Engineer
Your
Competitive
Advantage

Beyond Process: Using Stages to Deliver a Body of Knowledge for Product Line Engineering

Process Insights North America

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Dr. Paul Clements
Vice President of Customer Success
BigLever

BigLever at a Glance

Industry leader in Product Line Engineering solutions

- 17 years of commercial practice
- Success stories across a spectrum of industry sectors

Industry standard feature-based PLE technology & methods

- Gears PLE Lifecycle Framework™
- PLE Ecosystem of third party tool integrations
- BigLever 3-Tiered PLE Methodology™

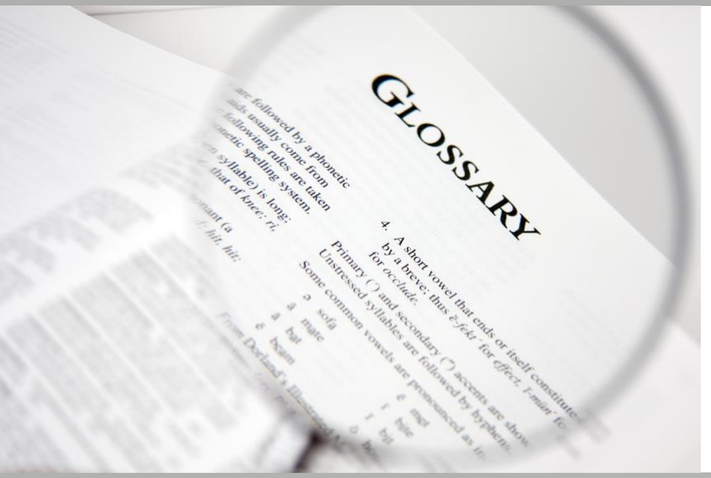
Industry's only holistic PLE solution

- PLE business strategy
- Organizational change for PLE adoption
- PLE Factory infrastructure

Product Line Engineering (PLE) Defined

Product Line:

a family of similar products or systems with variations
in features and functions

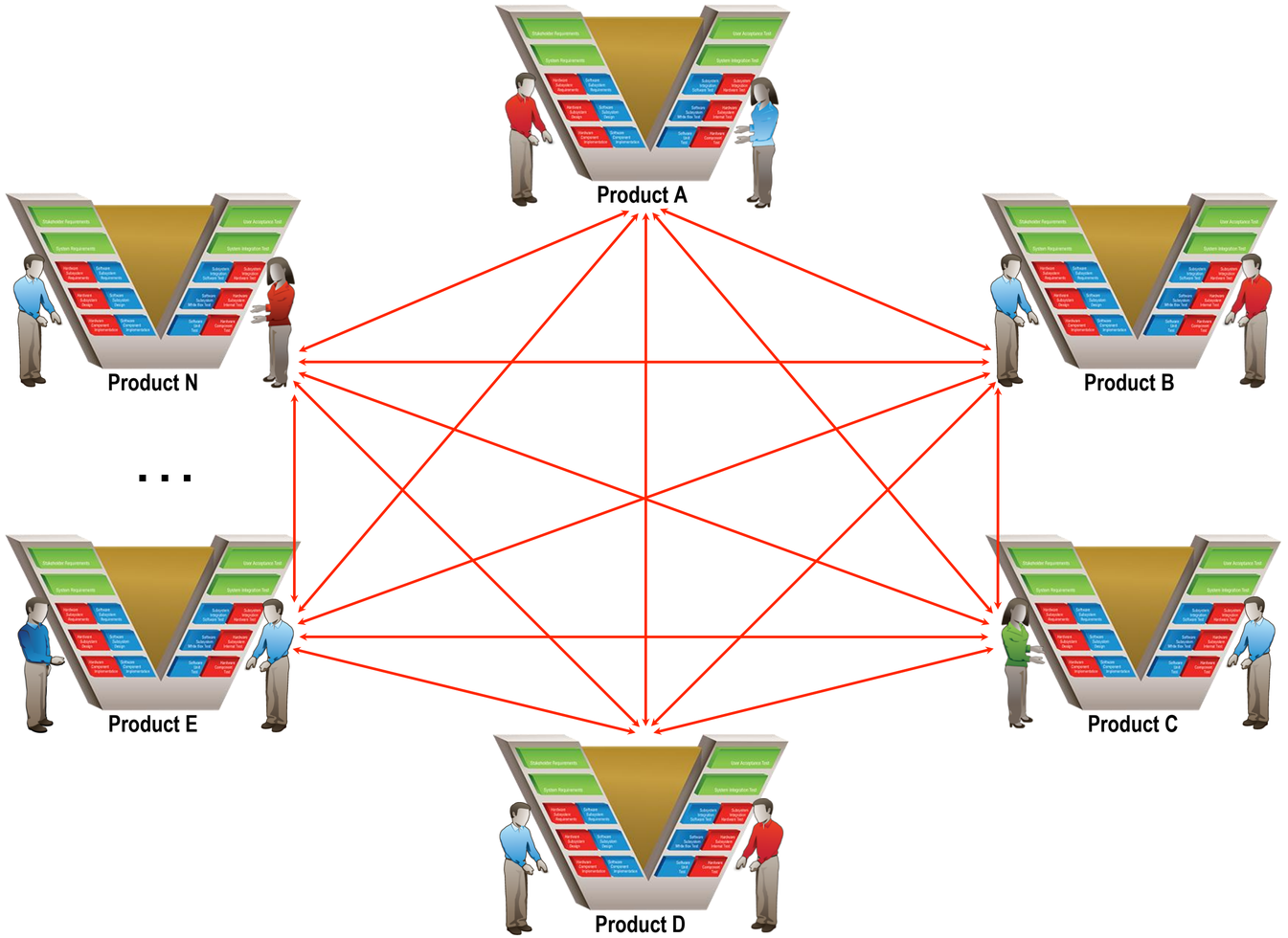


Product Line Engineering:

