

International Centre for Radio Astronomy Research Success drivers for large high-technology projects: Implications for the SKA yer 3-2

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Recent Studies in Mega-Project Success

PhD work by Phil Crosby (Supervisor – Prof. Peter Hall, ICRAR)

- Long and (dis)honourable history of mega-project failure
 - Cost over-runs > 25%, schedule slip >25%, severe and sustained operational problems > 1 yr
- Little outcome change in 100 years of project management
 - Flyvbjerg et al.
- Forensic dissection of individual failures is common
- Few mechanisms, and sometimes little will, to report or learn from failures
 - No common databases or reporting formats
- Optimism bias nearly always a key factor
 - Flyvbjerg: proponents lie to get projects funded
 - Often huge opportunity costs to community of failed projects



- The good news: about 40% of mega-projects are successful
- We wondered...what was special about these projects?
 - Can these traits be applied in the establishment and management of new projects (like the SKA)?
- · Our early research showed that much more than good project management practice was involved
 - Success often contingent on many project environment , and human, factors
- · We framed a research project to distil these factors



Research overview

Literature search

- Peer reviewed journal papers
- Reports and technical articles
- Case studies, project artefacts
- Project Management texts (manuals, books)

Field work

- 17 large, high-technology projects
- Defined (loosely) by >\$100m budget, substantial & specialized infrastructure, and grand science goal
- On-site investigations
 - 1-3 days
 - Project managers, team leaders, staff
 - Interviews 3-5 hours each
 - A Grounded Theory approach
 - Notes, recordings, photographs, etc.

Nothing works like field work, works!





Case studies & core work

Major Case Studies

- Telescopes
 - ALMA (Chile)
 - ASKAP (Aust)
 - ATCA (Aust)
 - KAT 7 (South Africa)
 - LOFAR (Netherlands)
 - SKA (UK base)
 - VISTA (Chile)
- Particle Accelerators
 - ILC/XFEL (Germany)
 - LHC (Swit)
 - SYNCROTRON (Aust)
- Fusion
 - HiPER (UK base)
 - ITER (France)
- Others
 - LIDAR (Antarctica), IRIDIUM (US)
 - OPAL Reactor (Aust), TOPSAT (UK)
- Field work supported core investigations, for example...







Research aims

- Understand the value of past project experience and lessons learned as future success indicators
- Identify specific success pre-cursors in large high-tech projects that are influential in shaping projects and building resilience
- Test causal links to early project outcomes in mega-projects, and identify key drivers for project success
- Examine the applicability of key success drivers and high-tech project management characteristics to the Square Kilometre Array
- Develop new, empirically verified indicators applicable as predictive tests of likely project success, and present these as a practical process tool.

"Important data and artefacts were gathered during the on-site fieldwork, however it was the 'lived experience' related by project management and staff that was most enlightening, and which cannot be obtained through 'desktop' research."

ICRAR

Broad findings – the 'richest seams'

Understanding	ļ
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14 conclusions. 5 Themes

Collaborating

Defining

Firmness

Flexibility

- what success means
- demands on management
- impact of complexity
- authenticity of endeavour
- international family
- suppliers (think strategic)
- sharing lessons learned
- project entity, and identity
- obligations & consequences
- structure, and policies
- external environment
- building in resilience
- information control
- avoiding undue optimism
- control, planning, and reviews
- project ambiguity/uncertainty
- trust, pressure, persuasion
- capturing knowledge

Key findings 1/5 - Complexity

• High _

Helmsman Scale	Organi- sational Level	Difficulty Level	Project Characteristics	Examples
< 4	SME	Minor/ large	Projects that can be done by smaller organisations	Build new custom home
4 - 5	Large	Small	Projects normally performed in the business units of large organisa- tions.	Product maintenance and competi- tive enhancements to ongoing busi- ness operations
5 - 6		Core	Standard core projects in the top 50-100 organisations. Normally has executive attention.	Regulatory, environmental, business upgrades. GST, Y2K, Clean fuels
6 - 7		Large	Largest projects commonly un- dertaken across the top 50-100 organisations. Normally have board attention.	Merger integration, core system replacement. A380 introduction
7 - 8	National National	Large National	Largest projects commonly un- dertaken in the Nation. Creates a noticable impact on the economy.	BHP Olympic dam, Broadband Rollout Some defence projects
8 - 9		Nationally significant	Rare and highly complex projects, seldom undertaken in the coun- try. Creates significant impact on national economy.	Snowy river scheme, Olympics, Col- lins
9 - 10	Interna- tional	Interna- tional	Significant multi-national project	Hadron Collider, Apollo, Joint Strike Fighter, BASEL II

