

Realizing the Dream

Building and Deploying a Re-Usable Requirements Library

Author:

Warren B. Smith

Systems Engineering Partner

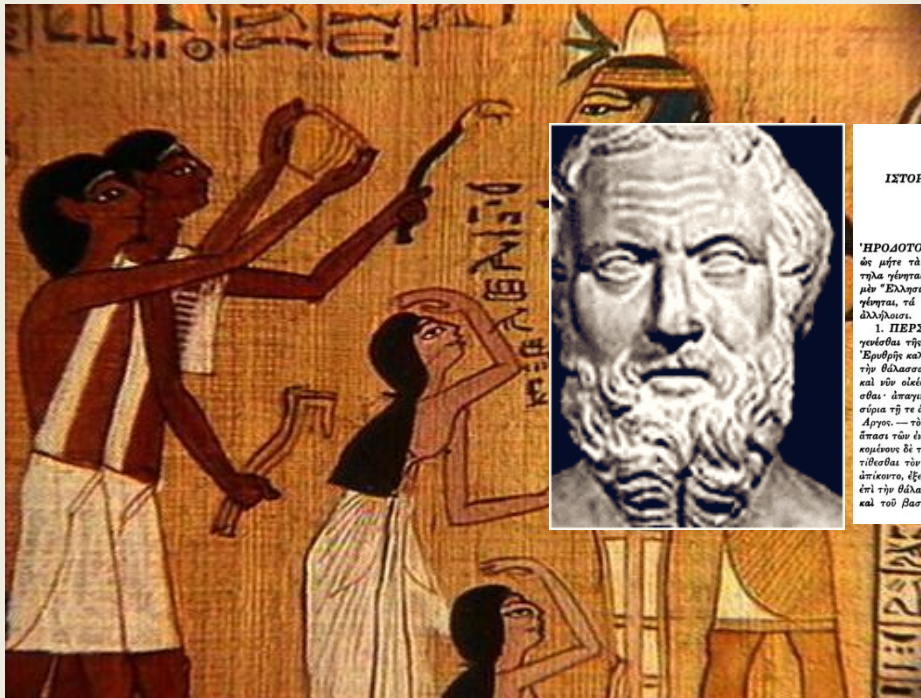
(480) 560-2655

wsmith@gatech.edu

wsmith@wrayn.com

WRAYN LLC

What do these people have in common?



ΗΡΟΔΟΤΟΣ

ΤΟΥ ΔΑΙΚΑΡΝΗΣΣΕΟΣ

ΙΣΤΟΡΙΩΝ ΠΡΩΤΗ ΕΠΙΓΡΑΦΟΜΕΝΗ

ΚΛΕΙΩ.

ἩΡΟΔΟΤΟΣ Ἀλικαρνησέος ἱστορίης ἀπέδειξε ἦε·
ὡς μήτε τὰ γενόμενα ἐξ ἀνθρώπων τῷ χρόνῳ ἐξί-
τηλα γίνονται, μήτε ἔργα μεγάλα τε καὶ θωμαστά, τὰ
μὲν Ἕλλησι, τὰ δὲ βαρβάρουσι ἀποδεχθέντα, ἀεὶ καὶ
ῥήθηται, τὰ τε ἄλλα, καὶ δὲ ἦν αὐτῶν ἐπολιμνῶσαι
δύλαιοι.

1. ΠΕΡΣΕΩΝ μὲν γιν οἱ λόγοι Φοινίκας φασὶ
γενέσθαι τῆς διαφορῆς αἰτίους· τούτους γὰρ ἀπὸ τῆς
Ἐρυθρῆς καλομένης θαλάσσης ἀπικομένους ἐπὶ τῆςδε
τῆς θαλάσσης καὶ οἰκίσαντας τούτων τὸν χρόνον, τὸν
καὶ νῦν οἰκίσουσιν, αἰτίαν ναυτιλῆσι μακρῆσι ἐπιθέ-
σθαι ἀπομνησκόμενοι δὲ φορτίᾳ Ἀργεῖνόν τε καὶ Ἀσ-
σίαν τῇ τε ἄλλῃ [χώρα] ἀναπερικεσθαι καὶ δὴ καὶ ἐς
Ἀργεῖα. — τὸ δὲ Ἄργος τοῖτον τὸν χρόνον προείχε
ἅπανσι τῶν ἐν τῇ νῦν Ἑλλάδι καλομένη χώρῃ. — ἀπι-
κομένους δὲ τοῖς Φοινίκας ἐς δὴ τὸ Ἄργος τοῦτο δια-
τίθεσθαι τὸν φόρον. πάντῃ δὲ ἡ ἑστὴ ἡμέρῃ αὖτ' ἦς
ἀπύκνουν, ἑκατονταμῖον σφί περὶ τὸν πότον, οὐδὲν
ἐπὶ τὴν θάλασσαν γνωσκεῖς ἄλλας τε πολλὰς καὶ δὴ
καὶ τοῦ βασιλῆος θυγατέρα· τὸ δὲ οἱ οὐνομα εἶναι.