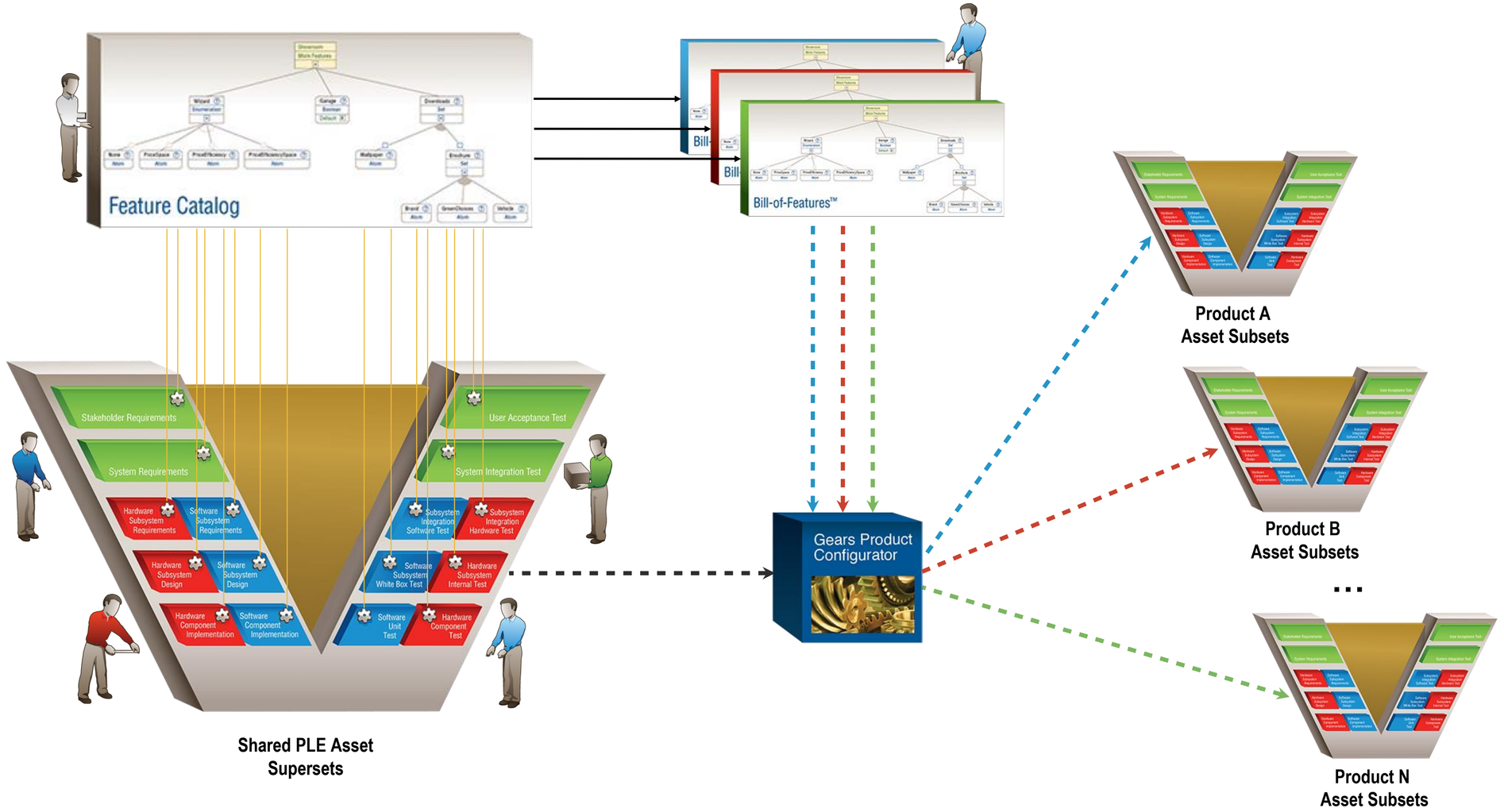
the engineering of a product line using
a *shared set of engineering assets*,
a *managed set of features*, and
an *automated means of production*…

- taking advantage of the **commonality** shared across the family
- efficiently and systematically managing the **variation** among the systems

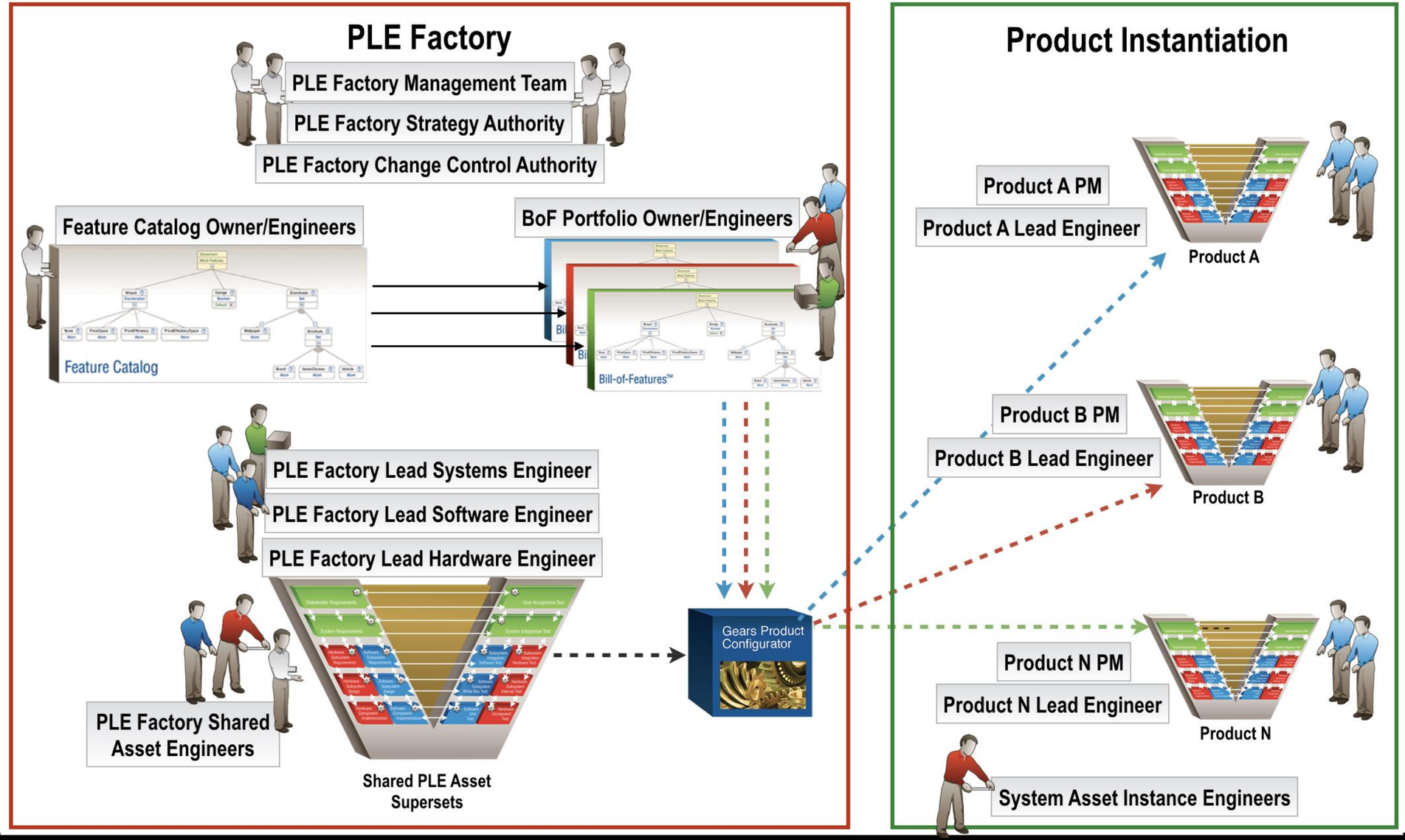
PLE is a move away from product-centric duplication, branch & merge, clone-and-own, N^2 coordination



