Correlating Product and Process Measures as a Model for Systems Engineering Measurement

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Abstract. Current measurement industry emphasis on process measures and compliance ignores elements of the history of measurement. The failure to establish product measures and provably correlate them with process measures leads to open-loop management systems that can only measure process compliance, with unknown effect on product quality. The new INCOSE Measurement Primer attempts to begin addressing this important distinction. In this paper a set of standard categories of measures are applied to various Systems Engineering work products identified as "output" in the INCOSE SE Handbook. Process and product measures for each process output are proposed, along with correlations between them, and associations to the INCOSE SE Leading Indicators where applicable.

Introduction – Measurement History

Measuring conformance to process, with the expectation that such conformance will provide better quality products, is based on the Deming Total Quality Management methodology (cf., Mead 2010) applied through such techniques as statistical process control. Such "process measures" become the basis for decisions about modifying the process application to improve the results. However, as seen in figure 1, such process measures, if decoupled from *product* quality measures derived from inspection, attempt to manage a closed-loop feedback control system using "open-loop" measurements of process application. There are few-to-no measures on process output, the "SE products". These process measures can be treated as process diagnostics to help us understand why or where in the process the product began deviating from its requirements (degraded quality), but, alone, cannot provide accurate measures of the product quality. Hence, there is a need for correlation of measures.

The history of process improvement harkens back to the beginning of the concepts regarding "inspection" of finished products, pioneered by Frederick W. Taylor and others. "Inspection was one of these tasks and was intended to ensure that no faulty product left the factory or workshop; focuses on the product and the detection of problems in the product; involves testing every item to ensure that it complies with product specifications; is carried out at the end of the production process; and relies on specially trained inspectors." (BPIR 2010)

The process of inspection which found defects then logically led to the processes involved in defect prevention, which is the focus of the Deming "14 Points". These emphasized the logic of not continuing to process products anytime after a defect is introduced. This inexorably leads to the need for incremental or "process" measures that examine the results of each intermediate step of any process. When a defect is found the correction must be immediately applied. This approach reduces defect "aging", or how long a defect persists before discovery and correction, and reduces the cost associated with producing defective products. The obvious goals are to (a) minimize the introduction of defects, and (b) discover and correct any and all defects in the phase in which they are introduced.

A key point to emphasize is that the incremental or process measures must be developed as measures which are correlated to the inspection results or product measures. Without such a correlation the utility of process measures is suspect. Certainly, delaying measurement until a product is completed may not be the cost-effective measure available. On the other hand, if there is no suitable, correlated process measure, then dismissing product measures is premature and leads to open-loop measurement systems that are not effective in system control.

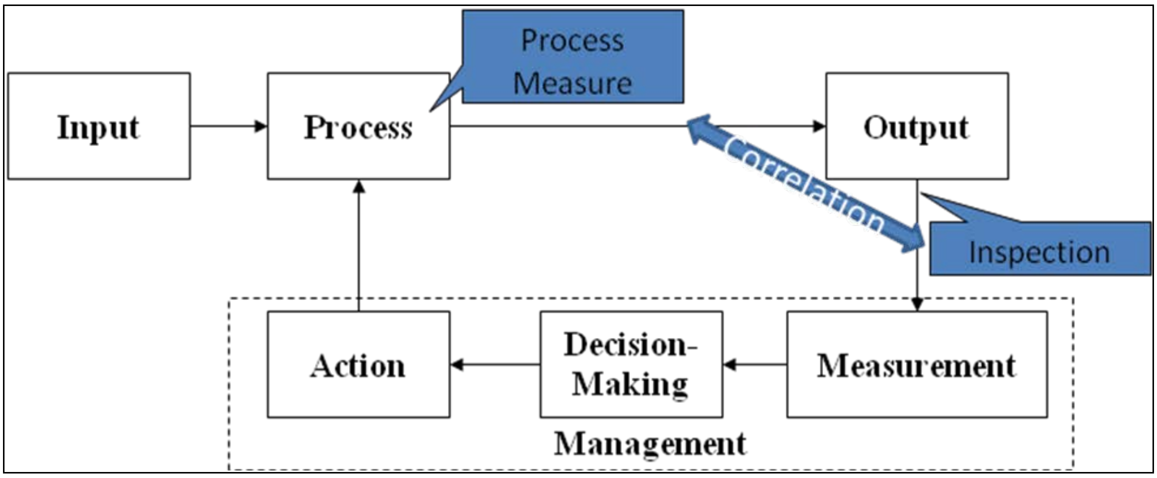

Figure 1. Measurement model as a closed-loop feedback control system for management.

