Some New Perspectives for Introducing Human-Systems Integration into the System Development Process

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ABSTRACT: As further background for this Special Issue, this paper introduces a sampling of the findings of a National Research Council Committee on Human-Systems Design Support for Changing Technology. The paper introduces the Incremental Commitment Model of system development that was designed to accommodate the needs of the human-system integration (HSI) community. The committee viewed effective integration of human-system issues as requiring (a) stakeholder satisficing—solutions that meet acceptability criteria of all stakeholders; (b) incremental growth of system definition and stakeholder commitment; (c) iterative and concurrent system definition and development; (d) HSI risk analysis and risk management in concert with that of the other engineering disciplines involved in a project; and (e) HSI outcomes or deliverables designed specifically to be shared and understood by the other stakeholders. As the committee members looked to the future, they envisioned a point when it would be possible to develop a fully integrated HSI development methodology. They also foresaw a time when HSI might become an independently recognized discipline and more HSI specialists would be qualified to lead project teams, placing the discipline in a more commanding role in the system development process.

Introduction

AN ASSESSMENT OF THE FIELDS OF HUMAN FACTORS/ERGONOMICS/COGNITIVE ENGINEERING reveals a lot of progress in attaining the status of a recognized discipline within the engineering profession, but much work remains to be done. There are no engineering departments devoted to our field. With a few exceptions, education in the field is treated as a specialization in an existing department. There are several textbooks, research centers, societies, conferences, journals, and standards supporting our work, but industry recognition of the importance of considering human performance capacities and limitations in developing new processes, products, and services is haphazard at best. Some organizations in some industries have taken the lead in promoting its importance, but, with the exception of commercial software designed for individual businesses or consumers, our work is not widely accepted as routinely required in new system development.
The military services have gone the furthest in establishing standards and requiring their technology contractors to meet human factors requirements. The Army MANPRINT program has been in operation since the 1980s and has continually upgraded its management commitment and support for human-centered design. All three military services now have human-systems integration (HSI) programs in place (MANPRINT, SEAPRINT, and AIRPRINT). They address all of the kinds of human issues that arise in system development—human factors engineering, manpower planning, personnel selection, training, occupational health and safety (including survivability), and habitability (design of working environments). There is now even a JPRINT office, which coordinates activities across the services. The scope of activities of interest is nicely characterized in Figure 1, originally prepared by the U.S. Navy HSI community (U.S. Navy HSI Community, personal communication, 2005).

In the last few years, the term human-systems integration has been used to capture the full scope of work associated with accommodating people in systems and is particularly concerned with integrating human-systems design considerations into the larger domain of systems engineering (Booher, 2003).

Objective

This paper provides an overview of some of the contributions and perspectives of the National Research Council (NRC) Committee on Human-Systems Design Support for Changing Technology contained in our report concerning HSI in the system development process (Pew & Mavor, 2007). See Roth and Pew (2008, this issue) for further background. In particular, this paper introduces the committee's system development framework that drove our efforts at integration. It includes the HSI considerations associated with this framework, as well as some of the committee's visions and recommendations for the future.
The full report includes the presentation of the development framework, a section discussing critical considerations for introducing HSI into that life cycle, a section describing the full range of methods and tools applicable to HSI, and, finally, perspectives for the future, conclusions, and recommendations for needed work.

An HSI-Compatible Iterative System Life Cycle Development Framework

In the course of its deliberations, the committee identified five principles of system development that were regarded as essential to a successful project. These principles were considered critical from the point of view of both the systems engineering process and of HSI. The systems engineering process was conceptualized as a network of projects, each requiring multidisciplinary collaboration. These projects are partitioned into manageable work units consisting of analysis, development, design, implementation, and so forth. It is assumed that most of these work units will involve considerations of human interaction and therefore require participation by HSI specialists. System building requires decomposition into modules and submodules reflecting the hardware and software units to be designed, and the top-level conceptual design should reflect the expected, work-centered contribution of both the technology and the human participants.

Stakeholder Satisficing Solutions

The committee identified a variety of potential stakeholders in the systems engineering process, including program managers, system developers, first-level managers, contractor managers, human factors professionals, and others representing personnel selection, staffing, occupational health, safety, habitability, and, in the military, survivability. The ultimate target users of the system are, of course, also critical stakeholders, as are policy makers, regulators, and those providing research and development funds. The committee sought satisficing solutions among this diverse collection of stakeholders—that is, solutions that meet acceptability criteria of all of them but that are unlikely to be optimal solutions for any one of them.

