ACL ASPIRE CONSULTING LIMITED

There's a lot to designing a support solution, and your equipment's long-term success hinges on the outcome. As an integrated support engineer, you know what your job is and you know what your organisation does to design its support. But...

you've got a nagging feeling. There's something niggling in your brain. You're wondering if there's more to it. You don't know if there's something else you should be doing, or doing better. Trying to find out is as frustrating as not knowing.

For any concept that's been around a while, it can be difficult to strip away years of inherited knowledge and practice to find its true principles. Support Analysis is no different.

We understand that itch. We understand the need to know if there's more that you can do. We understand how inaccessible a large, complex topic, like Support Analysis, can be. We also understand that it doesn't need to be.

We have trained over 2,000 + integrated support engineers, like you. We have given them a foundation of the basic principles of Support Analysis. Principles that have empowered them to go on and succeed in their integrated support engineering career.

Would you like to succeed to?

1. Visit our website www.aspirecl.com/training
2. Pick one of our scheduled events
3. Book your place

BOOK NOW

Spending time with us will help you become the integrated support engineer you want to be, and your equipment deserves. With a strong grasp of the principles, you'll never have that niggle again.

PRINCIPLES OF SUPPORT ENGINEERING AND LOGISTIC SUPPORT ANALYSIS PRINCIPLES AND PRACTICE

YOUR GUIDE TO SUPPORT SOLUTIONS
www.aspirecl.com/training

Logistic Support Analysis

Course Introduction and Objectives

Overview

A practical course which teaches the application and management of Logistic Support Analysis (LSA) within a System Engineering context. After a general introduction to Integrated Logistic Support (ILS) and LSA the course follows the LSA process through the system life cycle. In each phase of the life cycle the relevant theories and concepts are introduced and these are then consolidated by the performance of a series of practical exercises. The need for and the concept of a logistics database, is addressed. The nature of a 'formal' Logistic Information Record [LIR] / Logistic Support Analysis Record (LSAR) is introduced early in the course and the results of the exercises will, where applicable, be related to the LSAR/LIR compilation process. Thus the training in the LSAR/LIR is fully integrated into the course and is not presented as a stand-alone topic.

Target Audience

The course is aimed primarily at LSA Practitioners and ILS or LSA Managers who require a basic understanding of the potential, the processes and the problems associated with LSA. The course is also suitable for members of support disciplines which have to interface with an ILS or LSA programme. The course will act as a comprehensive introduction to LSA and form a sound foundation upon which future development can be based.

Objectives and Utility

The course introduces the fundamental concepts that are a pre-requisite to a genuine understanding of ILS and LSA and relates the Standards to these concepts in order to facilitate the effective application of the standards. The delegate will understand the LSA process and the LSA tasks as defined by a range of standards, including Defence Standard 00-600, S3000L, and TA-STD 0017 and will gain practical experience of the major analytical techniques used in the LSA process. The delegate will understand the relationship of the logistics database (LIR/LSAR) to the LSA tasks and analytical processes and understand the key management issues as they appertain to LSA, in particular the planning process, the need for an LSA strategy and the requirement to tailor the LSA process. The aim of this course is to present LSA concepts in a simple logical manner and to dispel any misconceptions. The course will enable the organisation to increase their LSA effectiveness. For the Customer the effective application of LSA will result in improved system cost effectiveness, for the Contractor it will result in a quality improvement, to both their products and their service.

The Training Process

The course begins by establishing a need for LSA. From this need a logical argument is developed for System Engineering and, that sub-set of Systems Engineering which is LSA. The LSA process is then addressed throughout the system life cycle. At each stage the relevant theory is presented and discussed, this is then consolidated through a series of practical exercises. This approach ensures that the delegate has a sound understanding of the concepts and the issues associated with LSA, for example, the difficulties involved and the size of the task. Because the approach is logical and structured it aids recall and understanding. Because the Standards are related to the theory, the delegates develop the ability to make a critical appraisal of the contents and the requirements of the Standards.

Logistic Support Analysis

Course Programme

Day 1	
T0001	An Introduction to Support Engineering
T0002	Systems Engineering and System Life Cycles
T0005	Designing a Support Solution
T0035	An Introduction to Support Metrics
T0004	Managing Support Data

Day 2	
004	Support Engineering during the Concept Phase
014-01	The Use Study - Task 201 - Activity B.1
014-03	Baselining the Mission System Task 203 - Activity B.3
005	Support Engineering During the Assessment Phase
014-02	Standardisation - Task 202 - Activity B.2
014-04	Exploiting New Technology - Task 204 - Activity B.4
014-05	Support Requirements - Task 205 - Activity B.5

Day 3	
015-01	Functional Requirements - Task 301 - Activity C.1
T0037	FMECA and RCM
015-02	Support Concepts and Systems - Task 302 - Activity C.2
015-03	Evaluation of Alternatives and Trade Offs - Task 303 - Activity C.3

Day 4	
007	Support Engineering During the Demonstration Phase
016-01	Task Analysis - Task 401 - Activity D.1
016-02	Planning the Fielding Process - Task 402 - Activity D.2
017	Op' Suitability Test, Evaluation, V and V - Task 501 - Activity F.1

Day 5	
T0030	Support Engineering During the In-Service Phase
T0027	Support Engineering Activities - Support Resource Risk Management
T0032	Support Engineering Activities - Managing Disposal
T0033	Support Engineering Activities - In-service Supportability
T0036	Support Engineering Activities - Assessing Support Performance
T0031	Support Engineering Activities - In-service Feedback
T0038	The Management of Support Engineering

Logistic Support Analysis

Product

A 5-day practical course in Logistic Support Analysis (LSA) which follows an accelerated process that relates LSA processes to the system life cycle and the Systems Engineering process.

Course Overview

A practical course which teaches the application and management of Logistic Support Analysis (LSA) within a System Engineering context. After a general introduction to Integrated Logistic Support (ILS) and LSA the course follows the LSA process through the system life cycle. In each phase of the life cycle the relevant theories and concepts are introduced and these are then consolidated by the performance of a series of practical exercises. The need for and the concept of a logistics database, is addressed. The nature of a 'formal' Logistic Information Record [LIR] / Logistic Support Analysis Record (LSAR) is introduced early in the course and the results of the exercises will, where applicable, be related to the LSAR/LIR compilation process. Thus the training in the LSAR/LIR is fully integrated into the course and is not presented as a stand-alone topic.

Target Audience

The course is aimed primarily at LSA Practitioners and ILS or LSA Managers who require a basic understanding of the potential, the processes and the problems associated with LSA. The course is also suitable for members of support disciplines which have to interface with an ILS or LSA programme. The course will act as a comprehensive introduction to LSA and form a sound foundation upon which future development can be based.

Process Justification

The course begins by establishing a need for LSA. From this need a logical argument is developed for System Engineering and, that sub-set of Systems Engineering which is LSA. The LSA process is then addressed throughout the system life cycle. At each stage the relevant theory is presented and discussed, this is then consolidated through a series of practical exercises. This approach ensures that the delegate has a sound understanding of the concepts and the issues associated with LSA, for example, the difficulties involved and the size of the task. Because the approach is logical and structured it aids recall and understanding. Because the Standards are related to the theory, the delegates develop the ability to make a critical appraisal of the contents and the requirements of the Standards.

Objectives and Utility

The course introduces the fundamental concepts that are a pre-requisite to a genuine understanding of ILS and LSA and relates the Standards to these concepts in order to facilitate the effective application of the standards. The delegate will understand the LSA process and the LSA tasks as defined by a range of standards, including Defence Standard 00-600, S3000L, and TA-STD 0017 and will gain practical experience of the major analytical techniques used in the LSA process. The delegate will understand the relationship of the logistics database (LIR/LSAR) to the LSA tasks and analytical processes and understand the key management issues as they appertain to LSA, in particular the planning process, the need for an LSA strategy and the requirement to tailor the LSA process. The aim of this course is to present LSA concepts in a simple logical manner and to dispel any misconceptions. The course will enable the organisation to increase their LSA effectiveness. For the Customer the effective application of LSA will result in improved system cost effectiveness, for the Contractor it will result in a quality improvement, to both their products and their service.

Capability

Aspire has strong theoretical knowledge gained over many years study of ILS related topics and through our close relationships with Academia. This is coupled with a great deal of practical experience which has been gained at all levels within ILS organisations; as analysts, ILS and LSA Managers, both within the Contractors and the Customers organisations, on National [UK and other nations] and International programmes. This experience encompasses all three services. Additionally the Course Presenter has first hand experience, and therefore understanding, of the problems faced by the customer. The presenters of this course will always be practicing and experienced ILS Managers. Innovative and effective presentation is an Aspire trade mark and will be used throughout the course.

Course Contents List

Day 1

Day 2

Day 3

Day 4

04	**007**	Support Engineering During the Demonstration Phase
04.01	**016-01**	Task Analysis - Task 401 - Activity D.1
04.02	**016-02**	Planning the Fielding Process - Task 402 - Activity D.2
04.04	**017**	Op' Suitability Test, Evaluation, V and V - Task 501 - Activity F.1

Day 5

05	**T0030**	Support Engineering During the In-Service Phase
05.01	**T0027**	Support Engineering Activities - Support Resource Risk Management
05.02	**T0032**	Support Engineering Activities - Managing Disposal
05.03	**T0033**	Support Engineering Activities - In-service Supportability
05.04	**T0036**	Support Engineering Activities - Assessing Support Performance
05.05	**T0031**	Support Engineering Activities - In-service Feedback
06	**T0038**	The Management of Support Engineering

Module Titl	An Introduction to Support Engineering

Module Code	Issue	Date	Duration	Seq No	Period
T0001	1	08/05/2024	6	01	Day 1

Objectives

TO 1: The aim of this module is to give the Delegates a basic grounding in Support Engineering and to introduce them to various standards, specifications and terminologies that are in play. The Delegates will understand why we need to apply Support Engineering, what it is trying to achieve and how, its relationship to Systems Engineering and the need for Data management systems and processes.

EO 1.1. Understand the magnitude of the support issues associated with many Defence systems today, and hence the need for a structured, systematic Support Engineering methodology.

KLP 1.1.1 Identify and critically examine the underlying problems that affect Defence systems generally, and which determine the need for a Support Engineering discipline.

KLP 1.1.2 Illustrate the magnitude of problem in performance / availability terms (Utilising press articles, NAO and GAO reports etc). Identify and discuss the wide range of issues that affect system availability and through life cost [TLC]. Illustrate the magnitude of the TLCs involved via simple exercise.

KLP 1.1.3 Identify and discuss the root causes of these issues, consider what could be done to address the issues. The aim is to make it clear that addressing these issues is practicable.

KLP 1.1.4 Be able to construct a logical argument that both defines and justifies Support Engineering and Logistic Support Analysis.

KLP 1.1.5 Define what is meant by a Support Solution the nature of the Support Engineering process – via discussion. Differentiate between the Support Engineering 'Product' and the Support Engineering 'Process'.

KLP 1.1.6 To understand, in layman's terms, what Support Engineering and LSA are, and to be able to distinguish between them. Define the rationale for LSA, and hence the aims of and LSA programme.

KLP 1.1.7 The delegates will gain an awareness of the wide range of standards, specifications, terminologies, etc that are in use by the Support Engineering communities.

KLP 1.1.8 Be able to develop and to define a logical management and technical response, a Support Engineering 'methodology', to the Support Issues faced in the Defence sector. This 'methodology' to be founded on the development of a coherent, optimal and integrated solution - the Support Solution, generated via a coherent, optimal and integrated process. The delegates will understand that Support Engineering and LSA are not only practicable, but that they are, by definition, the most rational and cost effective approach that it is possible to implement.

EO 1.2. Understand how "Systems" (Product) and "System Engineering" (Process) ; principles and standards apply to Support Engineering. Understand the role of Systems Engineering in managing the complexity inherent in Support Solutions and in the Support Engineering processes.

EO 1.3. The Delegates will be able to define the ultimate aim of the Support Engineering and LSA processes, i.e. a Support Solution that is optimal within the given constraints. The Support Solution being comprised of the Mission System (Design for Support [DfS]) and the Support System (Design the Support [DtS]) both of which take cognisance of the Employment Plan (where, how, how often, how long, in what environment, exposed to what enemy action - is the Mission System is operated).

EO 1.4. To be aware that the Support Engineering and LSA processes require significant amounts of information and data to created, collected and collated, and hence that there is a need for a structured approach to information and data management.

Overview

This module addresses the basic principles that underpin the ILS / Supportability Engineering and LSA concepts. The aim being to define why we need ILS and LSA, what they are, and in the process, clarifying the differences between them. The Delegates are encouraged to work this out by themselves, by following a logical process of induction and deduction; this process being facilitated by the Instructor.

The Delegates will consider how support impacts operational capability and cost of ownership in the real world. They will discuss what can, and does, go wrong; based on the delegates own experience (if applicable) and on a range of current articles gleaned from the international press. The magnitude of the costs associated with support will be emphasised via a simple instructor led exercise. Thus the delegates define why we need Supportability Engineering.

The delegates will then consider what the fundamental causes of these problems are, causes will be at a high level, for example - 'Poor Design', 'Insufficient Resources', 'Poor Requirements', 'Poor Configuration Control' etc.

The next task will be to discuss how these problems should be addressed, in order to facilitate this discussion the instructor will introduce the idea of a "Support Solution", comprised of:

1. A system/equipment which is supportable, (the Mission System)
2. An optimal support infrastructure (the Support System)
3. Which take cognisance of the nature of operations and the environment in which they take place (the Employment Plan).

