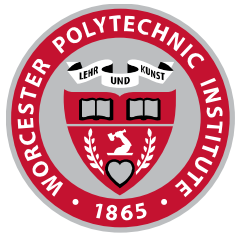

WPI

Leading Indicators Trends link to Technical Debt Types in Test and evaluation phase of Systems Engineering Lifecycle

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Dr. Beth Wilson

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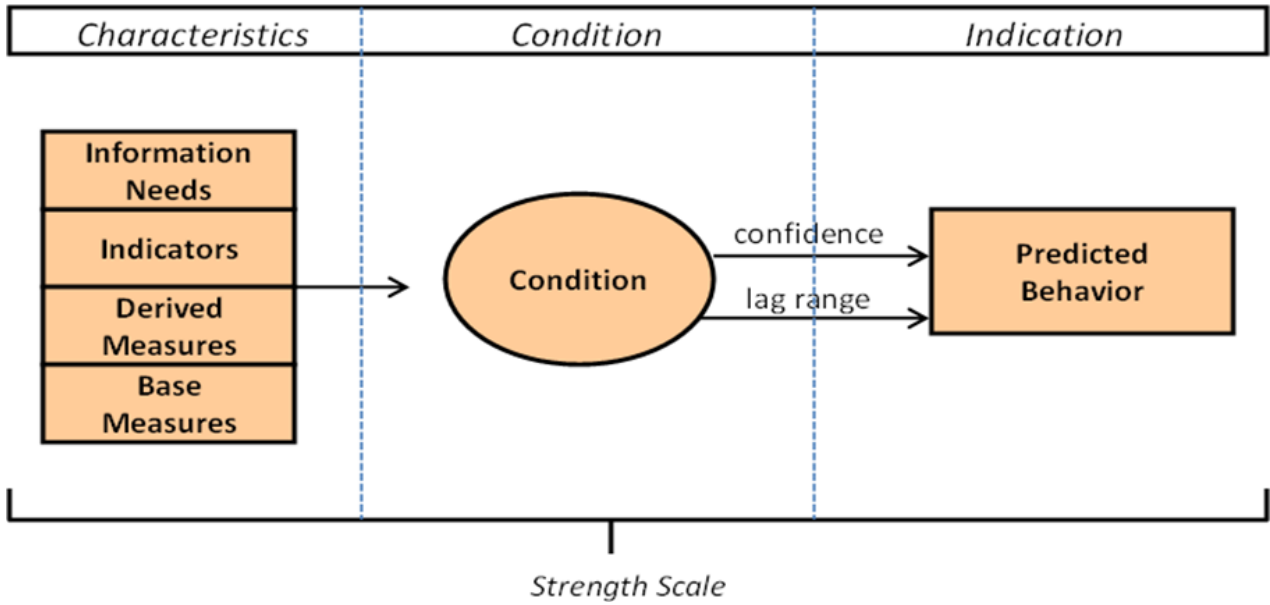
Agenda

- Definitions: Leading Indicators
- Definitions: Technical Debt
- Hubble Space Telescope Case Study : Technical Debt Examples
- Systems Engineering Integrated Product Development and Technical Debt
- Proposed Mapping Technical Debt types and Leading Indicators trends
- Hubble Space Telescope Case Study : Technical Debt types to Leading Indicator trends linking Examples

Definitions: Leading Indicators

- A leading indicator is a measure for evaluating the effectiveness of how a specific activity is applied on a project in a manner that provides information about impacts that are likely to affect the system performance objectives. [1]
- Leading indicators aid leadership in delivering value to customers and end users, **while assisting in taking interventions and actions to avoid rework and wasted effort. [1]**
- Leading indicators support the effective management of systems engineering by providing visibility into expected project performance and potential future states. [1]



[1]