Incremental Growth of System Definition and Stakeholder Commitment

Although a strict “waterfall” development methodology assumes that a team can largely define the requirements and specifications for a system before anything is contracted for or built, as a practical matter, this rarely happens. There is always a tension between systems engineering and human factors specialists. The systems engineering staff push for early, complete, and detailed specification of requirements. The human factors staff have difficulty specifying detailed requirements until candidate architectures have been considered and early prototypes have been explored. So much depends on just what decision support and user interfaces are going to be required.

The committee’s report suggests that the system development process be regarded as incremental—system definition should evolve over time, and stakeholders should have opportunities to review and commit to further development at each of a series of
milestones. Early in the process, the specification vocabulary should emphasize more negotiation-oriented terms, such as goals and objectives, and only later move toward more formal requirements. Experience also suggests that system definition is never really complete, and, when possible, design should provide for further evolution and adaptation even after the system has been deployed in the field.

Iterative System Definition and Development

Development should be not only incremental but also iterative. At each milestone, there should be the opportunity to decide that one or more of the work units is too risky and does not meet the standard for going forward. The staff can then use the feedback from the review to undertake the redevelopment of such work units.

Concurrent System Definition and Development

System development may be phased, such that some work units are still in the analysis stage while the better-understood units are already in design and/or implementation. It should be expected that the specification of some work units or modules, even ones that eventually will be serially integrated, may go on in parallel and that integration will take place in a subsequent development phase.

This has particular implications for HSI professionals because they must be prepared to proceed with design hypotheses based on sparse information and limited understanding about how the other parts of the system will be defined. It should be expected that their understanding and their design specifications will, of necessity, continue to evolve as other aspects of the design evolve.

Risk Management

Effective system engineering is risk-driven. The risks are viewed not just in terms of development cost and schedule constraints but also with a long view toward subsequent production feasibility and cost, life cycle operational costs, and forecast system effectiveness. At each milestone, the team reviews the risk associated with each work unit or module. This risk assessment is used to determine whether to progress to the next development phase or to undertake further exploration and evaluation of the design before proceeding.

As will be elaborated in a later section, the HSI development risks should be addressed in concert with software development risks and all other system development risks. The need for HSI risks to compete with the other system risks implies that HSI specialists cannot cost-justify undertaking the same levels of analysis and design for all human performance aspects. They must make judgments about which aspects represent the highest risks and focus their analysis on those aspects. If new kinds of automation are planned to be introduced, they are likely to introduce high risk, which requires more analysis and design, whereas making use of relatively standard office procedures applied in new scenarios may be lower risk and not justify extensive analysis and design effort.

These five principles are both descriptive and prescriptive. They are descriptive in the sense that they represent properties of effective systems engineering as it is often executed. The committee also believes that they are prescriptive of good
practice for systems engineering in general as well as for the HSI aspects of the design. The HSI community should embrace these principles because they are good practice and because they will facilitate the acceptance of HSI as part of the systems engineering process.

The Incremental Commitment Model

Figure 2 presents the Incremental Commitment Model (ICM) in its simplest form. The system development phases are labeled Exploration, Valuation, Architecting, Development, and Operation. However, as shown, a second round of architecting and development for some work units may be taking place in parallel with the development of other units. Some details about activities that take place in these phases are shown just below the labels. Five milestone reviews are shown, and their definitions and abbreviations are displayed at the top of the diagram. At each milestone, the team assesses the risk of proceeding with each work unit and may decide to skip a phase (risk negligible), go on to the next phase (risk acceptable), iterate the current phase (risk high but addressable), decide that a new approach is required, or abort the development (risk unacceptable).

This model was derived from the spiral model conceptions of Boehm, Brown, Basili, and Turner (2004) that were specifically designed to be consistent with the DoD 5000 acquisition milestone schedule. It was arranged to accommodate the kinds of activities that are required during exploration and valuation to accomplish

Figure 2. Overview of the Incremental Commitment Model (Pew & Mavor, 2007, with permission from the National Academy of Sciences, courtesy of the National Academies Press).
sound work-centered design, which requires considerable front-end analysis before solutions can be conceptualized.