Traditional closed-loop feedback control systems measure the process output to ensure conformance with output requirements and to provide direct feedback to the application of the process to maintain the operation of a system within stable bounds. A simple example is a cruise-control system found on many automobiles, which attempts to maintain the vehicle speed within a given range of a value set by the driver, by controlling the throttle. The vehicle speed (the output of the propulsion function) is continuously evaluated and compared with the set point; and the control system adjusts the throttle to provide propulsion power (in the form of gasoline or diesel flow rates, or electrical power) to maintain the speed.

An equivalent "open-loop" control system would attempt to control speed using a curve or table of "throttle vs. speed" correlation which would control the application of vehicle power for a given desired speed. Unfortunately, such a look-up table would have to be built based on a given set of conditions, such as level terrain with no wind (a nominal condition), but would be largely useless for hilly terrain, inevitably producing large under- and over-speed conditions. The failure to use the process *output* as the control measure causes the control system to fail in its primary function, as is well understood from control theory.

The latest release of the INCOSE SE Leading Indicators Guide (INCOSE-TP-2005-001-03, v2.0, 29 January 2010) contains an explicit measure of product quality, the "defect and error trends" (section 3.15). This indicator can be used to not only assess work product quality (the complement of defects), but also to measure defect aging, the time between when a defect is introduced and it is discovered. As noted, it can be applied to any SE or design work product "such as a requirements document. It could easily be applied to the creation [of] architecture diagrams, SysML models, or analysis/trade-study reports" (INCOSE-TP-2005-0001-03, 2010). "Trends" can be evaluated assuming that historical data or standards exist as a basis for establishing work product quality. Other SE products that should be measured for "quality" include plans, specifications, architectures, verification procedures, and integrated systems.

And herein lies a challenge: without a **standard** for product quality one can **only** use trends and compare with historical information as a basis for taking corrective action. There is no "right/wrong" assessment without a standard.

A Model for Developing Process and Product Measures

If a standard is necessary for a work product and its associated quality measure, then we are well on our way to having a process-development model for each of these items that enable us to begin correlating product and process measures, as depicted in figure 2.

