TFD Europe

Q. Why Use TFD?
A. The Trusted Name in Logistic Support Decision Making

TFD Group is the world leader in the development of analytical methods and software decision support tools for planners, developers, operators and maintainers of hardware systems. ***TFD*** provides products, services and advice to make logistic support decisions to plan and control support solutions in military and commercial environments. You should you use ***TFD*** to:

- Plan the delivery of support performance goals such as Operational Availability (Ao) at minimum cost for support resources at all locations: people, skills, spares, tools, test equipment, facilities, information and energy
- Select equipment and their support solutions based on minimising Life-Cycle Cost (LCC)
- Estimate system LCCs in flexible scenarios based on bottom-up activity costs
- Explore 'what if' scenarios, and identify and quantify the cost-benefit of continuous improvement opportunities
- Control in-service support delivery against KPIs in real world situations through targeted and prioritised recommendations for action.
- Collate, control and manage all the data needed for logistics analysis and modelling for multiple systems

***TFD* provide a comprehensive suite of tools, the *TFD Supportability Workbench*, to meet all of these needs. TFD also provide skilled and experienced support analysts to solve your problems**

TFD Group has more than a thousand software installations & license holders worldwide including: USA, Europe, Brazil, Israel, Japan, Korea, Australia, South Africa, China, Taiwan and Singapore.

TFD clients include many military agencies, most of the significant aerospace and defence companies and commercial organisations including: UK MOD, FMV Sweden, Lockheed-Martin, Northrop-Grumman, BAE SYSTEMS, Raytheon, Boeing, General Dynamics, Thales, EADS, Bell Helicopter, Parker Hannifin, NASA, NOAA, ESA, United Nations and US Coast Guard.

TFD has extensive experience of unravelling complex logistics problems in Performance Based Logistics environments. In particular, ***TFD*** has been actively engaged for many years with the UK MOD, other international defence departments and defence suppliers to provide: Integrated Logistic Support (ILS) including availability, R&M, logistic support analysis & management; in-service support including integrated supply support management; and options analysis and mathematical modelling.

TFD is the solution to support analysis problems

For more information about all TFD products please contact:
Email: tfde@tfdg.com **Tel: +44 (0) 1603 726660**

Q. Why Use the TFD Architecture?
A. An Integrated Supportability Workbench for Logistic Decision Support

The ***TFD Supportability Workbench*** includes a suite of tools to meet all these needs to:

- Plan the right Support Solution using ***EDCAS***
- Optimise the spares solution using ***Tempo*** anticipating changes over time
- Develop a detailed Life-Cycle Cost across all resources using ***MAAP***
- Explore 'what if' scenarios using ***mPOWER***
- Monitor, control and sustain in-service support using ***SCO***
- All supported by the ***TFD data Vault (TFD dV)***

TFD provide a comprehensive suite of tools, the TFD Supportability Workbench, to meet all of these needs

