



**Engineer  
Your  
Competitive  
Advantage**



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

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## 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™

**onePLE**

### **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...*

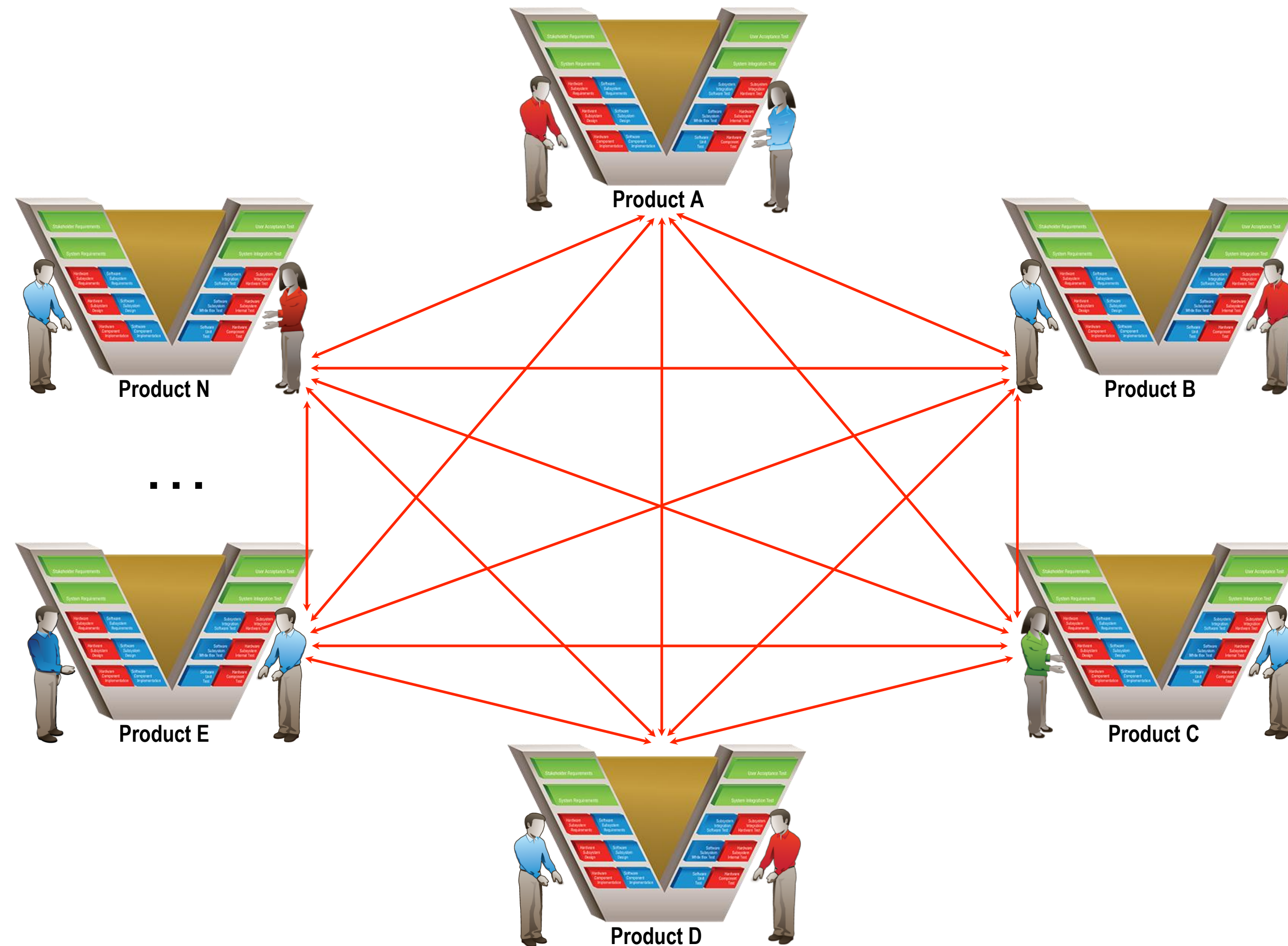


INNOVATION

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