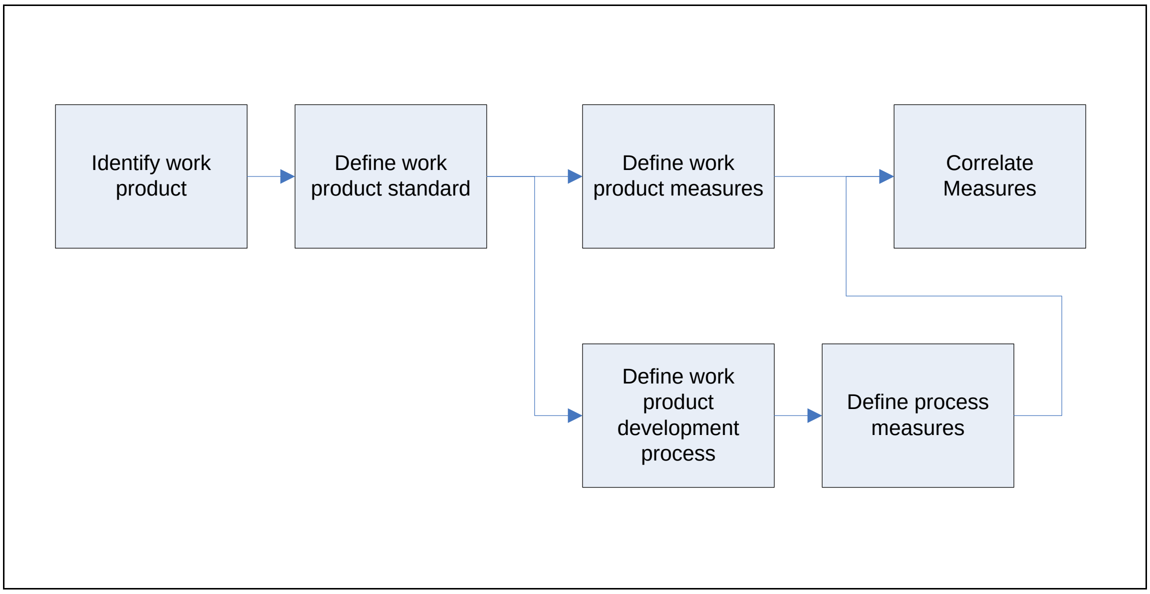

Figure 2. Process development model enabling correlation of process and product measures.

Work products are identified based on downstream "customer" need; these are the "outputs" identified for each process in the INCOSE SE Handbook and ISO 15288. The "standard" for each work product is derived from the needs of the receiving customer: what level of completeness and correctness is required? These are sometimes couched in terms of "fitness for use" considerations, and will often be derivable from Crosby's definition of "quality": "quality is conformance to requirements" (Crosby 1979).

There will always be at least two complementary considerations for work product quality (Carson and Zlicaric, 2008): "(1) the inherent quality of the work product (conformance to work product standards, e.g., specifications, drawings, plans, reports), and (2) the conformance of the work product to the technical requirements associated with the system or element thereof (e.g., the design satisfies its requirements)". This has led Paul Solomon to the concept of "Performance-Based Earned Value®" (Solomon and Young, 2007) to ensure that each work product is fit for use, both from an inherent, artifact-based evaluation of quality (a standard template, for example), and from its fitness for use in the specific context, e.g., conformance to the technical requirements.

For the common SE work product of “requirements” it would be necessary to establish a standard for what “good requirements” look like: their common characteristics or quality attributes and structure (Hooks 1993, Kar and Bailey 1996; Carson 2001).

(Halligan 2009) has recently established requirements quality criteria based on the structure and syntactic content of the requirements and applied a quality measurement to such a structured requirement to assess conformance of the work product to the standard. Suggested syntactic elements are listed and exemplified in table 1.

Table 1: Syntactic elements of requirements (after Halligan 2009)

Element	Text
Actor:	The system,
Condition:	upon receipt of a message,
Action:	shall switch
Object of Action:	that message
Constraints of Action:	within 10 milliseconds of receipt
Refinement of Object:	for messages in ACP128 format having a valid routing indicator
Source of Object:	from the message input port,
Destination of Object:	to a message output port,
(Further) Refinement of Action:	corresponding to the routing indicator in the message.

The associated measures assign a value of either 0 or 1 for each syntactic element for each requirement; the average yields the overall requirements quality measure. As Halligan notes (Halligan 2009, section 5), a good requirement should have all the essential elements. This is similar to the Boeing approach (Carson and Zlicaric 2008). And, as Halligan also notes (Halligan 2009, section 6), the measure should be linked to management decision-making, as indicated in figure 1.

Once the work *product* standard is established we can also define the *process* necessary to create the product that conforms to the standard, and the associated process measures. Various SE processes are available (e.g., SIMILAR (Bahill & Gissing 1998), ISO 15288:2008, INCOSE SE Handbook 2010). Each process step produces outputs that are identified. Each process step can have a standard for its outputs. One task then is to establish measures for each standard output, as has been done above for “requirements”.

The *process* standards establish the processes necessary to produce the outputs. A second task is to establish the process measures for the processes that produce the standard outputs. The final task is to correlate the process and product measures, with a goal of using the process measures as surrogates for the product measures, thus replacing product “inspection” with process monitoring while retaining product quality. An example is indicated in figure 3.