These three elements will then be examined to determine those characteristics which impact support. These characteristics comprise the "Limiting Factors", these being the factors that prevent us (limit us) from achieving high Availability and low Through Life Cost, and hence these factor are the subject of Support Engineering/ILS.

This list of factors is extensive and a brief examination will reveal that they tend to be interconnected; they interact with each other (e.g. Reliability and the nature of the Supply Support and repair arrangements for technical spares). This is the basis of the 'I' in ILS, and the instructor will lead a discussion which aims to identify all the types of integration that need to be addressed; six categories of support 'integration' will be identified via this discussion.

This leads to the conclusion that the Support Solution is a complex SYSTEM in its own right (or more accurately, a particular perspective on a larger system, a support Weltanschauung - a support 'Worldview' - to steal a term from 'Soft Systems' practice).

Hence the subsequent conclusion that in order to effectively manage such complexity, we need to apply a systems engineering approach to support. Thus we introduce "Support Engineering" (ILS) as the systems engineering process by which the Support Solution (the "System") should be developed - applying the twin ideas of Systems and Systems Engineering to support. This can also be presented more simply as the need for an unambiguously defined support "Product" and an associated "Process".

The Systems and Systems Engineering discussion includes an introduction to LSA (or Support Analysis [SA] or Product Support Analysis [PSA]); LSA being as a subset of Support Engineering. Three concepts which define LSA are considered namely:

1. The application of engineering and analytical techniques that will facilitate the optimisation of the Support Solution. Hence LSA calls for modelling techniques (trade-offs, optimisation etc), structured analyses, learning from experience, risk and opportunity identification, mitigation and exploitation etc.
2. The application of some simple logic; LSA was designed so as to consolidate a series of disparate processes, stove piped organisations, with a great deal of duplication (and hence divergent outputs) into a coherent approach.
3. To strive for a single set of supporting information, a single version of the truth, to support both the evolving support Products (a Maintenance Plan for example) and the associated Processes (a FMECA for example) - this is where the LSA Database / Logistics Product Data [LPD] / Logistic Support Analysis Record [LSAR] / Integrated Data Environment [IDE] comes into play.

The delegates then consider, albeit at a high level, the need to 'design' both the Mission System and the Support System. A number of key design characteristics are then examined, including for example, Reliability, Maintainabiity, Testability, System Architecture, Spares Optimisation, Maintenance Planning and Level of Repair Analysis [LoRA], etc.

The final section addresses the need to manage support data, during both the development and In-service phases of the system life cycle.

Exercises	
E-010	Identifying the Through Life Issues
E-011	The Reliability - Supportability Paradox
E-012	Identifying the Limiting and Strategic Factors
E-124	TLC Magnitude
E-125	The Cube Law

Module Titl	Systems Engineering and System Life Cycles

Module Code	Issue	Date	Duration	Seq No	Period
T0002	1	04/04/2020		01.01	Day 1

Objectives

EO 1.2. Understand how “Systems” (Product) and “System Engineering” (Process) ; principles and standards apply to Support Engineering. Understand the role of Systems Engineering in managing the complexity inherent in Support Solutions and in the Support Engineering processes.

KLP 1.2.1 The delegates will understand basic Systems and Systems Engineering principles.

KLP 1.2.2 The Delegates will understand the role of Life Cycle Phases and the application of iterative, evolutionary approaches on Systems Engineering, and hence on Support Engineering, programmes.

KLP 1.2.3 The delegates will be aware of the key activities that collectively comprise a Logistic Support Analysis [LSA] programme; and that LSA is a critical element of Systems Engineering and a subset of the Support Engineering process.

Overview

The basic Systems Engineering Concepts developed in the previous module will be expanded on. The key characteristics of a System will be introduced and related to examples in the world of Support Engineering, for example the natures of closed and open systems will be explained and related to deterministic and probabilistic measures respectively; the concept of 'Emergent Properties' will be explained and related to system operational availability and through life cost [TLC].

The concept of formal life cycle phases will be introduced along with a brief history. The process will start with a review of the 'cascade' model, and a discussion of it short comings and why it is not suitable for complex systems, such as the typical defence system. The concept of an iterative, evolutionary, approach will then be introduced, along with the key examples that are relevant to Support Engineering in the Defence Sector, i.e. the UK CADMID cycle, the US DOD Acquisition cycle and the phases as defined in the ASD S-Series and the NATO Standard. We will introduce the "Generic" series of life cycle phases that will be used during elements of this course, (illustrating it's relationship to the standards mentioned above).

The Generic Life Cycle phases being: Concept; System Level Development; Detail Design and Development; Manufacture (and Transition to In-Service); In-Service; Disposal.

A high level overview of the LSA process will be presented, based on a series of activities (derived from ASD S3000L and TA-STD-0017).

This will then be related to the generic System Life Cycle. This introduction will consider which LSA Processes are implemented in each phase of the life cycle and what 'Products' result.
The critical roles of 'Baselines' and 'Feedback' (e.g. DRACAS, FRACAS, SIR-ACAS) in the Systems Engineering process will be discussed. Delegates may discuss the differences between the principles of LSA/SA and what happens in practice and consider how this situation may be addressed. Similarly, the concept of 'Assurance' (as opposed to 'demonstration') and the logic of the 'Support Case will be introduced and discussed.

The Delegates will be asked to consider the need for, and the underlying logic of, some form of database to collect and collate Support Engineering Data and nature of any associated information management requirements. The roles of the LSA Database will be introduced, those roles being:
1. To facilitate the collection and to collation of Process information and data (e.g. FMECA).
2. To facilitate the collection and to collation of evolving Product information and data (e.g. the Maintenance Plan).
3. To facilitate integration - a single source of information, with a logical structure, and hence the removal of duplication, divergence and nugatory effort.
4. To facilitate effective management (via progress monitoring and the provision of a robust audit trail).

A chart will be provided which shows:
1. Each life cycle phase, (and the alternative terminologies used)
2. The Support Engineering - LSA Processes that will be conducted in each phase
3. The Process Deliverables
4. The Product Deliverables
5. The evolving Support Case and its relationship to the Process Deliverables
6. The evolving LSA Database

Module Titl	Designing a Support Solution

Module Code	Issue	Date	Duration	Seq No	Period
T0005	1	08/04/2020		01.02	Day 1

Objectives

EO 1.3. The Delegates will be able to define the ultimate aim of the Support Engineering and LSA processes, i.e. a Support Solution that is optimal within the given constraints. The Support Solution being comprised of the Mission System (Design for Support [DfS]) and the Support System (Design the Support [DtS]) both of which take cognisance of the Employment Plan (where, how, how often, how long, in what environment, exposed to what enemy action - is the Mission System is operated).

KLP 1.3.1 The Delegates will be introduced to the basic design concepts that need to be applied in order to develop a supportable Mission System, and an optimal Support System. Key elements of the concept of the Total System, the Mission System, the Support System, and the Employment plan are discussed from a 'design' perspective.

KLP 1.3.2 The Delegates will be introduced to example Support Metrics, used to quantify the Mission System, such as reliability, maintainability, testability and logistic supportability and be aware of the statistical/probabilistic nature of many support measures and the potential for misinterpretation of such metrics.

KLP 1.3.3 Similarly, the Delegates will be introduced to the basic supportability measures used to quantify Support System performance, such as Turn Around Time [TAT] for repairable items. This will be related to the Employment Plan and the Lines of Communication [LoC]; the potential impact of enemy action on the LoC and hence on TAT and hence the level of resource required to attain a given level of availability.

KLP 1.3.4 Supportability measures used to quantify the 'Total System' performance such as Availability will be discussed.

Overview

The aim of this module is to acquaint the Delegate with the ultimate aim of any analysis that is carried out, namely to institute some form of action, in the in the shape of an impact on the Mission System or Support System design or in the manner in which the system is operated, i.e. the Employment Plan. If the delegate understands this, there is a better chance that they will avoid 'paralysis by analysis'.

The concept of the Total System, and its elements - the Mission System, the Support System and the Employment Plan - is reviewed. The concept of the Support Solution and the support characteristics related to each is reviewed. (For example: Reliability, System Architecture, Standardisation, for the Mission System; Turn-Around-Time [TAT], Level of Repair, Spares Holdings, for the Support System; Mission Duration, Length of the Lines of Communication, Physical Environment, for the Employment Plan).

All the main elements of the Support Solution are addressed, hence this addresses both "Design for Support" and "Design the Support" aspects of the LSA process. The module will provide the delegate with an understanding, albeit at a high level, of how the design of each element of the Support Solution and can be designed so as to improve supportability.

This design activity is the responsibility of the various Support Engineering / ILS disciplines, hence this module indicates how each discipline can contribute to improving operational capability and reducing through life cost [TLC].

Each element/discipline is explored, in layman's terms, and the basic supportability measures are introduced and their (probabilistic) nature explained (and the implications of that nature).

Where applicable, the Delegates are introduced to the appropriate standards.

Module Titl	An Introduction to Support Metrics

Module Code	Issue	Date	Duration	Seq No	Period
T0035	1	03/05/2007	1	01.02.01	Day 1

Objectives

The delegate will: Gain an appreciation of the range of support metrics that are used on the typical Support Engineering programme Understand the nature these metrics, i.e. that they are typically based on statistical or probabilistic measures (and they do not therefore behave in an 'intuitive' manner). An understanding of the associated, basic, terminology.

Overview

This module is presented in a "popular science" style, it avoids an overly mathematical approach.   The delegates are introduced to some basic probability theory and this is then applied to key aspects of support engineering. These include: Reliability: constant failure rate and Mean Time Between Failure [MTBF] are explored Maintainability: (MTTR, MTTR (max)) Spares optimisation: the principles underpinning simple spreadsheet spares models or more sophisticated tools such as Vmetric and Opus are explained.   The delegate will be introduced to basic concepts and terminology, such as a Probability Distribution Function [PDF] and Cumulative Distribution Function [CDF], Mean, Mode and Median, via the use of a series of simple exercises.   The delegate will be introduced to the more commonly used Availability measures.   The shortcomings of the commonly used metrics will be exposed and explained.

Exercises	
E-127	Introducing MTBF, Failure Rate and the Exponential Distribution

Module Titl	Managing Support Data

Module Code	Issue	Date	Duration	Seq No	Period
T0004	1	04/04/2020		01.03	Day 1

Objectives

EO 1.4. To be aware that the Support Engineering and LSA processes require significant amounts of information and data to created, collected and collated, and hence that there is a need for a structured approach to information and data management.

KLP 1.4.1 Understand that the purpose of this data is to define the Support Engineering processes and the outputs of those processes; outputs which can be categorised as either "Process Deliverables" or "Product Deliverables".

KLP 1.4.2 Be aware of the disparate standards that are available that define alternative Data Models to facilitate Support Engineering.

KLP 1.4.3 Understand the concept of an "Integrated Data Environment [IDE].

Overview

The Delegate will develop, via logical argument, the basic concept of an LSA Database, i.e. The idea of a 'core' System Breakdown Structure [SBS] to which a wide range of information and data can be 'hung' (related). With much of this information being stored in 'Libraries' such as a library of Skills and a library of Part Numbers, etc.

The concept will be illustrated by the Instructor who will build a diagram of the LSA Database, in stages, to complement the discussion. This diagram will then evolve during the remainder of the course.

The instructor will Introduce the basic fundamentals of the data structure, UML, entities, relationships, etc., but this will be presented using layman's language and simplified diagrams.

The instructor will initiate a discussion of the key issues associated with such systems, for example, the need to manage different marks of the same system, or alternative versions of a single equipment etc, and the challenges that this poses. This section will be based on ASD S3000L chapter 4 - "Configuration Management" (point out that it address CM only in the context of the LSA Database however). The concepts of Physical and Functional breakdowns and 'Candidate Items' will be introduced at this time. The many misconceptions that are associated with these topics will be addressed.

NB: These topics will only be addressed at a fairly high level, more detail will be presented as individual LSA activities are introduced.

Module Titl	Support Engineering during the Concept Phase

Module Code	Issue	Date	Duration	Seq No	Period
004	A	04/02/2019	1	02	Day 2

Objectives

The Delegate will:
1. Be able to explain the need for, and the process of, LSA during the Concept Formulation / Pre Concept phase.
2. Be able to relate this need and this process to the relevant LSA tasks.
3. Understand the need for an LSA strategy and the factors that need to be considered when developing a strategy.

Overview

The objectives of the Concept Formulation / Pre-Concept Phase are defined and related to the LSA process. The roles of the Use Study and Comparative analysis are examined. The requirement for and the nature of the LSA Strategy is discussed.

Exercises	
E-003	Baseline Comparison System - Fuel System

Module Titl	The Use Study - Task 201 - Activity B.1

Module Code	Issue	Date	Duration	Seq No	Period
014-01	1	30/10/2020		02.01	Day 2

Objectives

1. To give a brief description and the purpose of LSA task 201, as defined by Def-Stan 00-60 and as called up by Def Stan 00-600. To explain the basic approach taken to Task 201 in an accessible manner. The explanation will help the delegate to interpret the difficult language of the standards.

Overview

This module gives a comprehensive overview of LSA task 201 as defined by Def. Stan. 00-60.

