Lean Product Development - 15 years of Innovation at LAI

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Lean Product Development
15 years of Innovation at LAI

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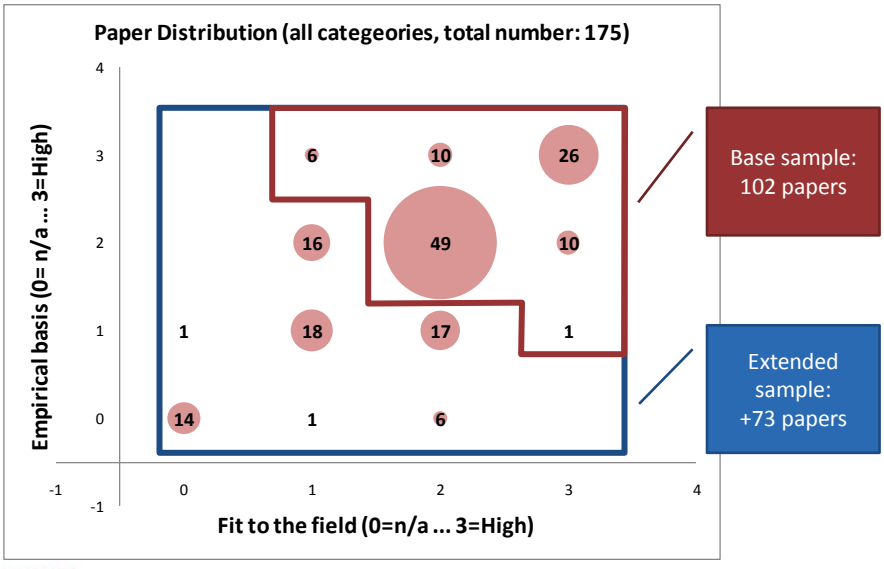
Lean PD Research at LAI

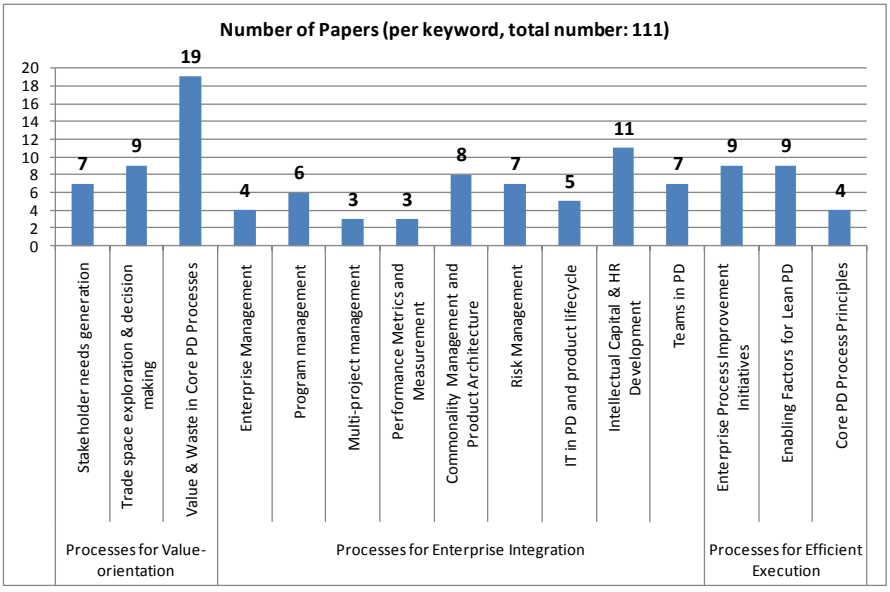
- Overview of 15 years of research in lean product development
- Goal:
  - Tie together different pieces of research from different points in time
  - Present the "bigger picture" of the relationships within PD and LAIs research
  - Develop a series of reports for LAI members that present an integrated view on the main topics of Lean PD
  - Develop publications and / or a book from these reports