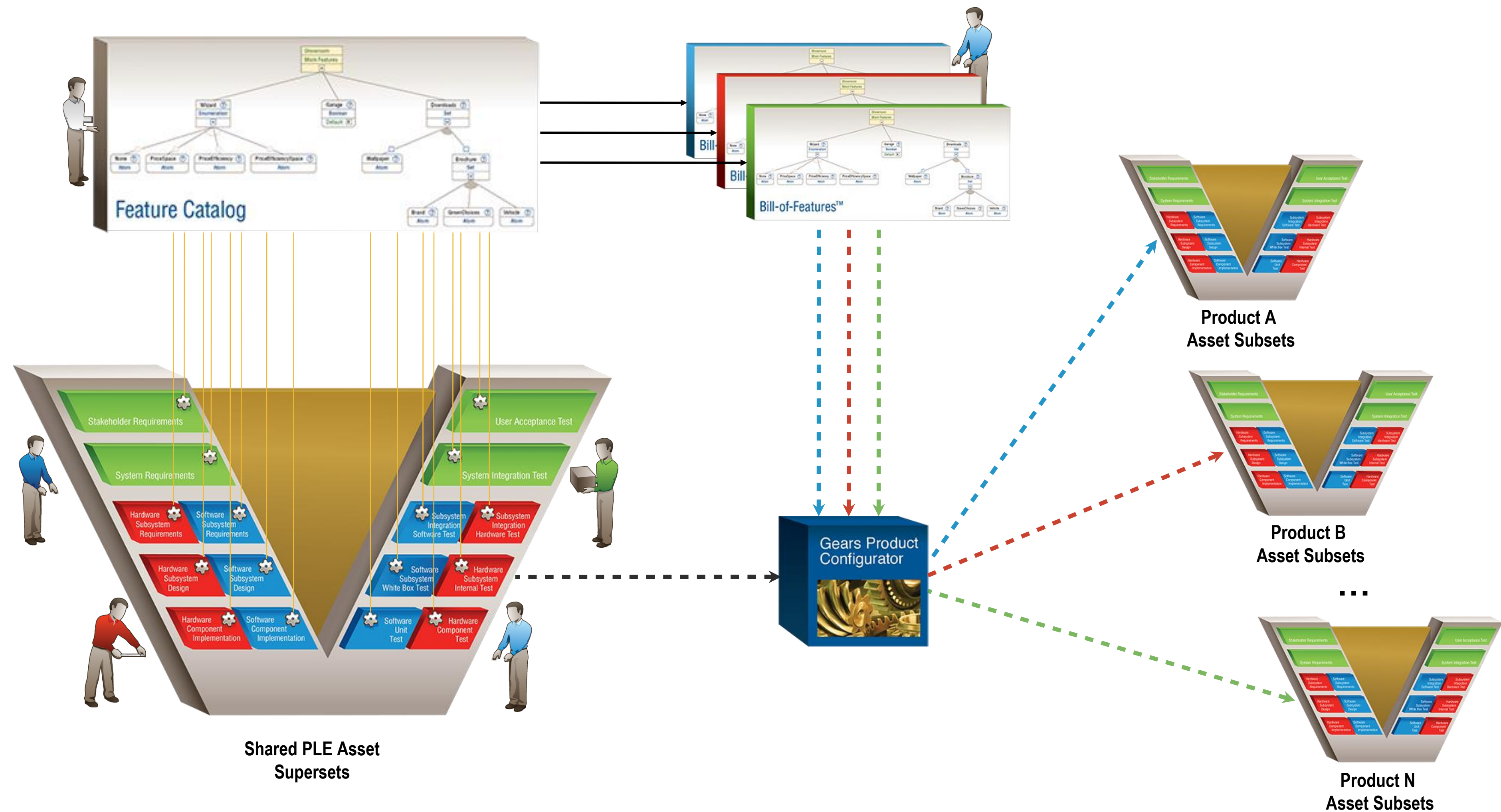


# PLE is a move away from product-centric duplication, branch & merge, clone-and-own, $N^2$ coordination



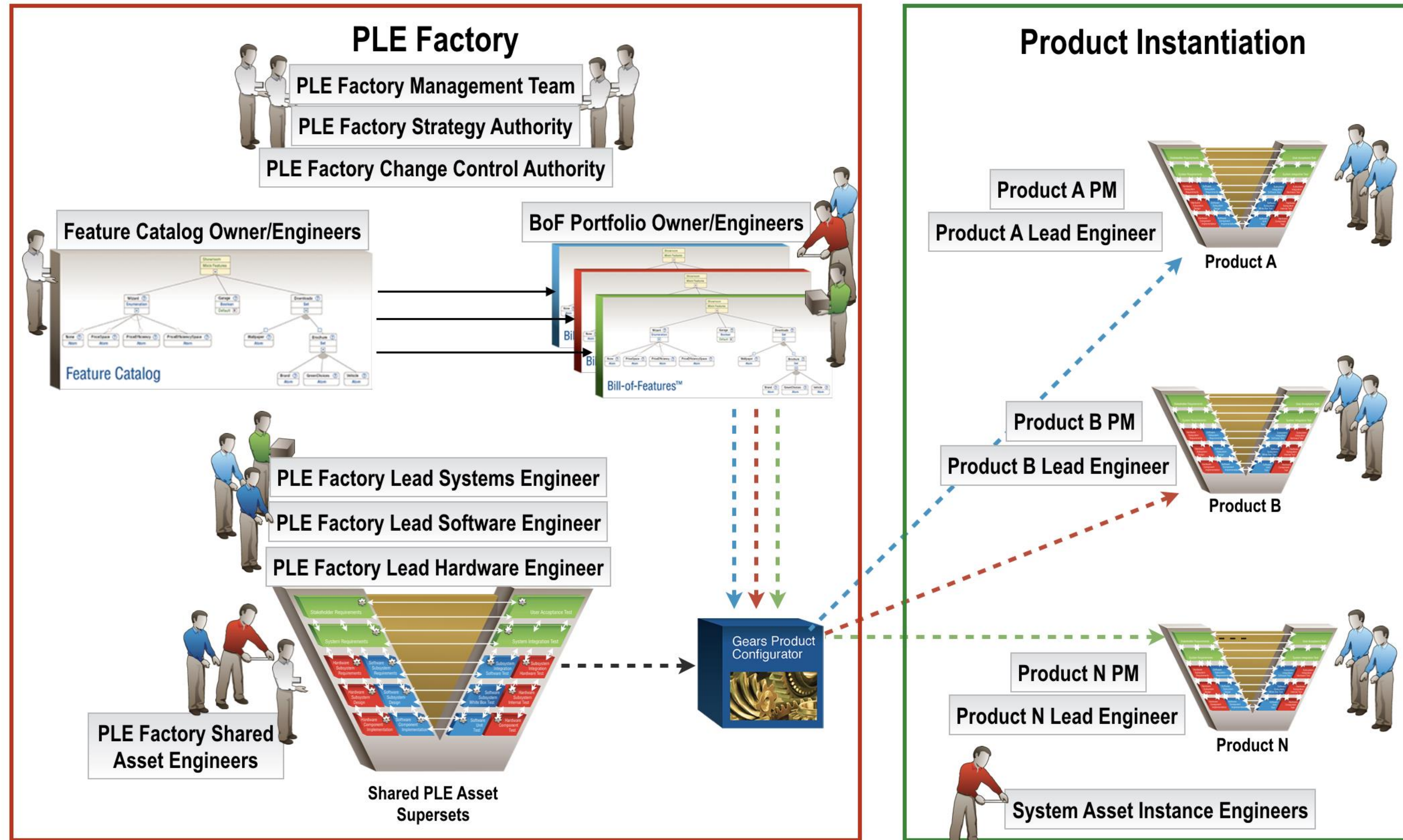


# Feature-based PLE Factory Workflow





# Concept of Operations Org Chart





# Holistic concerns in a PLE Technical Solution

## Multi-product

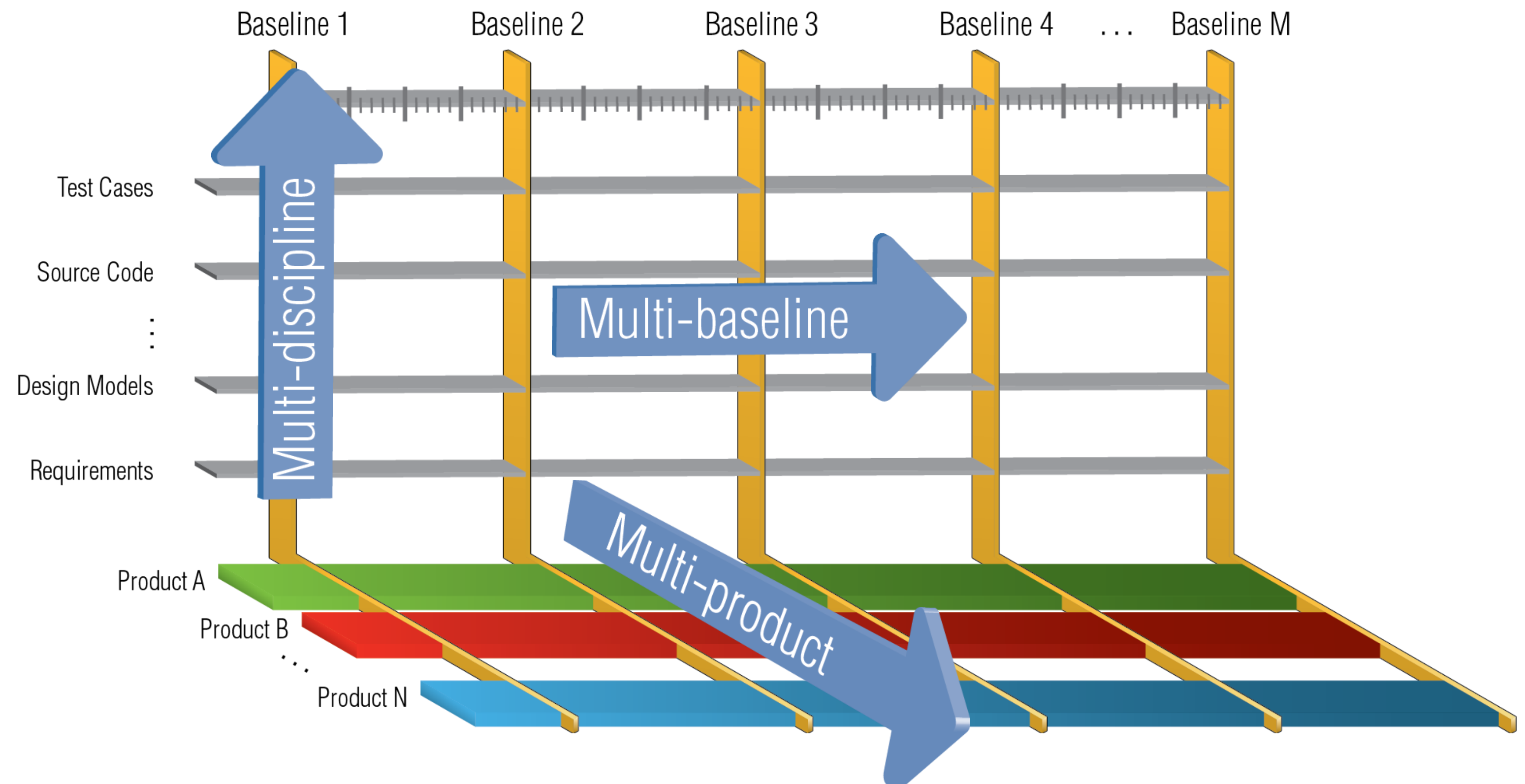
Feature-based variation management and automated production line

