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Reliability Engineering: Value, Waste, and Costs

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Abstract. Several reliability engineering activities practised today cannot contribute to the primary objective of reliability engineering, which is the prevention of failure. Lean Thinking (or lean) is well-known as management philosophy with the objective of maximising value by removal of waste from all activities. Can lean be applied to reliability engineering?

This paper starts with a brief discussion on the fundamentals of both reliability engineering and lean. It provides a definition of value in the context of reliability engineering, and applies this definition to identify categories of reliability engineering activities which can be considered as waste. The paper concludes with a discussion on reliability costs.

Introduction

The reliability of a product depends to a large extent on the quality and integrity of the processes used to design and to manufacture the product. High field reliability is typically achieved through the execution of specific reliability engineering activities during product development. However, the discipline of reliability engineering has not kept pace with modern technology. Some reliability engineering activities practised today are outdated, misleading, or even fundamentally flawed. This may result in the execution of activities which cannot contribute to the primary objective of reliability engineering, which is the prevention of failure. Furthermore, other useful reliability engineering activities are often omitted from product development processes, which may increase the risk of releasing products with inferior reliability.

Lean Thinking (or lean) is well-known as management philosophy with the primary objective of maximising value to the customer by removal of waste from all activities. A fundamental concept in lean is the creation of value through the elimination of waste, which is defined as any non-value added activity or process.

It may therefore be appropriate to challenge the value of reliability engineering, and to redefine the role thereof in product development. Lean provides a useful perspective with principles for a meaningful and critical assessment of the practice of reliability engineering. If a development process or a specific reliability engineering activity does not add value to the design and production of failure-free products, it may be considered as waste.

Fundamentals of reliability engineering

Reliability, according to the conventional definition, is "the probability that an item will perform a required function without failure under stated conditions for a stated period of time." [O'Connor and Kleyner, 2012]. This definition combines two distinct disciplines, namely statistics (e.g., probability) and engineering (e.g., required product or system functions, operating conditions and period of time).

Unfortunately, the focus on probability in this definition has over the years resulted in major emphasis on various aspects of mathematics and statistics in reliability engineering [Barnard, 2014]. This emphasis is understandable given the state of technology when reliability engineering activities were originally developed (i.e., vacuum tube). Many electrical and electronic parts at that time failed due to quality problems or due to wear-out, resulting in today's misleading beliefs that all parts have relevant failure rates, and that all system failures are caused by part failures.

Today, many consumer, industrial and defence products and systems are replaced by customers due to technological obsolescence (e.g., computers). Users of even complex products and systems became accustomed to extremely high reliability (e.g., motor cars). We clearly need a new definition for reliability, which is descriptive of the very high levels of reliability achieved by world-class companies today. Such a definition should put more emphasis on the engineering aspects of reliability, and less emphasis on the statistical aspects.

In 1965, Raymond Hollis wrote "Conventional statistical reliability techniques are a necessary condition of reliability. They are, however, insufficient and inadequate. Other reliability techniques are needed to turn a feasibly designed system into a completely successful one. The implementation of these techniques is lagging." [Hollis, 1965]. It is interesting to note that Hollis expressed the need for "reliability techniques which embody engineering principles" shortly after the birth of reliability engineering in 1957 [Coppola, 1984].

In 1995, Philip Crosby wrote that "All non-conformances are caused. Anything that is caused can be prevented." [Crosby, 1995]. These two short sentences, originally written from a quality perspective, are also applicable to the fundamentals of reliability engineering. They suggest that product or system failures are caused, and that all these failures can be prevented.

In 2011, Norman Pascoe wrote "All failures in electronic equipment can be attributed to a traceable and preventable cause and may not be satisfactorily explained as the manifestation of some statistical inevitability." [Pascoe, 2011]. Once again, it is suggested that all failures in electronic equipment are caused, and that these failures can be prevented.

When product failure occurs and root cause analysis is performed, it becomes evident that failures are created, primarily due to errors made by people. These include design and production personnel, as well as operators and maintenance personnel. Based on these statements, and applying common sense to real life experience, reliability and reliability engineering may be defined as follows [Barnard, 2008]:

- Reliability is the absence of failures in products.
- Reliability engineering is the management and engineering discipline that prevents the creation of failures in products.