Framework for PD Research

Level of analysis	Type of process: Processes for Value-orientation	Processes for Enterprise Integration	Processes for efficient execution
Project Portfolio ↕ Single Project	1. Stakeholder needs generation 2. Trade space exploration & decision making 3. Value & waste in core PD activities	4. Enterprise management 5. Program management 6. Multi-project management 7. Performance metrics and measurement 8. Product architecture & commonality management 9. Risk management 10. IT systems in PD 11. HR development & intellectual capital 12. Teams in PD	13. Enterprise process improvement 14. Enabling factors in Lean PD 15. Core PD process principles

Overview: Empirical basis vs. Fit to field





Group 1: Value-orientation

Level of analysis	Type of process: Processes for Value-orientation	Processes for Enterprise Integration	Processes for efficient execution
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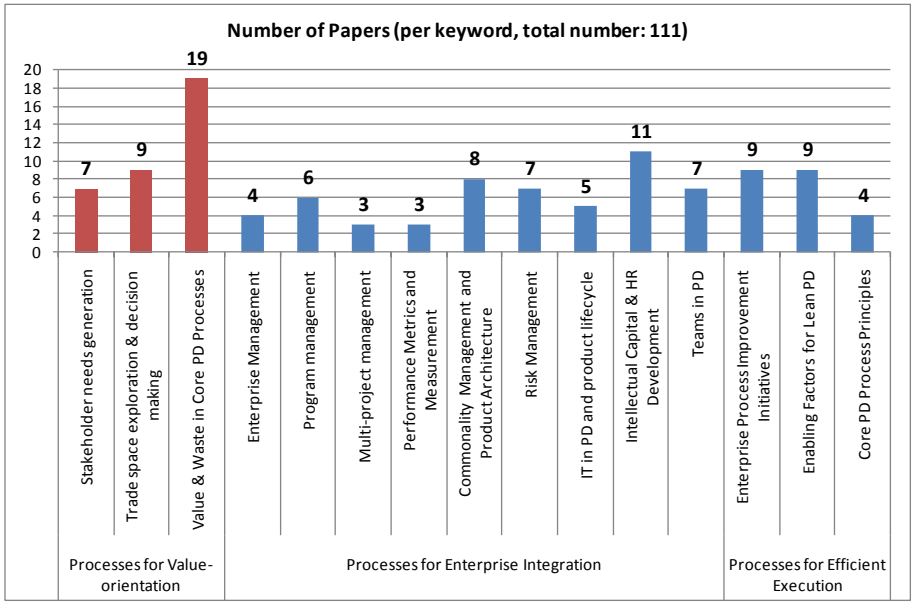


Value-orientation (1/2)

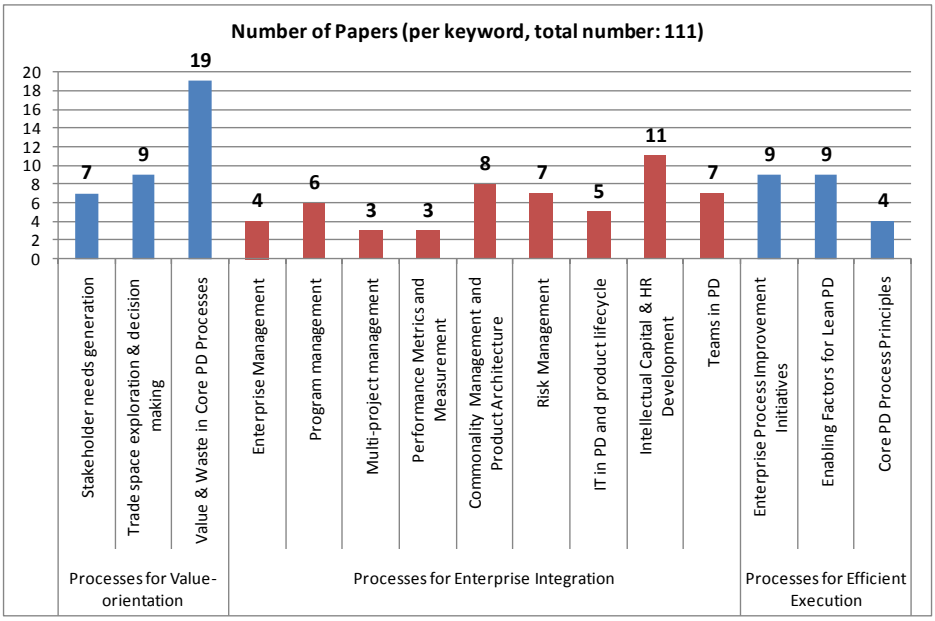
- Stakeholder needs generation
  - Process and method for user needs and requirements generation (Wirthlin 2000)
  - Valuation of complex space systems (McVey 2002)
  - Use, effectiveness and interoperability of modelling & simulation tools in requirements generation (Walton 1999)
  - Dominant Mission Emphasis (DME) as a principle to determine user needs (Gillespie 2009)
  - Lean Practices to Identify Customer Requirements in Software Development (Ippolito 2000a, b)
  - Using systems representation to facilitate collaboration between stakeholders in the design phase (Dare 2003)
- Tradespace exploration and decision making
  - Application of MATE in development programs (Derleth 2000, Spaulding 2003)
  - MATE, Concurrent design and product architecture (Ross 2003 and other work by him)
  - Product function analysis and representation to facilitate architecture decisions in design teams (Cunningham 1998)
  - Value-based Product Architecture for space systems (Loureiro 2006)
  - Using DOE to facilitate decision making on the corporate level (Tang 2006, 2007a, 2007b)
  - Decision-making and problem solving in teams: differences in interpretation, evaluation criteria, use of tools (Bernstein 2001)