Feature-based PLE Factory Workflow



Concept of Operations Org Chart



Holistic concerns in a PLE Technical Solution

Multi-product

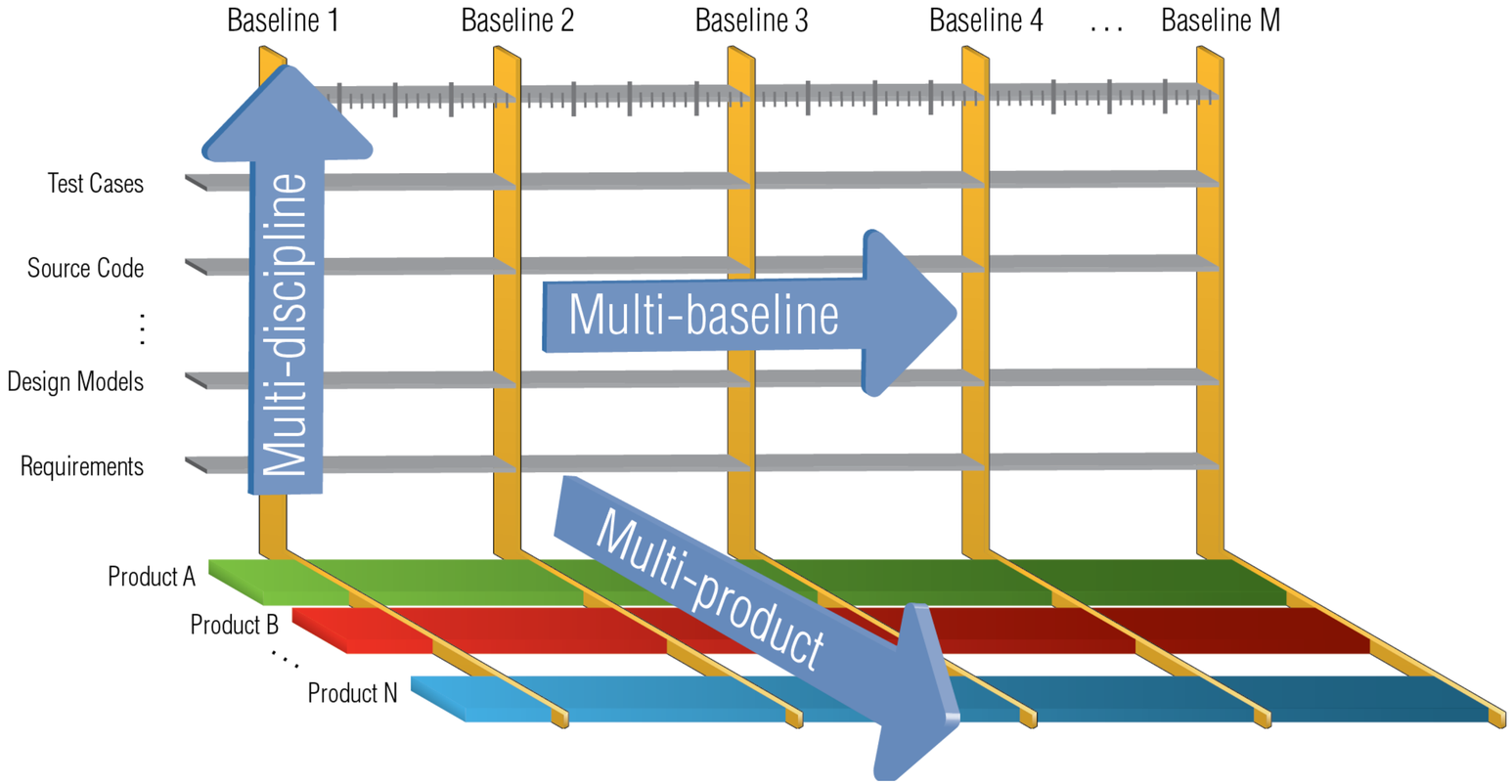
Feature-based variation management and automated production line

Multi-discipline

Product line lifecycle assets, architecture and traceability

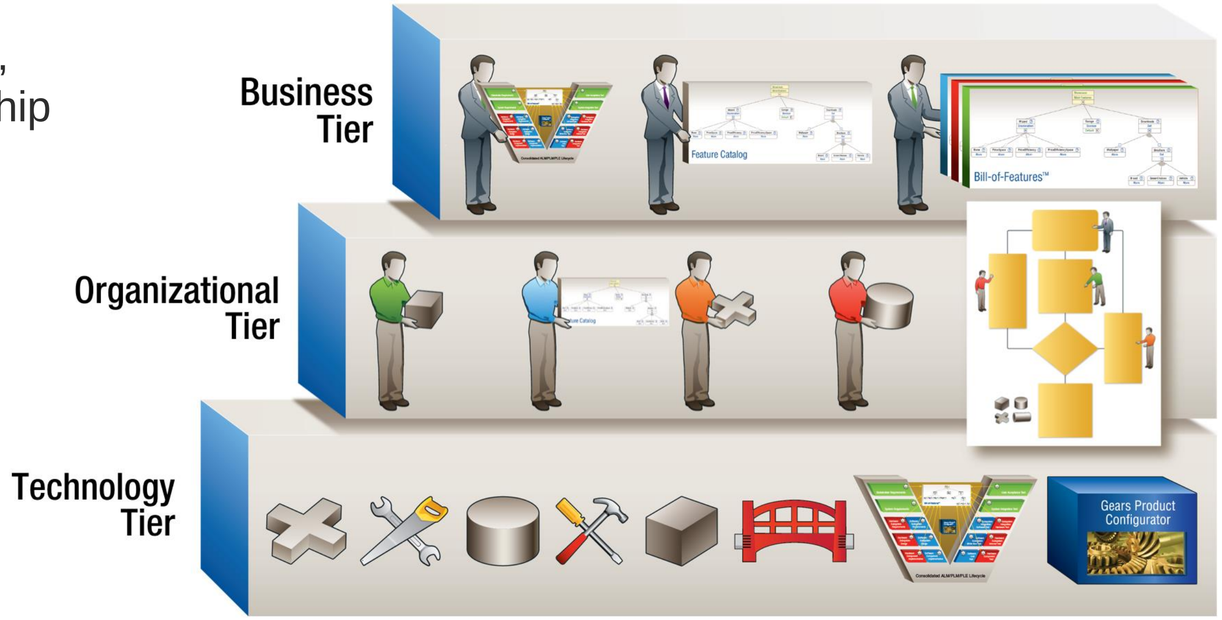
Multi-baseline

Product line change management and baseline management



PLE and Organizational Change

- PLE is about more than technology.
- Successful PLE requires significant *Organizational Change*, much more so than other engineering disciplines.
  - Strong collaboration between business, management, and engineering leadership
  - Active commitment and participation of business and management leadership