These simple definitions imply that a product is reliable if it does not fail (during its expected life under the full range of conditions experienced in the field), and that this failure-free state can only be achieved if failure is prevented from occurring.

What is required to prevent failure? Firstly, engineering knowledge to understand the applicable failure mechanisms, and secondly, management commitment to mitigate or eliminate them. Proactive prevention of failure should be the primary focus of reliability engineering, and never reactive failure management or failure correction. Reliability engineering activities change from proactive during design and development to reactive during production and especially during operations. Reactive reliability engineering should be avoided due to the very high cost of corrective actions (e.g., redesign and product recalls).

It is important to understand that reliability (similar to other dependability attributes such as availability, maintainability, and safety) is a non-functional requirement during design and development [Adams, 2015], and that it becomes a characteristic of a product or system during operations. Product development is an iterative process where design is followed by verification. Analysis and test are two primary verification methods used in engineering. Reliability engineering activities to perform reliability analyses and tests are well-documented in various text books on reliability engineering. Product reliability is the result of many management and technical decisions taken during all development stages (i.e., concept, definition, design and production).

Reliability engineering activities are often neglected during development, resulting in a substantial increase in risk of project failure, or customer dissatisfaction due to inferior reliability. It is therefore recommended that reliability engineering activities be formally integrated with other systems engineering technical processes. A practical way to achieve integration is to develop a reliability program plan at the start of a project.

Appropriate reliability engineering activities should be *selected* and *tailored* according to the objectives of the specific project, and should be documented in the reliability program plan. The plan should indicate which activities will be performed, objectives, timing, level of detail required, and the persons responsible for execution of the activities.

ANSI/GEIA-STD-0009, Reliability Program Standard for Systems Design, Development, and Manufacturing, can be referenced for this purpose [ANSI/GEIA-STD-0009, 2008]. This standard supports a system life-cycle approach to reliability engineering, and consists of four parts with the following objectives:

- Understand Customer / User Requirements and Constraints.
- Design and Redesign for Reliability.
- Produce Reliable Systems / Products.
- Monitor and Assess User Reliability.

Reliability engineering activities can be divided into two groups, namely *engineering analyses and tests*, and *failure analyses*. These activities are supported by various reliability management activities (e.g., design reviews, electronic part derating guidelines, preferred parts lists, preferred supplier lists, and reliability training).

Engineering analyses and tests refer to traditional design analyses and test methods. Included in this group are activities such as load-strength analysis, finite element analysis, vibration and shock analysis, thermal analysis and measurement, electrical stress analysis, wear-out life prediction, and HALT (Highly Accelerated Life Testing).

Failure analyses refer to traditional reliability analyses to improve understanding of cause-and-effect relationships. Included in this group are activities such as FMEA (Failure Mode and Effects Analysis), FTA (Fault Tree Analysis), RBD (Reliability Block Diagram) analysis, systems modelling and simulation, and root cause failure analysis.

Due to a multitude of reliability engineering activities available, inexperienced engineers may find it difficult to develop an efficient and effective reliability program plan. For example, should FMEA be performed, or should FTA rather be performed, or perhaps both analyses? Figure 1 indicates a few relevant aspects which may be used to guide the development of a reliability program plan for a specific project [Walden et al., 2015]. Aspects such as technology maturity, complexity, life cycle stage, and failure consequence should be considered during the activity selection process.

