Management of Large-Scale International

Fusion Power Associates
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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
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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
- 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

• LISP s 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 LISP s.