## Multi-discipline

Product line lifecycle assets, architecture and traceability

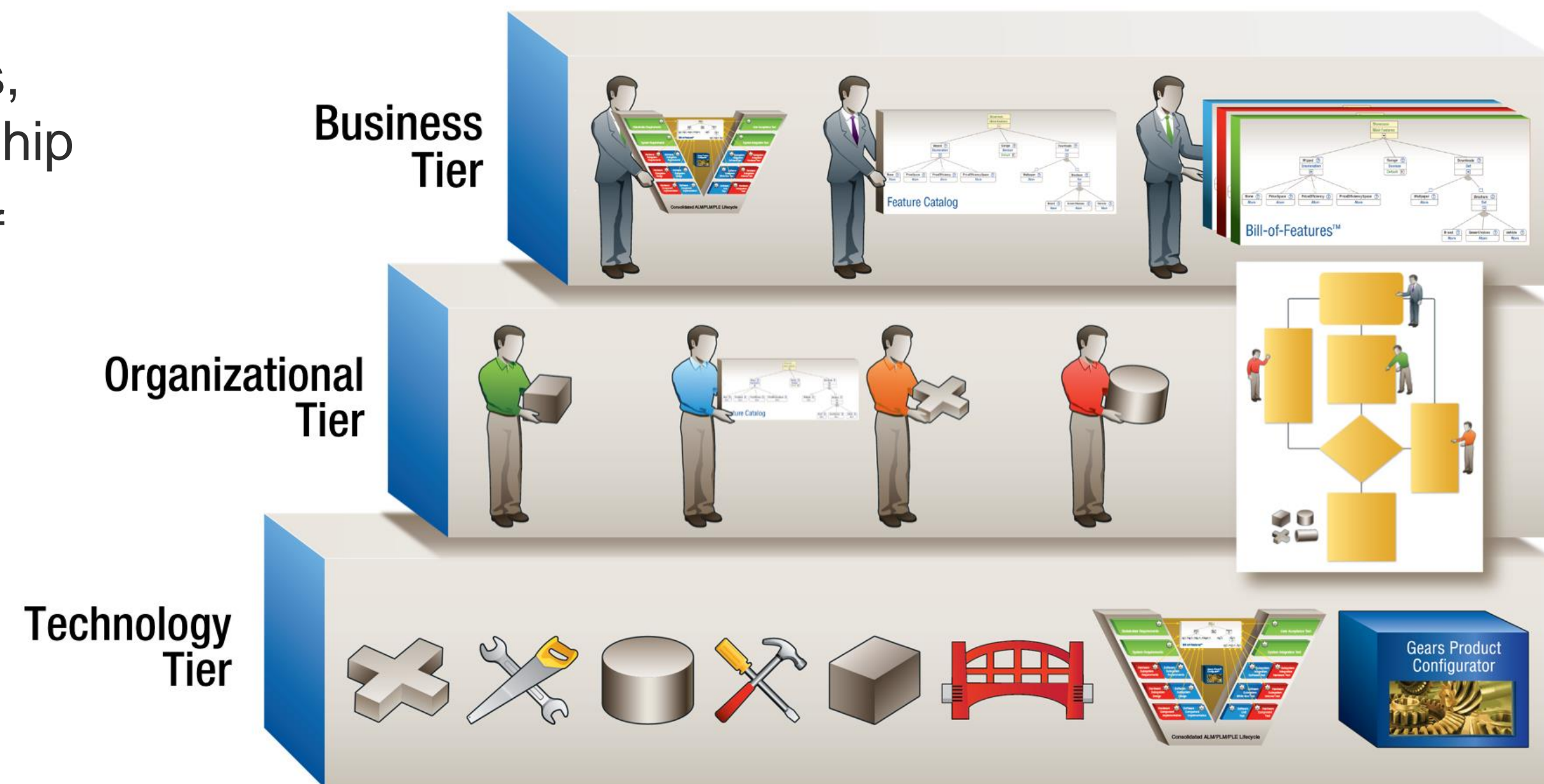
## Multi-baseline

Product line change management and baseline management





# PLE and Organizational Change





## PLE 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.



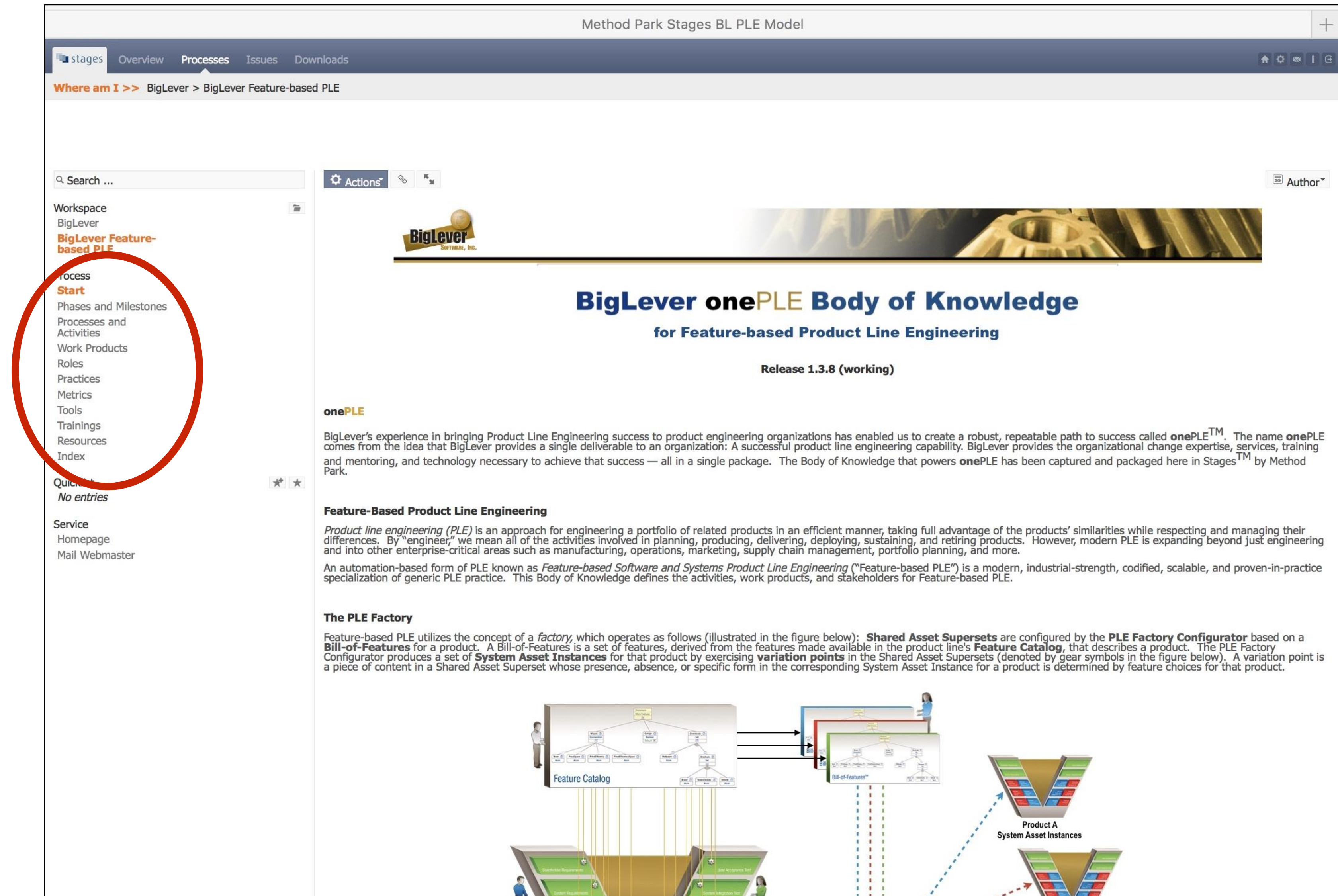
## Stages Use Case at BigLever

- 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 screenshot shows the 'Method Park Stages BL PLE Model' interface. The left sidebar contains a navigation menu with the following items: Workspace, BigLever, BigLever Feature-based PLE (highlighted with a red circle), Process, Start, Phases and Milestones, Processes and Activities, Work Products, Roles, Practices, Metrics, Tools, Trainings, Resources, Index, Quick Start, No entries, Service, Homepage, and Mail Webmaster. The main content area displays the 'BigLever onePLE Body of Knowledge for Feature-based Product Line Engineering' page, which includes the release version 'Release 1.3.8 (working)' and a detailed description of the onePLE framework. The description states that BigLever's experience in bringing Product Line Engineering success to product engineering organizations has enabled them to create a robust, repeatable path to success called onePLE™. The name onePLE comes from the idea that BigLever provides a single deliverable to an organization: A successful product line engineering capability. BigLever provides the organizational change expertise, services, training and mentoring, and technology necessary to achieve that success — all in a single package. The Body of Knowledge that powers onePLE has been captured and packaged here in Stages™ by Method Park.

