Management of Large-Scale International

Fusion Power Associates
Thirty-year Anniversary Meeting and Symposium

Dr. Benjamin J. Cross, P.E.
Savannah River National Laboratory

December 3, 2009

Developing a Body of Knowledge for Managing Large-Scale International Science Projects (LISPs)

A Proposal to Capture and Incorporate Key Project Management Lessons Learned for Successful Outcomes of Highly Complex Multinational Research Facility Design and Construction Projects

International Contributors to this Paper

D. Ciarlette	Oak Ridge National Laboratory, USA
B. Cross	Savannah River National Laboratory, USA
S. Manwani	Henley Business School, UK
L. Iandoli	University of Naples Federico, Secundo, Italy
B. Shore	University of New Hampshire, USA
C. Strawbridge	Oak Ridge National Laboratory, USA
G. Zollo	University of Naples Federico, Secundo, Italy

Project Management Successes

- **Project Management methodologies have proven successful in many industries/areas:**
  - **Civil infrastructure (dams, bridges, tunnels)**
  - **Defense systems and derivatives (aircraft, ships, weapons, satellites, spacecraft)**
  - **Environmental restoration**
  - **Information technology and software implementation**
  - **New product development (consumer products, including vehicles, etc.)**

Capturing PM Methods

- **PM methodologies are captured in various standards:**
  - **ANSI**
  - **PMBOK (Project Management Body of Knowledge, Project Management Institute)**
  - **ISO**
  - **PRINCE2 (Projects IN Controlled Environments, UK Office of Government Commerce)**

Extending Project Management to New, Complex Challenges

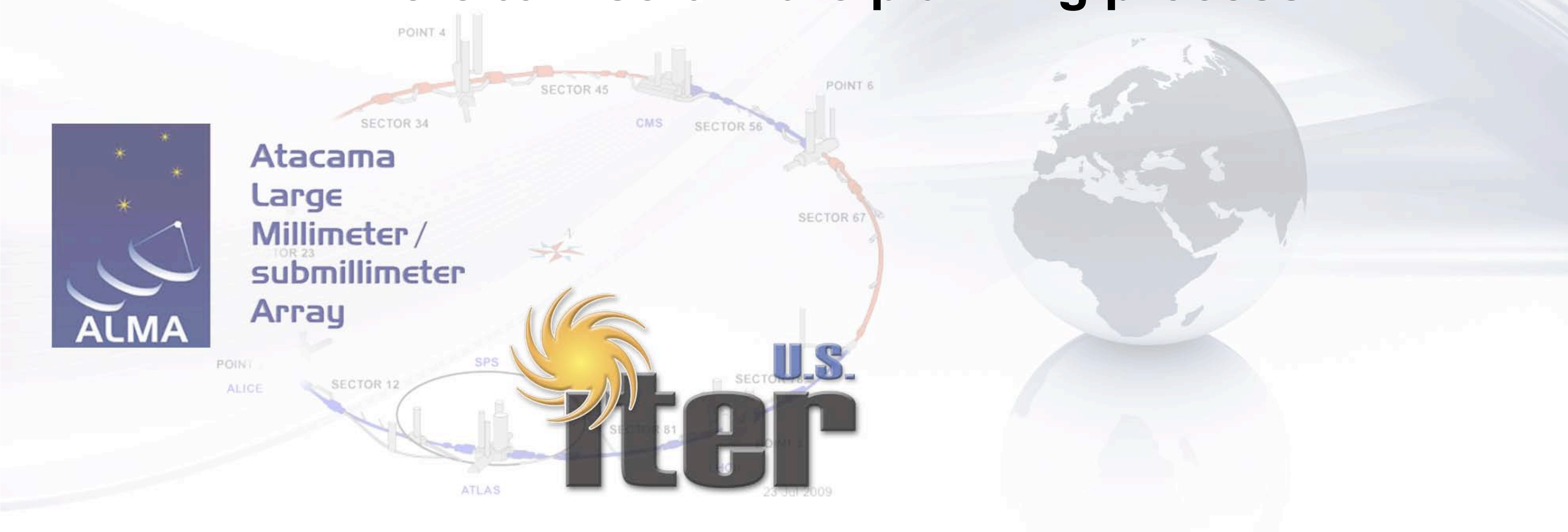
- **Emergence of large-scale international collaborations to develop 'big science' research facilities introduces new challenges to current PM methods & practices:**
  - **Multiple partners who have their own PM methods & practices**
  - **State-of-the-art R&D and technologies**
  - **Exceedingly high energies, temperatures, radiological conditions, special or uncharacterized materials, plasma control and diagnostics, etc.**
  - **Fast-tracking/overlapping phases of R&D with engineering design and construction**

Achieving Successful Outcomes w/LISPs

- **Lessons learned, practical experience from large international science projects (LISPs) must be captured and introduced in a disciplined, accessible, timely way into planning cycle for future projects**
  - Organizational/legal frameworks may differ
    - CERN model (LHC) vs Independent Legal Entity (ITER)
  - Different experience levels and limited sharing across scientific communities
    - Accelerator builders vs fusion modelers
  - First-of-a-kind (FOAK) facilities (limited learning curves)

Achieving Successful Outcomes w/LISPs

- **LHC, ALMA, ITER experiences should be used to improve success of ILC, SKA, etc.**
  - **What /how to capture?**
  - **Where to insert in the planning process?**



What Do We Mean by LISP?