An important feature of this process is the continuous nature of the analysis and design activities throughout the development process. This idea is captured schematically in Figure 3, which shows how system engineering activities—particularly HSI activities—take on different levels of importance or effort at different stages of development and have some level of importance throughout the process. For example, “understanding needs” peaks early in the exploration phase and then again as the system is first deployed, perhaps during a beta test phase when needs may be revised. Evaluation effort, including usability evaluation, peaks just before each commitment review in order to provide the most quantitative review criteria possible.

Figure 4 provides another way to highlight the highly iterative and concurrent nature of the development cycle with respect to HSI requirements by showing the
Figure 4. Conceptual summary of how HSI can be integrated into the Incremental Commitment Model (Pew & Mavor, 2007, with permission from the National Academy of Sciences, courtesy of the National Academies Press).

The incremental and concurrent approaches lead to cyclic refinements of requirements and specifications. Such iteration is necessary to fully achieve comprehensive performance requirements.

This characteristic encompasses the necessity of gradual development through defining system requirements and obtaining agreement among stakeholders in a developmental way. Requirements and commitment cannot be monolithic for complex systems; understanding, definition and commitment is achieved through a cyclic process.

The intensity of specific design activities will depend on the level of risk associated with them. If the user interface is considered a high-risk area, for example, then more design activity will be devoted to this component to achieve stakeholder commitments at particular design anchor points.

As with incremental growth, specific requirements and subsystem definition occur simultaneously with development of previously defined system components. This allows continual growth of complex systems without waiting for every requirement and subsystem to be defined.
mapping of HSI activities to systems engineering development phases. The figure also serves as a summary of the important features of the ICM.

The committee’s report includes a description of three case studies in widely different domains—unmanned aerial systems, shipping port radiation screening, and medical device design—to illustrate how HSI considerations are manifest in a sample of real applications.

**Risk Management**

As suggested earlier, for all work units the level of analysis and development effort should be driven by an analysis of the development risk. This risk is defined as the estimated probability of successful development, based on the team’s level of understanding of the context in which the system will be used and the team’s knowledge and experience with respect to the elements to be developed. If previous versions of the elements can be transferred to the new design, then the risk is very low. If no previous experience with these particular goals or requirements exists, the risk is high.

In the HSI domain, specialists are not accustomed to making this kind of explicit risk assessment, although undoubtedly it is often implicit in the definition of the work to be accomplished. It is important that it be made explicit, be as quantitative as possible, and be articulated as a part of each milestone review.

A significant difficulty in assessing the HSI development risk is that, unlike the other risk areas, there is less risk that the design will not be realizable but more risk that the resulting design will not meet usability goals, will reveal safety risks, or will expose unforeseen failure modes based on human performance capacities or limitations. Although addressing these kinds of risks requires much front-loaded activity associated with work-centered design, personnel selection, and training, the implications are very difficult to predict or foresee at these early stages. This is further reason that the development process must be iterative, allowing for the revision and elaboration of requirements at each development milestone.

Although it is very difficult to make creditable HSI risk assessments in the early stages, it is important to do so in order to be competitive in the context of other systems engineering development risks. Further research and development activity is needed to improve HSI risk assessment.

**Communicating HSI Contributions in Shared Representations**

The committee identified effective communication among team members as very important in the systems engineering process. When people from different disciplines collaborate in a design process, they bring their own perspectives, experience, language, and work practices to the table. Providing artifacts or deliverables that support successful communication across the diverse stakeholder audience is an important aspect of each discipline’s output.

This is particularly important for HSI input, for which the results are often qualitative and difficult to communicate. Within the HSI discipline, researchers and
practitioners work with specific operational definitions for such terms as *workload* and *situation awareness*, but other discipline specialists think of the broader, everyday meanings of these terms. Although block diagrams and oral descriptions are typical outputs of a cognitive task analysis, the information gained is much richer than what is communicated by these products.

The committee adopted the term *shared representation* to reflect an idea originally introduced by Curtis, Krasner, and Inscoe (1988). A shared representation is one that abstracts and presents the essential details of analysis required to support the conclusions and recommendations to be communicated in a medium that can be understood easily by all stakeholders. An effective shared representation should accomplish the following:

- Establish a shared language aligned with the problem to be solved.
- Facilitate the social process to support multidisciplinary understanding.
- Make differences and relationships apparent.
- Provide a strategically selected level of ambiguity versus definition.