**Feature-Based Product Line Engineering**

Product line engineering (PLE) is an approach for engineering a portfolio of related products in an efficient manner, taking full advantage of the products' similarities while respecting and managing their differences. By "engineer," we mean all of the activities involved in planning, producing, delivering, deploying, sustaining, and retiring products. However, modern PLE is expanding beyond just engineering and into other enterprise-critical areas such as manufacturing, operations, marketing, supply chain management, portfolio planning, and more.

An automation-based form of PLE known as *Feature-based Software and Systems Product Line Engineering* ("Feature-based PLE") is a modern, industrial-strength, codified, scalable, and proven-in-practice specialization of generic PLE practice. This Body of Knowledge defines the activities, work products, and stakeholders for Feature-based PLE.

**The PLE Factory**

Feature-based PLE utilizes the concept of a *factory*, which operates as follows (illustrated in the figure below): **Shared Asset Supersets** are configured by the **PLE Factory Configurator** based on a **Bill-of-Features** for a product. A Bill-of-Features is a set of features, derived from the features made available in the product line's **Feature Catalog**, that describes a product. The PLE Factory Configurator produces a set of **System Asset Instances** for that product by exercising **variation points** in the Shared Asset Supersets (denoted by gear symbols in the figure below). A variation point is a piece of content in a Shared Asset Superset whose presence, absence, or specific form in the corresponding System Asset Instance for a product is determined by feature choices for that product.

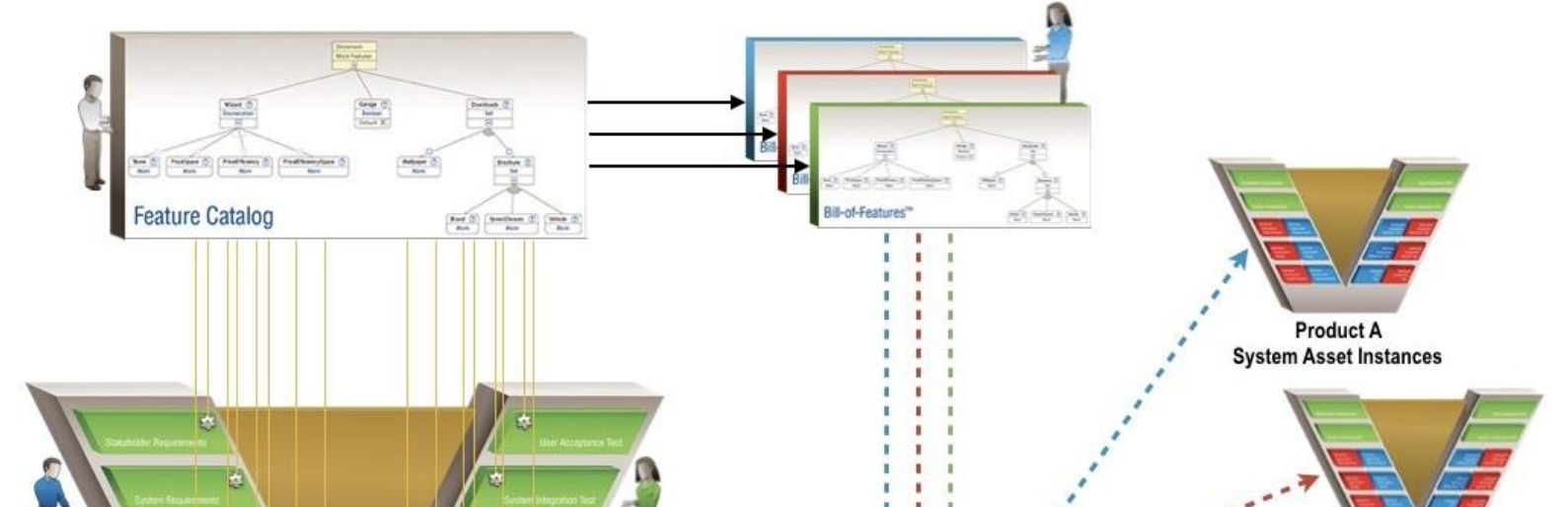






Table 1

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				✓		✓	✓	✓	✓	✓			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, ...)
		Using the Gears logic editor				✓		✓	✓	✓					
		Good naming practices				✓		✓	✓						
	Production Line Architecture	Guidelines				✓		✓	✓	✓					
		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.