Value-orientation (2/2)

- Value & Waste in Core PD processes
  - Defining & measuring waste in PD projects, identifying root causes (Kato 2005, Pessao 2008a,b,c, Bauch 2004, Graebsch 2005, 2007)
  - Value-driven analysis and optimization of PD process (McManus 2005(PDVSM), MacKenzie 2006, Millard 2001, Whitaker 2005)
  - VSM on Coordination Level (Frenkel 2004)
  - Value identification, proposition and delivery in flight testing: coordination with SE value stream and other test aircraft, improvement of daily operations (Carreras 2002)
  - Value stream mapping: Program-level change management in large and complex systems (Davis 2008)
  - Value stream mapping: Study of Class-1 Changes on the Enterprise level, causes and effects (Hsu 1999)

Group 2: Enterprise Orientation

		Type of process		
		Processes for Value-orientation	Processes for Enterprise Integration	Processes for efficient execution
Level of analysis: Project Portfolio ↕ Single Project		1. Stakeholder needs generation 2. Trade space exploration & decision making 3. Value & waste in core PD activities	4. Enterprise management 5. Program management 6. Multi-project management 7. Performance metrics and measurement 8. Product architecture & commonality management 9. Risk management 10. IT systems in PD 11. HR development & intellectual capital 12. Teams in PD	13. Enterprise process improvement 14. Enabling factors in Lean PD 15. Core PD process principles



Enterprise Integration (1/4)

- Enterprise Management
  - Innovation across supplier networks (communication, joint funding, training, incentives in contracts, competition) (Kirtley 2002)
  - Complexity as driving factor in PD outsourcing decisions (Makumbe 2008, 2009a,b)
  - Enterprise-wide technology transition process: balanced TT process, enabling environment, selection of TT projects, team formation and plan execution, project charter, collaboration process, shared teams, formal reviews (Shroyer 2002 plus "Manual for Effective Technology Transition Processes")
- Program Management
  - Aligning economic incentives in program management (Cowap 1998)
  - Program process and schedule management (McNutt 1998)
  - Analysis of strategic, political and cultural characteristics factors influencing product line engineering (strategic plans, metrics, uniform implementation, commonality, senior management support) (Beckert 2000)
  - Interaction between prime contractor and program office in PD: cost and cycle time implications of management policies (Morgan 1999)
  - Maximizing lifecycle value in PD (value identification, proposition, delivery) (Stanke 2001)
  - Enterprise-level factors determining success of PD projects: distributed leadership, informal and formal structures (Stanke 2006)
- Multi-project management
  - Manpower staffing decisions for projects in a multi-project enterprise environment: recommendations regarding overtime, project prioritization, resource allocation, project cancellation, project scheduling, portfolio balance based on intellectual capital growth and monetary return (Herweg 2001)
  - Analysis of multi-project PD: risks due to shrinking budget and schedule, PD development cycle times and relation between the projects; analysis of risk causes; staffing issues one of the main risks; recommendations for policies to minimize risk (Wright 2003)
  - Identifying leverage points in acquisition programs: program management cannot be compared to portfolio management; coupling between functions not understood by people in the system; systemic risks are not sufficiently addressed; insufficient number of skilled people; no clear incentives; conflict-oriented resource allocation process; interdependencies among projects not understood; important decisions are avoided; necessity to document slows process down; discusses possible interventions (Wirthlin 2009)