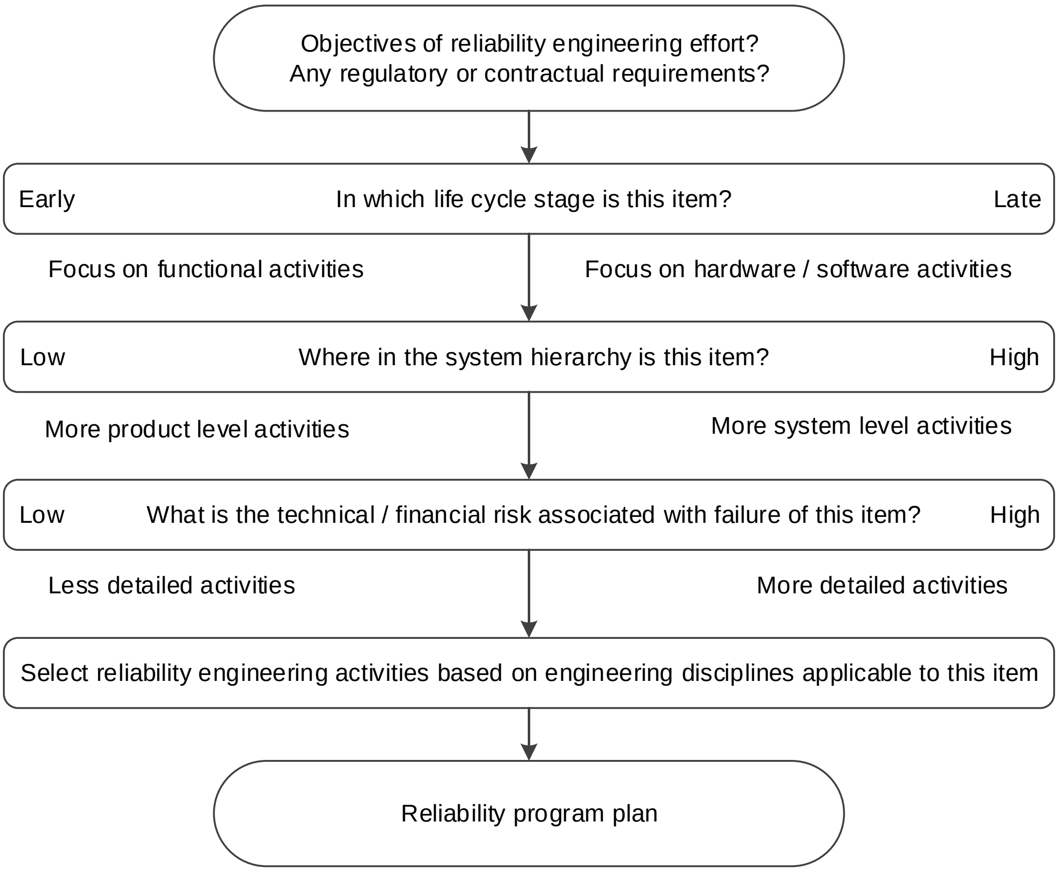

Figure 1. Reliability program plan development

Fundamentals of lean

Lean is well-known as management philosophy with the primary objective of maximising value to the customer by removal of waste from all activities. The origins of lean can be found in the Toyota Production System, which is seen as a major contributor to Toyota's success in the automotive market. This production system dramatically reduced vehicle production time and costs, and simultaneously increased product quality and reliability.

The 'father' of lean at Toyota, Taiichi Ohno, first published his views in a Japanese book called "Toyota Seisan Hoshiki" in 1978. This book, which was translated into English in 1988 and published as the "Toyota Production System", gave English speaking readers insight into these fundamentals. He wrote that the "most important objective of the Toyota system has been to increase production efficiency by consistently and thoroughly eliminating waste." [Ohno, 1988].

However, it was the book titled "The machine that changed the world" which made the lean philosophy generally known to many industries [Womack, Jones and Roos, 1990]. While Ohno's original book describes the *production system* at Toyota, a publication in 2006 by Morgan and Liker provides more insight into the *product development system* at Toyota [Morgan and Liker, 2006]. "The Toyota system developed products in much less time with many fewer hours of engineering, products that cost less to manufacture and that had fewer defects as reported by customers." [Morgan and Liker, 2006].

The concepts of value and waste are fundamental in lean. The overall objective is to minimise waste in order to maximise value. Waste is simply anything which does not create value. There is an inverse relationship between value and waste; more waste means less value (and vice versa). "In short, lean thinking is *lean* because it provides a way to do more and more with less and less." [Womack and Jones, 2003]. Lean has increasing efficiencies as a central aim, as epitomised by the Toyota production system [Smart et al., 2003].