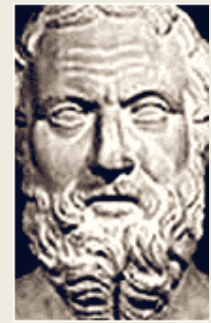


The Power of Documentation

- *2500 Years after Herodotus documented the Procedure for Mummification, 2 Scientists used that documentation to faithfully recreate a Mummy.*
- **Ronn Wade** (left), the Director of Anatomical Services at the University of Maryland Medical School in Baltimore.
- **Bob Brier** (right), an Egyptologist at the C. W. Post Campus of Long Island University.



<http://emhotep.net/2011/06/28/egypt-in-the-news/mumab-a-modern-day-ancient-egyptian-mummy-and-what-he-has-taught-us-so-far/>



Some Facts

- Ancient Egyptian Culture was dominant for approximately 2500 years -- *think about it...*
- The Priest Class represented a successful, viable organization during most of this time - They *documented and retained* their most valuable organizational skill during the entire period.
- The Modern team *successfully* recreated a mummification process *from source documentation* published 2454 years ago.
- *Could your company successfully recreate one of your processes from your source documentation published 2454 days ago? (about 6 years, 8 months).*

A Question...

Hmm... Could I re-design a Printer from 2010 from our *own company's* documentation?



What is “Re-Use”?

- This term means different things to different people
 - *Clarify the definition today*
- Transfer of product requirements and designs across projects and product variants within an organization
 - Leverage mature system designs over-and-over again in product lines, similar systems or variants
 - Accommodate variations in design or application
- Transfer of common design information from one project to another or between product variants, for instance:
 - Use or application
 - Behavior
 - Requirements
 - Test descriptions

Two Types of Re-Use

- Re-use of “Common” requirements and design
 - Many organizations include “common” elements
 - Common requirements
 - Common architectures
 - Common processes
- Element Re-Use
 - Product Variants
 - Re-usable ‘components’
 - Product Lines



Today's focus

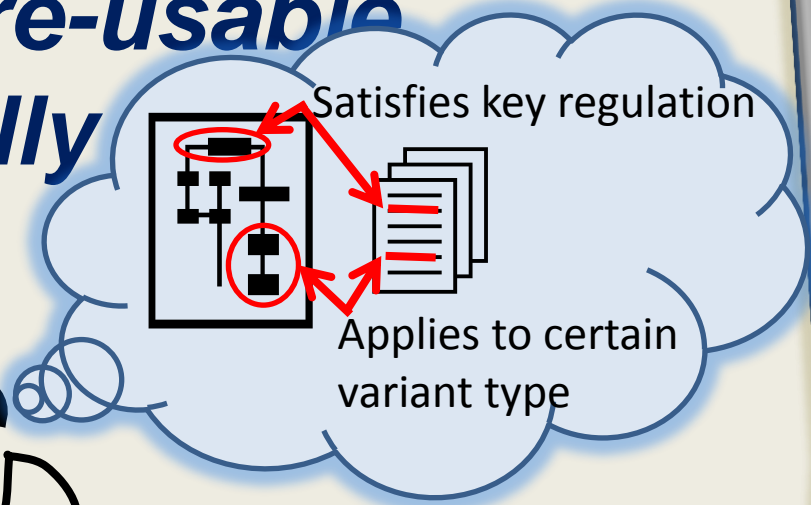


Today's focus

Where does re-usable content typically



- Engineer knows where data resides
- Engineer knows how to read data
- Engineer can find “golden nuggets”



- Engineer's brain:

