Project Science

Complex Projects

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Project configurations

- Linear projects
- Nonlinearities/complications in projects
- Composite operating+project setting
- Multiple support sources
- Collaborative projects
- Global projects
- Bottom-up collaboratories
- “Almost big” science

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The "Linear" Project

ideal case

Executing the project consists solely of carrying out a well defined plan

- **Project goals and requirements are stable**
- **Sponsor support and funding are stable**
- **Managing institutions do not confuse the goal of project success with their other goals**
- **Resources are matched to project**
- **Resources are really controlled in one project office**
- **Project team owns the plan**

The result is that the major risks are technical

- **Remaining risks are inexperience and human behavior**

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Managing complex (nonlinear) projects

- **Most real world projects are not linear projects**
- **Nonlinear projects are managed with great management attention to nonlinear attributes**
  - **Diffuse goals steered towards project goal**
  - **Multiple resource bases coordinated through negotiation and consensus building rather than real control**
  - **Project replanning places heavy burden on leadership and erodes focus on and respect for project plan**
  - **Project is distracted by reinventing and rejustifying itself**

Managing complex (nonlinear) projects

- **Most nonlinear projects are managed without reference to a simple linear plan**
  - **How it could be**
  - **The most important things that should be managed for project success are the linear attributes**
  - **Nonlinear aspects are taken for granted and an accommodation is made and not seen as a complication**
  - **This accommodation is a slippery slope**
- **Projects must strive to achieve a linear model as much as possible in order to minimize risk**

Generic nonlinearities/complications...

- **Major project replanning is caused by:**
  - **Project goals unstable**
  - **Politics interfere with project progress**
    - **project either follows politics or**
    - **tries to operate adaptively in the lee of the political winds**
  - **Sponsor attention or support varies within term of project**
  - **Annual funding does not follow either:**
    - **funding profile dictated by technical pace of project or**
    - **funding profile agreed to in a funding limited plan**

…Generic nonlinearities/complications…

- **Institutional setting of project poor**
  - **Operating laboratory management imperatives distort decision making, resource allocation, funds management**
  - **Host institutional culture incompatible with project culture**
  - **Host institutional support infrastructure not matched to project**
  - **Institutional setting fragmented among disparate institutions**

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…Generic nonlinearities/complications…

- **Project team members suffer cultural mismatch**
  - **traditional "small science" vs. "big science" gap**
  - **values system not matched to project science**
    - **project science not matched to traditional graduate student education, nor to tenure evaluation process**
    - **projects are successful because the contributions of many types of team members are combined, thus contributions must be matched to project needs and not just to academic meritocracy**
  - **team members do not respect the systems and processes of large projects**
  - **dysfunctional information sharing, information structure**
    - **Promotes fragmentation into small islands or "stovepipes" often along scientist/nonscientist lines**

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…Generic nonlinearities/complications

- **Resources management decentralized**
  - **European model with independent institutes each controlling own budget and resources**
- **Scientific creativity without formal change management**
- **Project unable to “heal” or to confront surprise**

Composite operating+project setting

- **Project is either a:**
  - **Hybrid “operating + project” organization or**
  - **A project embedded in and dependent upon a large operating scientific laboratory for significant resources**
- **Either may bring project culture into tension with the imperatives and culture of an operating laboratory**
- **In a linear project, the sole management imperative is successful completion of the project within the plan**
- **In a composite project, operating laboratory imperatives can intrude**

Operating laboratory imperatives

- **Maximize or maintain overall laboratory funding**
  - **Tendency to commingle lab and project resources**
- **Maintain operating laboratory programs without reductions to support projects**
  - **Sharing assets dilutes strength**
- **Exercise flexibility in assigning functional resources**
  - **Key skills and leaders moved around among lab programs**
  - **Resources may be denied to projects when needed**
  - **Resources may suffer divided attention**

Manager culture at operating labs

- **Projects are managed to one-time-only plan with well defined product**
  - **Resource requirements are well defined**
  - **Manager perspective is delivery of product**
  - **Projects are inherently unstable and not conservative**
  - **Managers work to build up to plan, follow it, repair it, finish it, and dismantle project team**
- **Laboratories are managed to a plan that is relative from year to year with a broader mission**
  - **Resource stream is variable**
  - **Manager perspective is conservative and management attention is on the marginal changes**
  - **Managers are adapting and revising priorities frequently as goals and conditions dictate**

Advantages of operating laboratory setting

- **Significant competences, technical capabilities and infrastructure may already be available**
- **Avoid need to start from green field**
- **Precious resources can be assigned from laboratory and returned to it when no longer needed**
- **These advantages are realized only when the assignment, priority and reabsorption are well managed**
  - **This is limited by operating lab manager culture**