Lean has been widely applied in many manufacturing industries, and in other sectors such as logistics and distribution, services, retail, healthcare, construction, maintenance, and government [Lean Enterprise Institute, 2014]. More recently, and important in the context of reliability engineering, lean has been introduced to new product development and systems engineering. Lean product development is "a customer focused and knowledge based approach to eliminate the waste of design reiteration in new product development." [Paschkewitz, 2014]. Lean systems engineering is defined as the "application of lean wisdom, principles, practices and tools to systems engineering in order to enhance the delivery of value to system's stakeholders." [Oppenheim, 2011].

An overemphasis on waste removal from processes should be challenged when lean principles are applied to industries other than manufacturing. The approach of identifying wasteful activities and then to eliminate them, has caused lean to be thought of (and even incorrectly defined) in terms of removing waste [Browning, 2003]. The focus should in the first place be on value creation, and not on waste removal. Lean can become disabling if it privileges short term efficiency gain over design integrity, robustness and system reliability. The disabling effect is especially relevant in non-repetitive activities such as product development [Smart et al., 2003].

Lean principles

The practice of lean is often described by the so-called lean principles, originally described as definition of value, mapping of the value stream, flow, pull and perfection [Womack and Jones, 2003]. A sixth principle was later added to ensure adequate consideration for respect for people in any lean implementation [Oppenheim, 2011]. The implementation of lean techniques therefore consists of the following:

1. Define value from the viewpoint of the customer (either external or internal).
2. Identify and map all steps in the value stream (eliminating waste whenever possible).
3. Ensure that the work flows through these steps without delays or rework.
4. Establish pull from the next upstream activity.
5. Pursue perfection of all activities and processes.
6. Introduce respect for people in all work activities.

These steps are repeated as continuous improvement process until a state of perfection is approached where value is created without any waste, as shown in Figure 2. *The core idea is to maximize customer value while minimizing waste. Simply, lean means creating more value for customers with fewer resources. The ultimate goal is to provide perfect value to the customer through a perfect value creation process that has zero waste.* [Lean Enterprise Institute, 2014].

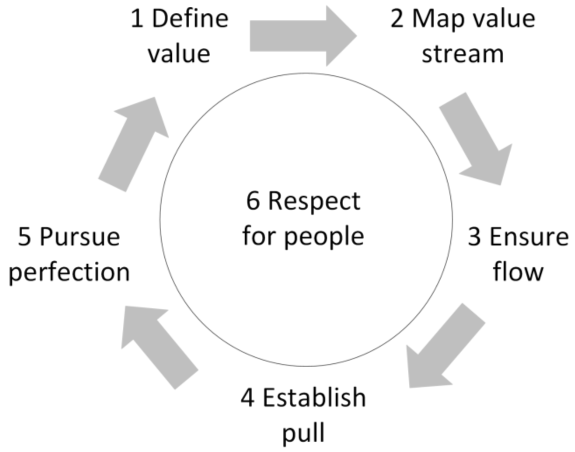

Figure 2. Lean principles as continuous process

Value

Value of a product or system to a customer depends on customer perceptions and preferences. Value is concerned with the importance, worth, or usefulness of something. The value of a product or system is always determined by the customer, and not by the developer or producer. It is important to note that the customer is not necessarily the end user; it can be anybody receiving a product or service in a supply chain.

Customer value of a product or system has an absolute aspect (i.e., how well its attributes address customer needs), and a relative aspect (i.e., value in comparison with competing products or systems). Several authors have proposed equations to quantify the absolute aspect of value, and these equations all define value essentially as a ratio of benefits to costs:

$$Product\ value\ \propto \frac{Benefits}{Costs} \tag{1}$$

or

$$Product\ value\ \propto \frac{Product\ performance}{(Price)(Lead\ time)} \tag{2}$$

Product value is thus proportional to the benefits the product provides and inversely proportional to the time and money expended to get those benefits [Browning, 2003].

Waste

Lean classifies all work activities into three categories [Oppenheim, 2011]:

- Value added activities, which have to satisfy the following three conditions:
  - Transform information or material, or reduce uncertainty.
  - Customer is willing to pay for (that is, if customer understood details, he would approve of this activity).
  - It is done right the first time.
- Required (also called necessary) non-value added activities, which do not meet the definition of value added activities, but which cannot be eliminated because they are required by law, contract, company mandate, current technology, or other such reason.
- Non-value added activities, which consume resources and create no value (also called pure waste).