PLE and Organizational Change

- Organizational Change is hard and has many failure modes
  - Inertia of product silos, protecting product ownership, and shortsighted focus on just the next product
  - Resistance to change — status quo is the enemy
  - “We’re too busy to save time, and can’t afford to save money.” *
  - Inadequate funding models
- There are many roles that need to work together to make PLE a success
  - They need to know what to do
  - They need to know the best ways to do it
  - They need *on-demand training*

* Dr. Beth Wilson, Principal Engineering Fellow, Raytheon

Stages provides a process platform… and a training platform as well

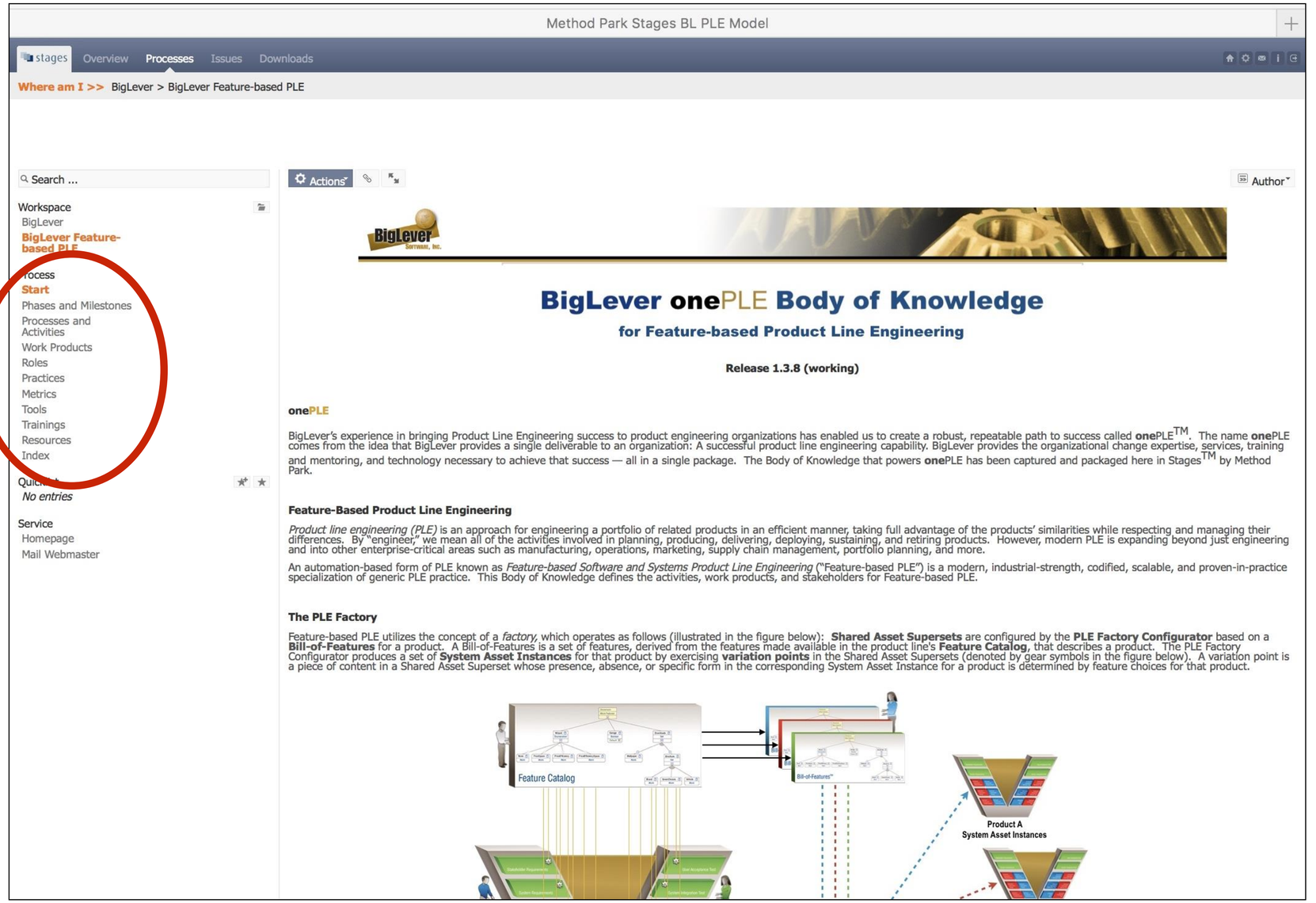
- Using Stages, BigLever has created an industry first: A web-based comprehensive body of PLE knowledge structured and available on-line for use throughout an organization.
- The Body of Knowledge contains detailed process descriptions for every aspect of Feature-based PLE, including all of the activities involved in
  - PLE adoption and roll-out
  - establishing and operating a PLE Factory
  - using the PLE Factory to build and deliver products
- Anyone in an organization can go to the Body of Knowledge, look up their role, see its definition and the processes and activities for which they are responsible, and then undertake associated training.

Stages Use Case at BigLever

- We are not a company putting processes into place.
- We are a company helping our customers put processes into place.

Overview

- The Body of Knowledge comprises
  - Processes and activities
  - Roles and responsibilities
  - Phases of PLE
  - Work products
  - **Training materials**



The BoK reflects a comprehensive curriculum for PLE based on a role/topic matrix.