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- High-tech mega-projects
 - More than difficult and complicated
 - High maintenance programs
 - Inevitably flawed
 - Rarely fully understood
 - Collaborations add to complexity
 - Beyond the PM-BoK skill level
 - To understand risk, level of complexity should be known – through calculation, or classification

Example:

F-16 (1976), 15 Subsystems, 10³ Interfaces

F-35 (2006), 130 Subsystems, 10⁵ Interfaces





Key findings 2/5 - Procurement

- Project Procurement
 - Strategically important to success
 - Establish function early
 - Policies & plans required
 - Research the (global) market
 - Align contracting model with project legal entity
 - Emphasise competitiveness and Value for Money approach
 - Involve industry
 - Understand risk
 - Evidence based supplier assessments (selection & QA)





Key findings 3/5 - Resilience

- The building of robustness
 - <u>Attitudinal Factors</u>
 - Realism, not optimism
 - Research lessons learned
 - Deal with ambiguity and uncertainty



- Launch Conditioning Factors
- Declare the project mission
- Control the messages
- Anticipate the unexpected (contingency, and task forces)
- The 'hungry' external forces
 (e.g. political, environmental, economic)
- Adopt *Mission Assurance* as a function, and mantra



Key findings 4/5 – Project Manager-ship

- The more subtle factors...
- Cope with the temporary and uncertain nature of mega-projects
- Demonstrate personal authenticity
- Apply persuasive skill in the management of collaborations
- Balance management and leadership talent
- Motivate through persuasion, encouragement, and negotiation
- Share knowledge and build trust in a diverse cultural environment
- Match competence to the project
- Drive a clear sense of urgency.



- Plus 5 Initiative factors...
- Right-sized project & structure and regulatory levels
- Pre-form project task forces
- Be an information 'control-freak'
- Make mission-assurance a central function
- Show competency amid complexity, and
- Courage through sound risk.

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Key findings 5/5 - Project Reviews

Periodic project reviews

- Towards the industrial model
- Stage gate mapped to project phases / milestones
- Critical information only
- Report against baseline data
- Time-bound responses

- Post project reviews
- Almost never done!
- Crucial avenue of improvement
- Opportunity for serious review and opportunities, without blame
- Cognitive mapping feeds organizational learning, through root-cause analysis -(process suggested)



- 'Mining' the knowledge
- Avoid project amnesia
- Capture wisdom in searchable 'knowledge-bank' system
- Combined with a learning culture
- = lift in organisational performance

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Research Outcomes



Summary

- Our key conclusions can be interpreted as predictive success indicators.
- When diligently applied and pursued, these will lift the probability of success in high-tech mega-projects.
- As a practical aid, the Checklist for High-Technology Project Success (CHiPS) tool is presented.
- Example pages follow...

The Checklist for High-tech Project Success (CHiPS) Tool ver1.4							
Project Phase	Key Indicators	Example Evidence	Findings	✓ or X			
Planning & Concept Design (project feasibility)	12. A risk analysis has been conducted including identification of technical, programmatical, and institutional risks, risk controls, and cost/schedule impacts. Risk planning has accounted for unknown unknowns.	Project risks have been exposed through an inclusive process. Risks are categorised, rated in terms of potential severity, and associated mitigation factors, controls, and impacts are postulated. Documents show that unexpected negative events, and possible impacts, have been considered.					
	13. Budget and schedule estimates are benchmarked against specific analogous projects, and contain realistic budget and schedule contingency.	Top-down budgets and schedules are developed. Budgets and schedules are benchmarked against at least two other projects of similar size and complexity. Budgets and schedules include identified contingency components that reflect potential impacts within risk plans.					
	14. Ambiguities are identified and (mostly) resolved. Uncertainties are identified and conditionally qualified.	Project plans clearly identify areas where information is currently ambiguous, or uncertain. Uncertainties are defined in terms of possible solutions and (possibly compromised) outcomes.					
	15. Project reviews (e.g. CoDR, PDR, CDR) are conducted by independent experts, and have firm time criteria for response.	A process exists to conduct major reviews, including panel selection, conduct, and guidance for reporting.					