'Uncertainty reduction' is an important value added activity in the context of this paper, since reliability engineering is concerned with the identification and subsequent prevention of highly uncertain events (i.e. failures).

Ohno classified waste in manufacturing [Ohno, 1988] into the following seven categories[1] (product development examples shown in parenthesis):

- Overproduction (e.g., producing more than the next process or activity needs).
- Waiting (e.g., waiting for information).
- Transportation (e.g., moving information around).
- Processing (e.g., doing unnecessary processing on a task, or an unnecessary task).
- Inventory (e.g., build-up of information that is not being used).
- Motion (e.g., excessive motion or activity during task execution).
- Defects (e.g., inspection or correction of errors made).

Lean applied to reliability engineering

Any process can be viewed as a group of related activities that collectively produce a required output. While the efficiency of all processes may be improved by the removal of wasteful activities, a process can in totality be considered as waste, and specifically if it does not produce the required output. It may therefore be useful to distinguish between waste associated with a process failing to support the primary objective of that process, and waste associated with an individual activity of an otherwise valuable process.

The accurate definition of value and the subsequent identification of waste are essential steps for successful lean implementation. Value and waste may be relatively easy to define for a manufacturing process, but it may be much more difficult for product development. Lean in a manufacturing process is activity (or task) based, with a strong focus on identification and elimination of wasteful activities. The focus is on waste removal (i.e., activity based).

However, lean in product development is knowledge based, with a strong focus on the development process itself. A major source of waste in product development is caused by the reiteration of a design stage due to late identification of design deficiencies, including inferior product reliability. The overall objective in lean product development is thus to increase learning and capturing of knowledge early during product development stages to make the correct design decisions in order not to repeat any design stage [Paschkewitz, 2014]. In lean product development, it is therefore often beneficial to perform more (and not less) activities to become leaner. The focus is on value creation (i.e., knowledge based).

Lean principles

The six lean principles can almost directly be applied to the practice of reliability engineering. For example, 'define value' refers to the definition of the real expectations and needs of the customer, including all reliability requirements. The life and mission profiles, operating conditions and environment, nominal and extreme user profiles, duty cycles, and consequence of failure need to be fully understood and defined. 'Map value stream' refers to the development and integration of the reliability program plan, detailing resources and activities that can add value at the right time. 'Ensure flow' refers to the management of the reliability program plan, ensuring removal of barriers to the flow of new knowledge and continuous learning. 'Establish pull' refers to deliverables produced as late as possible with maximum knowledge, and tasks pulled by team performing the

[1] Ohno used slightly different terms for these categories of waste.

work to support decision points. 'Pursue perfection' refers to a culture of continuous improvement and learning. 'Respect for people' is an important principle to manage in reliability engineering, since knowledge is typically generated during product development through observed failure modes in products.

Value

The application of lean to reliability engineering implies that reliability engineering activities should focus on the creation of value to the customer. Alternatively, it means that the execution of reliability engineering activities should not be considered as waste. We therefore need a definition on the value of a reliability activity.

Reliability engineering as process is analogous to the process used by medical practitioners. Many people regularly consult medical doctors, whether they are ill or not. Doctors, except for performing medical procedures, examine patients (by using some analysis or test method) to identify an existing disease (i.e., diagnosis), or to confirm the absence of abnormalities which can lead to future disease. Both these outcomes are valuable from the patient's viewpoint (and therefore they are willing to pay for it). This is exactly how reliability engineering is practised. A product or system is analysed and tested (hopefully during development) to identify potential catastrophic or critical failure modes which can be corrected prior to operations, or to provide evidence of the absence of those failure modes.

A closer look at the execution of typical reliability engineering activities reveals that a specific activity can:

- Identify a design or process improvement opportunity (i.e., creates value), or
- Confirm the absence of a design or process improvement opportunity (i.e., creates value), or
- Provide no useful information (i.e., creates no value).