- Incorporates experience informing future decisions
- Acts as a body of knowledge
- Acts as a search engine
- Acts as a repository of implications and rationale

Our History of Re-Use Libraries

- Foundational thinking in 1990s
- Developed Re-Usability approach - Mid 2000s
 - Commonality Assessment Process (CAP)
 - Started with Re-Usable Requirements (presented here)
 - Published/Presented first paper 2005
- Developed and deployed multiple libraries:
 - US Army
 - NASA
 - Commercial
 - Measured ROI
- Expanded re-usability approach to MBSE
 - Published/Presented Model-Based Re-Usable Elements (MBREs)
 - Incorporated Re-Use libraries into MBSE Tool

Characteristics of a Re-Use Library

- A Re-use library transforms individual *tribal* knowledge into *organizational* knowledge
 - Corporate or Organizational Asset
- A Re-use library contains requirements, analysis, design, and verification information common to the organization's products
 - Product Lines / Variants
 - Requirements / Verification Methods
- Searchable, Filtered sets
- Built-in Training / Use instructions
- *Information is enabled by model-based systems engineering*
 - *Performing engineering from re-usable elements*
 - *Platform for retaining re-use library*
 - *Design repository or product data management system.*

Back to the Printer question...

- **Printer Company:**

- Black and White Printers
- Color Printers
- Print 2-sided pages
- Print Photos
- Scale Pages
- Faster Print Times
- Hundred other Printer Features

Documentation tends to be a point solution.

Geared toward a single Project

- **BUT, the engineers still spend all day designing printers.**

Steps to Building Re-Usable Requirements

- **Perform Commonality Assessment**
- **Assess Engineering Artifacts**
 - System Requirements
 - System Design
 - Subsystem Requirements/Design
 - Verification Test Cases
 - Validation Test Scripts
- **Choose Re-Use Library Repository**
- **Engineer Common Artifacts**
- **Build Re-Use Library Repository**

Re-Use Libraries are a general solution.

A separate project

Bang for the Buck

- Commonality among Product Lines.
- Universally Applicable Requirements.
- Selectively Applicable Requirements.
- Library User Interface and Instructions.
- ROI.

Secret 1: Finding Commonality

Universally Applicable Requirements

- Re-Use Library's First Secret: Finding Commonality among Product Lines
 - 20%-70% of a product line's requirements are common.
 - Non-Functional
 - Selective Function, Interface and Performance
- Universally Applicable Requirements
 - Standard Behavior
 - Standard Architecture
 - Standard Interfaces
 - Regulatory Requirements
 - Best Practices

Universally Applicable Requirements

Example

Parameterization is key.

Because of the re-useable requirement, development time for the next Printer will be significantly less, and more complete due to the availability of the Universally Applicable, Parameterized Requirements.

*These requirements are annotated as **applicable to all variants** in the Library*

- **Common Parameterized Reliability Requirement:** “With the exception of Toner Replacement, the Printer shall operate without requiring maintenance, to include clearing paper jams and aligning printheads, for {PARAMETER} pages at {PARAMETER} pages printed per day over the course of the {PARAMETER (WARRANTY PERIOD)} months.”

Selectively Applicable Requirements

*These requirements are annotated as applicable to **specific variants** in the Library*

- *Selectively Applicable Requirement Example:*
“All Printers with top-loading paper feeds (vertical or near vertical) shall assure that the loaded paper does not curl or bend due to gravity.”

Secret 2: Ease of Use

Re-Usable Requirements Library

- The harsh reality of any tool is that if it is not sufficiently easy to use, it will become shelfware.
- Re-Use Library's second secret for a successful deployment - Assure the requirements:
 - Are easy to access
 - Are pertinent to the developer
 - Can generate requirements products (such as specifications) that the developers can use
 - Have impossible-to-miss, easily-accessible on-line training

Secret 3: The Library Deserves Attention

Building the Re-Usable Database

- Third and Final Secret:
 - Building such an Organizational Asset *cannot* be done as a “sidebar” to a production development effort.
 - A Library *must* be built as a project in its own right.
 - The Organizational Knowledge needed to build a re-useable requirements database *is different from* building a point-solution RM Db during a Product development lifecycle.