Pressures on individuals in operating laboratories

- **Career progression tied to individual contribution to overall laboratory mission**
  - **Significant contributions to discrete projects may not align well with broad laboratory mission**
  - **Split allegiance problem even if reporting lines always clear**
  - **Reabsorption into ongoing laboratory programs not always smooth**
    - **Project funding may be a bump in lab funding**
    - **Time in project may interrupt career progression**

Solutions to composite project environment – for managers

- **No substitute for proper management awareness, attention and active management of this issue**
  - **Make contribution to projects a core part of incentives system**
- **Situate projects in "skunk works"**
  - **Consciously create fenced project with dedicated resources, complete staffing and strong top management champions**
    - **Create a "stovepipe"**
  - **Properly manage staffing bump and reabsorption of core staff**
- **Resist ongoing fiefdoms, operational "stovepipes"**
- **Match overall lab programs to resources**
  - **An overloaded donkey cart lifts the donkey's hooves off the ground**

Advice for the project participants

- **Watch for these conditions and deal with them at the initiation of the project**
- **…continued vigilance…**

Multiple support sources

- **Multiple funding sources may be:**
  - **predominantly controlled by single project management**
    - **not significantly different from linear model**
  - **or substantially controlled outside of project management**
    - **project decisions require negotiation and consensus building retarding project**
  - **contingency may be held outside project**
    - **retards project management and introduces oversight officials into inappropriate management role**

Coping with multiple funding sources

- **Multiple funding control points inevitably leads to a project that costs more, takes longer and is less agile and adaptive than one with single point control of resources**
- **Major resource partners may be exposed to risk of delay or shortfall from subsidiary contributors**
- **Partner performance risk should be folded into the contingency fund planning and into workplan strategy for dealing with delays**

Coping with multiple funding sources

- **Management attention is divided by need to negotiate and manage partner contribution issues**
  - **This may be a very delicate and sophisticated task**
  - **Include additional strength in management team to support this**

Coping with multiple funding sources

- **Build a strong set of Memoranda of Understandings with partners with appropriate attention to**
  - **how binding they are**
  - **management of delay and default**
  - **how project benefits are tied to progress**
  - **how performance is assessed periodically**

Collaborative projects

- **Consider a**
  - **well defined project with**
  - **a central project management and**
  - **major resources are controlled by that management, but**
  - **the project teams consist of multiple groups of contributors from different institutions that have a continuing existence**
- **This differs from collaborations of groups that combine to exploit the project's product**
  - **The "science team" collaboration**

Collaborative projects

- **Most common paradigm in high-energy physics detector projects**
- **Project challenges arise from**
  - **distributed nature of team**
  - **uneasy match between project WBS and collaborating group capabilities/roles**
  - **Group allegiance/advocacy of their solutions to project needs vs. allegiance to overall project goal**
    - **This is a bottom-up version of operating lab goal tension**

Collaborative projects – wide area

- **“The most important tool of the high-energy physicist is a Boeing 707!” – attributed to G. K. O'Neill, Princeton, circa 1968**
- **Teleconference, email, video conference, web collaboration tools**
- **Collaboration meetings face-to-face needed in the right balance**

Collaborative projects - responsibilities

- **Delegate responsibility through the organization and WBS**
- **Don’t build the WBS to match the collaborating groups**
  - **Follow the deliverables**
  - **But define the responsibility of the collaborating group very clearly through**
    - **the details of the WBS and**
    - **through collaboration MOU’s**

Collaborative projects – group goals

- **Assume collaborating groups join because they want to achieve the project goal, the science goal**
- **Recognize that they bring their own continuing goals to this perspective**
  - **funding needs**
  - **their in-house technology or expertise**
  - **their style of work and culture**
- **Integrating collaborating groups requires**
  - **Communication**
  - **Process and governance**

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Collaborative projects - process

- **Projects are a command structure**
- **Collaborations require visibility of project process and sharing in governance**
- **Projects are not democracies**
- **The project director and project manager must have full authority**
- **The collaborative balance must be established by appropriate process**
  - **Process must be defined and consistent to build trust**

Collaborative projects - buildup

- **Early buildup phase**
  - **Project organizers need to build strong collaborative team**
  - **Collaborators are encouraged and courted**
  - **Project offers an opportunity**
  - **Collaborating group offers a contribution**
  - **The “politics of inclusion”**
  - **Build an army for a campaign**

Collaborative projects - buildup

- **From a toast I made once in Moscow during the buildup "courting" phase of a very big high-energy physics collaboration**

  "un catalogo egli è che ho fatt'io;
  Osservat'e, leggete con me!
  In Italia seicento e quaranta;
  In Alemagna duecento trent'una;
  Cento in Francia, in Turchia novant'una;
  Ma, ma in Ispagna, son già mille e tre!"

  Leporello; Atto I. Scena V.