Enterprise Integration (2/4)

- Performance Metrics and Measurement in PD
  - Measure cost, schedule and performance in PD projects (Browning 1998)
  - Focus on proper metrics, maintaining a historical database, use in decision-making process (Stout 1995)
  - Analysis and survey regarding importance of PD processes (Liu 2003)
  - Ricardo's work / leading indicators
- Commonality Management and Product Architecture
  - Measuring and assessing the quality of commonality implementation (Bador 2007a,b,c)
  - Divergence (reduction of commonality) and life cycle offset (spacing of products in time) in commonality management (Boas 2008)
  - Benefits, cost, appropriateness & organizational structures of increased commonality in aerospace industry (Nuffort 2001)
  - Partitioning of systems to include complexity and cost, not just function, for reliability and maintainability (Silva 2001)
  - Front end modularity as an architecture concept in the automotive industry (Mahe 2008)
  - Integrating Product Architecture in the Extended / Virtual Enterprise (Glazner 2006)

Enterprise Integration (3/4)

- Risk Management
  - Process framework and collection of methods for risk management in PD (Oehmen 2005)
  - Adaptation of FMEA to identify and manage risk in PD projects (Wagener 2007)
  - Uncertainty in requirements generation and development (Bresnahan 2006)
  - Risk quantification by combining value and performance probability assessment (Browning 1999)
  - Classification of uncertainties, resulting risks and mitigation strategies (McManus 2005)
  - Real options for valuating decisions in complex systems: introducing characterization of real options and logical C-DSM models (Mikaelian 2009)
- IT Systems in PD and the product life cycle
  - Product Data Management in the Enterprise (Hines 2005)
  - Cost advantages through common databases (Hoult 1995)
  - Advantages and implementation of software factories (Menendez 1997)
  - Management of IT in aerospace industry (Ferre 2004)

Enterprise Integration (4/4)

- Intellectual capital & HR development
  - Usage of tools to counteract loss of intellectual capital: intellectual capital correlates with program success; use of tools hinders development of tacit knowledge (Andrew 2001)
  - Conceptual framework to measure intellectual capital in PD: human, structural and relational capital (Siegel 2004)
  - Developing senior system engineers: Experiential learning, individual traits, organizational design (Davidz 2005, 2006)
  - Supporting "Acquisition Intrapreneurs": Program contracting officers and engineers identified; incentives for increased innovation include specific funding and reporting; long-term support through creating the right jobs, environment, localized training and support (Forseth 2002)
  - Developing collaborative systems thinking in teams: team traits, technical process and culture (Lamb 2007, 2008, 2009a, b)
  - Knowledge creation in multi-disciplinary teams: theoretical, practicable, educable and evidentiary knowledge components; the role of universities and companies in the "knowledge supply chain" (Roth 2005)
  - Large-scale cultural change in a company (Roth 2005b, to the desert and back)
- Teams in PD
  - Team learning in pharmaceutical industry (experiential, contextual, vicarious) (Bresman 2005)
  - Integrated Product Teams (IPT) implementation (training, budget, balance team and function) (Hernandez 1995)
  - Balance of influence between function managers and team leaders in IPTs, effects on risk and performance (Susman 1995)
  - Integration of multiple IPTs in one program (Browning 1997)
  - Information flow between IPTs (Pomponi 1997, 1998)
  - Factors facilitating the development of high performance teams (Oehmen 2005)
  - Adapting SE for distributed design teams (Utter 2007)