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



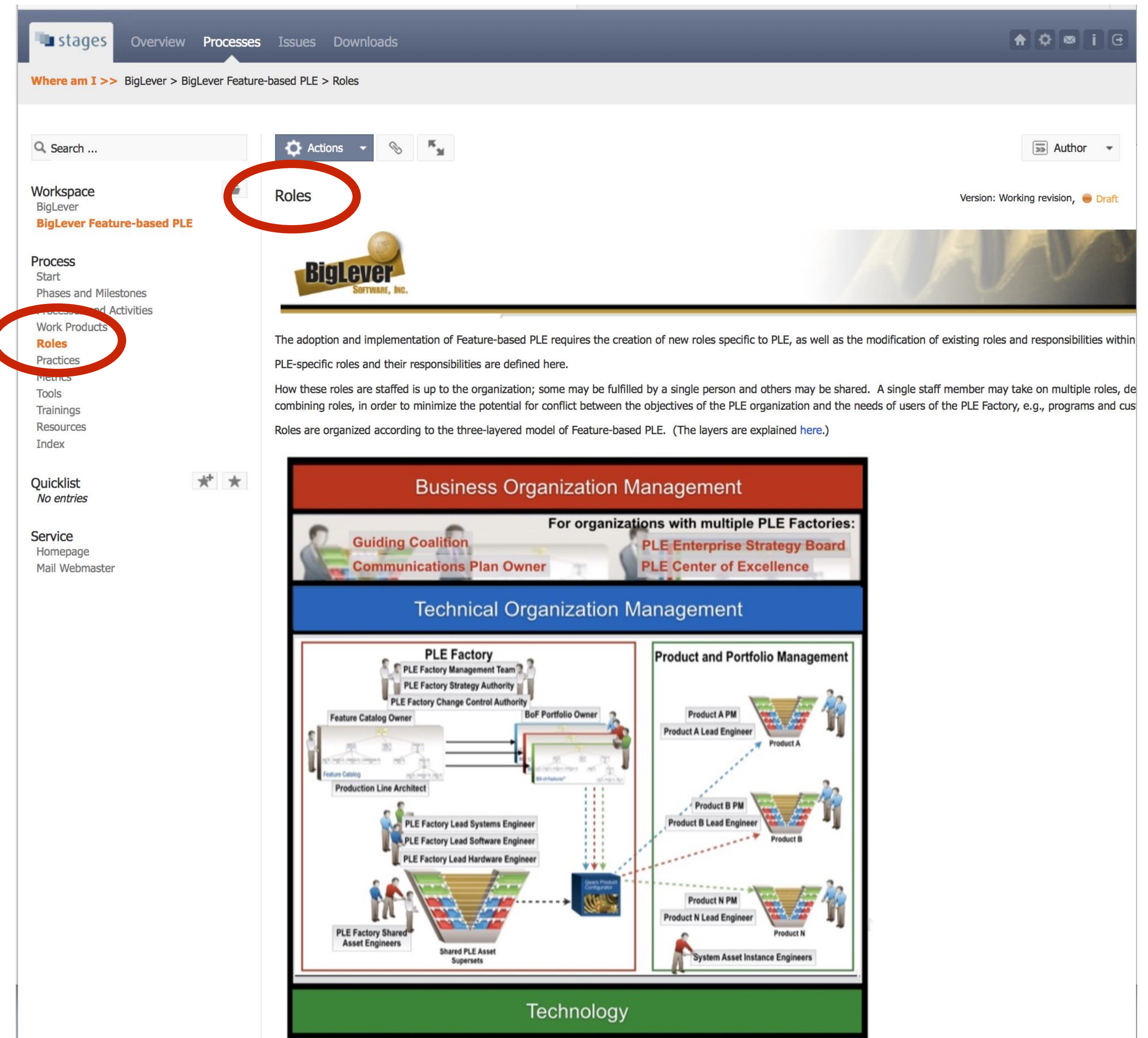
## Current contents include...

- 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

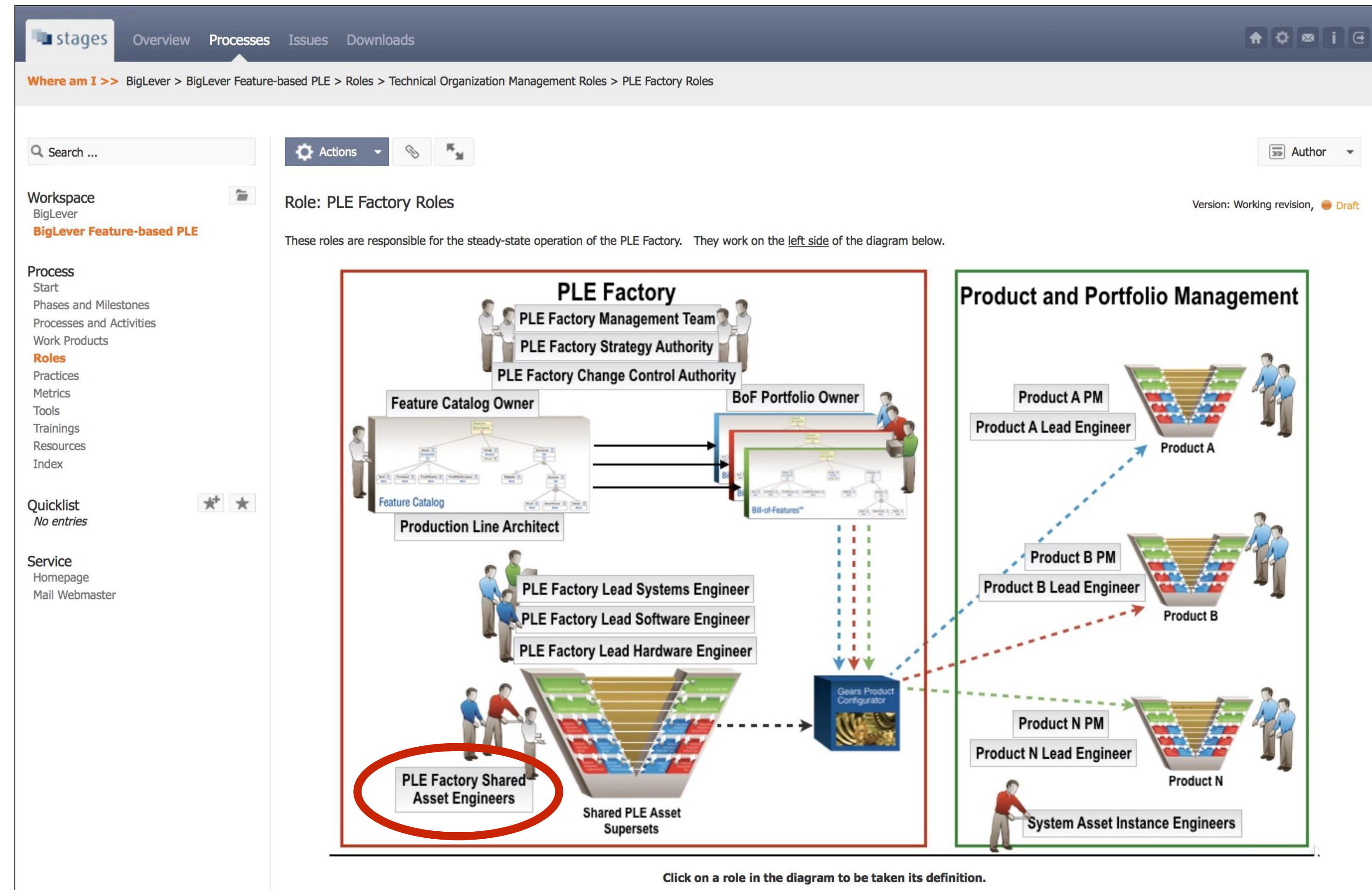
- A Shared Asset Engineer visits Roles.