Shared representations may take the form of stories, scenarios, personas, graphics, video excerpts, models, simulations, or demonstrations—whatever is needed to make the point. What is important is that they be designed with the other stakeholders in mind and that an explicit effort be made to ensure that the conclusions are understandable and supportable.

**Summary**

Effective HSI contributions require that a system development framework be adopted that accommodates the kind of up-front information collection and analysis that provides the requisite background for design. However, it is equally important that HSI specialists (a) understand the perspectives of the other design stakeholders, (b) be responsive to the needs for milestone review inputs that can compete on equal terms with those of the other participating disciplines, and (c) contribute realistic HSI development risk analyses that make clear which work units are worthy of specific human performance analysis before committing to requirements.

**Visions for the Future**

A section of the NRC report is devoted to the presentation of the committee’s visions for the future—defined as 5 to 10 years in the future—and some research that will support those visions. In this section three of these perspectives are summarized.

**An Integrated Design Methodology**

In the current state of the art, a wide variety of methods and tools for supporting HSI during the various phases of system design and development are available. For example:
When taken together, these and other sources present a comprehensive scope of HSI methods. However, the methods themselves tend to exist in isolation, often with overlapping applicability and in competition with one another. Nemeth (2004) assembled existing methods into a coherent book, but there are still gaps within the existing methods, and more work is needed to improve their integration into a coherent methodology and suite of tools that would support a more integrated methodology. Within the field, there has been little effort to think in terms of end-to-end support of the HSI development process with tools that are coordinated seamlessly.

The committee members believe it is becoming feasible to think seriously about assembling such an integrated methodology for human-systems design that takes advantage of advances in simulation and modeling, as well as the technologies associated with virtual environments, gaming, multimedia, and collaboration. Such a methodology would encompass the following:

- Defining opportunities and requirements
- Defining the context of use
- Designing solutions
- Evaluating

These points comprise the steps that are taken repeatedly—in some cases concurrently—and iteratively as life cycle phases and milestones are met. The first two bulleted items are discussed together because they both relate to exploration and evaluation of high-level opportunities.

**Defining Opportunities and Context of Use.** With respect to these activities, the goal is to produce shared representations or artifacts that are linked associatively to one another. The outputs of context of use analyses would include specifications of domain characteristics and constraints, stakeholder objectives, and human performance needs. The committee has argued for the importance of capturing the context of use in a form that can inform later phases of design. This is important to ensure that operational objectives and constraints and their design implications are taken into account in the system design process, so that the final “as-built” system meets the support objectives and constraints identified in earlier phases. This goal can be met only if methods and tools facilitate the capture and traceability of HSI design objectives, specifications, and constraints across design phases.

It is to be expected that early in the process, these representations will be incomplete. As a team undertakes the initial steps in designing solutions, there will be much iteration of the initial representations. Also, the choice, scope, and completeness of these representations will be in scale with the size and complexity of
the enterprise. The list below surveys alternatives applicable to the most complex project:

- Work domain representations that define the problem space to be addressed and likely sources of performance complexity
- Stakeholder success criteria
- A description of the anticipated work environment that ultimately can be populated with product or workstation descriptions
- Goal/task decompositions reflecting the activities required
- Outputs of cognitive task analyses that specify users’ goals, motivations, and required knowledge and skills
- Scenarios representative of the domain and activities to be performed
- Timelines or Gantt charts supporting visualization of the potential sequences of overlapping activities implied by the scenarios
- Situations in which the current system does not fully meet user requirements
- Personas representative of the potential individual users of the system
- A catalog of information required to accomplish these activities
- A risk analysis identifying HSI risks, including safety risks and potential for human error
- The business case for undertaking the development
- System requirements specifications (at varying levels of detail) derived from the information-gathering and representation activities.

In the early phases of the system development, these representations will be static descriptions cataloged in a set of associative databases. They must be interlinked, because an important feature of the representations should be that a stakeholder could ask questions and trace audit trails through them. For example, the information requirements should be linked to the goal decomposition, to the Gantt chart, or to a scenario so that a stakeholder or team member could ask where and when that information is needed or could trace a requirement to the source that generated it. Having these representations in interactive form makes it possible for stakeholders to study, explore, and review the state of the development in more depth so that they do not have to rely solely on the presentations at the milestone reviews.