Module Titl	Baselining the Mission System Task 203 - Activity B.3

Module Code	Issue	Date	Duration	Seq No	Period
014-03	1	30/10/2020		02.02	Day 2

Objectives

1. To give a brief description and the purpose of LSA task 203 as defined by Def-Stan 00-60 and as called up by Def Stan 00-600. To explain the basic approach taken to Task 203 in an accessible manner. The explanation will help the delegate to interpret the difficult language of the standards.

Overview

This module gives a comprehensive overview of LSA task 203 as defined by Def. Stan. 00-60.

Module Titl	Support Engineering During the Assessment Phase

Module Code	Issue	Date	Duration	Seq No	Period
005	3	06/05/2009	5	03	Day 2

Objectives

The Delegate will: 1
. Be able to explain how the LSA process is used to develop Supportability Requirements for inclusion in requirements documentation and contracts.
2. Be able to explain that the LSA process is used to evaluate alternative "Total System" design solutions.
3. Be able to relate these processes to the relevant LSA tasks.
4. Understand the purpose of the individual LSA tasks, and [at a high level] how to perform those each task.
5. Be able to relate the results of the LSA tasks to the relevant sections of the LSAR.
6. Be able to demonstrate the process of translating an LSA strategy into an effective LSAP. Understand how to develop the support requirements using Comparative Analysis and allocation techniques whilst taking into account management and technical constraints.
7. Understand and be able to implement [simple] techniques that are used to predict the Support Characteristics of a system level design concept whilst having an appreciation of the limitations and risks associated with these techniques.
8. Understand and be able to conduct simple system optimisation tasks and trade off's. The Delegate will be able to relate this process to the LSA tasks.
9. Appreciate the management tasks that are required to ensure that the LSA programme is cost effective, this includes an understanding of the requirement for and the nature of LSA reviews.

Overview

This module concentrates on the processes of developing a set of supportability requirements and then developing a design for the total systems that meets these requirements. The roles of the Use Study and the Baseline Comparison System in the process are discussed in depth. The objectives of the Feasibility / Concept Exploration Phase are defined. The requirement to consider standardisation approaches and the potential Supportability benefits that may accrue through the use of new and emerging technologies are explained. The structure and content of a typical Use Study is presented in outline. The delegate is shown when and where there is a relationship between the outputs of these process and the data in the LSAR. The process of developing an LSA strategy into an effective plan is explained. The following LSA techniques are introduced during this lesson and, where necessary, expanded upon in other modules: Reliability Prediction. Maintainability Prediction. FMECA. Fault Tree Analysis (FTA). Reliability Block Diagrams (RBDs). Reliability Cantered Maintenance (RCM). Level of Repair Analysis (LoRA). LSA Candidate Selection. High Level Task Analysis. The Trade Off and Optimisation Process.

Exercises	
E-004	Setting "Design To" Targets - Allocation
E-006	FMECA Exercise - Fuel System
E-007	RCM Analysis - A simple overview
E-008	Modelling Exercises

Module Titl	Standardisation - Task 202 - Activity B.2

Module Code	Issue	Date	Duration	Seq No	Period
014-02	1	30/10/2020		03.01	Day 2

Objectives

1. To give a brief description and the purpose of LSA task 202, as defined by Def-Stan 00-60 and as called up by Def Stan 00-600. To explain the basic approach taken to Task 202 in an accessible manner. The explanation will help the delegate to interpret the difficult language of the standards.

Overview

This module gives a comprehensive overview of LSA task 202 as defined by Def. Stan. 00-60.

Module Titl	Exploiting New Technology - Task 204 - Activity B.4

Module Code	Issue	Date	Duration	Seq No	Period
014-04	1	30/10/2020		03.02	Day 2

Objectives

1. To give a brief description and the purpose of LSA task 204, as defined by Def-Stan 00-60 and as called up by Def Stan 00-600. To explain the basic approach taken to Task 204 in an accessible manner. The explanation will help the delegate to interpret the difficult language of the standards.

Overview

This module gives a comprehensive overview of LSA task 204 as defined by Def. Stan. 00-60.

Module Titl	Support Requirements - Task 205 - Activity B.5

Module Code	Issue	Date	Duration	Seq No	Period
014-05	1	30/10/2020		03.03	Day 2

Objectives

1. To give a brief description and the purpose of LSA task 205, as defined by Def-Stan 00-60 and as called up by Def Stan 00-600. To explain the basic approach taken to Task 205 in an accessible manner. The explanation will help the delegate to interpret the difficult language of the standards.

Overview

This module gives a comprehensive overview of LSA task 205 as defined by Def. Stan. 00-60.

Module Titl	Functional Requirements - Task 301 - Activity C.1

Module Code	Issue	Date	Duration	Seq No	Period
015-01	1	30/10/2020	3	03.04	Day 3

Objectives

1. To give a brief description and the purpose of LSA task 301, as defined by Def-Stan 00-60 and as called up by Def Stan 00-600. To explain the basic approach taken to Task 301 in an accessible manner. The explanation will help the delegate to interpret the difficult language of the standards.

Overview

This module gives a comprehensive overview of LSA task 301 as defined by Def. Stan. 00-60.

Module Titl	FMECA and RCM

Module Code	Issue	Date	Duration	Seq No	Period
T0037	**1**	**07/05/2024**	**3**	**03.04.01**	**Day 3**

Objectives

The delegate will:
1. Understand the reasons for and the procedures required for the completion of a Failure Modes, Effects and Criticality Analysis (FMECA).
2. Be able to understand the difference between Failure Modes and Effects Analysis (FMEA) and Criticality Analysis (CA) and the benefits of each individually.
3. Be able to identify the elements of a FMEA and CA and demonstrate how the results can be entered onto a criticality matrix and the benefits of such a matrix.
4. Be able to understand the reason for FMECA within an LSA scenario.

5. To enable the delegate to identify the full range of preventive maintenance activities and understand the criteria for establishing the frequencies of these activities.
6 To introduce the topics associated with initial application of RCM and necessary follow-on actions
7. To enable the delegate to understand why RCM is an integral part of the LSA process and what it can achieve during each life cycle.
8. To identify where this analysis information is documented in the LSAR.

Overview

In order for the Analyst to fully appreciate the reason for and the requirements of a Failure Modes and Effects Analysis (FMEA) and Criticality Analysis (CA) it is necessary to fully understand the principles behind these techniques.
The process of carrying out a FMECA can be split into two distinct operations, i.e., compiling a FMEA and then attaching a CA to these results.
When combined they form what is commonly known as a FMECA.
This module identifies the details of an FMECA in relation to the nature of failures, introduces a structured method of data recording and shows the delegate how to interpret this information once collected. After all, information is of little use if it is ignored or misinterpreted.
Once relevant information has been documented and assessed it may be necessary to grade this in order to focus the analysis in areas of greatest need, a Criticality Matrix can be used for this task. This module introduces this Matrix and shows how it can be used to priorities the analysis process.

Reliability Centred Maintenance (RCM) is a much misunderstood topic. It is a title which is often misapplied to any process that results in a maintenance schedule. Additionally RCM is considered by many to be a simple "box filling" exercise, yes / no answers, and a hindrance to more important things. This course will dispel these and other misunderstandings. The module develops the argument for RCM and the benefits and strengths of the technique become very apparent. This module explains the aims of RCM, i.e. to improve Safety, operating performance, operational availability and cost effectiveness and achieve the inherent Reliability imbedded within an equipment. The manner in which this achieved and how this differs from past approaches is addressed. The role of RCM as an integral part of Logistic Support Analysis (LSA) is discussed.

Module Titl	Support Concepts and Systems - Task 302 - Activity C.2

Module Code	Issue	Date	Duration	Seq No	Period
015-02	1	30/10/2020	3	03.05	Day 3

Objectives

1. To give a brief description and the purpose of LSA task 302, as defined by Def-Stan 00-60 and as called up by Def Stan 00-600. To explain the basic approach taken to Task 302 in an accessible manner. The explanation will help the delegate to interpret the difficult language of the standards.

Overview

This module gives a comprehensive overview of LSA task 302 as defined by Def. Stan. 00-60.

Module Titl	Evaluation of Alternatives and Trade Offs - Task 303 - Acti vity G.3

Module Code	Issue	Date	Duration	Seq No	Period
015-03	1	30/10/2020	3	03.06	Day 3

Objectives

1. To give a brief description and the purpose of LSA task 303, as defined by Def-Stan 00-60 and as called up by Def Stan 00-600. To explain the basic approach taken to Task 303 in an accessible manner. The explanation will help the delegate to interpret the difficult language of the standards.

Overview

The module describes each of the tasks which make up the 300 Series. Each tasks is described in detail and related to the Systems Engineering Process.

Module Titl	Support Engineering During the Demonstration Phase

Module Code	Issue	Date	Duration	Seq No	Period
007	2	16/02/2016	4	04	Day 4

Objectives

The Delegate will:
1. Understand the underlying principles of the LSA approach to the process of identifying Logistic Support Resources.
2. Be able to define the Task Analysis process and show how it relates to the LSAR and how it initiates the generation of many of the support deliverables and products.
3. Be able to outline the processes that must occur after Task Analysis in order to translate the results into the final support deliverables or products.
4. Have an appreciation of the management tasks that complement the identification of the Logistic Support Resources, for example the development of a Post Production Support Risk Management Plan.

Overview

This module concentrates upon the Support Resource Identification aspects of the LSA process. The Objectives of the Full Development / Engineering and Manufacturing Development Phase are defined. The techniques that are introduced or expanded upon in this module are: Detailed Task Analysis. The LSAR reports and their relationship to Support "Deliverables" and DIDs. Spares Modelling techniques. Testing Supportability. The Early Fielding Analysis Task. The Post Production Support Risk Analysis Plan.

Exercises	
E-009	Task Analysis

Module Titl	Task Analysis - Task 401 - Activity D.1

Module Code	Issue	Date	Duration	Seq No	Period
016-01	2	03/05/2007	2	04.01	Day 4

Objectives

To describe the need for and to outline an approach for managing the manpower intensive Task Analysis process, and to relate that process to the population of a logistic database.

Overview

The module outlines activities that are required in order to conduct Task Analysis. It addresses the LSA task as it is defined in a range of LSA standards.

Module Titl	Planning the Fielding Process - Task 402 - Activity D.2

Module Code	Issue	Date	Duration	Seq No	Period
016-02	2	03/05/2007	0.5	04.02	Day 4

Objectives

To describe the need for and to outline an approach for managing the support aspects of the fielding process.

Overview

The module outlines activities that are required in order to produce a Fielding Plan. It addresses the LSA task - Early Fielding Analysis / Early Distristribution Analysis as it is defined in the LSA standards.

Module Titl	Op' Suitability Test, Evaluation, V and V - Task 501 - Activity 5.1

Module Code	Issue	Date	Duration	Seq No	Period
017	2	19/05/2020	1	04.04	Day 4

Objectives

To describe the purpose and general approaches to address the Operational Suitability Test, Evaluation, Verification, and Validation task / activity as defined in the various Defence Standards.

Overview

The module describes the sOperational Suitability Test, Evaluation, Verification, and Validation process. It addresses two main elements, the first dealing with assessing compliance during the acquisition phase and the second with assessing compliance during the in-service phase. Each of these elements is described and related to the Systems Engineering Process.

Module Titl	Support Engineering During the In-Service Phase

Module Code	Issue	Date	Duration	Seq No	Period
T0030	1	04/04/2020		05	Day 5

Objectives

TO 1: Understand the need to implement effective Support Engineering during the In-Service phase of the System Life Cycle in order to maintain and adapt the Support Solution, as required.

EO 1.1. Recognise that there are many events and issues that will trigger a need to apply Support Engineering during the In-service phase.

KLP 1.1.1 Any improved understanding as more, and better, data becomes available.

KLP 1.1.2 Any changes to any element of the Total System, i.e. the Mission System, Support System or Employment Plan, for whatever reason.

EO 1.2. Understand the need to prepare strategies and plans, using the available standards and guides, to manage any risks that impact the availability of Support Resources during the In-service phase of the System Lifecycle.

EO 1.3. Understand the need to identify and manage the disposal of components and materials, which may be elements of either the Mission System or the Support System, that will require special disposal considerations. This will require the analysis of extant disposal procedures and the development of new end-of-life disposal procedures when necessary.

EO 1.4. Understand the need to establish and to maintain an on-going Support Engineering process during the In-Service Phase of a system's lifecycle.

EO 1.5. Understand the need to continuously evaluate the performance of the Support Solution by designing and deploying a structured 'Performance Measurement Framework'.

EO 1.6. Understand the need for developing plans and effective processes for collecting and analysing comprehensive field feedback data.

EO 1.7. Understand the need for establishing and maintaining an In-service Integrated Data Environment [IDE].

KLP 1.7.1 Recognise the interconnectedness of the system, that a change in one element of a system can require a change in another, apparently un-connected element.

KLP 1.7.2 Recognise that a single database cannot address all the data and information needs associated with a Supportability Engineering programme or the provision of In-service Support.

KLP 1.7.3 Be aware of the many applications that have a role in Support Engineering and in the provision of In-service Support.

Overview

This module is presented in parallel with an on-going Instructor Lead exercise. This module is comprised of this "Master" module supported by five "Sub-modules".

The module commences with a general introduction after which the delegates, working in groups of two to four and led by the instructor, are asked to list reasons why Support Engineering should be implemented during the in-service Phase of the system lifecycle. The results of this exercise are then collated and recorded on flip charts befoe the instructor, using the presentation deck, reviews the findings and addresses any gaps.