# Example

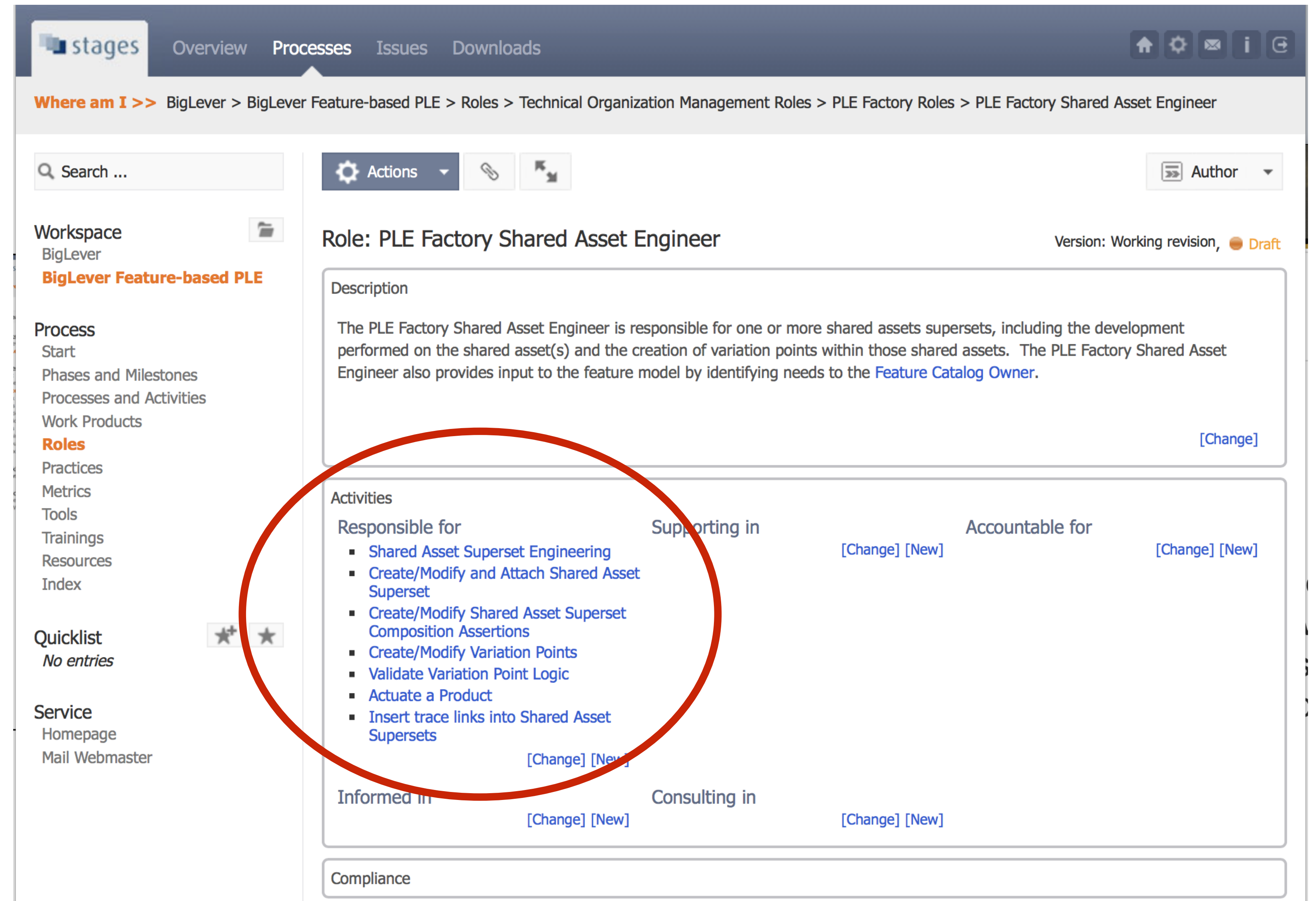
- A Shared Asset Engineer visits PLE Factory Roles...
- ...and clicks on “PLE Factory Shared Asset Engineers.”





# Example

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



The screenshot displays the BigLever software interface for the 'Role: PLE Factory Shared Asset Engineer'. The interface includes a navigation bar at the top with tabs for 'Overview', 'Processes', 'Issues', and 'Downloads'. A breadcrumb trail indicates the current location: 'Where am I >> BigLever > BigLever Feature-based PLE > Roles > Technical Organization Management Roles > PLE Factory Roles > PLE Factory Shared Asset Engineer'.

On the left sidebar, the 'Workspace' section shows 'BigLever' and 'BigLever Feature-based PLE'. The 'Process' section lists 'Start', 'Phases and Milestones', 'Processes and Activities', 'Work Products', 'Roles' (highlighted), 'Practices', 'Metrics', 'Tools', 'Trainings', 'Resources', and 'Index'. The 'Quicklist' section shows 'No entries'. The 'Service' section lists 'Homepage' and 'Mail Webmaster'.

The main content area displays the role details for 'Role: PLE Factory Shared Asset Engineer'. The 'Description' section states: 'The PLE Factory Shared Asset Engineer is responsible for one or more shared assets supersets, including the development performed on the shared asset(s) and the creation of variation points within those shared assets. The PLE Factory Shared Asset Engineer also provides input to the feature model by identifying needs to the [Feature Catalog Owner](#).' A '[Change]' link is available.

The 'Activities' section is circled in red and contains a table with the following columns: 'Responsible for', 'Supporting in', and 'Accountable for'. The 'Responsible for' column lists the following activities:

- Shared Asset Superset Engineering
- Create/Modify and Attach Shared Asset Superset
- Create/Modify Shared Asset Superset Composition Assertions
- Create/Modify Variation Points
- Validate Variation Point Logic
- Actuate a Product
- Insert trace links into Shared Asset Supersets

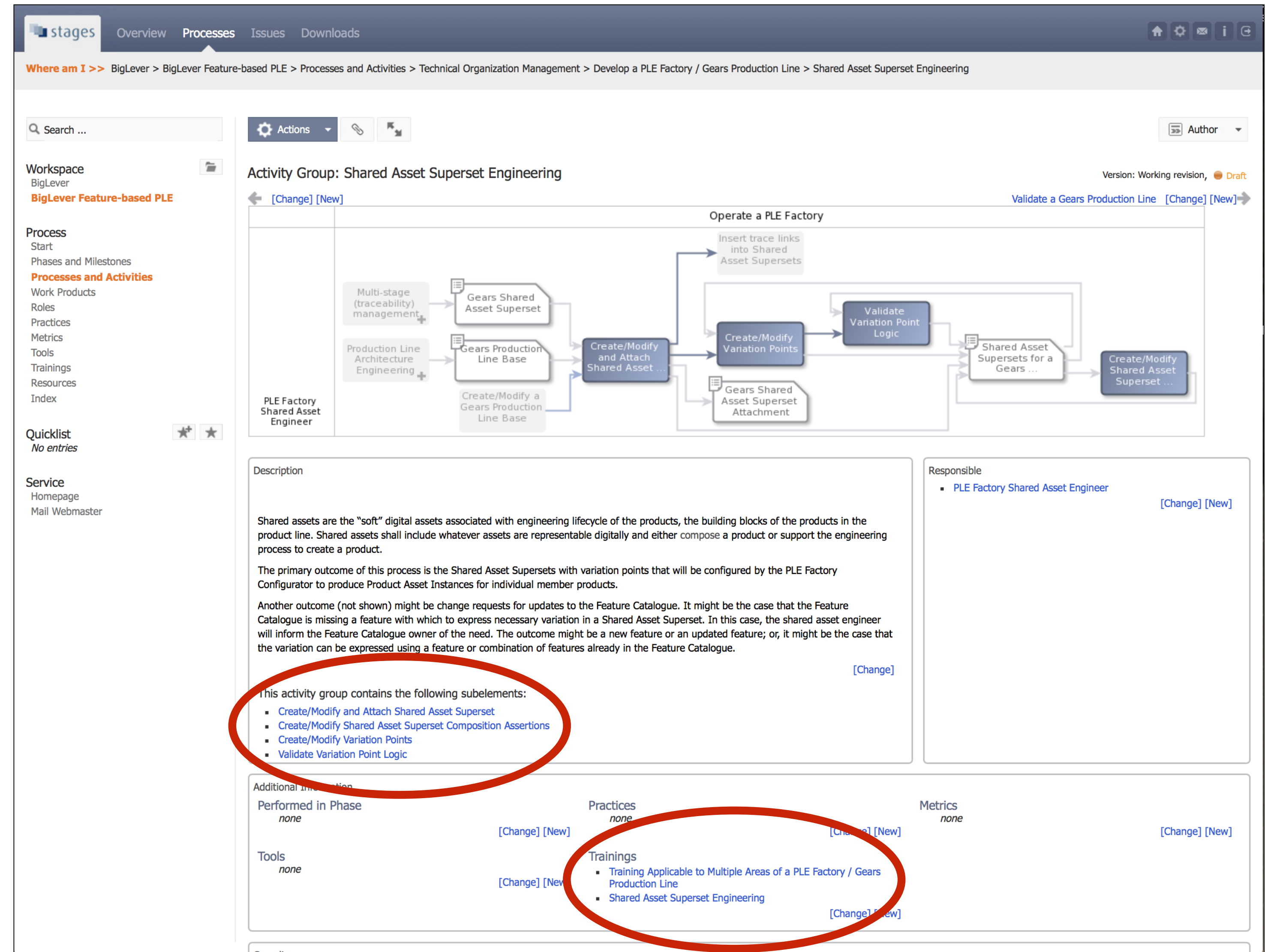
The 'Supporting in' and 'Accountable for' columns are currently empty, with '[Change]' and '[New]' links available for each column header.