This early phase of investigation and analysis provides a crucial window of flexibility in which new ideas can be explored and compared at low cost to the project and its stakeholders. Project teams would be able to engage in various types of what-if analyses, exploring, for example, the consequences of using certain types of new technologies or exploring the consequences of potential new scenarios. The interlinkage of descriptions should include the ability for any stakeholder to make annotations and recommendations, which could then be analyzed by the team when it is time to move from exploration to stakeholder commitment.

**Design Solutions.** As design is initiated and alternative function allocations between human and system are considered, the representations described earlier would continue to be enriched and, in some cases, transformed into more quantitative
representations. System components would be enumerated and prototypes of the user interfaces sketched out as facades, with the functionality only implied. Using the postulated scenarios, one may explore implications of the tentative design solutions via high-level simulation before committing resources to a particular solution.

At this point, the framework of a formal system simulation that will embody the growing richness of the system representation should be structured. The previously static work domain descriptions and scenarios should become executable in the context of the simulation so that the operational concepts can be envisioned as a part of the system representation. The Gantt charts can become time-based and synchronized with the scenarios. The personas—including user motives, knowledge, skills, and strategies—might be implemented as human performance models. The simple facades will become working prototypes, but much of the system backing it up may still be scripted. At this stage, it becomes possible to postulate alternative system designs that can be quantitatively evaluated, either in a modeling framework or as human-in-the-loop simulations. Gradually, as the design is committed, the scripted modules will be fleshed out in hardware and software and those modules substituted for the scripted versions.

In the prototyping languages of today and tomorrow, it should be possible to move seamlessly from early prototypes to production-quality software. The goal is that at each stage there will be artifacts that represent the current state of development that may be examined and used by relevant stakeholders. These artifacts become the basis for visualizing the operational concepts and how they might play out.

**Evaluation.** Various forms of evaluation are ongoing throughout the development life cycle, with peaks at the incremental commitment milestones, as illustrated in Figure 3. As the modeling and human-in-the-loop simulation efforts progress, a measurement module is added that makes it possible to generate performance measures appropriate to the current state of system development. At different stages in development, the measurement may consist of video recording of simulated or real interactions, keystroke-level monitoring of model users’ or real users’ activity, eye-movement recording, and higher-level derivation of human and system performance measures. Model results must be validated with human-in-the-loop simulations.

As detailed design and implementation are completed, the simulation transitions to actual system hardware and software, and evaluation of actual system components in use is undertaken. The evaluation culminates in a formal, summative evaluation—field test and evaluation in the case of the military, early beta test deployment to a restricted number of field sites in the case of commercial software. Evaluation reports become shared representations that are useful at each life cycle milestone and that are linked with the configurations tested.

**The Meaning of Integration.** There are several senses in which this postulated development process is integrated. First, it is integrated in the sense that the products of each activity are manifest in representations that may be shared across the
The development of such an integrated methodology is not realizable with the tools and technology that are currently available. It will require a substantial research and development program to bring it about. Better representations are needed of the output of cognitive task analyses that capture more of the richness of the information that is acquired during the ethnographic activities.

Todd Warfel (2006) described a task analysis grid that illustrates a recent development along this line. Although hypertext linking is a technology that will be useful for providing the kind of associative annotation and linking required to support the interactive requirements among cognitive task analyses, information requirements, design, and so forth, some kind of automation support will be needed to reduce the intense human effort to create the extensive set of links implied and to keep them current as changes in the various representations are undertaken. For the methodology to be useful, it will require that HSI specialists be capable of transitioning from text scenarios to computer-supported scenarios to human-in-the-loop simulations and computer models. At the current state of the art, these activities are undertaken by simulation and modeling specialists. There is a significant need for the development of modeling and simulation languages that are programmable by individuals without requiring that they have extensive computer science and simulation backgrounds.

Developing Human-Systems Integration as a Discipline

The committee envisioned an HSI discipline defined as a “comprehensive management and technical program that focuses on the integration of human considerations into the system acquisition and development process to enhance human-system design, reduce life cycle ownership cost, and optimize total system performance” (Booher, 2003). This perspective asserts that HSI is fundamentally an engineering discipline. It can emerge as a recognized discipline in its own right within an engineering school or department supported by the appropriate academic curricula and programs.