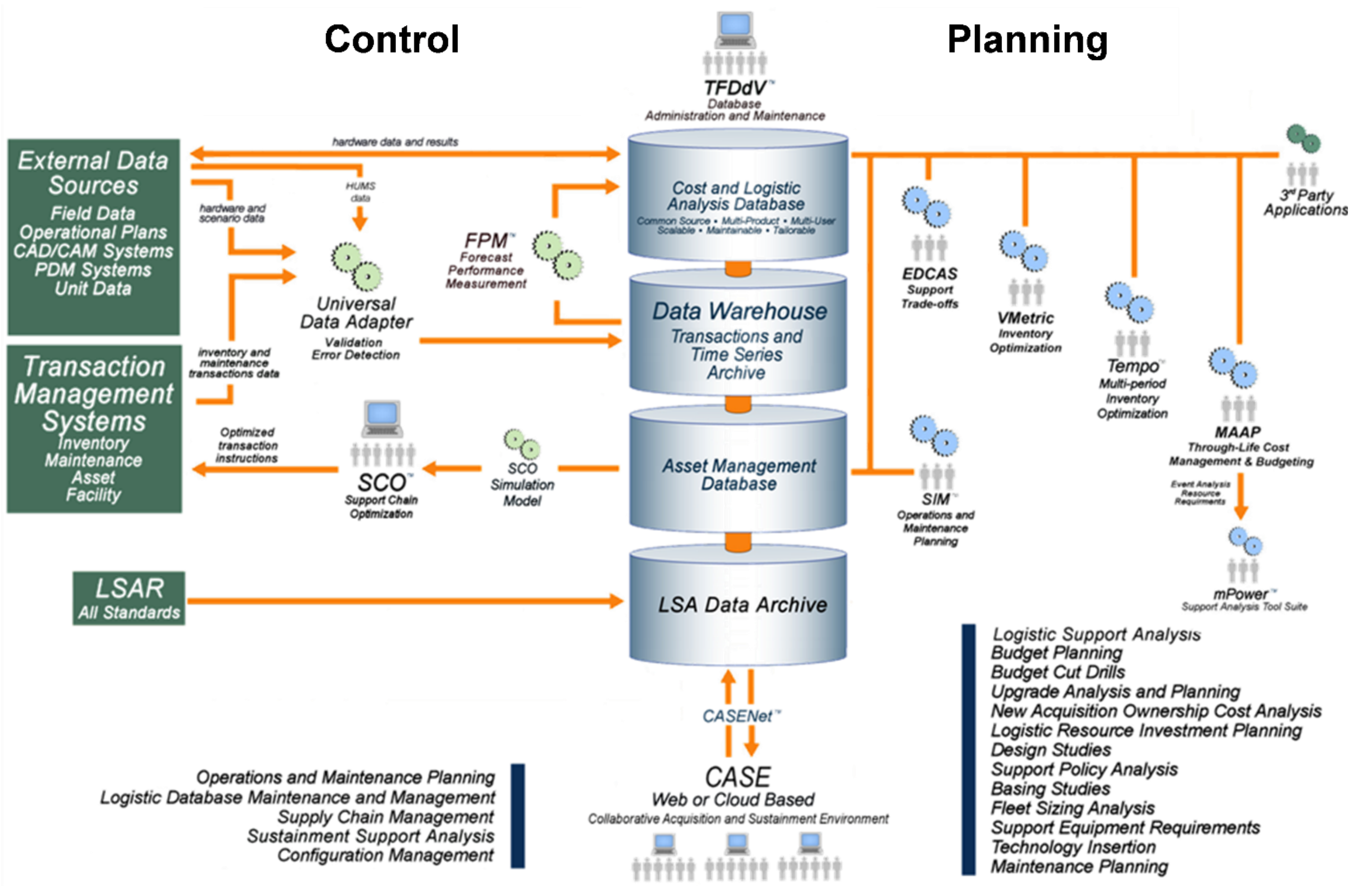
TFD also provide skilled and experienced support analysts to solve your problems

The ***TFD Supportability Workbench*** is based upon the central core of the ***TFD dV*** as the single dependable source of trusted logistic data.

The workbench provides tools to both plan support packages including all the necessary resources to achieve the maximum or required output for minimum cost, and to control support performance to achieve in-service KPI's despite real word events and changing scenarios.

The ***TFD Supportability Workbench*** includes capabilities to import data, subject to rigorous validation, from external data sources such as LSARs, design and other support documentation, HUMS and transaction systems for inventory, work and asset management such as ERP systems. It can also include interfaces to other Third-party tools used by specific customers.

The ***TFD Supportability Workbench*** can be hosted on a single computer, or support multiple users either on a network or in the Cloud.



Q. Which TFD Tool Should I Use?
A. An Integrated Supportability Workbench for Logistic Decision Support

The ***TFD Supportability Workbench*** includes a suite of tools to meet all these needs to:

- Plan the right Support Solution using ***EDCAS***
- Optimise the Spares Solution using ***Tempo*** anticipating changes over time
- Develop a detailed Life-Cycle Cost across all resources using ***MAAP***
- Explore 'what if' scenarios using ***mPOWER***
- Monitor, control and sustain In-service Support using ***SCO***
- Plan future support capability for aero-engines and other serialised lifed components using ***SIM***
- All supported by the ***TFD data Vault (TFD dV)***

The ***TFD Supportability Workbench*** is based upon the central core of the TFD dV as the single dependable source of trusted logistic data. The workbench provides tools to both plan support packages (including all the necessary resources to achieve the maximum or required output for minimum cost), and to control support performance to achieve in-service KPI's; despite real word events and changing scenarios.