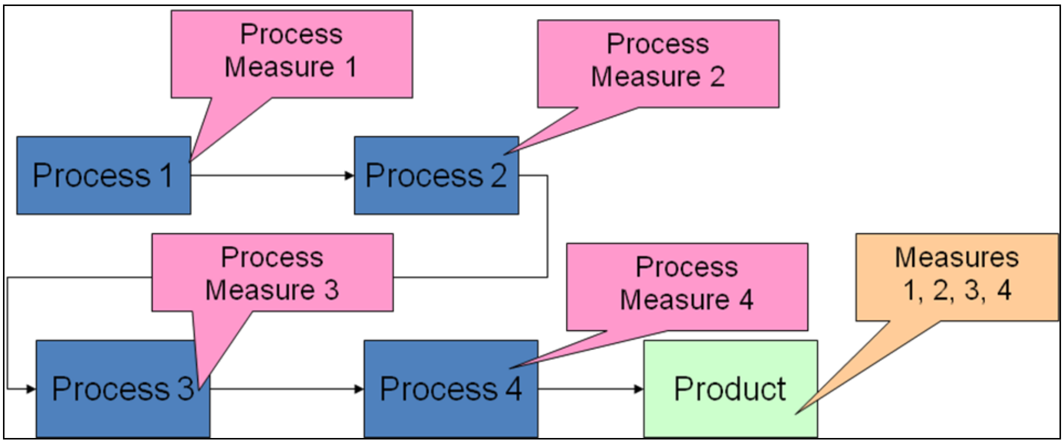

Figure 3. Example process measures for each process step need to be correlated with product measures.

Common Product and Process Measures

(Olson 2008) has established a set of five common measures for any work product. These are size, effort, cost, schedule, defects, and are all "base measures" per the SE Leading Indicators Guide (INCOSE 2010) and other measurement standards (e.g., ISO/IEC 15939:2007). Product quality as discussed above is complementary to "defects". Measures that can be derived from this set include productivity (size/effort), defect density (defects/size), and earned value measures of cost performance index (roughly, cost/size) and schedule performance index (schedule/size).

Application to INCOSE SE Handbook Outputs

If we examine the INCOSE SE Handbook we can see that each process step (especially the technical processes in section 4) has identified outputs to which the common measures can be applied.

For example, section 4.1 lists the outputs of "Stakeholder Requirements Definition" as:

- Concepts of production, deployment, operations, support, disposal
- Stakeholder requirements
- Measures of Effectiveness Needs
- Measures of Effectiveness Data
- Validation Criteria
- Requirements Verification and Traceability Matrix
- Stakeholder Requirements Traceability

For each of these we can identify measures related to size, effort, cost, schedule, and defects, and categorize them as "product" or "process" measures, then attempt to correlate the product and process measures. Once correlation is established and validated, the process measures can be used to control the process without sacrificing the quality of the product.

If we address the first of these outputs, "Concepts of production," etc., we can apply the common measures and identify Candidate product and process measures, and attempt to correlate them. This is indicated in table 2.

Let us consider in turn the five common measures for the "concepts" outputs.

Table 2: Candidate product and process measures for "Concepts" outputs from INCOSE SE Handbook, section 4.1.1.4, "Stakeholder Requirements Definition"

Technical Process Outputs (ISEH v3.2, sections 4.x.1.4)	Common Measurement Category (Olson 2008)	Work Product (Output) Measures	Process Measures	Correlation	INCOSE SE Leading Indicators Reference
Stakeholder Requirements Definition					
Conops (concepts of production, deployment, operations, support, disposal)	Size	· Pages · Number of concepts	· Number of concepts vs. plan · Number of stakeholders contacted	Number of concepts	None
	Effort	Total effort (hours)	· Incremental effort (hours)	"Incremental" = "total" upon completion	3.18 Schedule and Cost Pressure
	Cost	· Total cost (labor + materiel)	· Incremental cost over time (labor + materiel)	"Incremental" = "total" upon completion (Cost Performance Index in Earned Value Management)	3.18 Schedule and Cost Pressure
	Schedule	· Schedule (timeliness - available when needed)	· Schedule (calendar days for starting and finishing)	Schedule Performance Index in Earned Value Management	3.18 Schedule and Cost Pressure
	Defects (quality)	· Inconsistency with user needs · Incompleteness: -Percentage of incomplete or missing concepts, -Percentage of lifeycle covered by concepts	Checklist of concepts needed vs. developed (operations, production, support, disposal)	Missing concepts identified	3.15 Defect and Error Trends

