processing information	(*provide capabilities*) The AA might provide capabilities for data visualization to help physicians process information they need without expending a great deal of effort.
Coordinating	(*control activities*) The AA might control aspects of coordination between staff members by making sure that physician entries in problem lists for patients with complex medical conditions adhere to standards that typically help when other physicians serve the same patients.
Creating value	(*coproduce activities*) The AA might help in creating value for both physicians and patients by helping them coproduce active monitoring of medical conditions and treatments that require follow-up and attention.
Maintaining security	(*execute activities*) The AA might help in maintaining security and patient privacy by executing activities that monitor the content of incoming and outgoing electronic messages that involve security- or privacy-related issues.

Table 5. Applicability of different roles of automated agents to different facets of work in the context of using an electronic medical record system

Conclusions: Uses of the Agent Responsibility Framework

This paper's main contribution is introducing an extension of Shneiderman's HCAI framework in the form of an agent responsibility framework that emphasizes roles and responsibilities of algorithmic agents regardless of whether AI is involved. The AR framework assumes that SA&D related to systems in organizations can express important aspects of system requirements by describing roles and responsibilities of algorithmic agents in relation to an entire work system or specific facets of work within a work system. A potentially useful version of the AR framework with 6 roles and 6 facets was presented, but the framework could be expanded or otherwise modified in many directions. For example, if workarounds are a major issue in a specific work system, then a facet called improvising or performing workarounds should be included in discussions of the system. Alter (2021a) explained 18 facets of work (one of which was improvising), but there is no need to think about all of them in any specific situation, just as there is no need to consider using every symbol in BPMN when describing a specific system.

The ideas in the AR framework can be used in many ways, some of which look at roles or facets in a general way and some of which look at specific roles or facets in more detail. All of the following approaches recognize that a specific AA may have responsibilities related to different roles and may touch multiple facets of work. Notice, for example, that most of the following approaches might help in discussing and designing RPA applications that assign responsibilities to unattended or attended bots. They might also be used in work systems designed to include mixed initiative interactions between people and robots.

- **Focus on roles in a general sense**. Consider the spectrum of roles in the AR framework and think about how well those roles are performed or should be performed in the future in the work system, regardless of which facets of work are involved. For example, think about how well the work system is monitored or how well its operation is controlled.
- **Focus on facets in a general sense**. Identify facets of work (the vertical dimensions of the AR framework) that seem important for the work system and evaluate how well those facets of work are performed. Without looking at the framework's roles in detail, try to imagine ways in which those facets of work might be performed more efficiently and effectively in the work system.
- **Identify responsibilities of specific AAs across the spectrum of roles**. This leads immediately to identifying responsibilities of those AAs and asking about the extent to which those responsibilities are being satisfied or probably will be satisfied in the future after proposed changes.
- **Identify responsibilities of specific AAs in relation to specific facets**. This leads immediately to asking how well those AAs satisfy those responsibilities related to those facets of work.
- **Focus on a specific role and specific facet**. Explore how well one or more AAs meet responsibilities related to a specific role for an important facet of work.

All of the above can be done with the 6x6 version of the AR framework or with an expanded version that might involve more facets or more responsibilities that are not included in Figure 3. As noted earlier, 18 different facets of work meet the criteria for being considered a facet of work, even though it is impractical to look in depth at every imaginable facet in a real world analysis.

Next steps. This paper presented a new AR framework and applied it to two situations that were selected for illustrative purposes. The next step is to obtain experience by applying it in instructional situations and/or real world situations to evaluate its practicality for describing systems and/or in SA&D.

If the AR framework proves useful in those initial applications, then further research or just trial applications should aim at applying the framework as part of broader SA&D methods and tools, mostly during the requirements determination phase. Further application could occur as a sanity check during the development and implementation phases for AAs that affect important facets of work in the work systems that are supported, controlled, or automated. A practical question during that extended use is the extent to which applications of the AR framework fit with other SA&D ideas and tools that focus on requirements determination and on evaluation of existing systems. Linkage to documentation tools and methods such as BPMN is not a primary concern, at least initially, because the purpose is to help people think about systems in organizations and not to document systems, software, or networks. As noted in the introduction, focusing on high precision models too early may not be helpful when the task at hand is visualizing and collaborating around shared understandings of high level issues.

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