	The Checklist for H	igh-tech Project Success	(CHiPS) Tool ver 1.4	
Project Phase	Key Indicators	Example Evidence	Findings	✓ or X
Approval for expenditure	 25. There is a detailed project budget and schedule containing realistic budget and schedule contingency for both identified risks and unknown unknowns. Optimism tendencies are exposed and corrected. Resources are allocated for capturing project lessons. The project scope can genuinely be accomplished within the proposed budget and any contingency reserves. 	Detailed budget for project commencement plus 2 years. Medium level budget for remainder of project lifecycle. Contingency reserves are calculated or otherwise assessed, and valued. Detailed schedule with critical path and project dependencies identified. Budgets are based on traceable cost models or data, with adequate margins, and benchmarked against analogous situations, or certified for accuracy by qualified cost accountant. Schedules are independently reviewed and certified as practicable. The budget includes provision for post- project reviews.		
	26. The project mission, broad goals, and specific objectives are clear. Project success criteria and critical success factors are expressed.	Project mission, goals, and specific objectives are declared in project documentation. Success criteria and critical success drivers are recorded, and reflected in project artefacts.		
	27. A coherent and complete system description, and systems engineering approach, is embodied in project plans	Project plans contain a clear description of the project system, interconnects, and dependencies. A systems engineering approach is underpins all artefacts.		



Current advice for the SKA project

Defining the mission

- Agree and announce the overall success metrics
- Declare a 'shared construct' of project complexity

<u>Getting collaborations right</u> - Set up the SKA Project Advisory Committees to:

a) build on current foundations of industry engagementb) set key project IP & procurement policies

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AND re-engage with SKA community

Get tough, get real

- Instill qualities now, to build resilience
- Address optimism and contingency factors
- Set rules for project information flows
- Urgently implement a project staffing plan
- Maintain project pace every day

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- When diligently applied and pursued, these will lift the probability of success in high-tech mega-projects.
- As a practical aid, the Checklist for High-Technology Project Success (CHiPS) tool is presented.
- By any measure, the SKA project requires strong intervention to score adequately on the Checklist.

Published work (in print)

- Key Success Drivers Meta-Study Findings Applicable to Large High-Technology Projects. IJITPM. Vol 3, No. 2, 2012.
- Characteristics and techniques of successful high-technology project managers, IJPOM. Vol. 4, No. 2, 2012.
- Procurement strategies enabling success in high-technology megaprojects: Preparatory work for the SKA. Memo 129. 2011;
- Building resilience in large high-technology projects: front end conditioning for success. IJITPOM. Vol 3, No. 4, 2012.



Thank You







Phil Crosby - bio

50% Manager – Industry Participation Strategy with SKA Office, Manchester. 50% Strategic Planner (et al) with CASS, Sydney

Background in Electronics Engineering & Technical Standards work. Careers with BT (UK)), NATA (Australia), and Boeing prior to ATNF. Conducted major business studies of ANSTO (Australia), and Impact of Science in Antarctica, as well as technical assignments in India, Chile, Turkey, and Korea.

Apart from PhD related papers, he authored or co-authored: The SKA Industry Engagement Strategy, 2012. Towards an SKA Procurement Strategy, 2011 Guidelines for Procurement for Square Kilometre Array, 2009 ASKAP Australian Industry Participation Plan, 2008 ASKAP Industry Opportunities Register, 2008

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Amongst others, he is a member or Chair of: CASS Project Review Board Engineers Aust ,National Committee in Space Engineering (Former) SKA Power Investigation Taskforce '*Non-science benefits of the SKA*' Workshop Organising Committee (COST) Giant Magellan Telescope (GMT) Science & Industry Working Group Editorial Committee for Int'l Complex Project Mgmt Centre (ICCPM)