Value in reliability engineering is therefore created by:

- Performing an activity which, through any design or process improvement, results in the elimination (or reduction in the probability) of product failure, or
- Performing an activity which, through confirmation of the absence (or low probability) of potential failure modes, results in a reduction in uncertainty.

Individual activities of a development process can be evaluated using the following definition of value (based on Eq. (2)):

$$Reliability\ engineering\ activity\ value \propto \frac{Activity\ performance}{(Price)(Lead\ time)} \tag{3}$$

Activity performance should always be viewed in terms of its ability to contribute to the overall objective of reliability engineering, namely the prevention of failure. This definition is useful when different reliability activities are evaluated in terms of their performance, price and lead time. For example, identification of a design or production weakness using an efficient and inexpensive accelerated life test conducted over a short time period is clearly more valuable than an inefficient and expensive reliability test conducted over a long time period.

Figure 1, which is proposed to facilitate the development of a reliability program plan, does not refer to value of reliability engineering activities. From a lean viewpoint, we have to include the question “What value can be added by this specific activity?” to the diagram. If a specific activity does not contribute to the objective of designing and producing failure-free products and systems, it should simply not be performed.

Waste

Any product development process involves numerous engineering and management decisions. The execution of specific reliability engineering activities may provide the knowledge required to make the right technical decisions at the right time. Techniques such as QFD (Quality Function Deployment), set-based development, an extended exploration stage, and execution of reliability engineering activities (e.g., design of experiments, accelerated testing, FMEA and FTA) can be used for this purpose [Paschkewitz, 2014].

If a reliability engineering activity is not selected and executed where required, it may increase the risk of making inferior decisions. For example, worst case analysis performed during product development may prevent several problems in later life cycle stages (such as integration difficulties during production, and inferior product reliability during operations). All analyses and tests performed to understand applicable failure mechanisms prior to finalising a design configuration are thus extremely valuable. Waste associated with a product development process may therefore be eliminated by careful selection and execution of value added reliability engineering activities, especially early during product development.

Apart from the general sources of waste as defined by lean (i.e., overproduction, waiting, transportation, processing, inventory, motion and defects), there are specific sources of waste in reliability engineering. These can be grouped into categories relating to the *selection* and the *execution* of reliability engineering activities [Barnard, 2014].

Selection of reliability engineering activities

1 Selection of fundamentally flawed activities

Some reliability engineering activities are fundamentally flawed, and cannot contribute to the primary objective of reliability engineering. These activities can never add value, and are examples of pure waste. The most prominent activity in this category is reliability prediction based on any ‘parts count’ or ‘part stress’ method such as Mil-Hdbk-217 (and all derivatives thereof) [Jais et al., 2013]. It is simply not possible to determine product reliability by merely adding part failure rates obtained from any published document. The only valid reliability prediction is for wear-out failure modes, where the applicable failure mechanisms are well understood. Reliability demonstration based on Mil-Hdbk-781 is another example of a fundamentally flawed activity [O’Connor and Kleyner, 2012]. Note that both correct and incorrect execution of these activities are irrelevant, and will in both cases contribute to waste.

2 Selection of incorrect activities

Reliability engineering activities should be *selected* and *tailored* according to the objectives of the specific project (as illustrated by Figure 1). Aspects such as technology maturity, complexity, life cycle stage, and failure consequence should be considered during the selection process. If incorrect activities are selected for execution, it will certainly contribute to an increase in waste. Activities which may be non-value adding (even when correctly executed), include the following:

- FMEA (when FTA should rather be performed due to safety requirements).
- Reliability block diagram analysis (when performed on series systems (i.e., no redundancy)).
- Fault tree analysis (when performed on series systems (i.e., no redundancy)).

Execution of reliability engineering activities

1 Execution of activities at incorrect time

Execution of reliability engineering activities at the incorrect time during product or system development is a major contributor to waste. Incorrect time means that the activity is performed too early, or too late. Product development is an iterative process, where design is followed by verification, which may result in redesign. For obvious reasons, a specific theoretical analysis can only be performed after a specific design cycle has been completed, and a practical test can only be performed after a prototype has been manufactured. If either of these activities is performed too early, the analysis or test may provide incomplete or even invalid information, and may have to be repeated at a later stage.