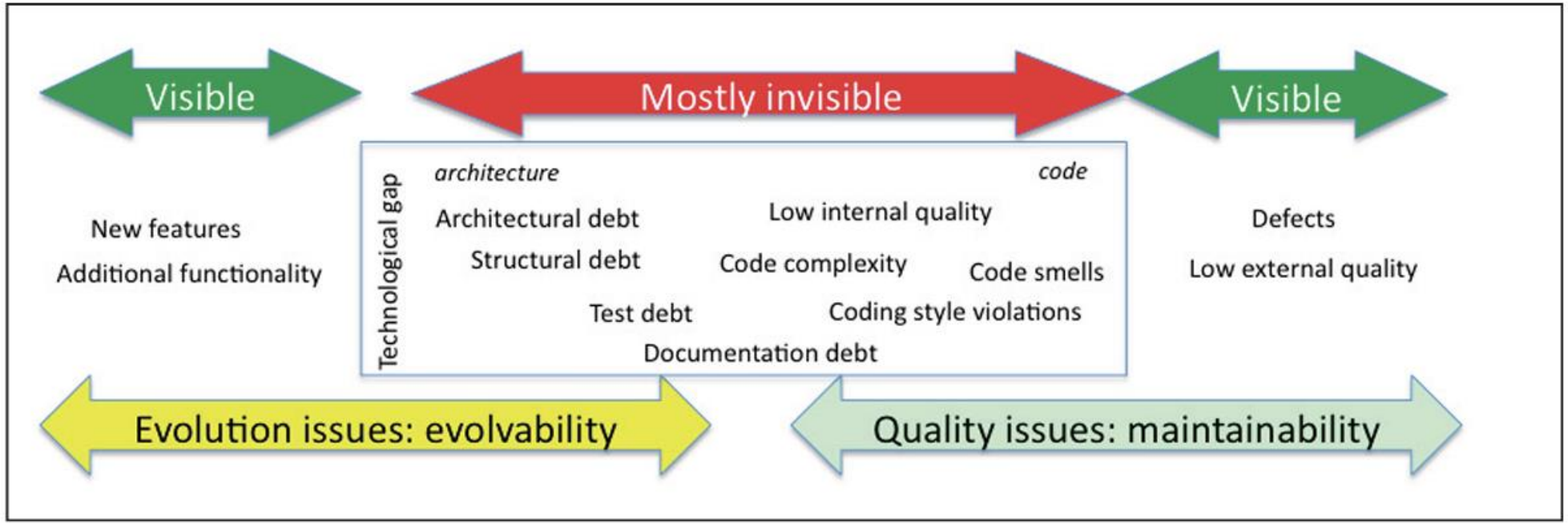
A leading indicator is composed of characteristics, a condition and a predicted behavior

Definitions: Technical Debt

- What is Technical Debt?

  There is no standard, recognized and commonly used Technical Debt Definition. The following is the most cited definition of Technical Debt:

  — "A collection of design or implementation constructs that are expedient in the short term**, but set up a technical context that can make future changes more costly or impossible.** TD presents an actual or contingent liability whose impact is limited to internal system qualities, primarily maintainability and evolvability''. [2]