  Don Giovanni by Mozart and da Ponte

Collaborative projects - definition

- **Project must be defined into a reference project and then to a baseline**
  - **Design and responsibility choices must be made**
    - **This can discourage and alienate some collaborating groups**
      - **If their aspirations were tied up in a particular approach they may lose interest**
    - **Define technology and design decision processes formally**
      - **Follow competitive review process and reach recommendation to project management**
      - **Support redefinition of roles after decision**
      - **Build trust and loyalty to the project through a formal and defendable process**
      - **Do not make needed project decisions hostage to collaborator resistance**

Collaborative projects

- **Build a linear project from the collaborating team**
- **Organize by deliverables**
- **Carefully define roles and responsibilities**
- **Employ open participatory process**
- **Director/Project Manager must have full authority**

Global projects

- **Global projects are international collaborative projects, but international collaboration**
  - **is not merely incidental**
    - **As in lab to lab or university to university**
  - **is fundamental to the architecture and nature of the collaboration and resource stream**
  - **is government to government in nature**

Global projects – one lead partner

- **Does one country take the lead?**
  - **Does that country contribute more?**
  - **Do they benefit more?**
  - **Do they take more risk?**
  - **Do they control key decisions?**
  - **Does this arrangement discourage partnership?**

Global projects – balanced partners

- **Is the international partnership symmetric and balanced with responsibilities and benefits balanced?**
  - **Is there a single project management authority?**
  - **Is there a clear definition of**
    - **Contributions of partners**
    - **Benefits to partners**
    - **Consequences of delay or default in contributions**
    - **Management of risks**
    - **“juste retour” or distribution of contracts or contribution “in kind”**
  - **Is there a competition for roles?**

Global projects – structure choice

- When is the decision made on one lead partner or a balanced partnership?
  - SSC was one lead partner up front
  - ALMA is a balanced partnership up front
  - LHC is one lead partner up front
  - Advanced LIGO is one lead partner up front
  - Linear Collider…? (appears to be balanced)
  - TMT, E-ELT, SKA, … large telescope projects?
- Make the decision up front at the very early pre-courtship stage
- Governments care about these things

Global projects – value accounting

- **Define contributions and economic benefits by value estimated in project cost book using a single reference currency and include all elements of WBS**
  - **US practice includes everything**
  - **European practice normally counts only new investment costs**
  - **Use US method to establish value**
  - **Let partners then use their own accounting to accomplish their pledged role**
  - **Measure earned value using US value**

Global projects

- **Intrinsic cultural differences will be a large factor in managing a global project**
  - **Work styles**
    - **August in France (February in Chile)**
  - **Risk management**
    - **Contingency never budgeted in the past**
    - **In some European countries groups just go back to sponsor for more resources or use operating budgets to stretch project and complete work scope**
    - **In other European countries, sponsor commitments are fixed and cannot be increased leaving only stretchout or new collaborators to address risks**

Global projects

- **Appropriate for the very biggest projects**
  - **Perhaps the only way to proceed on really big projects**
- **Always more expensive and less agile than single nation projects**
- **Very good for world science**
- **Rarely successful if truly global in scale**
  - **SSC**
  - **ITER to date …**
  - ***Space Station***

Bottom-up collaboratories

- **“Collaboratory”**
  - **“…laboratory without walls…”**
    - **Computational and informatics systems shared invisibly and transparently over wide areas**
    - **Instrumentation shared, operated and interrogated invisibly and transparently over wide areas**
  - **Very new idea enabled by information technology**
  - **An NSF incubated idea**

Top-down collaboratories

- **Central director and coordinating institution manages collaboratory including planning, program development, resource management**
- **Not different from collaborative project or central lab managed research effort except that technology enables wide area distribution of information resources or instrumentation reach**
  - **Even the centralized fields like high-energy physics are moving to data analysis collaboratories through virtual data grids**
  - **Astronomers forming virtual observatories**
  - **These separate science team from builders of big instruments**

Bottom-up collaboratories

- **Collaborating nodes in collaboratory share in program and project definition, execution, operation, program development and governance in flattened hierarchy**
- **This paradigm reflects**
  - **Distributed technology**
  - **Culture of the scientific field that creates the collaboratory**
    - **HEP – one costly detector – 1000 authors on papers**
    - **NEON -Environmental biology – 3 authors or less → NEON collaborators and long author lists**

Bottom-up collaboratories

- **A very long way from linear model of big science project**
- **Parallel instrumentation and information infrastructure projects are relatively loosely coordinated to produce a highly effective integrated scientific capability**
- **How are the normal project attributes of baseline definition, configuration management, performance measurement, risk management and project repair carried out?**

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"Almost big" science

- For this workshop, big science projects can be described by costs above ~$100 million
  - Above ~$1 billion also but …
- "almost big" means that you think you can scale from small projects and just use some of the big project methods
  - This usually happens because proponents don't feel they are in the big science range
- Perspectives discussed here are needed for these $5 million - $50 million projects
- "almost big" projects often started with the wrong perspective
- NAS study (2007) looked at DOE oversight for different size projects

The "Linear" Project

ideal case

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