Table 1

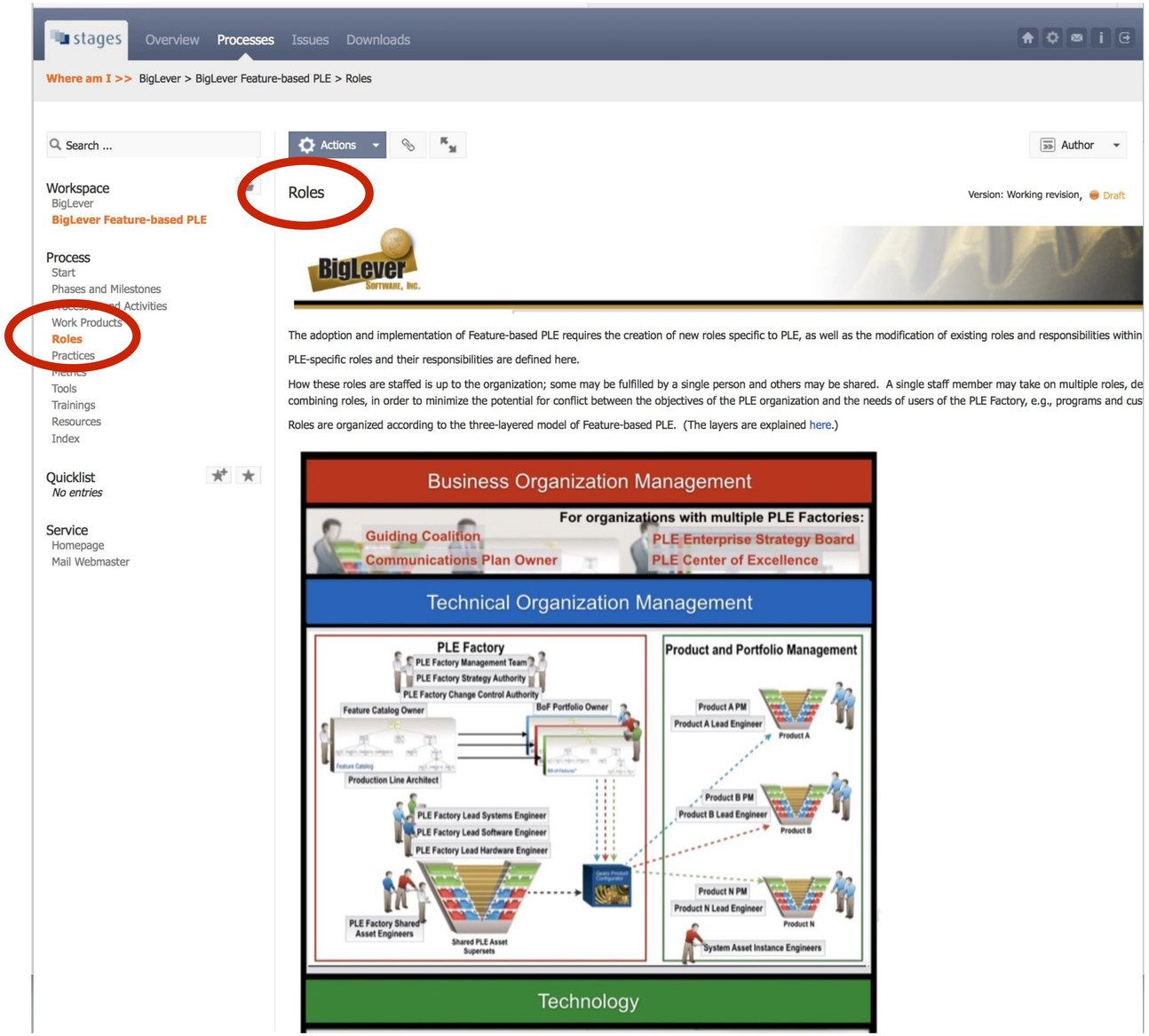
Tier	Track	Topic	Nominal Priority: 1 = high, 3 = low (TBD)	Audience											Comments on topic
				Leadership, Guiding Coalition		Adoption leaders	Potential new adopters	Factory					Product/ Portfolio	IT	
				Enterprise or Business Unit level	Individual Product Line Team level	COE staff, PLE champions, PLE experts		Management, CCB, PLCB	PL Architect, Feature catalog, BoF owners	Shared asset engineers	Lead engineers	Product validation, delivery	PMs, Lead Engineers, System Asset Engineers	IT technicians	
All	PLE intro and awareness	Introduction to PLE		✔	✔	✔	✔	✔	✔	✔	✔	✔	✔		
		Extended intro to PLE (incl. history, PLE&O, PLE & MBSE, etc.				✔	✔						✔		
		Demonstration of Gears and integrations				✔	✔	✔	✔	✔	✔	✔	✔	✔	
Business Organization Management Tier	PLE in a Proposal	How to describe your application of PLE in a proposal				✔		✔							
	PLE Adoption and Establishing a PLE Factory	Roles and activities of a PLE Guiding Coalition		✔	✔	✔									
		Living Business Plan		✔	✔	✔									
		Spiral adoption planning		✔	✔	✔									
		Communications planning		✔	✔	✔									
		Risks and roadblocks for PLE		✔	✔	✔									
		Funding the factory													
	Establishing Multiple PLE Factories	Building and Operating a PLE Center of Excellence		✔		✔									
Technical Organization Management Tier	Managing a PLE Factory	PLE Factory roles and organizational structure				✔	(✔)	✔	✔	✔	✔	✔			
		PLE processes				✔		✔	✔	✔	✔	✔			
		IP protection: Classified, unclassified product lines, Customer IP protection, …				✔		✔							
		PLE metrics and measures		✔	✔	✔	(✔)	✔							
	Using Gears Effectively (General topics)	Introduction to Gears				✔		✔	✔	✔	✔	✔	✔		
		Using the Gears logic editor				✔		✔	✔	✔					Introduction to the Gears logic editor: operator first, building complex expressions, a 3-part "Or," use of the Mixins…. construct, when to use the Mixins bit in the feature menu, short-circuit semantics (with examples of where you need them; how to work with sets: Why use ">=" and what it means, …)
		Good naming practices				✔		✔	✔						
		Guidelines				✔		✔	✔	✔					
	Production Line Architecture	Building a production line with Gears				✔		✔	✔						
		Production line hierarchy, Imported production lines, composition/self-composition assertions among IPLs, attaching shared assets				✔		✔	✔						Production Line Architecture: Structure the production line as a hierarchy of imported production lines, allocate shared assets appropriately to each level, and design product line's product family tree. Hierarchical production lines, private matrices, importing mixins, using <find> and so on for mixins you don't own…
	Feature Catalog Engineering	Building sound feature models				✔			✔						Feature Modeling: Best practices, and detailed guidance to build long-lasting, robust feature models for each subsystem in the business unit's production line.
		Assertions				✔		✔	✔						The Gears course covers intra-mixin assertions, which is good enough. For the others, how-to videos should provide enough coverage.
	Bill-of-Features Portfolio Engineering	Matrices and matrix rows				✔			✔				✔		
		Product family trees				✔			✔				✔		Multi-stage configuration: Wizard. Down-selection.
		Feature bundles				✔			✔				✔		
		Multi-instancing				✔			✔				✔		
	Shared Asset Engineering	Shared asset engineering: overview: supersets; variation points types;				✔		✔		✔					
		Filesystem shared assets; creating a superset; types of VPs; actuation; actuation to staging area				✔				✔					Continuous re-factoring to pull out commonality. Actuate to test using Local matrix.

Current contents include…

- 13 Best Practices compendia
- 16 Quick Reference Guides
- 9 slide decks explaining various PLE topics
- 14 white papers that describe detailed solutions to specific PLE problems
- 7 Frequently Asked Questions lists
- 5 slide sets for full-day or half-day courses (uploading these is ongoing)
- 22 short how-to videos (production and uploading of these is ongoing)
- 21 downloadable papers published in the open literature about PLE
- Full guidance on conducting a Business Getting Started Workshop and a Technical Getting Started Workshop
- A comprehensive collection of PLE overview and introduction materials that provides a starting point for people new to PLE.