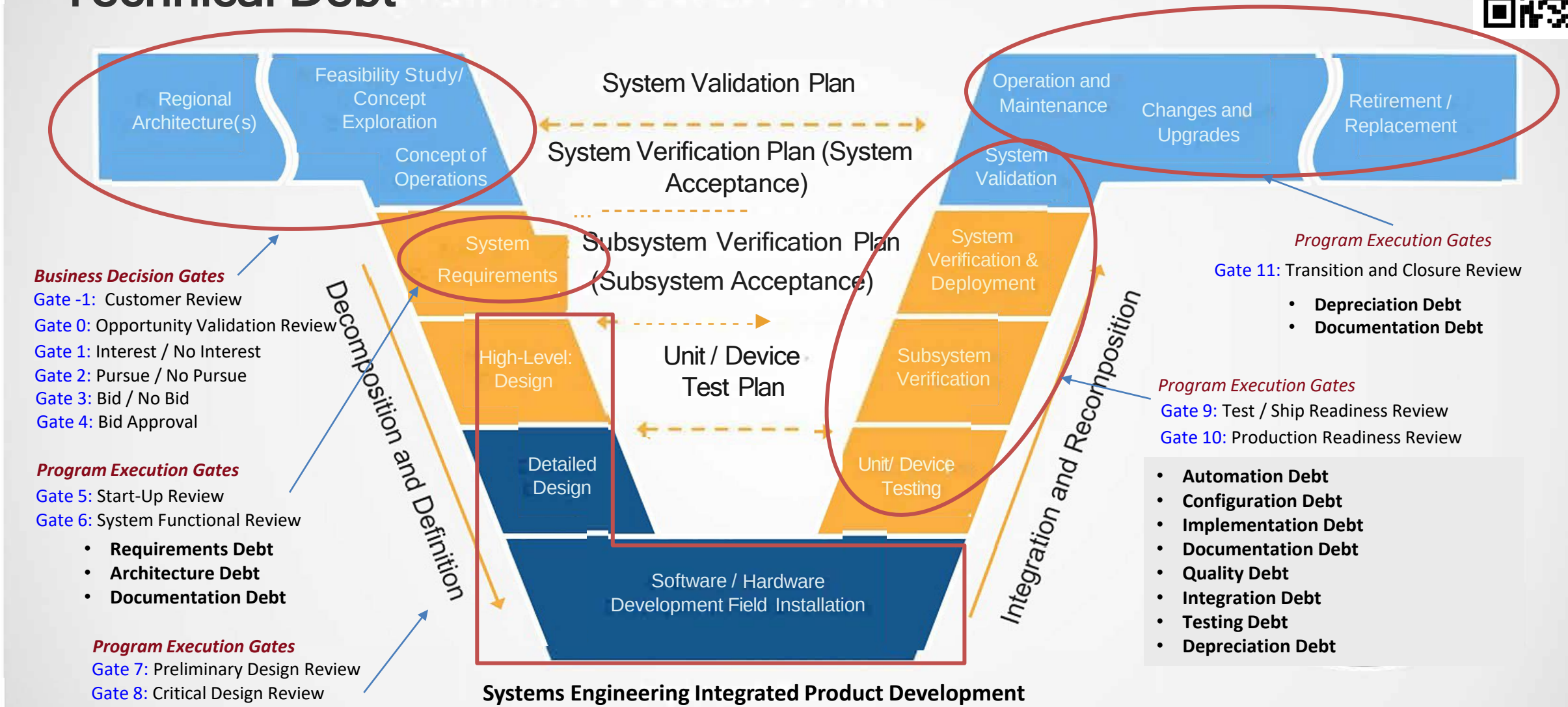


Technical debt landscape [3]

How a Technical Debt Manifest Could have saved HST millions!

Ref#	TD Item Description	Category	Scope	Cost to Correct	Impact (Cost to Not Correcting)	POC/ Submitter
001	Washer added to Null detector to stabilize the primary mirror on the test equipment	Test	Hardware not included in base, short term solution to conduct testing	$	$$$$	Test Technician
002	Did not request test documentation from mirror manufacturer	Test	Test documentation and results not delivered by the mirror manufacturer	$	$$$	Integration Team
003	Mirror post manufacturing measurement and verification	Verification	Primary Mirror's as manufactured dimensions didn't identically match the design. Accepted to be within tolerance	$	$$$$	Verification team

Systems Engineering Integrated Product Development and Technical Debt



Business Decision Gates

Gate -1: Customer Review
Gate 0: Opportunity Validation Review
Gate 1: Interest / No Interest
Gate 2: Pursue / No Pursue
Gate 3: Bid / No Bid
Gate 4: Bid Approval

Program Execution Gates

Gate 5: Start-Up Review
Gate 6: System Functional Review

- **Requirements Debt**
- **Architecture Debt**
- **Documentation Debt**

Program Execution Gates

Gate 7: Preliminary Design Review
Gate 8: Critical Design Review

Systems Engineering Integrated Product Development

Program Execution Gates

Gate 11: Transition and Closure Review

- **Depreciation Debt**
- **Documentation Debt**

Program Execution Gates

Gate 9: Test / Ship Readiness Review
Gate 10: Production Readiness Review

- **Automation Debt**
- **Configuration Debt**
- **Implementation Debt**
- **Documentation Debt**
- **Quality Debt**
- **Integration Debt**
- **Testing Debt**
- **Depreciation Debt**

Graphic[4]
IPDS Gates[5]

Proposed Mapping of Technical Debt types and Leading Indicators

Infrastructure TD	Interface Trends	Design TD
Code TD	System Definition Change Backlog Trend	Design TD
	Technology Maturity Trends	Design TD
	Requirements Validation Trends	Test TD
	Requirements Verification Trends	Test TD
	Technical Measurement Trends	Test TD

Hubble Space Telescope Case Study : Technical Debt to Leading Indicator trends linking Example

Event	TD Type	Leading indicator
"P-E and NASA both understood and accepted this approach despite a lack of independent measurements to confirm the reliability of the primary test. The failure was not one of system engineering design, but rather one of manufacturing system design and process/quality control. This event occurred at a time when there was also great concern about cost and schedule, possibly overshadowing the obvious need for independent verification testing, or attention to the apparently anomalous RNC data suggesting that something might have been wrong." [6]	Test Debt	Schedule and Cost Pressure
The exact cause of the spacing error is a matter of conjecture, since the records necessary to reproduce what actually happened could not be found – another breakdown in technical discipline. [6] After a long and protracted investigation by officials, the root cause of the calamity was elucidated. **A technician had inadvertently inserted a small 3 mm diameter washer into a device called a null corrector,** an instrument employed to check the mirror's shape during its production a few years earlier. [7]	Documentation TD Test TD	Process Compliance Trends Requirements Verification Trends
Since HST would actually operate in space and success could not be known with certainty until space performance was observed, the program struggled with ground vs. space approaches, incremental vs. all-up, and the associated cost and risk implications. [6]	Design TD Architecture TD Test TD	Technology Maturity Trends

Survey Questions

	TITLE	QUESTION TYPE
Q1	How familiar are you with Leading indicators in Systems Engineering? *	Scale
Q2	How of often do you use Leading Indicators in your Program/Project? *	Scale
Q3	How familiar are you with Technical Debt in Systems Engineering ? *	Scale
Q4	How of often do you use Technical Debt in your Program/Project?*	Scale

https://s.surveyplanet.com/9l0wfepu

Q&A:

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