The work product **size** can be measured in terms of the number of pages of text, or the number of concepts and their subordinate contributors (e.g., the number of missions in the concepts of operations). The related process measures can address the number of concepts addressed or completed compared with a plan. Related to this may be an assessment of the number of stakeholders who were contacted in order to obtain the information used to generate the concepts. The correlation between product and process measures is quite strong ("green" in the cell), since both measure the *number* of concepts. The only difference is that the process measures address incremental progress vs. a plan, whereas the product measures address the final product when completed. Therefore, the size measure is useful as both a process and product measure.

Effort, cost, and **schedule** measures have similar positive correlations, where the process measures yield incremental results compared with the final product measure results. In addition, the cost and schedule process metrics can be directly correlated to the cost and schedule performance indices of earned-value management (per ANSI/EIA-748B) as measures of incremental progress of the work expended in creating the product (the various concepts). Again, the correlation is quite strong ("green") between product and process metrics, and the process measures are effective surrogates for the product measures. These effort, cost, and schedule measures will be common across all work products, and will not be discussed further.

Of more significance are the **defect** measures, where there is a clear distinction between the work product and process measures, and limited correlation (“yellow” highlight). The process measures can assess levels of completeness vs. a plan, but only the product measures actually evaluate the content of the work product, e.g., the correlation (quality) or inconsistency (defect) with a user need. Example work product standards for the “concepts” documents are ANSI/AIAA-G-043-1992 and IEEE-1362-1998. The correlation between product and process measures is limited to completeness compared with some expectation (how many concepts of operation, or how many scenarios, or how many pages, etc.).

Given the degree of correlation, could the process measures substitute for the product measures? For size, effort, cost, and schedule measures the answer is clearly, “yes”. However, for the defect (quality) measures, the answer is clearly “no”, at least at the level of the actual concepts of operation, etc. As indicated above in figure 3, the process of developing a concept of operations would need to be decomposed into measurable process steps with associated measures for intermediate work products. These intermediate process measures could then become surrogates for the completed work product quality measure, which is the conformance of the concept of operations to a standard.

The INCOSE SE Leading Indicators Guide has identified several measures that can be associated with the common measures. “Schedule and Cost Pressure” (section 3.18) are clearly related to the Effort, Cost, and Schedule common measures (though the measure of “pressure” remains somewhat uncertain). “Defect and Error Trends” (3.15) can obviously be applied to the Defect common measure. There is no unique SE Leading Indicator related to the size of any concepts of operations or related documents. However, the scope of the SE Leading Indicators Guide is to identify the most important leading indicators, not provide a measurement for every process or work product.

As a second example we consider the next work product output, the “Stakeholder requirements” as indicated in table 3. The **size** can be assessed in terms of the number of requirements, and the process measures can address the number vs. time or per plan. The expected size can be evaluated using the techniques developed by (Carson et al. 2004) or other methods.

The **defects** can be assessed using techniques developed by (Carson and Zlicaric 2008) and (Halligan 2009) as discussed above. Again, except for the additional use of actual vs. expected “size”, there are no obvious process base measures that correlate to requirements quality. It might be possible to correlate a secondary process measure based on level of effort in developing requirements, where “no effort” would be expected to yield “poor quality” requirements, but this is a projection of the quality of requirements in the limiting case of no effort applied.