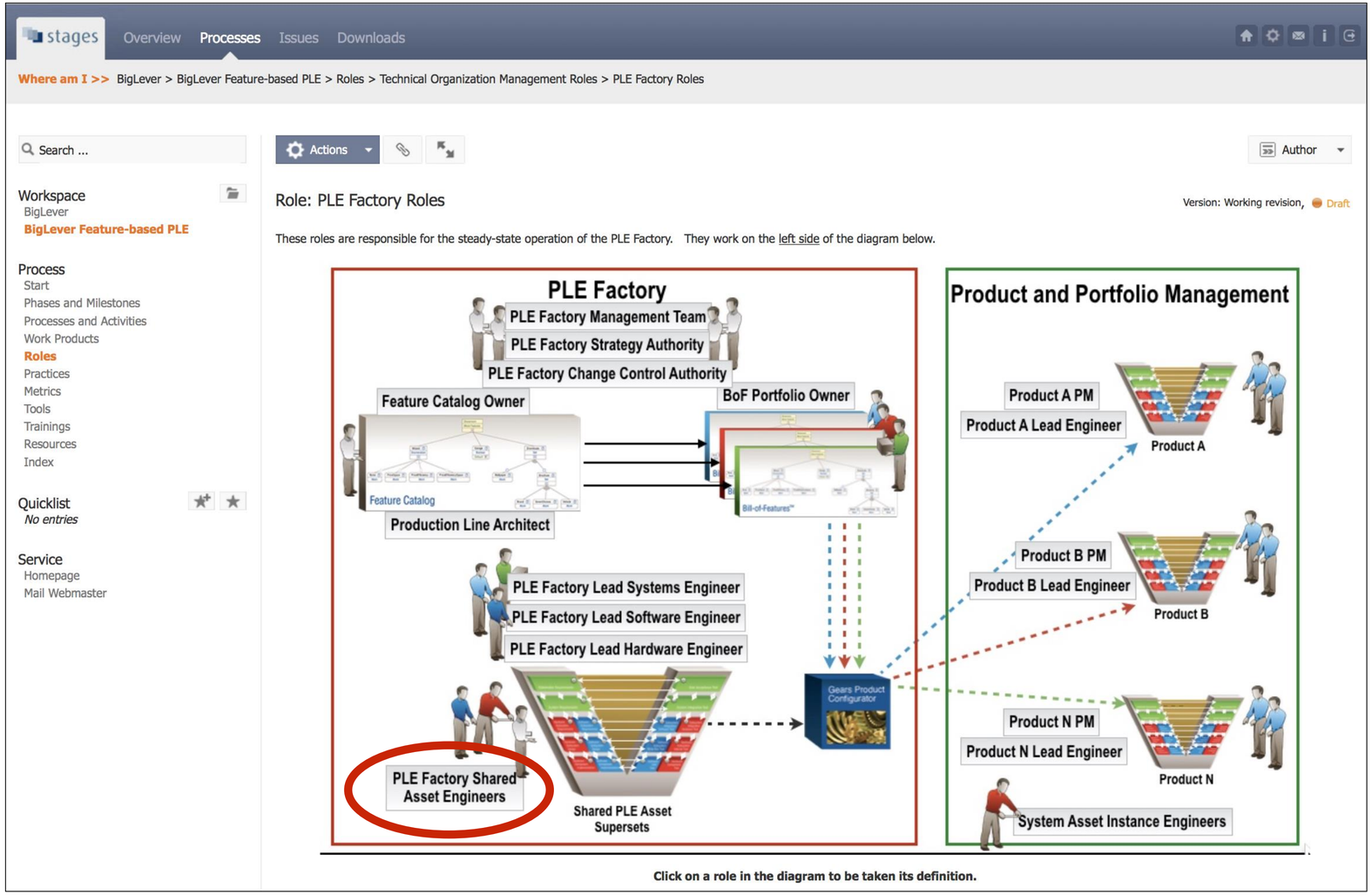
An Example of Using the Body of Knowledge

- A Shared Asset Engineer visits Roles.



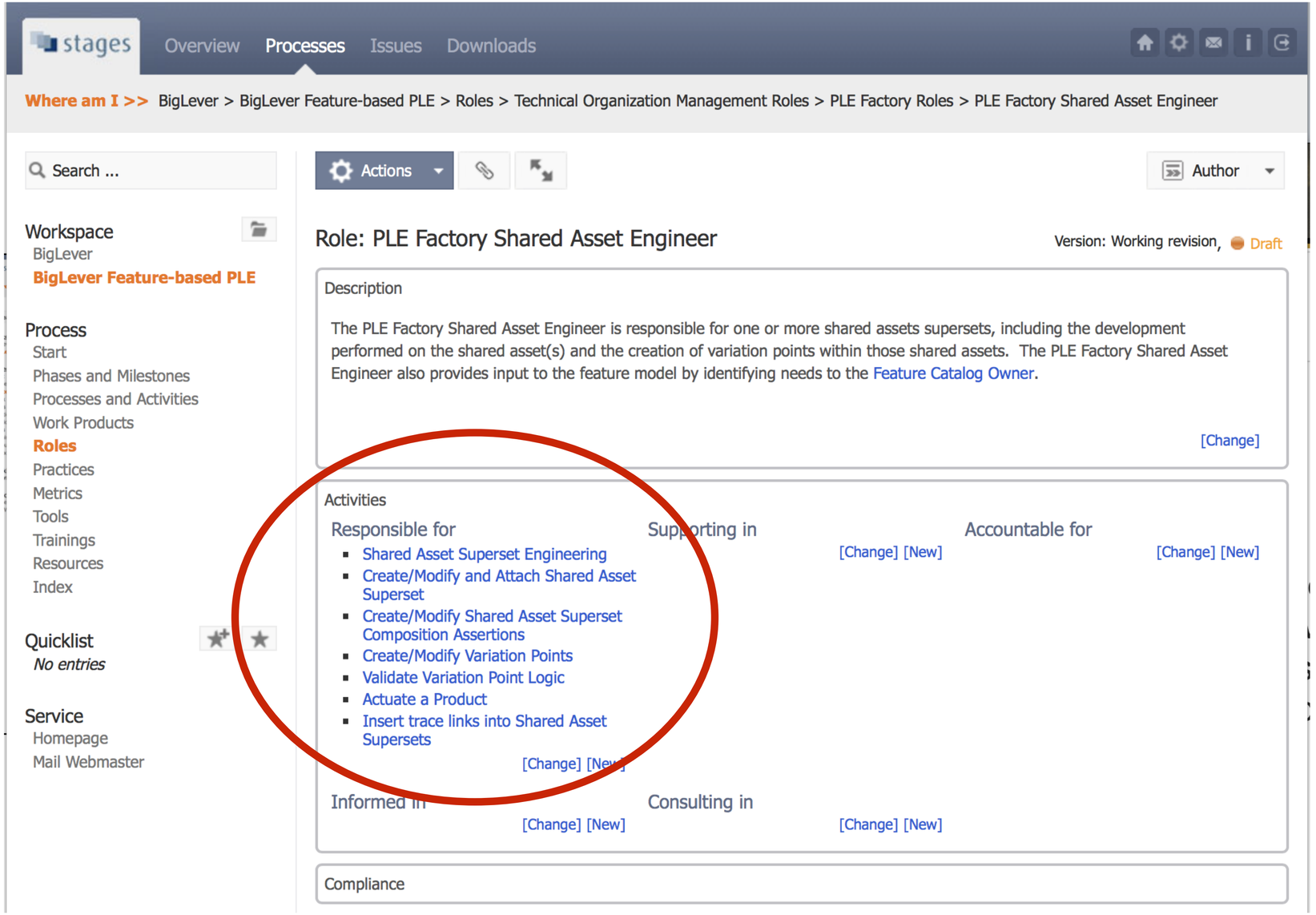
Example

- A Shared Asset Engineer visits PLE Factory Roles…
- …and clicks on “PLE Factory Shared Asset Engineers.”