A more serious (and frequent) problem seen in industry is that reliability activities are performed too late during development. Due to ever increasing pressure on time scales, there is usually a short window of opportunity to perform reliability engineering activities between design and production. "Reliability engineering often becomes a 'numbers game' after the real game is over. Reliability cannot be economically added after the system has been conceived, designed, manufactured and placed in operation." [Billinton].

2 Incorrect execution of activities

Reliability engineering activities that are normally considered as valuable (e.g., FMEA and HALT), are non-value adding when they are not correctly executed, or when incorrect assumptions are made during their execution. Execution of activities by people with inadequate skills and experience (e.g., a logistics engineer performing a Design FMEA, and an electronic design engineer performing finite element analysis or thermal analysis) is often encountered in practice, and may be a major contributor to waste. Activities which may be considered as non-value adding due to incorrect execution include the following:

- Reliability block diagram analysis (when using MTBF (Mean Time Between Failures) values published in part manufacturer's data sheets).
- Derating analysis (using part maximum ratings listed for 25°C ambient temperature).
- FMEA (without in-depth understanding of cause of failure modes).
- Reliability analysis based on hardware only (i.e., ignoring software).
- Weibull analysis (ignoring requirements for valid data analysis).
- HALT (without design or process improvement when required).

Reliability costs

The value of a reliability engineering activity is related to the costs associated with that activity (i.e., price and lead time, as shown in Eq. (3)). Execution of the activities described in a reliability program plan can be expensive, depending on the specific product and its reliability requirements. This is due to costs involved with design improvements, reliability personnel, reliability analyses, reliability tests, test equipment, and test units.

The conventional viewpoint on reliability costs is shown in Figure 3. It suggests that for higher reliability, reliability costs will increase and failure costs will obviously decrease, resulting in an optimum reliability value where total costs are minimised. Reliability costs include all costs associated with achieving reliability, while failure costs refer to all costs related to unreliability (e.g., rework, repair and warranty claims) [Barnard, 2015].

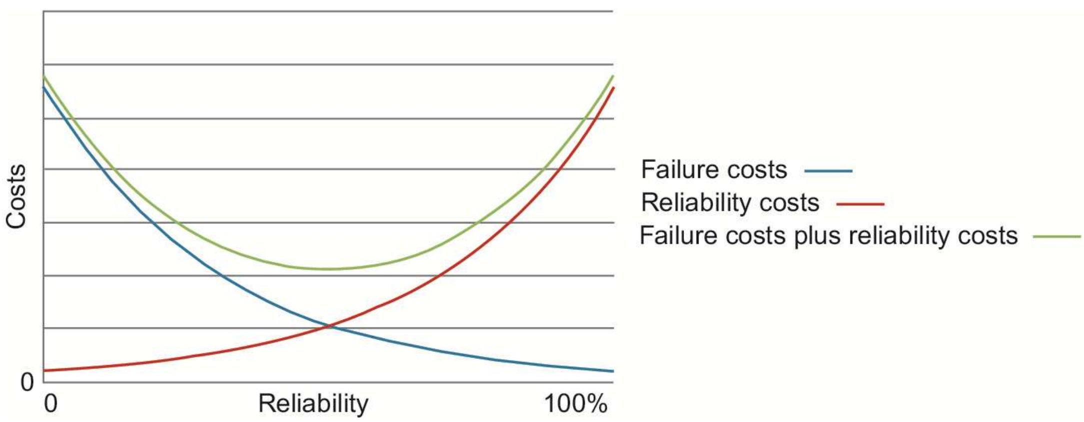

Figure 3. Conventional viewpoint on reliability costs

However, since less than 100% reliability is the result of failures, all of which have preventable causes, this viewpoint may be misleading. All efforts to improve reliability by identifying and removing potential causes of failures should result in cost savings later in the product life cycle [O'Connor and Kleyner, 2012]. The conventional viewpoint ignores other important 'bigger picture' or system aspects such as enhanced brand reputation, increased market share, and more focus of engineers on new product development (and not repairing failed units). At higher levels of reliability, the return on investment becomes progressively larger than the cost of achieving that higher reliability (i.e., incremental profit) [Haibel, 2012]. The system viewpoint on reliability costs is shown in Figure 4.