EDCAS (Equipment Designer's Cost Analysis System) is used to:

Select the best design for new equipment based on Life-Cycle Cost

Understand the impact on supportability and cost of part and configuration design trade-offs

Define the best repair strategy

Understand the cost and logistics performance of design alternatives

It provides a rapid, intuitive tool to answer many design and supportability questions - to establish the expected system availability, LOR policy, spares analysis and LCC. ***EDCAS*** can:

Cost the best design for new equipment

Define the best level of repair strategy for the support solution

Understand the impact on supportability and cost of part and configuration design trade-off

Understand the logistics of design alternatives

Using EDCAS reduces LCC

Tempo is used to:

- Develop optimum spares scales to meet fleet availability targets where:
  - The operational usage or fleet disposition changes over time through fleet expansion, re-basing, re-role or run-down
  - Equipment design changes over time, because of obsolescence, modifications, upgrades, or reliability improvement programmes
  - Support arrangements change over time as maintenance and repair policies, contractors, their performance and price evolve
  - While minimising wasted investment in stock with a short useable life

A spares solution optimised in Tempo is superior to one provided by steady-state tools because it:

- Explicitly handles inevitable changing scenarios
- Avoids the errors implicit in steady-state models, including over-stocking of life-limited and long-lead time parts
- Maximises return on investment and avoids waste from market-driven obsolescence
- Optimises procurement timing to match fleet build-up, re-basing and run-down for lowest cost
- Deals explicitly with time, eliminating the drudgery of hand-made multi-period calculations

Tempo is the next generation Inventory Optimisation Tool

MAAP is used to:

Estimate Through-Life Cost (TLC)

- Optimise all the support resources, not just spares, to deliver system availability
- Identify the drivers of support cost and performance
- Evaluate the benefits of support improvements before committing to them
- Evaluate how to cut costs, while minimising the loss of capability

The power of ***MAAP*** is considerably enhanced using the associated suite of utilities collectively called ***mPOWER***. This suite enables identification of the support cost drivers and quantification of the benefits of potential remedial action.

Together, ***MAAP*** and ***mPOWER*** are extremely powerful tools to identify and optimise the support performance and cost drivers of a system. They can provide:

- TLC Estimates
- Optimise all the support resources for system availability
- Identify support cost and performance drivers
- Evaluate the benefits of support improvements
- Maximise cost savings while minimising capability loss

MAAP & mPOWER - the answer to multi-resource planning, optimisation & continuous improvement

SCO (Support Chain Optimisation) is used to:

- Identify the parts in a support package which will run out in sufficient time to take effective action
- Identify the remedial actions that will prevent future support system default
- Prioritise the remedial actions by cost and the lead time needed to take action
- Justify the business cost benefits of early action
- Predict future support package performance.

SCO provides continuous availability-based inventory optimisation that sustains mission capability at lower cost by preserving the initial benefits of a system-based optimisation, and avoiding normally unseen in-service inventory cost growth of typically of 25-33%.

SCO provides near real time intervention advice to restore and sustain optimum system performance

SIM is used for fleets of serialised lifed parts, such as aero-engines to:

- Optimise operational planning and fleet life profile
- Optimise maintenance planning of scheduled, unscheduled, hard and Minimum Issue Life
- Quantify repair process capacity for part failure (MTBF), FOD, secondary and subsidiary damage
- Optimise logistic resources (spares, people and support equipment) by location and time period

SIM provides:

- Through-life management planning
- Operational and maintenance planning
- Total asset visibility
- Inventory and multi-resource optimisation
- Modification change management
- Exhaustive resource analysis and reporting

SIM – a modelling platform for systems with life-limited, serial tracked parts

The ***TFD dV*** is used to:

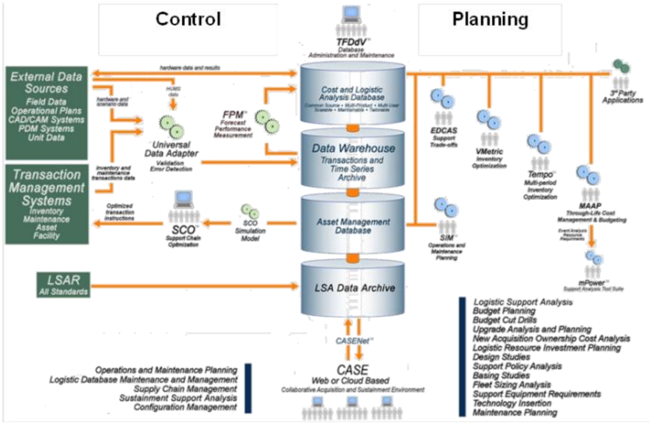
- Collate the data needed for logistics analysis and modelling for multiple systems
- Provide a controlled data store
- Centrally manage logistic data
- Protect investment in trustworthy data