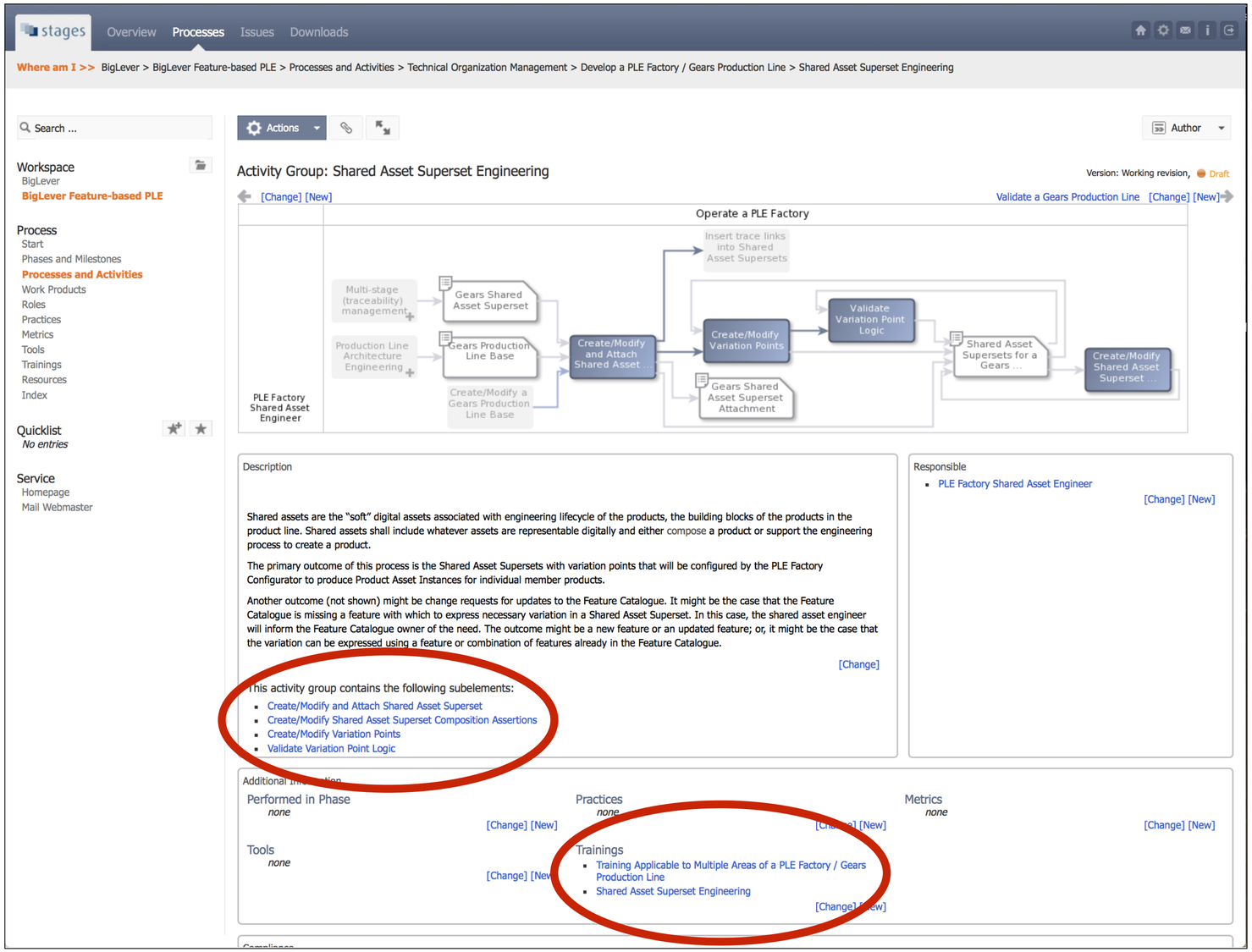
Example

- …and finds the processes for which he/she is responsible.