- **Large:** > ~$1B USD (US ITER = $1.45B–$2.2B)
- **International:** Two or more countries with formal agreement to cooperate toward achieving scientific, R&D, or engineering goal
  - Agreements can span years or decades (ITER ~25 years)
  - Work proceeds in stages established within governmental agreements (i.e. design, construction, operations)
- **Science:** Often entails design & construction of large, unique facility for targeted research
  - Usually highly complex technical objectives requiring globally pooled knowledge and industrial capability
  - Recent examples: Large Hadron Collider (CERN), ITER (Cadarache, FR), ALMA (Santiago, CE)
  - Partners contribute hardware, cash, staff and/or all three

LISPs vs. Conventional Projects: Differentiating Characteristics

- Worldwide participation
- Partner criteria
- Central organization governance
- Multi-source funding
- Political risk in funding
- Social risk
- Local control
- Cross-country collaboration
- Coordinating in-kind contributions
- Large budgets
- Dependence upon scientific, technological breakthroughs

Worldwide Participation

– Many LISPS involve participation and funding from governments, universities, industries, and research laboratories located around the world.

- May also have multiple partners within each domestic team

- ITER has seven members (CN, EU, IN, KO, RF, JA, US)
  – EU includes all participants within EC
  – US ITER has three US national labs (ORNL, PPPL, SRNL), plus eventually 10-12 universities

Partner Criteria, Capabilities May Vary

- There may be no clear-cut 'qualifications' for participation.
  - Technical expertise and national interests (not just research results; could be prestige of 'the neighborhood')
  - Supportive funding
- Assigning leadership positions among partners can be very challenging and highly political.
- While it is best to establish criteria early in project life cycle, ever-evolving political issues may defy early agreements.

Central Organization Governance

- In conventional single-organization projects, governance structure is often centralized. Lines of authority and responsibility are reasonably clear.
  - ‘Borderless’ organization should also be a LISP goal
- Creating central organization for LISPs that meets partners’ interests and can exert effective governance is complex.
  - Decisions requiring full consensus become harder as number of participants grows, which can practically affect schedule
- Each participating country expects that its financial contribution and scientific expertise should ensure it a prominent role within the central organization.
  - Defining “prominent” can be an issue
  - Management team can be politicized vs. best capable

Multi-Source Funding : Good and Bad

- Leading-edge research facility costs can easily exceed national budgets in specific science programs.
  - Creates internal friction between national science area program goals and new breakthrough facilities
- There is an established global history of collaboration for science and research.
  - Enables sharing and access by all to research results for reasonable levels of investment (non-host ITER participants in for 9% of total budget but get 100% research output)
  - Major facility construction differs significantly from less intense research collaborations
- Broader participation with international community can mitigate risks for all players.
  - Care needed to ensure management complexity does not overtake technical risk

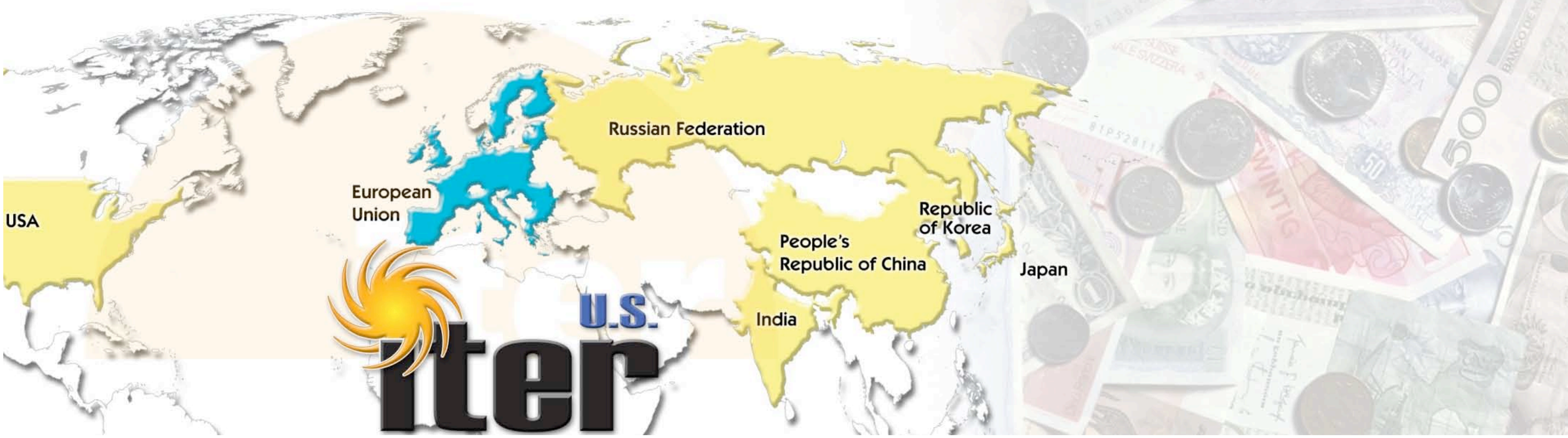
Political Risks in LISPs Create Instability