The ***TFD dV***:

- Was specifically designed and evolved over 30+ years to support logistic support decisions
- Contains logistic support data in its appropriate context for dependable reuse
- Enforces data quality during data entry and protects it subsequently from corruption through over-writing by automated uploads
- Drives the ***TFD Supportability Workbench***
- Can also drive Third-Party analysis tools

The TFD dV is a comprehensive, robust, common source repository for logistic data

The ***TFD Supportability Workbench*** provides tools for use from initial design through to optimizing in-service system operation.



Q. Why Use VMetric?

A. To Develop optimum spares scales to meet fleet availability targets

You should you use ***VMetric*** when you need to:

- Develop optimum spares scales to meet fleet availability targets
- Identify inadequate or expensive spares recommendations
- Be sure of achieving target fill rate or availability levels

VMetric – The Inventory Optimisation Tool

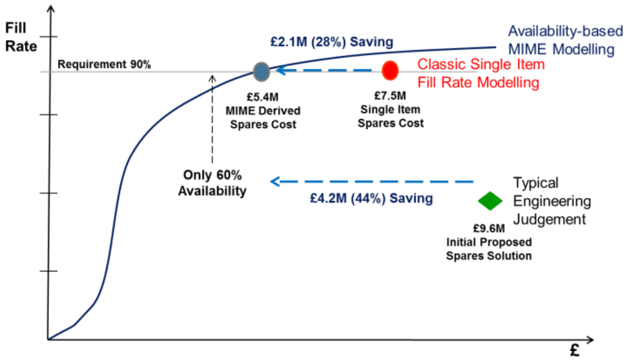
The aim of spares provisioning is to choose the spares that maximise Operational Availability (Ao) for an affordable cost, or minimises the cost for a required Ao. To preserve system availability, the spares stock must be sufficient to cover the time taken to replenish the stock with a serviceable item. The main drivers are the failure rates, the repair turn-round times, if appropriate, and both the purchase and repair costs. Reducing repair turn-round times will minimise the need to hold spares to stock the pipeline.

Spares Optimisation Approaches

There are 3 typical approaches to calculate stocks.

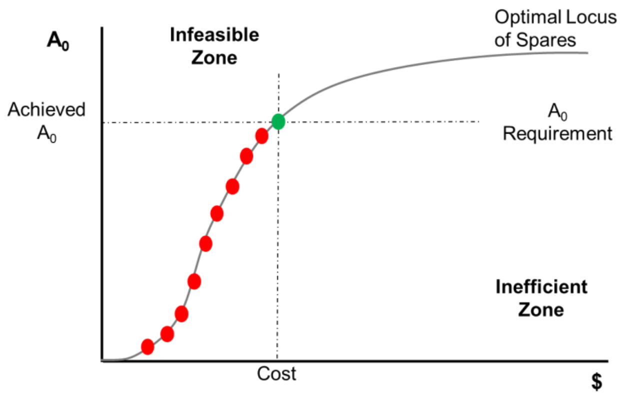
- Engineering judgement based on previous experience. This approach is often flawed leading to shortfalls or expensive stock holdings.
- Single Item Modelling works at the item level treating each part independently. Typical measures of performance are Off-the-Shelf and Overall Satisfaction Rates which, in effect, describe the confidence of having a specific part available when required. These measures are also called Fill Rates. This approach can be described colloquially as “Happy Shelves”.
- System-based modelling works at system level addressing all parts simultaneously with overall system availability the key performance metric. By choosing to hold the spare with the largest impact on system availability, at a cost, the overall risk or shortage is reduced for the overall system. Multi-Indenture Multi-Echelon (MIME) modelling incorporates these principles for complex environments where spares are required at multiple locations, with partial or full repairs at various levels. This approach can be described colloquially as “Happy Systems”.