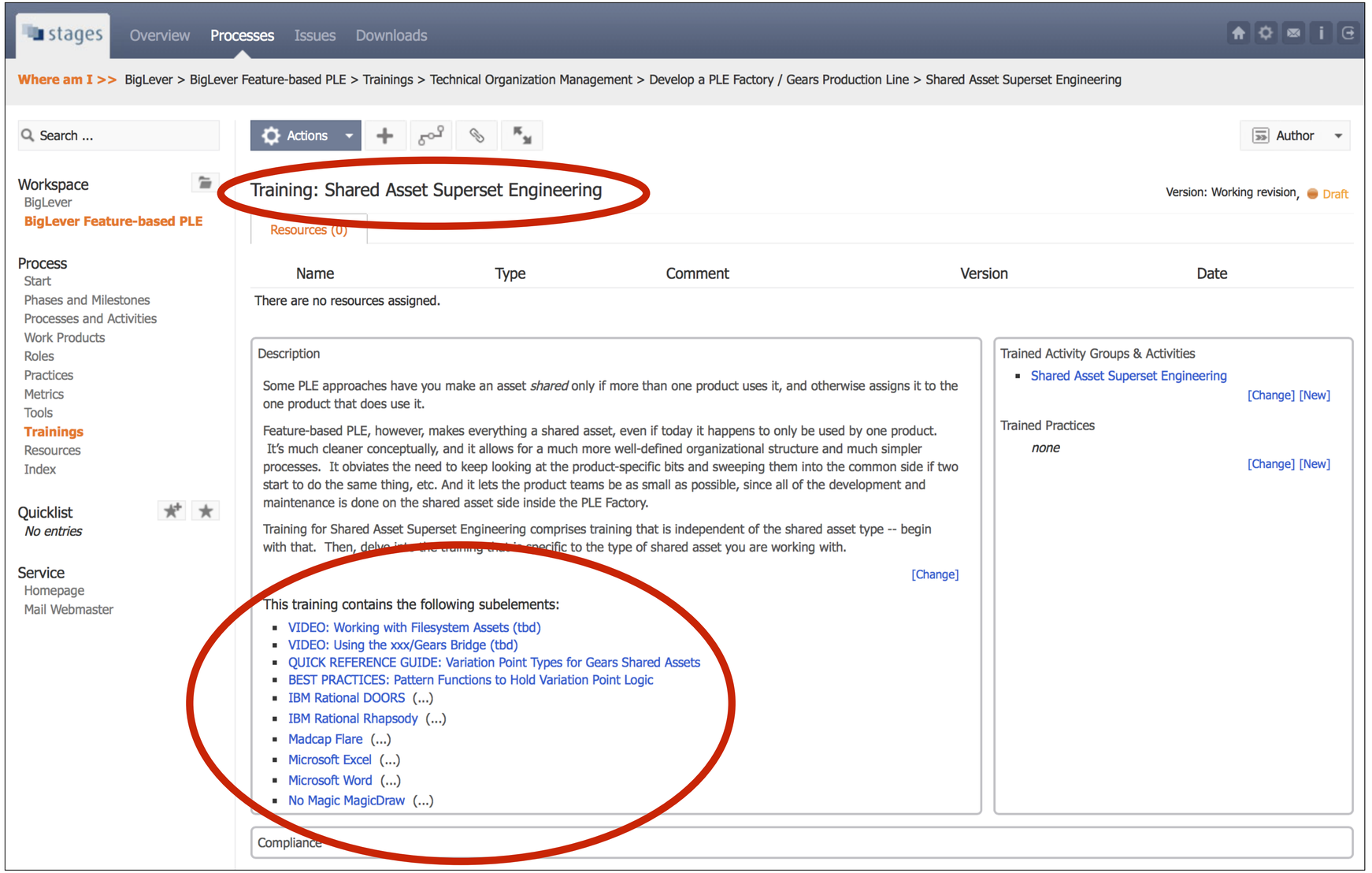
Example

- Our engineer…
  - …visits the definition for Shared Asset Superset Engineering process.
  - …explores sub-processes for further elaboration
  - …follows pointers to training materials for how-to knowledge and best practices



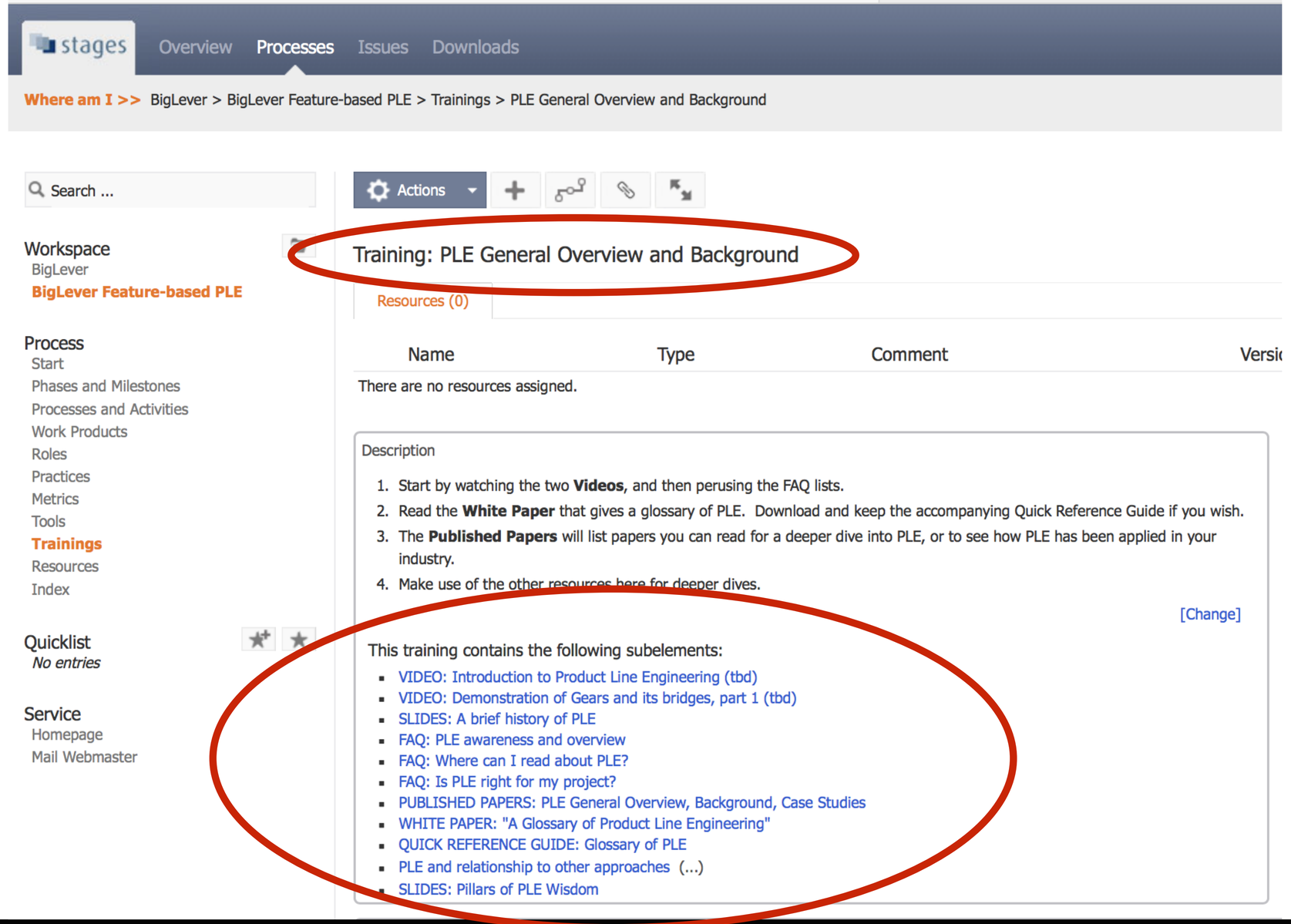
Example

- Our engineer goes to Training for Shared Asset Engineering and explores the training materials available.
- Training materials include
  - courses
  - best practices compendia
  - Quick Reference Guides
  - slide presentations
  - detailed how-to videos
  - white papers for topic deep-dives
  - and more.



Training for everyone

- Everyone can receive a comprehensive introduction and overview of PLE to the level desired.



Results

- This has allowed BigLever to change its model for helping our customers adopt PLE
- Instead of high-intensity on-site training and consulting, we can now take a broader lighter-weight strategic mentoring approach
  - On-line Body of Knowledge plus a methodology “Support” line
- That’s good for us
  - We can leverage our staff much more efficiently
- That’s good for our customers
  - Many dislike or cannot pay for “consulting”
  - Training is available on-demand, in the context of a comprehensive PLE process/roles model
- Stages’ file-upload capability provides an outstanding means to capture our training curriculum and body of knowledge for Product Line Engineering.

www.biglever.com