Table 3: Candidate product and process measures for "Stakeholder Requirements" outputs from INCOSE SE Handbook, section 4.1.1.4, "Stakeholder Requirements Definition" (only Size and Defects)

Technical Process Outputs (ISEH v3.2, sections 4.x.1.4)	Common Measurement Category (Olson 2008)	Work Product (Output) Measures	Process Measures	Correlation	INCOSE SE Leading Indicators Reference
Stakeholder requirements	Size	· Size (# requirements)	· Size (# requirements vs. plan) · Completeness of requirements vs. plan	"Incremental" = "total" upon completion	3.4. Requirements Validation Trends
	Defects	· Defects - quality of requirements · Completeness of requirements vs. a standard ("coverage" vs. interfaces and operational/lifecycle needs)	· Incremental number of requirements over time or vs. plan	Number of requirements Secondary correlation for quality of requirements based on "effort"	3.4. Requirements Validation Trends 3.15 Defect and Error Trends

If, as (Halligan 2009) shows, several essential features of high quality requirements can be separately identified and associated with specific process elements, then it might be possible to improve the correlation. For example, it is commonly known that one of the key process outputs of a good functional analysis (or activity diagrams in UML/SysML) are the "verbs" intended to follow the "shall" in the requirements statements (Piraino et al., 2001). Therefore, it would be possible to correlate the quality of the future requirement to be written based on the common process measures associated with the functional analysis, such as effort and schedule.

The completeness and correctness of stakeholder requirements can also be validated as an element of the "Requirements Validation Trends" SE Leading Indicator, which could help address both the size (total number) and defects (missing requirements) from a stakeholder perspective. Again, the Defect and Error Trends would be derived based on the actual defects in the requirements (the complement of "quality").

Discussion and Summary

We have recovered the basis for substituting process measures for product "inspection" measures when a correlation can be established. We note that, for the five common measures of effort, cost, schedule, size, and defects, the first three are amenable to strong process/product measures correlation because the measures are inherent to the process and, when completed, the final product. These three measures are also independent of the kind of SE output being discussed.

The other two measures for size and defects depend on the specific process output. Product and process measures for **size** also seem to correlate similarly to the other three common measures for a similar reason: size of the work product can be measured incrementally as the product is created, and the final value for the process would, indeed, be the product measure.

"Defects" are also dependent on the specific product. However, in contrast to the other four common measures, in many cases there appears to be little-to-no correlation with process measures at this level of description. Defining intermediate work products and assessing them individually for product quality would serve as process measures, and might enable the substitution of these for the final product measures. As seen in the tables in Appendix A, this is apparent for certain kinds of work products where incremental completion is possible, e.g. traceability, completeness and data for MOEs and TPMs, and completeness of verification.

Focusing on SE work products provides a basis for defining product and process measures that can be correlated in the five common measurement categories. Understanding the limitations of the process measures and their degree of correlation to product measures helps focus the application of the measures to ensure proper operation of closed-loop SE management.

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Biography

Dr. Ron Carson is a Technical Fellow in Systems Engineering at The Boeing Company, an Adjunct Professor in Systems Engineering at the Missouri University of Science & Technology (formerly, University of Missouri-Rolla), and an INCOSE Fellow. He was a contributor to the INCOSE/Lean Aerospace Initiative SE Leading Indicators released in June 2007 and a coauthor of v2.0 of the INCOSE Measurement Primer (November 2010). He works with senior Systems Engineers at Boeing facilities to improve the quality of Systems Engineering program performance and education, and is currently working on automated methods to improve the writing of high-quality requirements. He holds four patents in satellite communications and has published 19 articles in Systems Engineering, primarily in the area of Requirements Analysis.

Appendix

The following tables 4 to 7 list the work products (outputs) from the INCOSE SE Handbook, v3.2, for selected technical processes 4.1-4.3 and 4.6, along with respective candidate measures for Size and Defects.

Table 4: Candidate product and process measures for selected outputs from INCOSE SE Handbook, section 4.1.1.4, “Stakeholder Requirements Definition”