Over many years, Engineering Judgement has proven to be the least effective and most expensive approach. Single Item Modelling for each item is better but for a given availability level System-based Modelling typically produces scales that are 25-30% cheaper as illustrated below from recent MOD data.



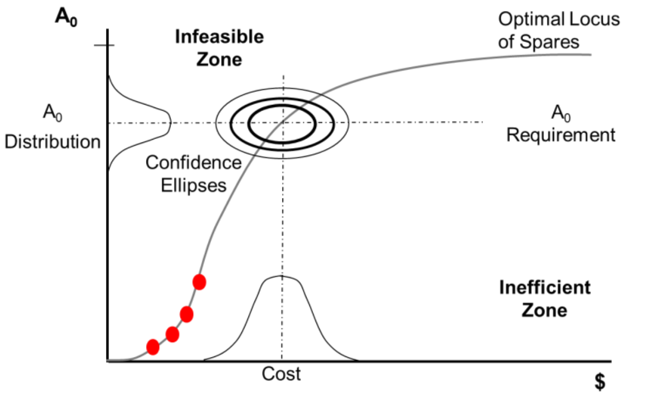
Marginal Analysis

Marginal analysis is a mathematical technique to optimise spares selection. The diagram below illustrates the technique. Provision of spare parts improves system availability by reducing the probability that a spare is not available when required. The contribution to availability is a function of the part’s failure rate and the time for it to be repaired, and of course all parts have specific procurement and repair costs. Selecting the part which most increases availability for least cost is the most cost effective. But once a part has been provisioned, the contribution to availability from another one must be recalculated, and the next selection made. Repeating this process will lead to a series of individual part choices that form an optimal locus of spares to achieve system availability for a specific cost until the requirement is met. By definition, it is infeasible to achieve more availability than the optimal locus while any other choice is sub-optimal, inefficient and wasteful.

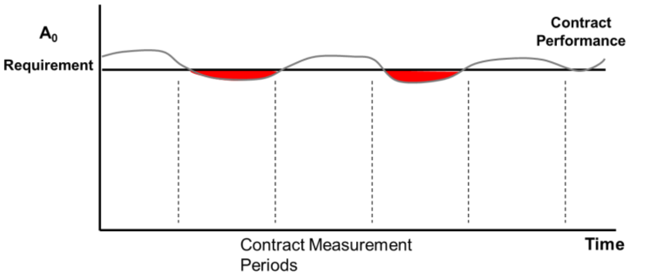


Confidence Limits

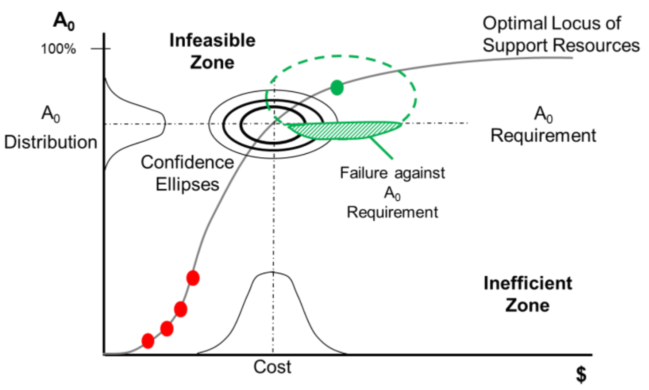
The achieved availability is based upon mean data but failures are inherently stochastic with some statistical variation. Likewise, the cost elements may in practice be subject to some variability. This can be thought of as ellipses of confidence about the mean point as illustrated below.



On average over the long term, the spares package will meet the requirement. But the solution will fail to meet the required availability for 50% of the time. As spares performance is usually measured over shorter periods, excess performance in one period will not offset under-performance in others and this will lead to contract penalties.



VMetric handles this issue automatically. If the requirement is to meet a minimum availability level for more than X% of time, the availability target is increased to reduce the commercial risk as illustrated below.



This approach does not require use of a separate simulation tool to evaluate performance of an optimum spares package in the required scenario.

Non-Cost Optimisation

Normally, spares packages are optimised for cost since cost is normally the principal constraint when procuring initial spares packages.

However, there may be other metrics against which to optimise in special circumstances. If storage space is the dominant constraint, as for example in submarines, spares should be optimised using the packed volume of each spare. ***VMetric*** is able to use a shadow currency, such as m^3, as the base for optimisation. Alternatively, if the constraint is weight as for example in a Fly-Away pack of aircraft spares, the shadow currency could be Kilograms.

