David S. Bayard
IEEE MED99 Control Conference

Enclosed below are the Abstract and Outline of proposed Keynote Address by Dr. David
S. Bayard, to be made at the 7th IEEE Mediterranean Conference on Control and
Automation, taking place in Haifa, Israel on June 28-30, 1999.

(1) ABSTRACT

Deep Space Control Challenges of the New Millennium

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The exploration of deep space presents a variety of significant control challenges. Long
communication delays coupled with challenging new science objectives require high
levels of system autonomy and increasingly demanding pointing and control capabilities.
Historically, missions based on the use of a large single spacecraft have been successful
and popular since the early days of NASA. However, these large spacecraft missions are
currently being displaced by more frequent and more focused missions based on the use
of smaller and less expensive spacecraft designs. This trend drives the need to design
smart software and good algorithms which together with the miniaturization of control
components will improve performance while replacing the heavier and more expensive
hardware used in the past.

NASA's future space exploration will also include mission types that have never been
attempted before, posing significant challenges to the underlying control system. This
includes controlled landing on small bodies (e.g., asteroids and comets), sample return
missions (where samples are brought back from other planets), robotic exploration of
planetary surfaces (e.g., intelligent rovers), high precision formation flying, and deep
space optical interferometry,

While the control of planetary spacecraft for traditional flyby and orbiter missions are
based on well-understood methodologies, control approaches for many future missions
will be fundamentally different. This paradigm shift will require completely new control
system development approaches, system architectures, and much greater levels of system
autonomy to meet expected performance in the presence of significant environmental
disturbances, and plant uncertainties. This paper will trace the motivation for these
changes and will layout the approach taken to meet the new challenges. Emerging
missions will be used to explain and illustrate the need for these changes.

(2) OUTLINE OF ADDRESS

Deep Space Control Challenges of the New Millennium

1) Background (3-4 charts)
- Introduction
- JPL's NASA Mission
- What has been NASA's paradigm shift?
- What are implications for control systems

2) Control System Context (5-7 charts)
- Unique Control System Challenges in the Past, Present and Future
- Mission examples: Galileo, Pathfinder, Cassini, Mars Sample Return, DS1, DS3, SIM, OP/SP, TPF
- Progression from (a) Classical, (b) Modern, (c) Post-Modern Control
- Progression from (a) Guidance and Control, (b) Guidance, Navigation and Control, and (c) Remote Agent (DS1)

3) Exciting programs and Missions supported by JPL Division 34 in the context of control challenges (3-5 charts)

4) Summary and Conclusions (1-2 charts)

(3) TECHNICAL SENSITIVITIES
The planned talk does not contain technically sensitive material. The talk will address only gross trends in the space and control field, at a level consistent with the open-literature articles found in the well known magazine "Aerospace America" published monthly by the American Institute of Aeronautics and Astronautics (AIAA). Detailed technical information is not required and will not be disclosed on any specific designs. All pictures and information to be shown are consistent with similar material appearing in news clips, science magazines (e.g., Discover magazine, Scientific American, Sky & Telescope, etc.) and JPL press releases, and are at a level commensurate with material used from similar public domain addresses made by JPL Director Dr. Edward Stone and NASA director Dan Goldin.

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