This approach is then repeated as the delegates address each of the key Support Engineering activities that will be conducted during the In-service Phase, these are:

1. Managing support resources through life - this includes obsolescence management and counterfeit prevention.
2. Planning the disposal of platform, components and materials.
3. In-service Supportability - maintaining an analysis capability through life - including the need to support specific operations - i.e. the need to conduct analyses, and to plan for, the support that will be required to support training, peacekeeping and combat operations.
4. Monitoring the perfomance of the Support Solution.
5. Implementing and utillising feedback systems.
6. The Integrated Data Environment [IDE] during the In-service Phase.

The structure of this moduel is based on activities defined SAE standard "*TA-STD-0017A - Product Support Analysis*" but other standards and specifications are referenced as appropriate.

ASPIRE CONSULTING LIMITED

Module Titl	Support Engineering Activities - Support Resource Risk M anagement

Module Code	Issue	Date	Duration	Seq No	Period
T0027	1	04/04/2020		05.01	Day 5

Objectives

TO 1: Be able to identify, define, plan and implement management strategies for managing and mitigating any risks that may impact the availability of Support Resources during the In-service Phase of the system life cycle.

EO 1.1. Understand that issues will arise continuously, hence the need to prepare strategies and plans, using the available standards and guides, for the on-going management of parts and materials during the In-service phase of the System Lifecycle.

KLP 1.1.1 That "you cannot 'solve' complex systems, you can only dance with them..."

EO 1.2. Be able to apply a structured approach to the identification of potential risks.

KLP 1.2.1 The approach – a) What can wrong, b) what will the impact be? c) What is the probability of this occurring?

KLP 1.2.2 To identify and respond proactively to Obsolescence issues.

KLP 1.2.3 To identify and respond proactively to Counterfeiting issues.

KLP 1.2.4 To identify and respond proactively to Diminishing Manufacturing Sources and Material Shortages [DMSMS] issues.

KLP 1.2.5 To identify and respond proactively to constraints or shortages of any other Support Resource, e.g. Manpower.

EO 1.3. Be able to develop and implement appropriate risk mitigation strategies.

KLP 1.3.1 Produce a risk management plan which will be maintained for the life of the system.

KLP 1.3.2 Produce a Counterfeit Prevention Plan.

Overview

This module is a Sub-module of the T-0030 Support Engineering During the In-Service Phase Master module.

This module takes a risk management apporach to managing support resources during the In-service Phase. The module encourages the delegates to consider all forms of Support Resource, e.g. to consider manpower, facilities, up to date publications etc as well as spares and consumables.

The Delegates will be asked to address this issue by applying the basic principles of risk management, to evaluate the Support Solution; to consider what can prevent the right resources, in the right quantities, and of the necessary quality, being in he right place, at the right time. i.e:

1. Identify potential risks.
2. Define the impact if the risk is realised - in financial, operational, support and legislative terms terms.
3. Determine/estimate the probability of the risk being realised.
4. Identify appropriate risk mitigation strategies.
5. Plan accordingly.
6. Implement the plan.
7. Update the plan as required.

Many of the risks can be identified via the application of a little imagination and common sense; but the Delegates are less likely to identify counterfeit parts as a risk unless they are aware of issue. Most individuals are probably not aware of all the form that counterfeit parts can take nor will they be aware of the magnitude of the issue.

The Delegates will be presented with real world examples of counterfeiting and they will be asked to consider what the potential impact of using uch counterfeit parts is, and what can be done to mitigate the this risk.

The Delegates will be introduced to the relevant elements of the appropriate standards, for example: "*SD-22 Diminishing Manufacturing Sources and Material Shortages – A Guidebook of Best Practices for Implementing a Robust DMSMS Management Program* and "*DEF STAN 05-135 - Avoidance of Counterfeit Material*".

Module Titl	Support Engineering Activities - Managing Disposal

Module Code	Issue	Date	Duration	Seq No	Period
T0032	1	09/04/2020		05.02	Day 5

Objectives

TO 1: To understand why Support Engineering disposal activities are required and the nature of the Disposal Management process and to be able to implement that process.

EO 1.1. To understand the factors that drive the need for a controlled disposal process.

KLP 1.1.1 Disposal can include, re-use, recycling parts, recycling materials, send to landfill, etc.

KLP 1.1.2 Applies to platforms, equipment, assemblies sub-assemblies, components and consumables.

EO 1.2. Understand the need to influence Design so as to facilitate effect disposal processes (e.g. recycling).

KLP 1.2.1 Start during the Concept Phase – Disposal Strategy – identify applicable regulations, monitor REACh substances, define disposal management processes (e.g. identifying and tracking hazardous substances), estimate the impact of disposal in terms of costs, resources etc.

KLP 1.2.2 Design the system so as to minimise the disposal issues, - avoid hazardous substances, consider need to able to breakdown the product so that the elements to be recovered or managed can be readily extracted.

EO 1.3. Understand the basic Disposal Analysis method.

KLP 1.3.1 Review each component, assembly, sub-assembly etc and identify those that qualify for some form of formal disposal procedure, gather data, such as data sheets, etc – Classify - Define the appropriate procedure - Record the results, etc (the IDE should address this need).

KLP 1.3.2 Provide feedback, (LI's / Lessons Learnt).

EO 1.4. Consider the 'Tasks' required in order to enable a system to be disposed of (dismantling procedure, tools required etc). Estimate the associated costs (including potential revenues).

KLP 1.4.1 This is related to the success of the design influence.

Overview

This module is a Sub-module of the T-0030 Support Engineering During the In-Service Phase Master module.

This is a short module which addresses planning for, and management of, the disposal of a platform, its components and materials. The disposal of platforms occurs at the at the end of the system's useful life, but the disposal of components and materials may occur at any time in the system lifecycle.

The Delegates will identify the factors that lead to the need for a controlled disposal process, including for example:

1. Any materials that could be pollutants or hazardous to health.
2. Equipment or materials that may be salvaged and recycled. (Including the platform per se in some instances).
3. The recovery of precious metals (from electronics for example).
4. Security issues
5. Etc…

The Delegates will then consider the level at which this may be applied. i.e. to:

1. Platforms
2. Equipment
3. Consumables
4. Etc.

… and how the design of a system may be influenced so as to facilitate an efficient Disposal process, e.g. By:

1. Avoiding the use of hazardous substances - REACH regulations will be introduced here.
2. Design the system so that it is easy to breakdown and to extract and to separate different materials.

The Delegates will be introduced to a simple "Disposal Analysis" approach at this juncture, i.e. review 'components', gather data, classify, define disposal procedures, record etc.

At the platform and equipment level it may be necessary to identify and to define disposal 'Tasks', e.g. Tasks associated with dismantling platforms and their subsystems and then readying these for disposal. The Delegates will discuss the relationship of this approach to the Task Analysis activity discussed earlier in the course.

The Delegates will be introduced to the relevant elements of the appropriate standards.

Module Titl	Support Engineering Activities - In-service Supportability

Module Code	Issue	Date	Duration	Seq No	Period
T0033	1	26/02/2024		05.03	Day 5

Objectives

TO 1: Understand the need to establish and to maintain an on-going Support Engineering process during the In-Service Phase of a system's lifecycle.

EO 1.1. The delegate will be able to define the main reasons why an on-going Supportability Analysis capability is required during the In-service Phase of a system's lifecycle.

KLP 1.1.1 Facilitating the management of Support Resource Risks and supporting Disposal Analysis.

KLP 1.1.2 Facilitate the effective management of any changes to the Mission and Support Systems and the Employment Plan.

KLP 1.1.3 Facilitate the effective management of any changes to policy or relevant regulations.

EO 1.2. Understand the need to deploy Support Engineering techniques when planning support operations.

KLP 1.2.1 Optimising the support solution for specific operations increases the chance of success.

KLP 1.2.2 Deploying support models will facilitate more effective operational analyses [OA].

Overview

This module is a Sub-module of the T-0030 Support Engineering During the In-Service Phase Master module.

The events, issues and risks etc addressed by previous Sub-modules provide part of the justification for maintaining a Support Engineeing Analysis capability throughout the In-service Phase, but there are other activities and issues etc that contribute to this requirement.

This module addresses both generic (e.g. any changes to the design of any element of the Total System) and specific (e.g. a mid life update programme) 'triggers' that lead to a requirement to conduct Support Engineering Analyses.

The role of Support Engineering Analyses, and of the associated Support Engineeing Database, (LSAR, LIR, IDE, IPD etc), in ensuring that all the impacts of any change are understood and addressed is examined, using a change to maintenance task as an example for discussion.

The need to deploy Support Engineering Analyses in support of Operational Planning, i.e. as an adjunct to Operational Analysis [OA] is addressed in some depth using an actual programme (albeit sanitised) to provide context to the discussions.

Module Titl	Support Engineering Activities - Assessing Support Perfor mance

Module Code	Issue	Date	Duration	Seq No	Period
T0036	1	05/03/2024		05.04	Day 5

Objectives

TO 1: Understand the need to continuously evaluate the performance of the Support Solution by designing and deploying a structured 'Performance Measurement Framework'. This framework enables the measurement, collection, and analysis of relevant Support Performance Data in order to identify the need for changes that will enhance System readiness and affordability.

EO 1.1. Understand the need to establish target (technical support requirements), predicted, contracted etc Support Performance Parameters.

- KLP 1.1.1 This activity should take place during the development phase of the life cycle.
- KLP 1.1.2 Note that we need to define how we intend to demonstrate whether the support targets that we have set have been met or otherwise – ref the KLP addressing the capability of extant information systems below.

EO 1.2. Understand the need to establish mechanisms for ascertaining 'actual' performance during the In-service phase and to determine if our system is meeting the targets defined above.

- KLP 1.2.1 Note the requirements or predicted performance parameters will have been used in Support Engineering analyses and modelling activities, hence determining 'actual' performance is essential if an optimal, or even adequate, Support Solution is to be sustained.
- KLP 1.2.2 We need to know if current systems are performing better or worse than previous systems?
- KLP 1.2.3 Understand that in the early days of a development programme we had limited data on the new system, support data being, in the main, statistical (stochastic). We will therefore not precisely how the system performs until the system has been in service for a period of time. Understand the relationship of this Activity to the conduct of Age Exploration in support of the RCM/SMA programme.
- KLP 1.2.4 Appreciate the limitations of extant information systems and the potential need to deploy new systems to collect the necessary data and information and the time and cost implications of this approach – note the relationship of this activity to the In-service Feedback activity.

EO 1.3. Understand the relationship of this task to the general management of support during the In-service phase and to the management of support contracts in particular.

Overview

This module is a Sub-module of the T-0030 Support Engineering During the In-Service Phase Master module.

This module requires the Delegates to discuss the rationale behind maintaining an on-going assessment of how well the deployed Support Solution is performing.

Following an intiial discussion to address this question, the Delegates are then required to consider how this will be achieved in practice. The delegates will consider what, and how, performance measures were set during the development phases of the system lifecycle. The argument that when any Support Requirement is set, the manner in which the achievement of that target, or the failure to achieve that target, will be determined also has to be established.

The Delegates will consider the limitations that are inevitably imposed by the capabilities of extant information systems, policies and procedures and how they will respond to any shortfalls in such capabilities.

This activity has a role to play in Support Contracts, for example such contracts may require a service provider to take part in, to contribute to this activity, or, this activity may be part of a strategy for assessing th eperformance of a support contractor. The implications of this will be discussed with the Delegates.

Module Titl	Support Engineering Activities - In-service Feedback

Module Code	Issue	Date	Duration	Seq No	Period
T0031	1	09/04/2020	6	05.05	Day 5

Objectives

TO 1: Understand why feedback data and information is required from the In-service phase and the uses to which it may be put.

EO 1.1. Understand the use of field feedback data.

- KLP 1.1.1 To verify performance meets the requirements.
- KLP 1.1.2 To identify trends – e.g. a component trending to failure.
- KLP 1.1.3 To understand failure dynamics (e.g. determining the P-F interval).
- KLP 1.1.4 To instigate corrective actions.
- KLP 1.1.5 To drive a continuous improvement programme; the aim is to continuously 'test and adjust' the system and its support, to maintain a Support System that is as near 'optimal' as is practicable.
- KLP 1.1.6 To prepare baseline systems for future procurement programmes.
- KLP 1.1.7 To collect 'sample' data so that we can refine statistical support measures, (e.g. MTBF, MTTR, etc).

EO 1.2. Be able to identify the parameters to be monitored.

- KLP 1.2.1 Design requirements, contractual requirements for the Mission System design (e.g. failure data, maintenance data, etc) and for support performance (e.g. TAT).

EO 1.3. Understand the need to review the extant arrangements for collecting and collating and sentencing field data.

- KLP 1.3.1 What systems are available? Stores systems, fault reports, MMS, etc.
- KLP 1.3.2 What data do they provide, what is the quality of this data (accuracy, completeness, volume (statistical accuracy) etc).

EO 1.4. Will this data meet the need? If not what is to be done?

Overview

This module is a sub-module of the T-0030 Support Engineering During the In-Service Phase master module.

The Delegates will be asked to consider and to attempt to define the reasons for and the nature of the feedback that will be required during the In Service Phase. The necessity for feedback will have been addressed in previous modules, it being a key characteristic of the Systems Engineering concept. The need for a "Closed Loop" system will be reiterated.

The high level "reasons for" will include:
1. To verify performance meets requirements
2. To instigate corrective actions
3. To drive a continuous improvement programme
4. etc.

