

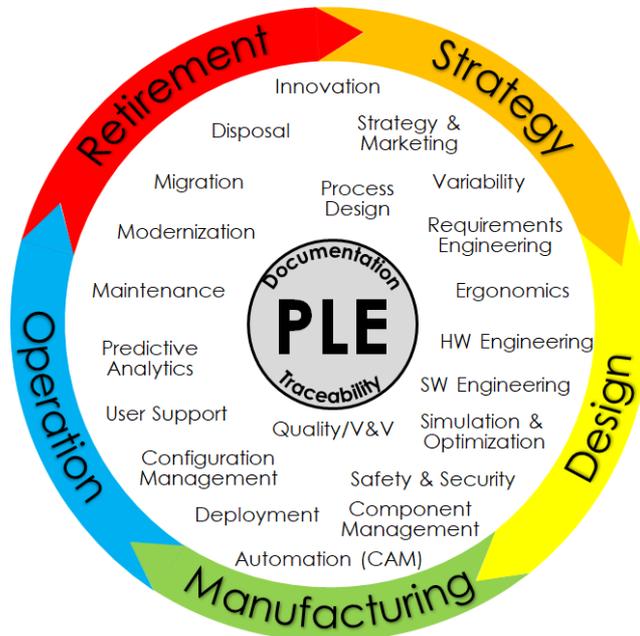
*If you want to be happy,
you should organize your family!*



Model-based Product Line Engineering (MB PLE)

Product Line Engineering

Today, complex technology products are often sold and installed in many instances and variations. At the same time, most of these products are built from components that are themselves subsystems with their own lifecycle and supply chain. This leads to **Systems of Systems** that are **difficult to manage and evolve** in an efficient way. **Product Line Engineering (PLE)** is a way to engineer a portfolio of related products in an efficient manner, taking full advantage of the products' similarities while respecting and managing their differences. PLE impacts all activities involved in planning, designing, producing, deploying, sustaining, and retiring products.



Typical PLE domains:

- transportation (automotive, railways, aviation)
- engines and production machines
- computer systems and devices
- consumer electronic systems
- civil engineering and buildings
- service products (banking, telecommunication, etc.)
- standard software products

Model-based Product Line Engineering



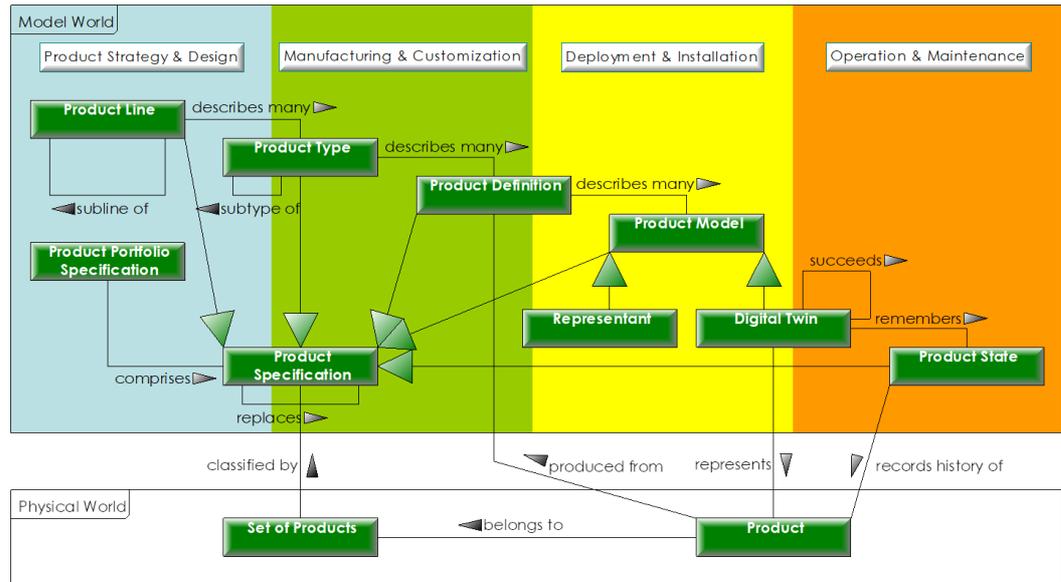
A **Model** is a simplifying abstraction of an original used for a particular purpose. Using a standardized modeling language improves communication among stakeholders, helps keeping artifacts consistent and reduces maintenance by avoiding redundancy. The **Object Management Group (OMG)** developed several modeling languages that may be used to develop complex products and product lines:

- The **Unified Modeling Language (UML)** helps to develop complex software systems
- The **Systems Modeling Language (SysML)** helps to develop interdisciplinary hardware systems
- The **UML Testing Profile (UTP)** helps to develop test specifications for complex systems
- The **Business Process Model and Notation (BPMN)** helps to develop product processes
- The **Business Motivation Model (BMM)** and the **Semantics of Business Vocabularies and Business Rules (SBVR)** help to design product strategies and consistent terminologies

As an active member of the Object Management Group, KnowGravity is proficient in applying these modeling languages, as well as other languages such as **Orthogonal Variability Modeling (OVM)**.

From Product Lines to Digital Twins

A **Product Line** is a specification of an entire family of related products offered by a vendor and may be refined into a **Product Type**, a **Product Definition** and ultimately into a **Product Model** that represents a **Digital Twin** of a physical product. A digital twin is an up-to-date and accurate representation of important properties of its physical twin as well as the history of those properties. By collecting historical data on its physical twin or entire fleets of similar devices, a digital twin may improve its operational performance as well as the precision of prognostics on its physical twin. KnowGravity developed the following **PLE framework** that reflects the stepwise refinement from a product line to a digital twin representing the operational product.



KnowGravity's PLE-related Services

Depending on the current development stage of a product, KnowGravity services may include the following activities:

- Specify the goals to be achieved by a product line and elaborate a suitable marketing strategy
- Identify important requirements and feature variability with interdependencies and constraints within a product line using Orthogonal Variability Modeling (OVM)
- Design the hardware of the product line using SysML
- Design the software of the product line using (executable) UML
- Specify validation and verification (V&V) procedures in a model-based fashion
- Identify, assess and mitigate safety and security risks associated with the product line
- Establish development and deployment processes that foster reusable assets and components

Why KnowGravity?

- KnowGravity has comprehensive engineering experience in a wide spectrum of domains and techniques, including mission- and safety-critical systems
- All employees of KnowGravity are modeling experts for business systems as well as for technical systems and are proficient in many domain specific modeling languages
- KnowGravity is an active OMG member in several modeling working groups
- KnowGravity has developed its own modeling tools (KnowEnterprise®, KnowDocs™, CASSANDRA) out of the need of its customer projects
- Employees of KnowGravity are co-authors of several books

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