Re-Use Library: Deployment Insights

- Generate baseline specifications from the library
- Support common templates to socialize use
- Trace back to the source material used to generate the Common Requirements
- Include fields for storing requirements *Analysis*

Return on Investment Calculations

Requirements Library

- Extracted from other Author's presentation
- Common Requirements Measurement
- WRAYN LLC has found a minimum of 30 minutes of engineering development time on any given requirement (usually much more).
- *Assumptions: Rate of \$60 / hour, 1/3 Rqmts are Parameterized, 15 Min to modify parameters.*
- Project would save \$30,000 by having re-usable requirements available:
 - Savings = 1000 Rqmts x 0.5 Hrs/Rqmt x \$60/Hr = **\$30,000**
- Project would expend \$6,995 checking the database and updating Parameters:
 - UseCost = Time to review 1000 pre-written Rqmts x \$/Hr + Time to update Params x \$/Hr
 - UseCost = ((1000 Rqmts/30 Rqmts/Hr) x \$60/Hr) + (0.25 Hrs x 333 Rqmts x \$60/Hr) = **\$6,995**
- Productivity Gain = (\$30,000 - \$6,995) / (\$30,000) = **328%**
- **\$3.28 project savings for every \$1.00 invested**
Paper captures summary ROI Analysis

Product Line Engineering (PLE) / Product Line Management (PLM)

- Pure::Variants
 - www.pure-systems.com
- Big Lever-Gears
 - www.biglever.com
- Sodius Branch Manager
 - sodius.com
 - it-qbase.eu/
- INCOSE ISO

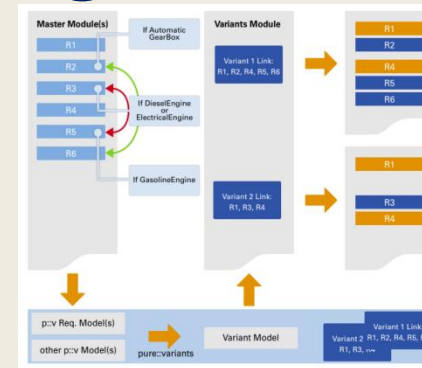


Image from “pure-variants-for-ibm-rational-doors-11.html”

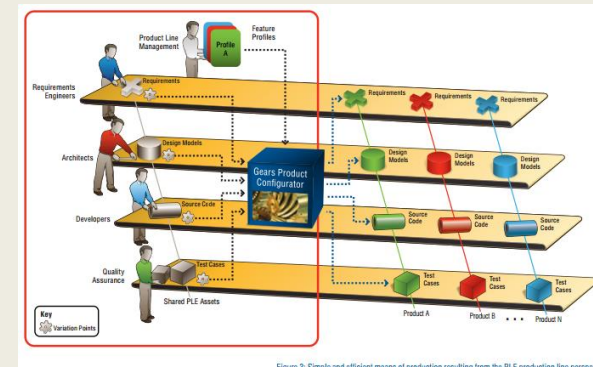
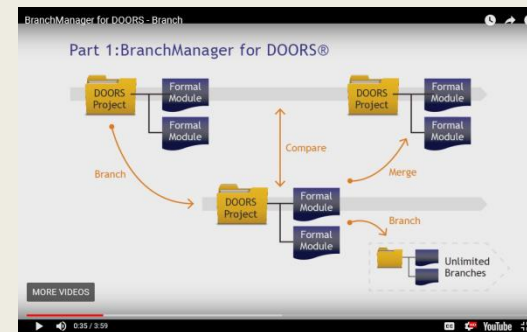


Image from “BigLever_Solution_Brochure.pdf”

Figure 3: Simple and efficient means of production resulting from the PLE production line perspective



Screenshot from “Branch Manager for DOORS” youtube

Benefits of Re-Use Libraries

Management Benefits

- Investment in Employees is not lost as they Retire
 - Saving and Re-Using Core Knowledge and Experience
 - Isolated experts no longer represent a bottleneck
- Replaces **Tribal Knowledge** with **Organizational Knowledge**
- Catapults Future Development Ahead of Schedule

Technical Benefits

- Assures **Completeness** and **Consistency** of Design
- Quicker, higher quality development of variants.
- Project Requirements, Design and Tests can be re-used on other Projects
- Traces and Documents Engineered Product Artifacts
- Specifications reflect collective knowledge

Building and Deploying a Re-Usable Requirements Library

Warren B. Smith

wsmith@wrayn.com

wsmith@gatech.edu

(480) 560-2655

Paper available upon request

WRAYN LLC