The "nature" of the feedback will include:

1. Reliability metrics.
2. Maintainability metrics.
3. System Operational Availability achieved.
4. Supply Support - Availability of spares, consumable, consumption rates etc.
5. Health and Usage Monitoring [HUMS] data.
6. etc

The S5000F Specification and the associated 'Use Cases' will be introduced. The Reliability, Availability, Maintainability and Testability Use Case (S5000F) will be examined in detail, as an exemplar of the overall concept (and the most likely to be implemented).

The relationship to extant systems, such as Failure Reporting Analysis and Corrective Action System [FRACAS], Data Reporting Analysis and Corrective Action System [DRACAS], will be briefly explored.

The aim being to build a coherent picture of the possible feedback loops that could be established, and what they would be used for and how.

The relationship to the Support Case will also be discussed with the Delegates and

The concept of an In Service Feedback Database will be raised, and the associated need to consider the potential data sources, e.g. Computerised Maintenance Management Systems, Supply Support systems, systems for recording operational activities, and their success or failure etc. This will lead to a discussion of the need to include the required feedback systems and any Continues Quality Improvement [CQI] or 'Kaizen' systems into the 'design' of the Support System, and to stress the relationship with any associated Performance Indicators [PIs] and Key Performance Indicators [KPIs].

There are, inevitably, also planning and contractual management aspects of any effective feedback system which need to be addressed. These will be considered and discussed by the delegates.

The Delegates will be introduced to the relevant elements of the appropriate standards.

Module Titl	The Management of Support Engineering

Module Code	Issue	Date	Duration	Seq No	Period
T0038	1	07/05/2024	2	06	Day 5

Objectives

The Delegate will:
1. Understand the relationships between the ILS Plans, in particular those between the ISP and the ILSP.
2. Be aware of the content and purpose of the ILSP, the ISP and the LSAP.
3. Understand the need for and the content of a support data management plan.
4. Understand the relationships between the Support EngineeringProcedures and the LSAP and identify the type and nature of the procedures that will be required.
5. Understand the LSA planning process and the importance programme tailoring and task focusing.
6. Be able to identify those factors that influence the Support Engineeringstrategy and which must be addressed during the planning process.
7. Be capable of defining the types of Support Engineeringreview and their purposes.
8. Identify the issues that must be addressed on each type of review.

Overview

The basic management issues are explored in this module. The purpose and content of the major ILS and Support Engineeringplans are discussed and typical outline plans examined. The importance of the strategic approach to Support Engineering is emphasised. The control of an LSA programme through the effective use of the Support Engineeringreview is discussed.

Exercises

Code	Title	Issue	Date	Duration	Stvle
E-003	**Baseline Comparison System - Fuel System**	**2**	**18/04/2006**	**60**	**Formal Exercise**

Objectives

The aim is for the delegates to understand the manner in which a Baseline Comparison System [BCS] should be used and the benefits, limitations and risks inherent in such an approach.

The delegates will also gain a little practical experience which will give them confidence that the approach is both practical and cost effective.

Approach

Initiated as a simple paper work exercise and concluded on the PC; carried out in a syndicate.

The instructor takes on the roles of both the Chief Designer and the experienced old maintainer of the system that was a precursor to the Aspire System.

Review the concept of the Baseline Comparison System [BCS], the delegates must understand that the aim is to develop specific, meaningful, achievable, and justifiable support requirements. (i.e. SMART requirements - Specific, Measurable, Assignable, Relevant, and Time-Bound - but note that there are alternative versions of the mnemonic). This should be compared with problems that ensue if requirements are merely derived from top level User Requirements, i.e. User Requirements may not be technically feasible, or affordable - they may degrade into nothing more than a glorified 'wish list' unless they are grounded in reality. The aim is to quantify the system being developed and to provide "design guidelines" to the design team.

Explain the scenario.

Handout the Drawings of the Baseline Fuel System, explain that this is a fuel system from the existing system, the one that is being upgraded to meet the new operational requirement.

Handout the BCS diagrams. Explain that the prepared BCS diagram was developed by dividing the components of the BCS system between the four functional groups defined by the designer. (There is a simple hierarchical breakdown of these four groups available).

Allow the delegates to study the diagrams and ask any questions.

Handout the "Historical Data" and explain the scenario, i.e. That this is historical data collected over a 14 year period, by the engineers working on the old platform, and that it has all the characteristics of data collected in this manner.

Ask the delegates to fill in the partially Blank BCS forms using the "Historical Data" working from the bottom up. Carry this out firstly on the fuel storage leg of the system on paper, finish the process in the Excel spread sheet. Explain that the purpose of the exercise is not to just copy that data into the spreadsheet, most of which has been completed for them, but rather so that they can study the data and look for clues that give them some insights into how the old system behaved, and to identify some of the support issues that affected the old system (so they can be avoided on the new system).

The delegates must understand how to calculate MTTR as it is summed up the hierarchy - demonstrate with an example on the white board. There is a worked example sheet in the instructors versio of the Exercise spreadsheet.

The Delegates will discover that the Fuel Contents Transmitter is missing from the MDS data, discuss possible causes of this ommission, i.e. human error, late modification, very high reliability in service, (ask them if they have ever had a fuel guage fail in their cars for example) etc. Show NRPD 95 as a potential alternative source of data, explain that this is a very old version of NRPD and that the latest version is in the form of a database) the relevant entries are marke, talk the delegates through each element. Use the reliability figure from NRPD.

Discuss the need for an MTTR - where could this come from ? Answer, go look at the vehicle and make an estimate - or ask the experienced old maintainer, noting that such experienced people should be able to provide estimated maintenace times for a whole maintenance manual full of activities in a very short period of time.

The delegates study the results and present their findings. They should identify the support drivers.

These can be general factors such as reliability or maintainability, or they could be something more specific, for example they should identify that leakage is a major problem on the fuel system and that the reliability is generally poor for such a simple system.

The leaking issue is readily identified by looking at the fault codes and the associated number of instances.
Note the poor reliability of the main fuel pump - due to two speed, reversable, but brushed motor.
Note the long maintenance times - completely unacceptable. Relate the problems changing the main pump - i.e. Strip out the piping, access the interior of the tank, remove the pump, damage the seal, = rubber that has been soaking in diesel for many years, and which uses the bag tank material as a gasket - hence this damages the tank, repair/replace the tank, reinstall the piping, leak check etc etc...

Acting as the experienced old maintainer, explain why leaks are such a problem, i.e. lots of pipes that have to be disturbed, that there is a poor jointing and sealing system (unions were 'self sealing' but over time the seals have degenerated) , pipes poorly supported hence they flex at the joins. Piping below the manifold is known as the "Rats Nest". Curing all the leaks following a maintenance task is a major headache, you have to fix one leak, clean/dry the piping and then run another leak check - and the need to repeat this process several times...

Summarise what we need the new design to address...

The Design Concept

Introduce the "New System Design Concept" - stress that this is just a concept at this stage - supported by a basic schematic diagram, it is not a fully worked up design.

Its features include:

1. A Manifold to replace the rats nest of piping.
2. A New jointing system.
3. A New "fibre optic" fuel contents system. This has cables running into the top of the tank- therefore fewer holes in the tank, holes are at the top, more accurate, no moving parts - more reliable. A number of sensors are used, at different points around the tank, the electonics then does a bit of trigonometery to determine the fule level; this much more acurate than a float based sensor, particularly so if the vehicle is on an incline. An independent sensor - identical to all the other sensors - is used to act as a low level warning system, the circuit is completely independent of the main fuel content system.
4. New tank, solid, composite material.
5. Two smaller, identical, pumps in parallel, with active redundancy, i.e. they are both in continuous operation, one pump is sufficient to supply the engine, they are non reversible, single speed pumps.

After the exercise has been completed - after Task 204 has been covered - the class are asked to identify an appropriate target for a Technology Demonstrator Programme. - The obvious case is the new fuel contents system. What is its reliability, are there any unforeseen problems, what will the effects of fuel contamination be for example, will the glass become discoloured over time and hence result in inaccurate readings, etc.

Note that this particular "Fibre Optic" technology does not exist - it is a figment of my imagination. It is similar to another apporach, which uses tubes which act as capacitors, with the fuel acting as the dialectric - the capacitance changes depending on the fuel level.

Ask "what is the next task? Remember the aim is to establish Support Requirements. The next task is to develop "Design To" Targets for the new system.

Set top level targets for new System, use the BCS to determine meaningful targets for the New System Design.

Finally ensure that the Delegates understand the limitation of the exercise, we have only addressed a couple of parameters, reliability and maintainability, in reality it would be a much more comprehensive review.

Scenario

The Chief System Designer Is initiating the Development of the Fuel System for "Project Aspire" he has developed a very simple functional breakdown, i.e.
Fuel Storage
Electrical Distribution
Flow Control
Monitoring System

The Chief Designer requires guidance on what is achievable in terms of Reliability and Failure Rates, these are required as an input to the Support section of the evolving Technical Requirements, [these are also required by the Project Manager, they are vital inputs to the model that are used to produce the TLC estimates]. He also requires some "Design Guidelines", that is guidance from the Support Community on what constitutes good design practice for a "supportable" fuel system. In addition to knowing what to do he wants to know what NOT to do, in other words are their any "lessons learnt" that he should know about?

The Maintenance Data System [MDS] report represents data that has been collected over 12 years and represents over 4 millions kilometres of use. Note that data is reported by fault codes and not "failure modes", the data presented is typical of historical data, it is far from perfect and is not complete.

The Chief Designer requires a target for both Reliability and Maintainability for the new system. We must be able to justify this target.
He requires a list of relevant design guidelines, these should be couched in the form of a formal requirement.

Resources

PC with MS Excel.
Blank Forms for developing the BCS, E-003 - BCS Block Diagram Blank.xls.
Soft copy of forms for developing the BCS, E-003 - BCS Block Diagram Blank.xls.
MDS Data [C-021-1].
Baseline Fuel System diagram [C-001-1].

Code	Title	Issue	Date	Duration	Stvle
E-004	**Setting "Design To" Targets - Allocation**	**1**	**27/01/2000**	**60**	**Formal Exercise**

Objectives

The aims are:
For the Delegate to understand the use of Allocation techniques when developing "Design To" targets.
For the Delegate to understand the limitations of the Allocation process and to be aware of the critical factors that must be considered when carrying out an Allocation.

Approach

This is a simple exercise initiated on paper work and finalised using the PC, the exercise is performed in Syndicates.

The exercise concludes with a study of the results and an exercise to rationalise those results.

Explain that the design options discussed previously have been accepted the task now is to develop "Design To" targets for this new concept, note that even if certain items are likely to be genuine COTS equipment it is necessary to determine an acceptable specification in order to support the selection process.

Hand out the Allocation Exercise charts, explain that these represent the new system breakdown.

Discuss the general approach to allocating Reliability, ask what factors have to be considered. For example:

Past Performance
Known Performance of some items
Level of Complexity
Ratios based on Historical Data

Delegates to study the results of the Reliability Allocation exercise.

Discuss the basic principles of Maintainability allocation, that is: the aim is for the least reliable to be the most maintainable. Refer to the appropriate training module.

Discuss how we will allocate Maintainability using the "Weighted Failure Rate" data. Demonstrate for the approach for the first level.

Have the Delegates allocate maintainability for the Storage system manually on paper to ensure that they understand the basic principles, complete the exercise using the PC file.

Delegate are to study the results, and then identify any apparent problems with the technique, then they should explain why these occur and suggest how they will respond.

The classic example is the light bulb with an MTTR of 54 hours.

Discuss the reallocation of MTTR and the potential for maintaining a "Risk" reserve.

Discuss the limitations of such approaches.

The delegates can then be asked to consider whether there are any impacts on Support Policy that result from this exercise. Consider any constraints that may apply to the Support Policy, for example:
- 1st line MaxMTTR and MTTR.
- 2nd line Max (on equipment) MaxMTTR and MTTR.

Use the fuel tank as an example, can this be maintained at 1st line? Probably not, but the analyst should confer with the User before finalising any decision.

Finally discuss the need for sensible minimum targets, e.g. 30 mins.

Scenario
Following an early design review the Chief Designer has settled on the proposed design concept, he now requires a detailed design specification. He needs R&M targets setting for each of the system LRU's, modules and each major component. These specifications are to be used as design targets and during the selection of appropriate Commercial Off The Shelf [COTS] components. The Chief designer is also concerned that one of the suppliers has in the past been prone to giving rather optimistic predictions of Reliability and Maintainability, this has resulted in difficulties in achieving overall System R&M targets. The Chief Designer would like your thoughts and recommendations on how to reduce this risk on the present programme. The ILSM is of course aware of this activity and has requested that you produce a short report detailing the impact of your allocation, if any , on other aspects of Support for Project Aspire.
Resources
PC's and MS Excel. E-004 - Allocation Exercise Blank.xls hard and soft copy. 1 per Syndicate. Sub Set of NRPD 95.

Code	Title	Issue	Date	Duration	Style
E-006	**FMECA Exercise - Fuel System**	**1**	**27/01/2000**	**60**	**Formal Exercise**

Objectives

To give the Delegate practical experience of performing an FMEA / FMECA.

For the Delegate to understand the relationship between the levels at which an FMECA is performed and the LSA Candidates.

For the Delegate to understand the relationship between the different levels of an FMECA and in particular the relationship between failure effects at one level and failure modes at the next higher level.

Approach

A discussion followed by a practical exercise which is performed by the Syndicate.