Group 3: Efficient Execution

		Type of process		
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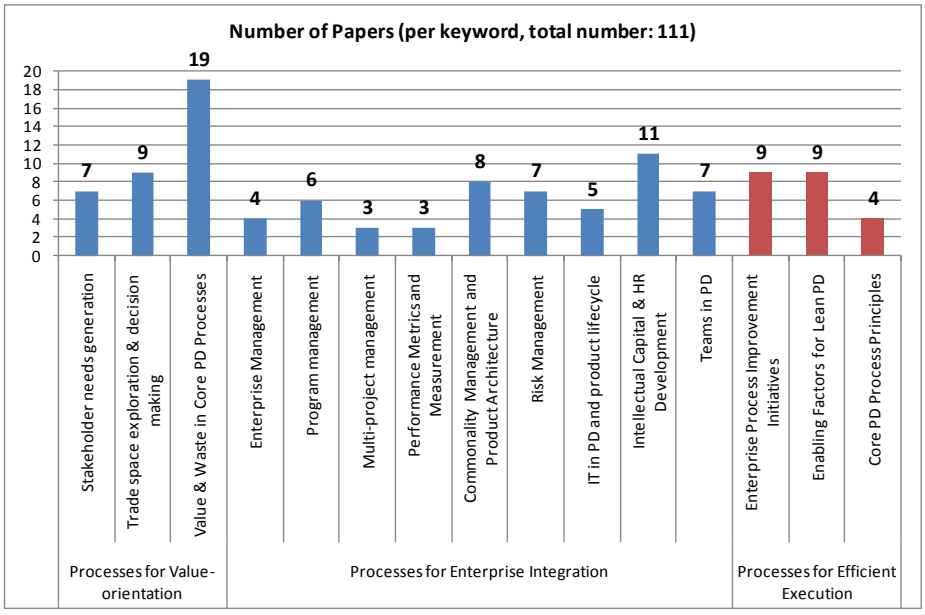

Efficient Execution

- Enterprise Process Improvement Initiatives
  - Introducing 6 Sigma at Raytheon (Roth 2005)
  - Comparing Lean, 6 Sigma and other process improvement initiatives (Bozdogan 2006, Rhodes 2006)
  - Introduction of Lean on Enterprise Level (Davidz 2002, Douglas 2002, Ferdowsi 2002)
  - Valuating Knowledge Management in companies (Taylor, 2006)

Efficient Execution (2/2)

- Enabling factors for Lean PD
  - Introducing Lean Management in PD: 11 components, 44 factors, implementation roadmap (Hoppmann 2009a, b)
  - Migrating to lean engineering processes: creating the right products, effective life cycle and enterprise integration, efficient engineering processes (McManus 2005)
  - Enabling factors and their influence on profit, market share, customer satisfaction, organizational effectiveness and product quality (Tang 2005)
  - Overview of concepts and elements of lean PD: lean concepts, integrated product and process development, lean in the context of PD, program management, metrics in PD, IT tools (Walton 1999)
  - Process analysis and DSM for Boeing UCAV project (Browning 1998b)
  - Distribution and cost of issues identified at tests during integration of spacecraft, identification of enterprise-level findings (Weigel 2000a, 2001)
  - Transforming test discrepancies into PD improvements (Weigel 2000b)
- Core PD Process Principles
  - Evolutionary / Spiral development: Implementing Evolutionary Acquisition in Development Programs (Ferdowsi 2003)
  - Iterations: Reducing overall system cost through cost-focussed design innovations and lean/6 sigma innovations (Tondreault 2003)
  - Concurrent engineering: Concurrent engineering on the enterprise level: benefits and implementation hurdles (Stagney 2003)
  - Set-based design: Definition and state in the aerospace industry; some evidence, proposal of model to implement set-based concurrent engineering (Bernstein 1998)

Some observations

- A lot of very interesting material.
- Strong correlation between people and topics (we have heard this before).
- A large number of students stay with LAI. It is interesting to see how their research progresses over time.
- Nobody ever uses the same terms for anything (especially in titles and abstracts).
- But I am very fortunate: Eric is a walking library.
- My favourite: What is the difference between a
  - “X-focused Y” and a
  - “Y-focused X”?
  - X,Y ∈ {project, program, enterprise, system}
  - (“centric” instead of “focused” also works well)