- Political fortunes of each partner may rise and fall; project funding could increase, decrease, or evaporate.
  - Eventually creates project-unique schedule impact (time constant that must be allowed for with reserves)

Political Risks in LISPs Create Instability

ITER examples:

- **Dissolution of Soviet Union**
- **Gain/loss of partners: – US (1999) + US (2003) – Canada (2003) + China + South Korea (2003) + India (2005) + Kazhakstan (?)**
- **Government changes in several Members that created delays due to differing priorities**
- **US 2008 budget reductions; restored in 2009**
- **Global currency devaluations squeezing many budgets**



Coordinating In-kind Contributions

- **Contributions may be 'in-kind' and/or cash or mix.**
  - 'In-kind' describes systems, hardware, and components to be delivered by each partner (ITER is 90% in-kind)
  - Cash can fund staff, common site expenses, operations and hardware contributions
  - Pros, cons of each…settled in project implementing agreements
- **In-kind contributions increase systems integration challenge.**
  - Partners must meet common design requirements and construction standards; all technical interfaces must be carefully defined and managed through design, fabrication, testing
  - Project technical complexity further exacerbates need

Dependence on Scientific, Technological Breakthroughs

- Outcomes (including designs) depend upon success of R&D activities in science and technology
- Breakthroughs may or may not occur
- Construction of complex, one-of-a-kind facilities almost certainly will face problems
  - Risk planning a necessity
  - Staff expertise and overall partnership's flexibility to respond are important

How LISPs Affect Project Management

- Management structure and governance
- Work distribution among partners (interfaces!)
- Budget allocations (host, non-host)
- Family and education benefits, pay equity (attracting and retaining highly qualified and competent staff)
- Managing intellectual property rights
- Meeting national export control laws and regulations
- More….

Why Develop Separate Body of PM Knowledge for LISPs?

- Current PM standards do not deal adequately with LISP issues
- More LISPs but overall fewer than other types of projects that populate popular knowledge base
- Lessons and experienced staff tend not to be renewed and applied due to extended schedules and specialist fields
- Size/scale have unique challenges (global procurements)
- Risk, uncertainty roll up to senior government level
- Political, economic consequences of failure
- Management risk rivals technical complexity

LISP Body of Knowledge Project Objectives:

- Study/assess completed and ongoing LISPs to identify key 'lessons learned'
- Develop practical body of project management knowledge unique to LISPs
- Formalize LISP BoK to support improved planning of future LISPs
- Create methods to sustain process

Benefits from LISP Body of Knowledge

- Formalizing importance, role of ‘project management’ in life cycles of these projects
- Emphasizing significance of integrated management approach from early stages in project life cycle
- Providing framework for addressing leadership, management issues
- Introducing structure for managing effective utilization, sharing of scarce project resources

Benefits from LISP Body of Knowledge (Cont.)

- Creating framework for working with geographically dispersed and diverse groups of individuals, constrained by diverse institutional and governmental cultures

- Contributing to understanding of how to effectively handle difficult management situations

- Establishing framework for development of project management training programs, workshops, seminars

LISP Body of Knowledge Project Stages

- Identify endorsing and sponsoring organizations (currently under way)
- Select research advisors and core team participants
- Organize core research team
- Create LISP Knowledge Base and Roadmap
- Implement through seminars, training programs, consultations

Summary

- LISPs are different.
- There is currently no Body of Knowledge that adequately addresses management issues associated with these projects.
- This BOK project will capture ‘Lessons Learned’ and develop from them a body of LISP knowledge to improve planning and success.
- This Body of Knowledge can serve as a ‘road map’ for those responsible for establishing and managing future LISPs.