Hold a discussion to develop the concept of the FMECA. The discussion should follow these guide lines:
We need to evaluate our evolving requirement in LCC terms.
We must therefore identify what it will cost to support
We need to know therefore how often it fails
We need to know the cost of each failure
We need to understand the manners [Modes] in which the system fails.
We need to know how important each failure modes is.
And how often it is likely to occur.

We have now laid the basic foundations for the FMECA

Discuss both bottom up and top down approaches. Discuss the Pro's and Con's of each. NB stress these terms refer to directions, not starting points.
E.g. Top down, is functionally based, easier to relate to operational requirements, easier to achieve during the early stages of development. However can result in addressing the same engineering failure mode many times.
Bottom up, very comprehensive, but hardware based, may miss functional effects of a failure.

Define FMEA Levels - Relate to Candidate item selection process - use the Aspire System Breakdown on the White Board. The manner in which several failure modes at one level can have the same failure effect at the next higher level and therefore result in a single failure mode at that higher level. The setting of the SHSC should be discussed at this point, demonstrate that the SHSC is dependent upon the effect on the End Item and this will then be cascaded down to the contributing Failure Modes. The master spreadsheet is annotated appropriately.

The Delegates define a simple maintenance breakdown hierarchy. They then identify at least two items at two levels which are to be analysed.

The Delegates FMEA needs to be performed on at least two level in order to demonstrate:

The relationship to the candidate item selection process.

The manner in which a failure effect at one level becomes a failure mode at the next higher level

Remember Why FMEA!
Discuss the uses of FMEA's, i.e.
Functional Analysis Eliminate functions, reduce risk, influence design etc.
Identify Maintenance Functions
Have we succeeded?

Introduce FMD 1991 as a source of Failure Mode Ratio information.

Question Delegates about potential design improvements, typical issues are: Pump hidden failures, response? Position of Main Cock, would be better placed between tank and manifold.

Criticality Analysis - talk through the criticality analysis only.

Maintainability Information - talk through the maintainability info sheet - refer to RCM inputs required.

Scenario

You have been tasked by the ILSM with identifying the Functional Requirements for the Aspire System iaw LSA task 301.

The initial stage of this task is to conduct an FMECA. The results need to be presented to the IPT at the next technical review. The presentation is to address the results of the FMECA, any associated risks and any feedback to the design process.

Resources

PCs and MS Excel
Blank FMECA forms E-006 - (FMECA Blank).xls
Aspire System Breakdown Master diagram.
FMD 1991

Code	Title	Issue	Date	Duration	Stvle
E-007	**RCM Analysis - A simple overview**	**2**	**19/04/2006**	**30**	**Formal Exercise**

Objectives

The Delegates will gain high level experience of the RCM process, they will address an On Condition Task, a Hard time Task, and a Failure Finding Task.

The Delegates will be introduced to an RCM logic flow diagram and the associated applicability and effectiveness criteria.

Approach

This is a simplified run through of the RCM process to consolidate the theory.

Explain the Logic Diagram - Note that the diagram is an Aspire version that is based on those found in existing standards.

Explain the Applicability and Effectiveness Criteria.

The instructor acts as the Design engineer and the experienced Maintenance Engineer as required.

Use the fuel pump as a simple example.

The failure of the pump bearing is preceded by a "buzz" from the pumps when you lay your hand on the outer casing. This is discernible at an early stage in the failure process, pumps will run for at least 75 to 80 hours after this is detected. Experienced engineers reckon that they can estimate the remaining life from the level of vibration.

The delegates are asked to identify an:

On Condition Task
A Hard Time Task
A Failure Finding Task
A Corrective Maintenance Task ("No Maintenance).

On Condition Task: on condition tasks can be developed for the fuel pump bearings.

Hard time task: An example of a Hard Time Task is the replacement of the pump motor brushes.

Hidden Failure Task: The failure of the pump due to the failure of the impeller is a hidden failure.

No Maintenance
Use the fuel pump suppresser failure as an example of a failure that does not justify a preventative maintenance task.

Scenario

The Chief Designer has heard a little about RCM and the types of tasks that can result from this process, however his understanding is still a little shaky. He has requested that you give an example of each type of task, for a simple system, that will aid his understanding.

Using the Fuel System find an example of:

An On Condition task

A Hard Time Task

A Failure Finding Task

A Corrective Maintenance Task

Once you have made your choice test your selection by running through the RCM logic and answering the Applicability and Effectiveness criteria questions.

Resources

RCM Logic Flow and Effectiveness and Applicability criteria check lists, E-007 - (RCM Logic & Applicability & Effectiveness criteria).xls.

Code	Title	Issue	Date	Duration	Stvle
E-008	**Modelling Exercises**	**2**	**28/11/2019**	**120**	**Formal Exercise**

Objectives

To demonstrate to the Delegates the power of Models.

To familiarise the Delegates with the concept of Sensitivity Analysis.

To demonstrate the concept of a trade off and to familiarise the delegates with a number of different types of trade off that can be performed on the Total System, i.e.

1. Trade-offs between design/equipment selection options
2. Mission System "System Architecture" trade offs
3. Support System Trade-offs etc.

To familiarise the Delegates with the concept of a Break Even analysis.

Approach

INTRODUCTION

A series of formal and related exercises performed in Syndicates

Give the delegates a brief introduction to the Training Model.

• Explain that it has been developed for the specific purpose of supporting training. To illustrate how Support Systems behave and to introduce the delegates to basis Support Engineering modelling techniques.
• Basic Model Structure
    1. Mission System: Equipment, LRAs and SRA's -
    2. Employment Plan: Organisations, Platforms, Environment, Operating Hours (V simple) -
    3. Support System: Resource Costs, Turn Around Times [TAT's] etc.
• Performs;
    1. Simple Trade-offs
    2. Sensitivity Analysis
• Give a guided tour of the worksheets. The main "Total System Model", "Eqt and LRA Data", "Results" and the "Mech Rate Int Gyro System" worksheets, noting that the "Ring Laser Gyro System" and the "Modified RLG System" workheets will be addressed later.
• Introduce the "Case Study - Navigation Sub System". Show the basic layout of the Mechanical Rate Integrating Gyro [RIG] system.

START VALUES:

Operating Hours Per Annum = 400
Number of Units = 40
Testability Factor = 100%
Maintainability Factor = 100%
MTBF Factor = 100%
NFF = 100%
System = Mech Rig System
Life Cycle = 25 Years
Systems/Unit = 16

Temperature = 20 Degrees
1st Line TAT = 15 days
Intermediate TAT = 90 Days
Depot TAT = 180 Days

PART 1 - Conduct a Sensitivity Analysis on the RIG.

The first stage of the analysis, know your enemy. Carry out a sensitivity analysis on the Mech RIG System to determine the sensitivity of the TLC to changes in MTBF.

Run a sensitivity Analysis on the RIG MTBF using the MTBF Factor. Standard settings - 95% Av. (Wind the spares levels up or down until you hit 95% - or as near as possible).

Enter a series of values, ranging from 10% to 200%, cut and paste the TLC into the results worksheet in each instance (use paste values) .

Point out the tables included on the "Total System Model" worksheet which links to the results sheet - simply for convenience.

If the spares levels hit zero - whilst still hitting the AV target - discuss the reasons for this... i.e. The system is reliable enough that it can stand the delay whilst a repairable goes around the repair loop and returns as a useable spare. Note the Av formula which displays on the "Total System Model" worksheet - note the the Logistics Delay Time [LDT] hits zero when no spares are required.

Produce a line chart showing the relationship between MTBF and TLC.

Mark the Baseline MTBF on the chart using the drawing tool in Excel.

Discuss:
1. Where is the baseline MTBF on the curve, what is the gradient like - visually - as a ratio?
2. What is the meaning of this? = Risk and leverage.
3. What is the effect of doubling the MTBF on TLC?
4. Is this a practical proposition, is it worth further investigation?

Answer - yes!

First impression is that improving reliability may be a good idea provided that the purchase cost is not too high.

Note the estimated cost of the RLG is £12,500 each as against £7,000 for the mechanical gyros and that we have not 'paid' for these gyros in this intial exercise.

PART 2 - Design Trade Off

Introduce the proposed RLG system.

Note: Same Signal Processing Unit, same platform, different accelerometers, new electronic unit required because outputs are different - new unit matches outputs to signal processor unit.

More expensive, but more reliable gyros.

Using the prepared data set conduct a Trade off between the Mechanical Rate Integrating Gyro and the Ring Laser Gyro systems.

Select each system in turn and using the same settings, and with the AV is set to 95% in each instance

Compare the costs between the two options.

Paste the data (Paste Values) from the Mech Rig and RLG columns of the "Eqt and LRA Data" worksheet into the Results Sheet, do this after the Av level has been set for each option.

Ask the delegates to create a 'difference' column by subtracting the data in the RLG column from that in the RIG column.

Ask the delegates to study the results data.

Discuss, note that the RLG gyro system has a lower TLC, but many of the **Initial Costs** are higher - due to the higher costs of the parts and support equipment etc, but the **Recurring Costs** are lower due to the increased reliability.

Explain that this is a fixed effectiveness comparison, the measure of effectiveness being the target value of Operational Availability achieved during the modelling exercise. [95%].

There is an improvement in the TLC, but it is not a great change, would it be worth pursuing? How long would it take to get a return on our investment?

PART 3 - Breakeven Analysis

Conduct a Sensitivity Analysis by varying the system life, do this for both the RLG Systems and the Rate Integrating Gyro - this is a Break even analysis.

Conduct a sensitivity analysis on the "Life" of each option, suggested life values are 1, 6, 11, 16, 21, 26 years, i.e. 5 year steps, transfer the data to the Results Sheet and produce a line chart.

NB: We start at 1 year, rather than zero because a zero messes up the calculations in the Excel model.

Discuss the results.

The Break Even point is circa 14-15 years.

Ask what if the reliability predictions for either alternative were wrong, even by a small percentage?

Would this be a big enough advantage to tip the scales in favour of the RLG?

Anser probably not - but not that there are a number of other advantages if we were to update to RLGs, namely:

1. They are less likely to become obsolete
2. They give us growth potential if greater precision was needed in the future
3. They require less manpower - a bonus if we have problems recruiting

Discuss how would be create a chart like the one in the PowerPoint presentation - with the 'cones' and the area of uncertainty? E.g. By using a three point estimate for MTBF and conducting 3 models runs for each option.

PART 4 - A Change in Architecture

Introduce the proposed new system architecture - i.e. the Alt B RLG - stres:

1. That this new system uses the technology as before
2. It is less reliable because there are more components and connectors
3. It is less maintainable because it is more comple, fault finding is a litte bit more challenging
4. It is more expensive, due to the additional parts.

Conduct a Trade off between the two alternative System Architectures for the RLG system.

Run the model for the Alt B RLG - setting AV to 95% again, and cut and past the data column form the Eqt and LRA data sheet onto the Results Worksheet, adjacent to the previous similar data sets.

Create a new RLG minus ALT B RLG column on the results sheet.

Identify the saving and ask the Delegates to explain how the saving occurs.

Discussion of results:

Note the curious effect on MTTR...

Why is the new system cheaper?

Examine the data for clues.

Production Costs are higher, as are initial support costs, but recurring costs are lower - discuss - explain why...

Because the part that fails most often is a cheap power supply, this is the item that was moved to create a new LRU. This LRU does not require any complex test regime, or test equipment, skilss or manpower, spares are cheap etc.

Introduce the concept of Large Vs Small LRU's

Discuss the potential benefits and draw backs of large and small Line Replaceable units.

PART 5 - A Support System Sensitivity Analysis

This is a simple exerecise, designed to make the point that we can conduct useful analysis on the Support System as well as on the Mission System.

Select the Mech RIG Platform for this exercise (Item 1 on the dropdown list) - this item is sensitive to changes in the Depot TAT.

Discuss with the delegates just how long it can take an LRU to go around the repair loop - typical 'bad' examples could take as long as 360 days. Set the Depot TAT in the model to their selected figure (noting that 365 is the maximum that the model will allow).

Buy spares until the AV is 95% or as near as can be achieved. Note the spares cost figure.

Discuss now what actually happens to such an LRU during this time - the answer being that for the vast majority of the time it is merely sat on a shelf somewhere. Active transit and repair times are likely to be in the order of 30 days maximum - the remaining time is therefore due to poor burecratic processes.

Ask the delegates to set the Depot TAT to what they think is a sensible, achievable figure. Reset the spares holdings until the Av figure is once again 95%. Note the new spares cost figure.

The difference is dramatic - this is because spares numbers, and hence spares cost is directly proportional to TAT, for a given Av target. Halve the TAT, and you halve the spares cost.

There are opportunities here for both the supplier and the end user...

As a thought exercise, considere how many spares would be required it the TAT was zeros (the answer is zero). Why does this happen?

If the TLC was held constant instead of AV - what would be the effect of shortening the Turn around Time [TAT] ?

PART 6 - LoRA discussion only

Development of the maintenance plan through the use of LORA.

No actual run required here use, the existing relevant runs done previously, discuss the relationship to the LSAR and the task code.

Scenario

PART 1

The design team has a requirement for a simple stabilization and navigation system, there is an existing system available off the shelf, this is the Mechanical Rate Integrating Gyro System. This mechanical Gyro system has an adequate but not outstanding reliability. The systems people are considering replacing the mechanical gyroscopes with Ring Laser Gyros [RLG] which are much more reliable. The draw back of the RLG is its cost and the fact that the basic gyro is not repairable.