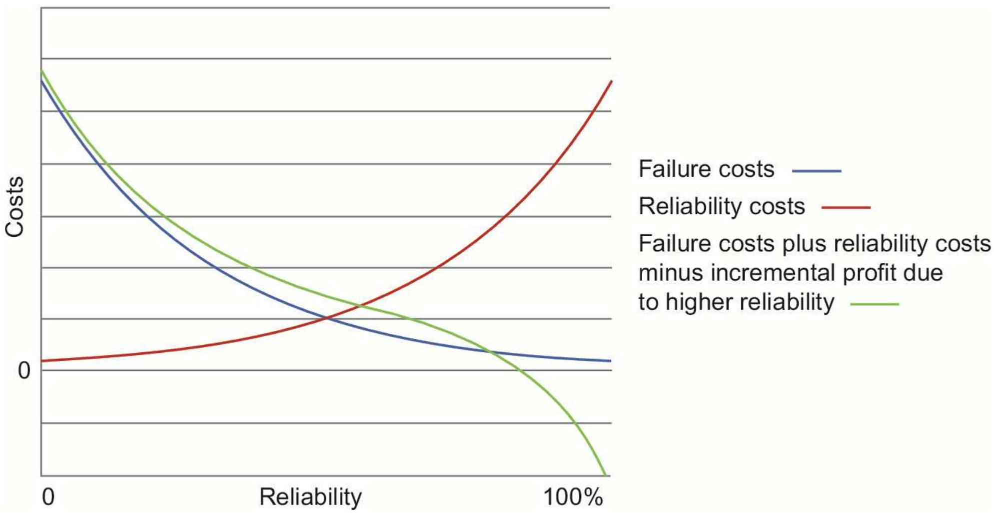

Figure 4. System viewpoint on reliability costs

It may be tempting for project management to argue in favour of an optimum reliability value. Although the system viewpoint is a conceptual model, it provides a sound argument that expenses to improve reliability are indeed investments, and not costs. It is important to communicate these concepts clearly to project management. If not, they may be reluctant to support proactive reliability activities, and therefore only 'pay lip service' to reliability efforts.

Conclusions

Several reliability engineering activities practised today cannot contribute to the primary objective of reliability engineering. It may therefore be appropriate to challenge the value of reliability engineering, and to redefine the role thereof in product development and systems engineering. Lean as management philosophy provides a useful perspective with principles for a meaningful and critical assessment of the practice of reliability engineering.

The reduction (or preferably the elimination) of waste is a key principle of lean. A major source of waste in product development is caused by the reiteration of a design cycle due to design deficiencies (e.g., inferior product reliability). The risk associated with this type of waste may be reduced by the *correct selection* and *correct execution* of specific reliability engineering activities, especially early during product development.

Any reliability engineering activity which does not contribute to the objective of designing and producing failure-free products and systems may be considered as waste, and should not be performed. On the other hand, the execution of more reliability engineering activities (and not less) can be extremely valuable in product development.

Lean is thus applicable to reliability engineering, and the definition of value and identification of waste should be considered during any product development process. The focus on value plays an important role in the establishment of a specific development process, while the focus on waste applies more to the individual activities of that development process.

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Biography

Albertyn Barnard received the degree M.Eng. (Electronics) and M.Eng. (Engineering Management) from the University of Pretoria, South Africa, and is currently a Ph.D. candidate in Development and Management at the North-West University, South Africa. He has provided consulting services in systems and reliability engineering to the defence, nuclear, aerospace, utilities and commercial industries since 1982. He provides training in reliability engineering to industry and at post-graduate level at the University of Pretoria.

He has presented award-winning technical papers at international symposia, and is author of "Reliability and stupidity: mistakes in reliability engineering and how to avoid them" in *Reliability Characterisation of Electrical and Electronic Systems*. Albertyn served as President of INCOSE South Africa in 2008, and established the INCOSE Reliability Engineering Working Group in 2011.