Non Steady State Scenarios

VMetric, like all current spares optimisation tools, takes a steady state view and assumes long-term scenarios which remain unchanged forever. But in the real world, the situation always changes as basing, activity levels, support arrangements, even system configuration evolve.

In a best attempt to address this issue, users of steady-state tools split scenarios into multiple time-slices, chain together a sequence of runs for each fixed condition, and load results from the last run as inputs to the next. As the volume of change increases, complexity, workload, time and error probability all grow exponentially. For changing scenarios, TFD's ***Tempo*** tool is more appropriate.

VMetric minimise spares inventory costs

VMetric is the pre-eminent spares optimisation in the world to:

- Generate optimum spares scales to meet fleet availability targets
- Identify inadequate or expensive spares recommendations
- Ensure achievement of target fill rate or system availability levels
- Optimise spares packages against constraints other than cost

VMetric - The Pre-eminent Inventory Optimisation Tool

Q. Why Use MAAP?

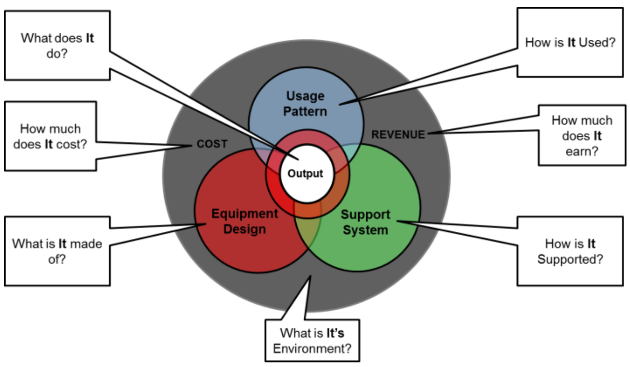
A. To Identify and Optimise the Support Cost Drivers to Derive System Through Life Cost

You should you use ***MAAP*** when you:

- Need a Through-Life Cost (TLC) Estimate
- Need to optimise all the support resources, not just spares, to deliver system availability
- Need to identify the drivers of support cost and performance
- Need to evaluate the benefits of support improvements before committing to them
- Need to evaluate how to cut costs while minimising the loss of capability

MAAP – The answer to multi-resource planning, optimisation and continuous improvement

The cost and output of a Capability are defined by the interaction of its Usage Pattern, its Equipment Design (as described by the system structure and the related attributes, such as reliability and maintainability), and the Support System.

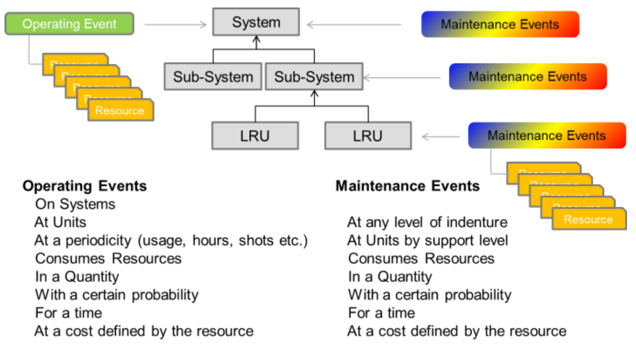


In use, the Capability undergoes various series of Operating Events (OEs), such as flights, miles, days, landings, cycles, shots and their combinations. These happen on specific systems or platforms, at nominated Units, at a frequency, and consume resources in quantity, with a certain probability, for a time and at a cost defined by the resource.

OEs have differing impacts on different parts of the Equipment Design, depending upon the duty cycle and component reliability, to generate Maintenance Events (MEs), which may be Preventative, Corrective or Condition-based Monitoring.