The Chief Designer has requested that you carry out a simple investigation to determine if the RLG concept is viable, you are to determine the potential impact of the change to RLG's in terms of the system Through Life Cost. The Chief Designer wants a preliminary analysis and an indication of the associated risks ready for his meeting with the Customer this afternoon.

PART 2

The Chief Designer is interested in your results and requests that you perform a more rigorous analysis. He is sceptical about model outputs however and he requires a full explanation of the nature of any savings made and the mechanism by which they have been achieved.

PART 3

The Chief Designer is not convinced that the improvement in TLC is worthwhile. He wants to know what is the risks that he will not actually get a return on the initial investment. He has requested a further analysis of the costs to evaluate these risks.

PART 4

The gains in TLC are not particularly astounding, the team are looking for possible incremental improvements.

One of the designers has come up with an innovative approach. He proposes separating the PSU from the SPU and creating a new LRA.
This is purely a change in architecture.
The new system is less reliable than the previous version, it is also more expensive to buy and some repairs are more expensive! However he believes it will reduce life cycle cost. The Chief Designer is sceptical, and has asked for an analysis to prove or disprove this theory. Please conduct a study, present the results and an explanation of the results for the benefit of the Chief Designer.

PART 5

The target Through Life Cost has not yet been met. The Chief Engineer wants suggestions on how to meet this requirement. There is very little potential now to improve the Mission System design, is there any potential in the Support System design? Report your suggestions to the Chief Designer and give indicative values for the savings.

Resources

PCs with MS Excel
Total System Model - 05

Code	Title	Issue	Date	Duration	Style
E-009	**Task Analysis**	**1**	**27/01/2000**	**60**	**Formal Exercise**

Objectives

To ensure that the Delegates understand the Task Analysis Process and the potential magnitude of the task.

To acquaint the Delegate with some of the limitations imposed on the Task Analysis process by the structure of Def Stan 00-60 Part 0.

Approach

A Practical exercise performed on Paper forms as a Syndicate. [The LDM course uses a different version of this exercise (E-032) and includes an LSAR data entry exercise].

Hand out and brief the Delegates on the Task Analysis Work sheets.

The Delegates select a Task [from those identified as a result of the FMECA and RCM exercises where appropriate].

Delegates develop a Task Taxonomy.

Add Task Elements

Identify appropriate resources, use the Use Study to identify Manpower & Personnel and the Tool list and diagrams supplied.

Discuss:

Address:

Developing an effective task structure that enables the greatest re-usability of information within the Logistics Database, the LSAR.

The limitations imposed by the structure of 00-60 part 0, i.e. the impact of the Task Code on task reusability.

The magnitude of the task.

Who should carry out the Task Analysis - maintainability engineers or tech authors? Think ILS!

Scenario

The LSA programme is about commence the Task Analysis process, however the Chief Engineer has heard some horror stories about the cost and utility of this process from other programmes. He has asked you to prepare an example of the Task Analysis process and to use this to brief him. He requires:

An understanding of the process.

An understanding of the potential problems and pitfalls associated with the process.

A strategy that will ensure both an effective and an efficient implementation of the process.

Resources
The Results of the FMECA and RCM exercises where appropriate. Task Analysis Forms E-009 - [Task Analysis Form].doc Case Study Tool List The Aspire Use Study.

Code	Title	Issue	Date	Duration	Stvle
E-010	**Identifying the Through Life Issues**	**2**	**01/08/2007**	**60**	**Instructor Led Session**

Objectives

To raise or to refresh the awareness of the delegates of those problems, which may be experienced by both the supplier or the operator when operating and supporting complex systems (in order to realise an Operational Capability).

The delegates will analyse the problems that are identified in order to determine their root causes.

The delegates will categorise the problems in terms of whom they effect, the Operator or the Supplier (the Original Equipment Manufacturer [OEM]) and whether they are a management or an engineering issue.

The delegates will identify and define appropriate management and engineering responses to the problems identified.

The delegates will consider the need for a coherent strategy for addressing these issues, i.e. we need a systems engineering methodology, which has been designed to eliminate the causes and to mitigate the consequences of these problems by addressing the root causes.

The delegate will then understand the aims of Support Engineering - albeit at a very high level.

Approach

The aim is to lead the delegates through the process of identifying those problems associated with maintaining capability Through Life and which face both the operators and the suppliers of complex systems.

This exercise may be run as a detailed formal exercise or as an instructor led session. If the case of the latter option (e.g. On the LSA Course) his may become more of a instructor presentation, interwoven with the "T0001 - Introduction to Support Engineering" module presentation, with the instructor asking occasional questions in order to prompt the delegates to engage and to consider the issues faced in the real world and to consider the potential root causes of such issues. The discussion at this stage is to be kept at a high level and not duplicate the more detailed approach that will be addressed by E-012 - Identifying the Limiting and Strategic Factors.

Stage 1 - IDENTIFY THE PROBLEMS

The delegates are asked to identify problems associated with developing and maintaining capabilities through life.

The responses can be classified as:

1. Financial
2. Capability Related
3. Risk

If this is being run as a formal exercise, list the problems on the white board / flip chart, Financial on the left, Capability related on the right, [this allows the instructor to relate this to **COST : EFFECTIVENESS** at the end of the exercise]. Risks can be placed in the centre or off to one side.

Prompt the delegates as necessary, e.g. Ask them to consider:-

- Capability problems
- TLC issues
- Acquisition costs
- Quality issues (i.e. good training, poor training)
- Resource issues (i.e. too much - too little)

Introduce the Generic problems below.

GENERIC EXAMPLES

Financial:

- Rising acquisition costs, include the support aspects of this, i.e. cost of reliability, and maintainability etc.
- Support Costs, discuss the ratio of support costs to acquisition costs.
- Budget limitations
- Contractor Profit Margins, increases achieved by increasing price or reducing costs or by selling more.

Capability Related:

- Low availability
- Long Lead Times
- The size of the logistics tail
- Quality:
    - Errors in illustrated parts catalogues.
    - Wrong spare parts
    - Unnecessary test equipment
    - Unreliable test equipment
    - Inadequate or no training
    - Poor/ inaccurate Technical Data
    - Lack of spares / Wrong spares

Risk:

- Operational risk, i.e. the risk due to a limitation of operational capability, threats that cannot be adequately countered. Usually countered by spending money, I.e. translating into a financial risk.
- Financial Risk

NB: Other issues may be identified by the delegates.

Stage 2 - ANALYSE ISSUES - DETERMINE CAUSES - CATEGORISE

The aim of this stage is to get the delegates to identify the root causes of the problems identified.

- Poor Requirements
- Support not proactively Managed
- Through Life Cost not Proactively Managed
- Insufficient Cognisance of the Operational Deployment
- Inadequate Procurement Processes

Other causes may be identified by the delegates.

Stage 3 - CATEGORISE BY OWNER

Identify who is responsible for addressing the issue, i.e:

a) Supplier

b) Operator
c) Both

The aim here is to begin the process of identifying the organisation responsible for implementing an effective Support Engineering methodology.

Stage 4 - DEFINE AN APPROPRIATE RESPONSE

Consider the required response, but keep it at a very high level, consider:

a) The required engineering response
b) The required management response

The aim here is to begin the process of developing a solution, i.e. to begin defining the required Support Engineering processes.

Once it has been decided that an issue is to be addressed the RACI matrix could be applied, i.e. for each issue, and each response to an issue, identify those personnel who are Responsible; Accountable; and who needs to be Consulted and who needs to be Informed.

SUMMARISE

The problems cause either degraded capability or they increase through life cost, it must be possible therefore to relate any proposed solution to one or both of these issues.

Scenario

You are a senior manager in a large defence organisation - it can be a Public Sector organisation such as the UK MOD or a Medium to large Defence sector Prime Contractor.

Within your organisation there are many apocryphal stories, and many formally documented performance incidents, that may loosely be classified as 'Support Issues'. The magnitude and the volume of these issues has now attracted the attention of the Directors of the organisation.

You have been tasked with addressing these issues, the first requirement is that you are to clarify the actual situation by defining the problems that the organisation faces, and then you are to recommend a structured, methodical, approach for addressing the issues.

Resources

White Board / Flip chart.

Code	Title	Issue	Date	Duration	Stvle
E-011	**The Reliability - Supportability Paradox**	**3**	**10/06/2024**	**10**	**Instructor Facilitated Session**

Objectives

For the delegates to understand some of the fundamental causes of the support problems. i.e.

1. That the complexity of modern systems results in a very wide range of support resources being required.
2. That due to the relative reliability of modern systems these resources, whilst being critical, are required infrequently.
3. That this situation is exacerbated by the relatively small populations of systems that are typically purchased by the military.
4. That modern materials and manufacturing techniques can make support very difficult and expensive.

Approach

Old system technology levels VS new system technology levels - compare the level of technology typical on a system from 20 - 30 years ago with an equivalent system today.

Present the prepared PowerPoint slide, representing a Main Battle Tank [MBT] from circa 30 + years ago and one representing a modern MBT.

Explain the simplifying assumptions presented on the slide - i.e. That new system contains circa the 5 times as much technology as the old one.

Explain that the new technology is, on average, 5 times as reliable as the old technology.

Explain that these are simplifying, but reasonable, assumptions.

Explain that these assumptions mean that the overall reliability of the two MBTs is therefore the same.

Emphasise that this is a rather simplistic exercise but that is designed to make a particular point.

Ask - What issues arise as a result of these changes?

The problem is, the reliability - supportability paradox, a wide range of resources are required to support the new system, at least 5 times the range that was needed to support the old system. These resources include, spares, skills, technical data, tools, training, etc.

However, in each instance, (and assuming similar usage rates) each resource is needed for only 20% of the time that the equivalent resource was required in order to support the Old MBT.

This increased complexity and increased reliability and the use of new technologies and materials can lead to;

• Increased skills fade
• More technical information required
• More technical support resources (spares, tools, etc) required
• Increased failure diagnosis time
• Potentially increased reliance on contractor support
• Challenges implementing battle damage repair [BDR]
• Etc ...

In addition to the financial aspects, this will also impact the size of the logistics tail...

Pose the questions:

1. How many systems do we buy today compared with in the past?
2. What is the effect of this in support terms?"

The answer is of course that the problems identified above are all exacerbated by having small populations.

Pose the question:

1. How do we manage to get so much more technology on board our systems?

There are many answers, but in the main this is due to new technologies that enable us to miniaturise equipment (consider even simple things, such as the electric motors used in vacuum cleaners), for example the use of Integrated Circuits, software in lieu of hardware, Surface Mount Technology [SMT] and Multi layer Circuit boards etc.

Discuss the problems inherent in these technologies. e.g:

1. High cost of circuit boards
2. Testability of circuit boards
3. Difficulty of repair of circuit boards.

Stress that this is not a campaign against these technologies, but simply aims to highlight some of the support problems that are experienced due to new technology in combination with present day force structures, consider also new materials and manufacturing techniques, e.g. the use of composite materials and 3D printing...

Scenario

You are a senior manager in a large defence organisation - it can be a Public Sector organisation such as the UK MOD or a Medium to large Defence sector Prime Contractor.

It is an indisputable fact that the current technology is significantly more reliable than that of the previous generation, however, the user community is reporting extensive problems supporting the current system and associated high costs.

Your task is to investigate the impact of new technology, in support terms, and to ascertain the root causes of the reported problems.

Resources

1. Example of SMT for display.
2. Example of a composite materiel?
Example of 3D printing and the impact, pro's and con's?

Code	Title	Issue	Date	Duration	Stvle
E-012	**Identifying the Limiting and Strategic Factors**	**1**	**19/03/2008**	**45**	**Instructor Facilitated Session**

Objectives

For the delegates to apply the simple management technique of identifying the Limiting and Strategic Factors to their target systems.

Approach

This exercise complements and is run as an integral element when presenting module T0001. As such it is not a simple stand-a-alone exercise; the approach defined is to be applied as appropriate during the relevant sections of the T0001 presentation.

Stage 1 - INTRODUCE THE CONCEPT

Introduce the concept of Limiting and Strategic Factors. i.e. Limiting Factors = anything which stops you from achieving your aim - Strategic Factors = That subset over which you have some control and those that give you the greatest 'leverage'.

Start Point = Customer wants low Through Life Cost [TLC] and high Availability - We need to identify what is preventing this from being achieved - so that we can fix it...

Consider:

• Where the TLC arises, namely:

1. How much it costs to buy the system
2. How much it costs to operate the system
3. How much it costs to restore / service the system, including the costs of resources (used and wasted), manpower (including training, used and wasted) i.e. what is the total bill for fixing and servicing the System.

• What determines System Availability? The answer includes:

1. A function of the Mission System design and the environment and the manner in which the system is operated - i.e. the Employment Plan
2. The manner and the environment in which it is maintained - The Support System and the Employment Plan

That is the interactions between:

1. The Mission System
2. The Employment Plan and
3. The Support System.

Hence Availability (and hence operational effectiveness) and TLC are determined by the nature of, and the interactions between, the elements of the Total System.

Show a diagram of the Total System.

So we 'decompose' each element of the Total System we will be able to identify the Limiting Factors.

Stage 2 - THE MISSION SYSTEM LIMITING FACTORS

Mission System: Explain that there are many features of the Mission Systems design, beyond Reliability, Maintainability and Testability, that impact support and hence TLC and Availability. These are all "Limiting Factors" they are therefore what the Supportability Engineering Manager has to manage and the design features that the engineer has to address, they are therefore the first items in our list of Supportability Engineering Elements.