The constitution of a new discipline involves defining and bringing together the relevant subject matter in educational programs, professional technical groups, and publication outlets. It requires developing advocacy among acquisition professionals and the variety of stakeholders in the system development process, including research and development funders, operational system managers, and others.
In the education realm currently, HSI is viewed as a support discipline. There are educational programs supporting certain components of HSI—human factors, usability, ergonomics, and so forth—but each is too narrowly focused to integrate effectively with other engineering personnel or to overcome program management constraints. There is a strong need that such a curriculum include education in the fundamentals of systems engineering. The Naval Postgraduate School is in the process of initiating an HSI curriculum, but no other programs of which I am aware have all the necessary components and focus on their integration.

Harold Booher’s book (2003) serves as a formal definition of the scope of the discipline, and, in addition to the NRC committee’s work, technical program sessions have begun to focus on HSI. The International Council on Systems Engineering (INCOSE) has an HSI working group that has produced a definitional document for inclusion in the recently published INCOSE System Engineering Handbook (Haskins, 2007). The Transportation Research Board of the National Academies sponsored an HSI workshop for transportation professionals in early 2007 (Landsburg et al., 2008). The U.S. Air Force sponsored a workshop, “Merging Cognitive Systems Engineering into Systems Engineering,” in late 2007 at the Center for Human and Machine Cognition (Neville, Hoffman, & Fowlkes, in press). The beginnings are here, but much more is needed for the field to be a recognized discipline nationally or internationally.

The committee believes that a market study would demonstrate that there is demand for this kind of HSI professional. This demand would presumably be derived from an increasing recognition among acquisition, program, and project managers of the important role of humans in systems and that effective human-systems integration can significantly reduce development and operational risk.

**Human-Systems Integration as the Lead Discipline**

The next logical step in the development of HSI—albeit a very big step—is for it to become the lead discipline in the system development life cycle for large-scale systems in which human-systems issues are paramount. It is in addressing the human-systems issues that the focus becomes the full scope of development, from environmental constraints and the concept of operations to the goals associated with mission or product success. Current development practice tends to be dominated by the technical disciplines that are most salient for the particular system being built—software for information-processing-intensive systems, and various electrical, mechanical, and physical sciences for systems heavily dominated by electronics, structures, or sensors, respectively. In these instances, it is often the case that human performance and operational considerations are undervalued or ignored.

The ultimate goal of our vision for HSI-led systems is that HSI professionals with systems engineering backgrounds and training will be in a position to take responsibility for overall program management for new, complex, people-intensive systems. Program managers with an HSI background and experience must be able to speak the language of developers and understand their constraints and be properly attuned to business case issues, such as schedule and resources, while ensuring
that HSI is appropriately addressed by the HSI specialty team. Assigning these professionals to program management roles would lead to the proper balance for ensuring that these kinds of systems meet stakeholder requirements—especially requirements of operational stakeholders—while delivering a product within schedule and budget constraints.

The ways in which the decomposition of the work domain should take precedence over the engineering decomposition of functional modules have been emphasized, because work domain factors are the ultimate contributors to operational system effectiveness and success. It is the HSI professional who brings the broadest perspective of these factors to the development process. Such a person, when also endowed with systems engineering training and expertise, becomes a strong candidate for program management in people-intensive systems. HSI would become the glue that pulls all the system components together in a way that emphasizes human use. This is not likely to come about in the next couple of years, but the committee believes it is a vision to be targeted.

In addition to these visions, the committee identified a wide range of additional recommendations spanning the full scope of the HSI development process. The reader is encouraged to explore them in detail in Pew and Mavor (2007).

**Implications for the Cognitive Engineering and Decision-Making Community**

This paper has highlighted some approaches to improved communication and cooperation with the systems engineering world and with the teams that are responsible for developing the kinds of complex systems for which proper attention to human performance capacities and limitations become critical success factors. The cognitive engineering and decision-making community has had as a primary goal to contribute to and influence the design outcomes for these kinds of systems. However, the message of this work is that achieving that influence will involve taking a broader view of the task before us and going beyond the kind of research and development that has been our bread and butter to include considerations of human-systems integration into the larger acquisition, design, and development space populated by many kinds of stakeholders who heretofore have been viewed as only peripheral to our interests.

**References**


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