Multi-Agent Software Design and Engineering for Human Centered Collaborative Autonomous Space Systems
NASA Intelligent Systems NCC2-1283 Final Report

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Detailed results of this three-year project are available in 37 publications, including 7 book chapters, 3 journal articles, and 27 refereed conference proceedings. In addition, various aspects of the project were the subject of 31 invited presentations and 6 tutorials at international conferences and workshops. Good descriptions of prior and ongoing work on foundational technologies in Brahms, KAoS, NOMADS, and the PSA project can be found in numerous publications not listed here.

For those who would like to explore the results in more detail, we enumerate some of the references that provide useful summaries of key phases of the project plan:

1.1. Perform Astronaut Work Practice Study. A good summary of the results of the astronaut work practice study and the resultant Brahms model can be found in 15.

1.2. Develop human-PSA work systems design. References 2/3 and 16 outline some initial observations and lessons learned respecting the design of human-automation work systems in general, with application to PSA.

1.3. Extend Teamwork theory. Reference 4 is an exploration of aspects of agent systems that make them acceptable to people, with categorizations of examples of relevant KAoS policies. Reference 5 presents an analysis of the dimensions of adjustable autonomy and how they relate to principles of mixed-initiative interaction. Reference 32 looks at these same issues from the perspective of system trustworthiness, and contrasts the KAoS approach to adjustable autonomy with related research by others, Reference 6 discusses coordination analogues in animal and human cultures to the problems of human-agent interaction.

2.1. Integrate agent frameworks. Reference 18 provides a summary of Brahms and KAoS
integration.

2.2. Initial mockup using selected PSA testbed. Reference 11a provides a description of the PSA platform and reference 13 discusses our initial evaluation of the PSA as a testbed platform.

3.1. Do human-robotic collaboration experiments and evaluate results. Due to lack of timely availability of the PSA as a testbed platform, we adopted the annual field experiments at the Mars Desert Research Station for the Mobile Agents project as our testbed platform. Reference 18 includes an overview one of the annual field tests.

3.2. Evaluate generalizability. References 7 and 10 further develop a theory of coordination and common ground in joint human-automation activity. We believe that this theoretical generalization of our work on the project can be applied widely to all future NASA missions involving people and automation. These references also discuss ten challenges for future research and development.

Book Chapters


Journal Articles


Refereed Conference Proceedings


**Invited Presentations**


46. Bradshaw, J. M. (2002). Lessons learned in the development and application of
DAML-based representation and reasoning methods for agent domains and policies. Invited workshop presentation for international FIPA meeting, Pensacola, FL, 15 October.


57. Bradshaw, Jeffrey M. (2003). Living with agents: From human-agent teamwork to cognitive prostheses. Inaugural lecture as honorary visiting researcher at the Centre for Intelligent Systems and their Applications and AIAI at the University of Edinburgh, Scotland, 4 September.


**Tutorials**