At the bottom of the page, there is a 'Compliance' section.



# 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



The screenshot displays the BigLever software interface, specifically the 'stages' application. The top navigation bar includes 'Overview', 'Processes', 'Issues', and 'Downloads'. The breadcrumb trail indicates the current location: 'Where am I >> BigLever > BigLever Feature-based PLE > Processes and Activities > Technical Organization Management > Develop a PLE Factory / Gears Production Line > Shared Asset Superset Engineering'.

The main content area is titled 'Activity Group: Shared Asset Superset Engineering'. It features a flowchart diagram illustrating the process steps: 'Multi-stage (traceability) management' leads to 'Gears Shared Asset Superset', which then leads to 'Production Line Architecture Engineering' and 'Gears Production Line Base'. These lead to 'Create/Modify and Attach Shared Asset', which further leads to 'Create/Modify Variation Points', 'Validate Variation Point Logic', 'Shared Asset Supersets for a Gears ...', and finally 'Create/Modify Shared Asset Superset ...'. The diagram also includes 'Insert trace links into Shared Asset Supersets' and 'Gears Shared Asset Superset Attachment'.

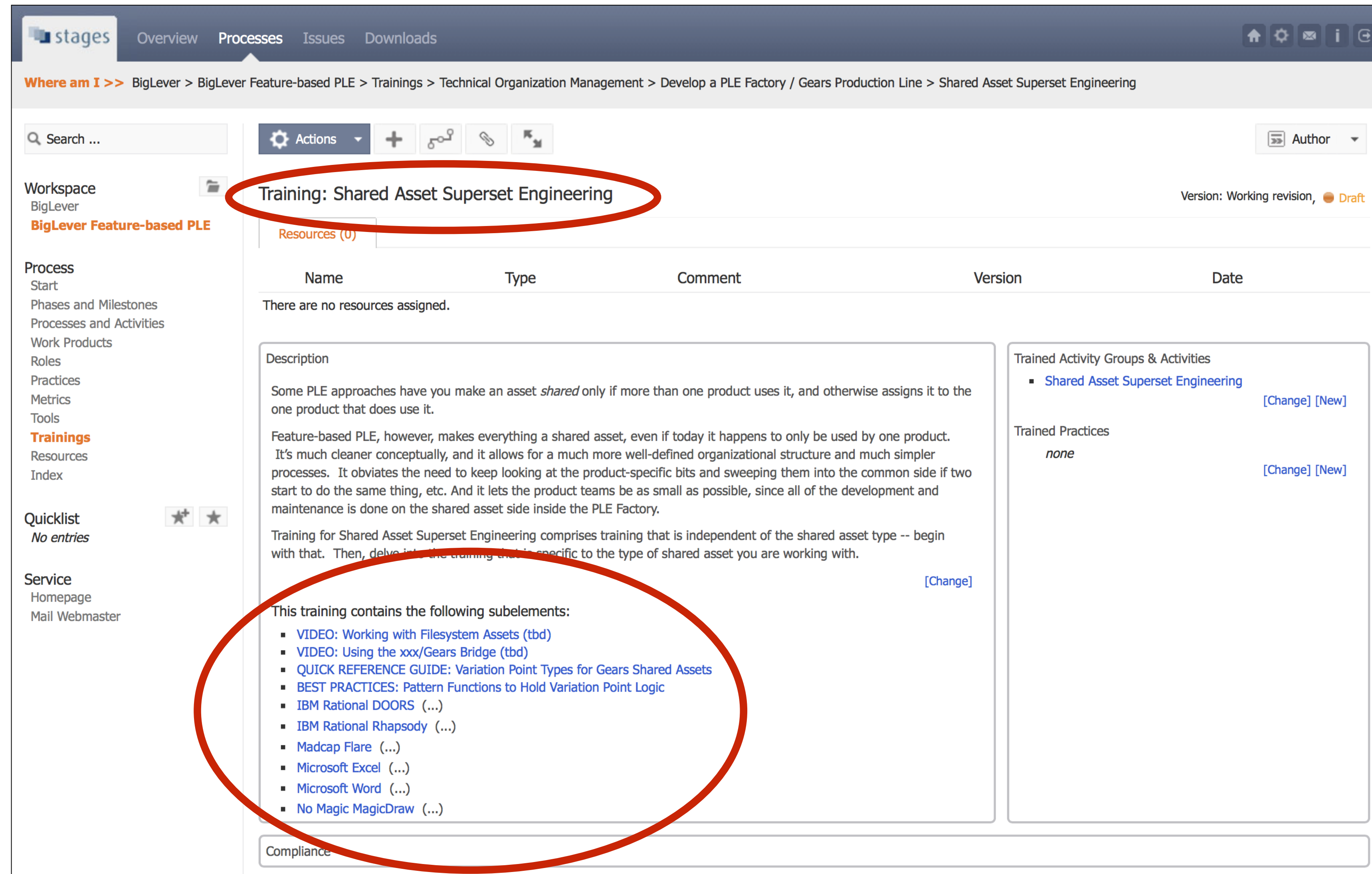
Below the flowchart, there is a 'Description' section with text explaining shared assets and the process outcomes. A red circle highlights a list of subelements: 'Create/Modify and Attach Shared Asset Superset', 'Create/Modify Shared Asset Superset Composition Assertions', 'Create/Modify Variation Points', and 'Validate Variation Point Logic'.

On the right side, there is a 'Responsible' section listing 'PLE Factory Shared Asset Engineer' with '[Change]' and '[New]' links. Below this, there are sections for 'Additional Information', 'Performed in Phase', 'Tools', 'Practices', 'Metrics', and 'Trainings'. A red circle highlights the 'Trainings' section, which lists 'Training Applicable to Multiple Areas of a PLE Factory / Gears Production Line' and 'Shared Asset Superset Engineering', both with '[Change]' and '[New]' links.