Technical Process Outputs (ISEH v3.2, section 4.1.1.4)	Common Measurement Category (Olson 2008)	Work Product (Output) Measures	Process Measures	Correlation	INCOSE SE Leading Indicators Reference
Stakeholder Requirements Definition					
Measures of Effectiveness (MOE) Needs	Size	· Number of required MOEs to characterize system effectiveness	· Number of MOEs vs. plan · Number / % of stakeholders contributing MOEs	Number of MOEs	3.13 Technical Measurement Trends
	Defects	· Insufficiency (incompleteness or deficient quality) of MOEs to characterize system effectiveness vs. operational/ lifecycle needs	· Insufficiency (incompleteness or deficient quality) of MOEs to characterize system effectiveness vs. operational/ lifecycle needs per unit time	· Insufficiency (incompleteness or deficient quality) of MOEs to characterize system effectiveness vs. operational/ lifecycle needs	3.13 Technical Measurement Trends 3.15 Defect and Error Trends
MOE Data	Size	· Number of MOE data points per MOE	· Data for each MOE per unit time	Number of MOE data points	3.13 Technical Measurement Trends
	Defects	· Missing, incomplete, or erroneous MOE data	· Missing, incomplete, or erroneous MOE data per unit time	Missing, incomplete, or erroneous MOE data	3.13 Technical Measurement Trends 3.15 Defect and Error Trends
Requirements Verification and Traceability Matrix	Size	· # or % requirements and traces to verification attributes	· # or % requirements and traces to verification attributes vs. plan · Completeness of requirements traces vs. plan	"Incremental" = "total" upon completion	3.1 Requirements Trends
	Defects	· Erroneous traces between requirements and verification attributes · Completeness of requirements traces to verification attributes	· Erroneous requirements traces per unit time · Completeness of requirements traces to verification attributes	· Erroneous requirements traces · Completeness of requirements traces to verification attributes	3.15 Defect and Error Trends
Stakeholder Requirements Traceability	Size	· # or % requirements traced to source documents or needs, e.g., concepts of operations	· # or % complete requirements traced to source documents or needs, e.g., concepts of operations, vs. plan	· # or % requirements traced to source documents or needs, e.g., concepts of operations)	3.4 Requirements Validation Trends
	Defects	· Erroneous traces between stakeholder requirements and source documents or needs, e.g., concepts of operations · Incompleteness of stakeholder requirements traces	· Erroneous traces between stakeholder requirements and source documents or needs, e.g., concepts of operations per unit time or vs. plan · Incompleteness of stakeholder requirements traces per unit time or vs. plan	· Erroneous traces between stakeholder requirements and source documents or needs, e.g., concepts of operations · Incompleteness of stakeholder requirements traces	3.4 Requirements Validation Trends 3.15 Defect and Error Trends

Table 5: Candidate product and process measures for selected outputs from INCOSE SE Handbook, section 4.2.1.4, "Requirements Analysis Process"

Technical Process Outputs (ISEH v3.2, sections 4.2.1.4)	Common Measurement Category (Olson 2008)	Work Product (Output) Measures	Process Measures	Correlation	INCOSE SE Leading Indicators Reference
Requirements Analysis					
System Functions	Size	· # functions	· # functions vs. plan · Completeness of functions vs. plan	"Incremental" = "total" upon completion	3.1 Requirements Trends
	Defects	· Quality of functions · Completeness of functions defined vs. functions needed based on boundary, interfaces, and operations	· Incremental number of functions over time or vs. plan	· Number of functions · Secondary correlation for quality of functions based on "effort"	3.1 Requirements Trends 3.15 Defect and Error Trends
System Functional Interfaces	Size	· # function interfaces	· # functional interfaces identified and defined vs. plan · Completeness of functional interfaces vs. plan	"Incremental" = "total" upon completion	3.1 Requirements Trends 3.3 Interface Trends
	Defects	· Quality of functional interface definition · Completeness of functional interfaces defined vs. functional interfaces needed based on boundary and operations	· Incremental number of functional interfaces defined over time or vs. plan	· Number of functions · Secondary correlation for quality of functional interfaces based on "effort"	3.1 Requirements Trends 3.3 Interface Trends 3.15 Defect and Error Trends
Verification Criteria	Size	· Number of verification criteria	· Number of verification criteria vs. plan · Number / % of stakeholders contributing verification criteria	Number of verification criteria	None
	Defects	· Insufficiency (incompleteness or deficient quality) of verification criteria to verify system	· Insufficiency (incompleteness or deficient quality) of verification criteria to verify system per unit time	· Insufficiency (incompleteness or deficient quality) of verification criteria to verify system	3.15 Defect and Error Trends
Specification Tree	Size	· # specifications	· # specifications vs. plan · Completeness of specifications vs. plan	"Incremental" = "total" upon completion	3.1 Requirements Trends
	Defects	· Quality of specifications · Completeness of specifications defined vs. specifications needed based system architecture	· Incremental number of specifications over time or vs. plan	· Number of specifications · Secondary correlation for quality of specifications based on "effort"	3.1 Requirements Trends 3.15 Defect and Error Trends 3.17 Architecture Trends