They include:

Reliability - Durability - Robustness
Maintainability
Testability
Standardisation (including interoperability)
Upgradeability
System Architecture
Resource Risk
Condition Monitoring
Usage Monitoring
Maintenance Aids
Operability
Health & Safety

Stage 3 - THE SUPPORT SYSTEM LIMITING FACTORS

<u>Identify the resources required for direct support.</u>

Commence by identifying those resources that are required in order to support a system directly, i.e. what resources are applied at the direct interface with the system in question. These are:

I, People
ii, Skills
iii, Tools
iv, Technical Data
v, Spares and consumables.

State that we also need to ensure that:

- the right resources are available
- at the right time
- in the right quantities
- in the right place

<u>Discuss the "systems" that are required to get these resources to this interface?</u>

Define how the resources are created and delivered to the system interface, also addressing the return flows where appropriate.

Stress the need to define processes, procedures, policy, organisational constructs, etc. It is the processes that are the limiting factors as well as the level and the quality of the resources available. Discuss the need ensure that these processes are optimal (or as near optimal as is practicable within the given programme constraints). We must therefore develop a programme that addresses the design of these processes just as we would address the design of the Mission System or of a piece of support equipment.

Stage 4 - THE EMPLOYMENT PLAN LIMITING FACTORS

Present the Employment Plan factors. But note the challenges in influencing the Employment Plan.

The following factors should be identified:

- Environment
- Enemy Action
- Numbers and Organisation
- Users – No's, Roles
- Locations
- Sortie Rates
- Durations
- Duty Cycles
- Operational Constraints on Support
- Length of Lines of Communication
- The Force Readiness Cycle

Stage 5 - PRESENT AND DISCUSS THE CONSOLIDATED LIST OF LIMITING FACTORS

Explain that this is very high level list.

Consider the size of the list and discuss the need to prioritise certain factors.

Revisit the concept of Strategic Factors - using the list of factors to provide some context (e.g. Discuss the strategic factors that would apply post a design freeze).

Explain the 'Systems' nature of the limiting factors - i.e. That they tend to interact and that this is one of the defining factors of a 'system' and hence we HAVE to adopt a systems approach to Support Engineering.

Scenario

Resources

Code	Title	Issue	Date	Duration	Stvle
E-124	**TLC Magnitude**	**1**	**01/06/2015**	**15**	**Formal Exercise**

Objectives

The magnitude of support costs is routinely under estimated, far too often over simplistic ratios are quoted, e.g. Support costs are 3 times the procurement cost (or 5 times, or 10 times etc). This may be true for some systems, but for others, particularly those that require a significant amount of manpower for operations and support, this is ususally a gross under estimation.

The aim of this short exercise is to raise awareness of the true magnitude of the costs and hence the potential for making savings.

Approach

1 - Tell the story of the Leopard II Programme.

An ex tank commander, now an inexprienced ILS engineering, asked if it was worth pursueing a Reliability Centred Maintenance programme, "because we have been maintaining the Leophard I for many years, is there really ny opportunity left to reduce cost further?"

Note that there were a number of fairly evident issues with the extant Leophard I maintenance programme, including missing, potentially critical maintenance tasks, and some completely nugatory tasks. But the key to the discussion was a rough and ready estimate of the magnnitude of the maintenance costs for the Leophard. This exercise is built on that rough and ready approach, applied nearly 30 years ago.

2 - Brief the Delegates on the E-124 worksheet.

Tell them they do not need any detailed knowledge of MBT's they just need to apply a bit of 'common sense' and to estimate a range of values.

At the start of the exercise the Data Grouping for the columns should be closed up, thus hiding the results.

Ask the Delegates to envisage the values for a Main Battle Tank, and to enter estimated figures for each of the 'White' cells.

Point out that the cost of people is not the same as their pay, it is the 'capitation rate', that is the average cost of employing those people, it should include an element for recruitment and training costs and it must cover other none productive time, for example, doing guard duty.

3 - Once complete click on the grouping button to reveal the result.

Was this what they expected?

Note that many elements are missing from this very simple model, the true figure would be larger still.

Do they think that theyy could shave between 1% and 10% off of this figure?

Scenario

Sinply complete the spreadsheet, fill in the the two yellow cells and then the empty white cells working in your syndicates.

Resources

Training Model 04.xls

Code	Title	Issue	Date	Duration	Stvle
E-125	**The Cube Law**	**1**	**01/06/2015**	**15**	**Instructor Led Session**

Objectives

To introduce the Delegates to the concept of multiple variate optimisation, and the unexpected power of the approach.

To introduce the concept of the "Cube Law" and to give the delegates' an appreciation of the potential effects of this law in the real world. The aim is to facilitate the delegates understanding that a number of small improvements, which may be of relatively low cost to implement, may lead to unexpectedly large improvements in performance.

Conversely, a number of apparently small reductions in support performance may lead to significant, and unexpected, degradation in operational performance and substantial increases in Through Life Cost.

The point is that in the world of Support Engineering, there are rarely any "Silver Bullets", but we know from experience that a number of small changes can, collectively, bring about significant change.

Approach

The Total System is extremely complex, its many elements interact in very complex ways, in such a system there is rarely a single, simple, change that can be made which will result in a significant improvement in performance. One of the reasons for this is that one or more variables may act as constraints on another. A simple example is that the benefit of a significant improvement in improving reliability may not be realised if, for example, there is a significant shortage of manpower, or if the supply system is so inefficient that the lack of spares, despite the reduced demand, limits the operator's ability to utilise the equipment.

Conversely, if we make a couple of smaller, cheaper changes, unexpectedly significant improvement may accrue. For example, given the example above, if we make a relatively small improvement to the supply system, and improve the management, and hence the utilisation, of our manpower and make a small improvement in reliability, we can find that the resulting improvements in performance and the return on investment, are far greater than we may have expected.

Before presenting the exercise, tell the Delegates that you are going to ask a question to which they can determine the answer by some simple mathematics, but that you don't want them to calculate that result; rather you want them to make a quick estimate, without thinking too long.

Show the two cubes, the delegates may open the worksheet on their computers, if available. Pose the following scenario, we are going to reduce the size of the cube by removing a slice from each of the three axes of the cube. Point out the empty dimension boxes and the dotted line on the red cube to make this clear.

If we assume that the cube is 8cm x 8cm x 8cm, and if we remove a 2 cm slice from each axis, how big is remaining cube, as a percentage of the original cube?

You can illustrate this by entering a 2, the width of the slice, in the centre dimension box, and clicking the 'Resize' button.

Ask the Delegates for their answers, record on a white board or flip chart.

Typically these figures will range from 80 % to 60% - The answer is that the remaining cube is 42% of the size of the original..

Use the outline button in the left hand margin to reveal the calculations that demonstrate this.

Explain that the same type of effect is demonstrated when optimising support for complex systems, explain that the use of complex system models enables an analyst to determine what factors can and should be changed. Relate Aspire's experience modelling complex systems for the UK Defence market, where we demonstrated that small changes to shift patterns, alternative flight servicing approaches, improved fleet planning, reducing diagnostic time and improving accuracy by fielding better technical publications and focused training, improved spares packages, etc contributed to an increase in the availability of an operationally critical platform of nearly 90%.

Ask the Delegates to experiment with the tool and determine by what percentage do they have to reduce each side in order to achieve a 50% reduction in the size of the cube. (The value is 1.65)

Scenario

Too often, when conducting a Supportability Engineering programme, too much focus is placed on one or two elements of support, typically, Reliability (if in the design phase) Spares and Technical Publications; often, to the detriment of others.

Too often also, when an organisation is experiencing availability problems with one of their systems, they often try to fix the issue by buying more spares, sometimes to great excess, and with limited effect.

The answer is to really understand how the different elements of a the system interact in order to deliver availability, be that good or bad, then we can respond in the most appropriate and, most cost effective manner, achieving the optimal solution within the given constraints.

This approach to problem solving can be regarded as a form of Root Cause Failure Analysis [RCFA], where the failure is poor Availability, but we are seeking a potentially complex cause, comprised not of one causal element, but several which interact in complex ways; hence we need to consider a modified approach, which we can call "Complex Root Cause Analysis" [CRCA].

Resources

The Supportability Engineering Workshop Training Model; worksheet "The Square Law".
Note that row 1 is hidden, this contains a scale factor, this ensures that the cubes are rendered at an appropriate size.

Code	Title	Issue	Date	Duration	Stvle
E-127	**Introducing MTBF, Failure Rate and the Exponential Distribution**	**1**	**01/06/2015**	**30**	**Instructor Led Session**

Objectives

The delegate will gain an appreciation of the statistical nature of many support measures, and will understand that these metrics can be misleading to the uninitiated, they are often counter intuitive.

The Delegate will understand the nature of a key support measure, namely Mean Time Between Failure [MTBF].

The delegate will understand the relationship between "Constant Failure Rate" and the "Exponential" Distribution.

The Delegate will understand the concept of "Probability of Survival" and will be able to determine the Probability of Survival for a given operating time and for a given MTBF.

Approach

Start by posing the scenario below to the Delegates, capture their responses on a white board/flip chart.
Typical responses will include:

50% This is based on the delegate's belief that the failure distribution follows a "Normal" distribution.

5-10% This is based on the delegate's belief that because the MTBF has been reached, most of the items must have failed, but a small percentage may survived

90-95% This is based on the delegate's belief that because the MTBF has only just been reached, most of the items must have survived, but a small percentage may failed.

If you don't get similar responses, run through these options anyway.

Occasionally, someone will know the correct answer which is 37% (0.367879447...). Write this answer on the Whiteboard/Flipchart.

Note that, with the information they were given, this is the correct answer beyond any doubt.

We now take several step back to explain why this is the case.

The argument is:

We stated MTBF - this means that we must be assuming constant failure rate.

Introduce the spreadsheet with the bathtub curve, explain the three sections of the curve, Infant Mortality, Wearout and Constant Failure Rate sections. Ask, intuitively, which part of the curve they think that the metric '**MTBF**' can be applied to?

Whilst you could of course calculate, mathematically, the average of the whole curve - use the data grouping button on column 'F' to expose the mean calculation column and hence the red Mean line on the chart to illustrate this value - it has no use in practical terms, it is not helpful in any of the three periods of a system's life.

The answer is of course the flat part of the curve, the bottom of the bath.

Explain that this means that the failure rate is constant - over this period, that is, the probability of a failure occurring in a particular hour during the early part of an item's life, is the same as the probability of that item failing in a particular hour towards the end of that item's life.

We now need to demonstrate the relationship between "Constant Failure Rate" and the Exponential Distribution which is used to describe it; at first this seems counter intuitive.

Start by tossing a coin, this will illustrate the basic principle and remind Delegates of basic probability theory, i.e. that the probability of throwing 1 head is 0.5 and hence the probability of throwing two heads with two successive throws is 0.25. - i.e. 0.5 x 0.5. By extension, the probability of throwing three in succession will be 0.5 cubed (i.e. 0.125) and hence the probability of throwing 'n' heads is 0.5 to the power 'n'.

Moving to the Exponential Demonstration-01 worksheet - explain the calculations in the table and then ask the delegates to populate the "weeks" column note that the first and second rows have been completed is complete - the probability or surviving for a very short period of time, is of course 1.0 or 100% and the probability of surviving 1 week has been determined to be 90% or 0.9

Ask therefore what is the probability of the items surviving for 2 weeks ? (Answer = 0.9x0.9 = 0.81) get them to enter this value in the R(x) column.

Repeat for the successive rows, noting that in each instance the previous result has to be squared to populate the R(x) column (= probability of survival - using 'x' as a measurement base - usually t for time). The delegates can calculate these values using a calculator or use a formula in Excel.

Having completed the chart - ask the delegates to use the red right angle cursor to determine the probability of survival at time = 380 - i.e. The MTBF.

This will of course = 37%

This is an exponential decay curve, it is an exponential "Probability Distribution Function [PDF]" it can be described using the Exponential Function 'e' = Eulers Number.

Noting that ʎ = 1/MTBF

Move onto the Exponential Demonstration-02 worksheet and show the delegates that the chart and the data are identical to the previous version, but in this case the values have been determined, using the formula R(t) = e^-ʎt (=1/e^ʎt): in one column using Eulers number 'e' which equals 2.71828182845905 (approximately)... and in the second column, the Excel Exponential function EXP.

The rate ʎ determines the gradient of the curve, the minus means it is a decay (rather than a growth) curve and the 't' determines a particular point on the x axis.

As ʎ = 1/MTBF, and in our initial example t - MTBF, so e^-ʎt =e^ -(1/MTBF) x MTBF = e^ -1 and e^-1 = 0.36787944... or approximately 37%

A key point for the Delegates to take away here is that this result is counter intuitive, and this is a common situation in the Support Engineering world, we are dealing with some complex situations, and some complex probabilistic measures are involved, if not handled carefully, they bite!

Scenario

A large number of Data Projectors - 1000 - like the one being used to present the course, are placed in a room and switched on.

The MTBF of this particular Data Projector is 500 hours; if we leave the projectors in the room for exactly 500 hours, how many of the projectors will still be working, that is; what percentage will have survived?

Resources

The Exponential 01 spreadsheet.
This contains two tables, for part population by the Delegates with pre-prepared charts. The charts are 'scatter graph' charts - this allows the 'X' axis values to be a non-geometric series.
Note: that the second part of the exercise can be hidden using the row Group button.
Note: that the spin button drives a cell in the hidden row 1, the failure rate is calculated using this value.