## 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.



stages Overview Processes Issues Downloads

Where am I >> BigLever > BigLever Feature-based PLE > Trainings > Technical Organization Management > Develop a PLE Factory / Gears Production Line > Shared Asset Superset Engineering

Search ...

Actions +

Workspace  
BigLever  
BigLever Feature-based PLE

Process  
Start  
Phases and Milestones  
Processes and Activities  
Work Products  
Roles  
Practices  
Metrics  
Tools  
Trainings  
Resources  
Index

Quicklist  
No entries

Service  
Homepage  
Mail Webmaster

Training: Shared Asset Superset Engineering

Resources (0)

Name	Type	Comment	Version	Date
There are no resources assigned.				

Description

Some PLE approaches have you make an asset *shared* only if more than one product uses it, and otherwise assigns it to the one product that does use it.

Feature-based PLE, however, makes everything a shared asset, even if today it happens to only be used by one product. It's much cleaner conceptually, and it allows for a much more well-defined organizational structure and much simpler processes. It obviates the need to keep looking at the product-specific bits and sweeping them into the common side if two start to do the same thing, etc. And it lets the product teams be as small as possible, since all of the development and maintenance is done on the shared asset side inside the PLE Factory.

Training for Shared Asset Superset Engineering comprises training that is independent of the shared asset type -- begin with that. Then, delve into the training that is specific to the type of shared asset you are working with.

This training contains the following subelements:

- VIDEO: Working with Filesystem Assets (tbd)
- VIDEO: Using the xxx/Gears Bridge (tbd)
- QUICK REFERENCE GUIDE: Variation Point Types for Gears Shared Assets
- BEST PRACTICES: Pattern Functions to Hold Variation Point Logic
- IBM Rational DOORS (...)
- IBM Rational Rhapsody (...)
- Madcap Flare (...)
- Microsoft Excel (...)
- Microsoft Word (...)
- No Magic MagicDraw (...)

Compliance

Trained Activity Groups & Activities

- Shared Asset Superset Engineering [Change] [New]

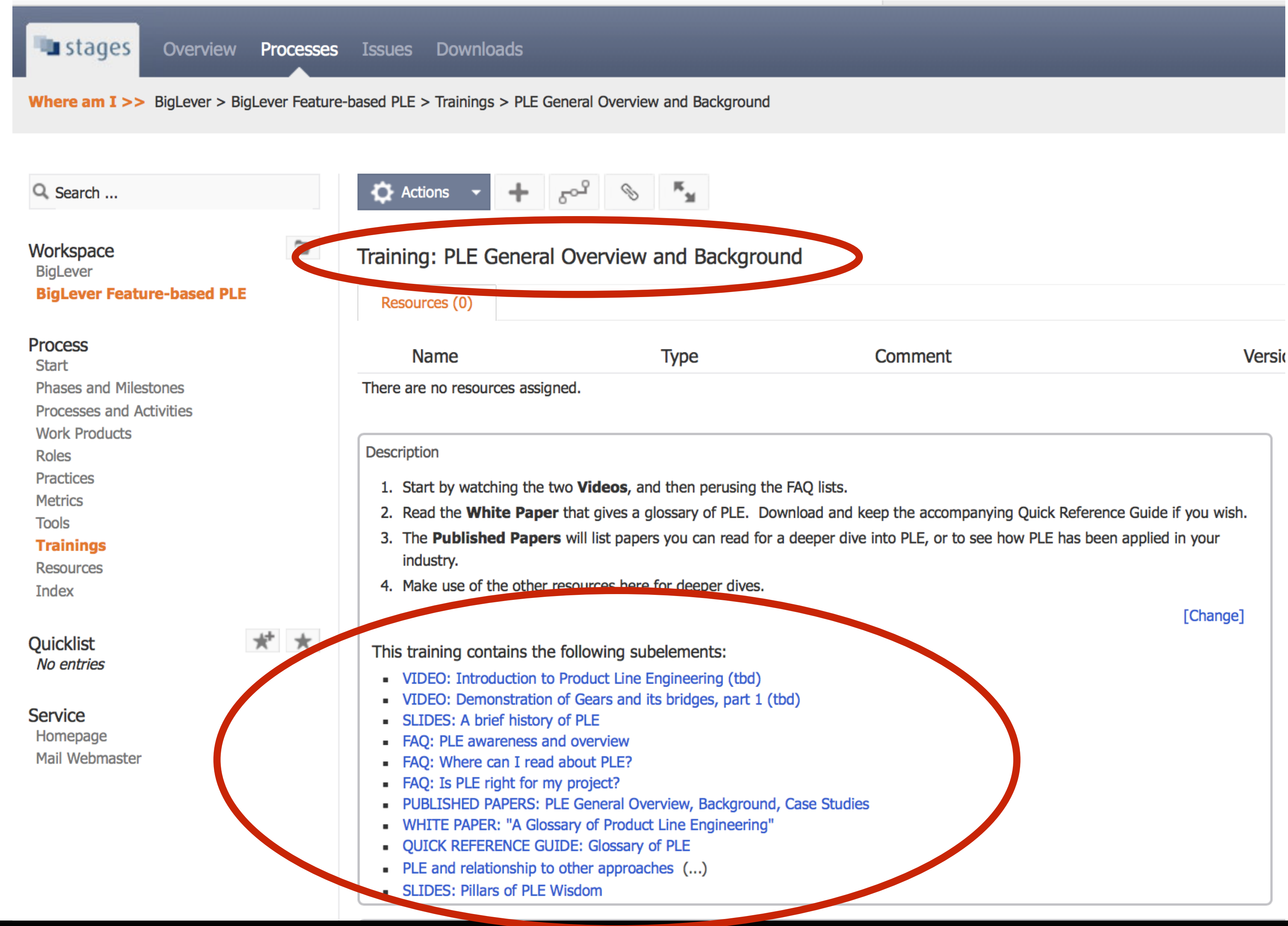
Trained Practices

none [Change] [New]



# Training for everyone

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



**stages** Overview Processes Issues Downloads

Where am I >> BigLever > BigLever Feature-based PLE > Trainings > PLE General Overview and Background

Search ...

Workspace  
BigLever  
BigLever Feature-based PLE

Process  
Start  
Phases and Milestones  
Processes and Activities  
Work Products  
Roles  
Practices  
Metrics  
Tools  
Trainings  
Resources  
Index

Quicklist  
No entries

Service  
Homepage  
Mail Webmaster

Actions + [Icons]

Training: PLE General Overview and Background

Resources (0)

Name	Type	Comment	Version
There are no resources assigned.			

Description

1. Start by watching the two **Videos**, and then perusing the FAQ lists.
2. Read the **White Paper** that gives a glossary of PLE. Download and keep the accompanying Quick Reference Guide if you wish.
3. The **Published Papers** will list papers you can read for a deeper dive into PLE, or to see how PLE has been applied in your industry.
4. Make use of the other resources here for deeper dives.

[Change]

This training contains the following subelements:

- VIDEO: Introduction to Product Line Engineering (tbd)
- VIDEO: Demonstration of Gears and its bridges, part 1 (tbd)
- SLIDES: A brief history of PLE
- FAQ: PLE awareness and overview
- FAQ: Where can I read about PLE?
- FAQ: Is PLE right for my project?
- PUBLISHED PAPERS: PLE General Overview, Background, Case Studies
- WHITE PAPER: "A Glossary of Product Line Engineering"
- QUICK REFERENCE GUIDE: Glossary of PLE
- PLE and relationship to other approaches (...)
- SLIDES: Pillars of PLE Wisdom



## 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](http://www.biglever.com)