Table 6: Candidate product and process measures for selected outputs from INCOSE SE Handbook, section 4.3.1.4, “Architectural Design Process”

Technical Process Outputs (ISEH v3.2, sections 4.3.1.4)	Common Measurement Category (Olson 2008)	Work Product (Output) Measures	Process Measures	Correlation	INCOSE SE Leading Indicators Reference
Architectural Design Process					
System Architecture	Size	· # architecture elements and interfaces · # architecture views (e.g., DoDAF, MODAF)	· # completed views vs. plan · Completeness of views vs. plan	"Incremental" = "total" upon completion	3.3 Interface Trends 3.17 Architecture Trends
	Defects	· Quality of architectural views vs. architectural standard · Fitness for use of architectural views · Completeness of architectural views vs. need	· Incremental number of architectural views over time or vs. plan	· Number of architectural views · Secondary correlation for quality of architectural views based on "effort"	3.15 Defect and Error Trends 3.17 Architecture Trends
Interface Requirements	Size	· # interfaces	· # interfaces identified and defined vs. plan · Completeness of interfaces vs. plan	"Incremental" = "total" upon completion	3.1 Requirements Trends 3.3 Interface Trends
	Defects	· Quality of interface definition · Completeness of interfaces defined vs. interfaces needed based on boundary and requirements	· Incremental number of interfaces defined over time or vs. plan	· Number of interfaces defined · Secondary correlation for quality of interfaces based on "effort"	3.1 Requirements Trends 3.3 Interface Trends 3.15 Defect and Error Trends
System Element Descriptions	Size	· Pages · Number of elements described	· Pages completed or number of elements described vs. plan	"Incremental" = "total" upon completion	3.6 Work Product Approval Trends
	Defects	· Quality of system element descriptions vs. standard · Fitness for use of descriptions · Completeness of descriptions vs. need	· Incremental number of descriptions over time or vs. plan	· Number of descriptions · Secondary correlation for quality of descriptions based on "effort"	3.15 Defect and Error Trends

Table 7: Candidate product and process measures for selected outputs from INCOSE SE Handbook, section 4.6.1.4, “Verification Process”

Technical Process Outputs (ISEH v3.2, sections 4.6.1.4)	Common Measurement Category (Olson 2008)	Work Product (Output) Measures	Process Measures	Correlation	INCOSE SE Leading Indicators Reference
Verification					
Verification Strategy	Size	· Pages	· Pages completed vs. plan	· Pages	3.6 Work Product Approval Trends
	Defects	· Quality vs. standards for a strategy · Inconsistency with program needs or constraints	· Approval time	· Quality of plans vs. ease or difficulty of approvals	3.6 Work Product Approval Trends 3.15 Defect and Error Trends
Verified System	Size	· # of procedures executed · # system elements verified	· # of procedures executed per unit time or vs. plan · # system elements verified per unit time or vs. plan	"Incremental" = "total" upon completion	3.5 Requirements Verification Trends
	Defects	· # or % system elements compliant / not compliant with requirements	· # or % system elements compliant / not compliant with requirements per unit time	· # or % system elements compliant / not compliant with requirements	3.5 Requirements Verification Trends 3.15 Defect and Error Trends
Verification Report	Size	· # pages · # procedures	· Pages completed vs. plan · Procedures reported vs. plan	· # pages · # procedures	3.5 Requirements Verification Trends 3.6 Work Product Approval Trends
	Defects	· Quality vs. standards for a verification report	· Approval time	· Quality of reports vs. ease or difficulty of approvals	3.5 Requirements Verification Trends 3.6 Work Product Approval Trends 3.15 Defect and Error Trends