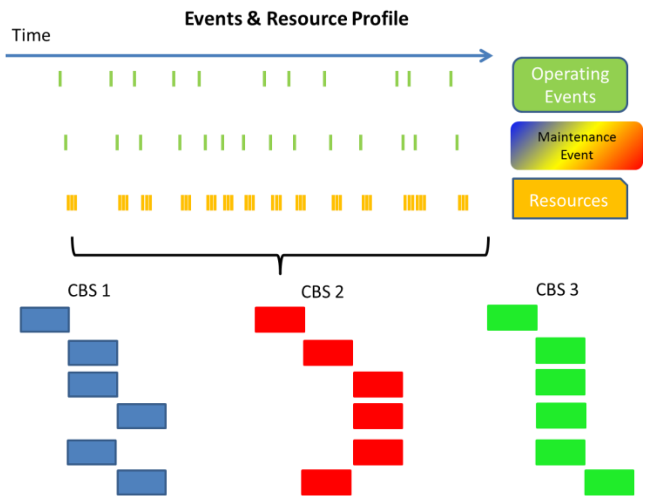
Depending upon the maintenance policy, MEs can occur at any level of equipment indenture, at Units by support echelon, and consume resources in a quantity with a certain probability for a time and at a cost defined by the resource.

Other Events can occur, such as Upgrade Events on the platforms, and Training Events to ensure that sufficient skilled manpower is available.



The resources include: skilled labour, parts, tools, workshops and facilities, technical data, software, energy and the cost of transportation. Non-recurring events (such as R&D) and recurring events (such as manufacturing) can also be captured. The Events define both where and when each resource will be required and, since probably only limited resources will be available in practice, have associated delay times.

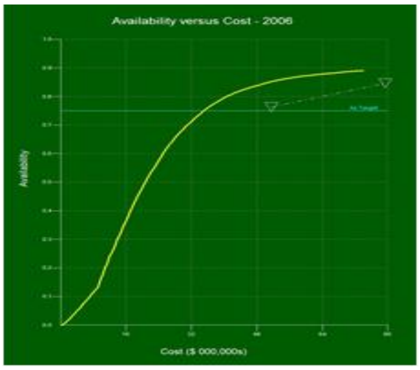
MAAP is a unique, activity-based cost analysis tool which aggregates the cost of each of the resources used in the Usage Pattern to summate a TLC for the Capability, as illustrated below.



Because ***MAAP*** is built granularly bottom-up, at an appropriate level of detail, the 'cost atoms' can be assembled in various ways within a Chart of Accounts of Cost Breakdown Structure to match budgetary categories, such as capital and running costs or management responsibilities.

Support Package Optimisation

In basic use, ***MAAP*** assumes the immediately available use of any resource that is needed to meet the Usage Pattern. This can be considered as 'logistics free', whereas affordability constraints will inevitably apply. Therefore, the support package must be optimised to achieve the best possible support performance for the minimum cost. This is achieved using ***mBOSS*** (***MAAP*** Budget Optimised Support Solution) from the associated ***mPOWER*** utility. ***mBOSS*** uses marginal analysis techniques to optimise across and between different support resources; parts are traded for people, tools etc while maintaining a coherent engineering and logistic package. The locus of individual resources that deliver the maximum achievable availability against cost is illustrated in the picture below.



Budget Reductions

In-service budget reductions are inevitable at some stage. Simplistically, savings could be achieved by reversing back down the locus of optimum solutions illustrated above, but some specific resources will be sunk fixed costs; a hangar cannot be 'unbuilt'. Thus, a different optimised solution must be found that adopts some endowment stock, while offering choices of what resources could be dispensed with.

This analysis is performed by ***mBRACE*** (***MAAP*** Budget Reductions Avoiding Capability Erosion) from the associated ***mPOWER*** utility. ***mBRACE*** will suggest how to maximise the cost reduction while minimising availability within the constraints.

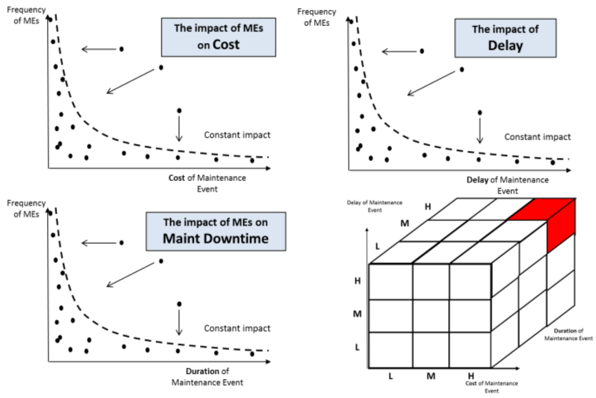
Supportability Audit

The Support Manager should always seek continuous improvement in the performance and cost of his system, but faced with other pressures, time is rarely available. The process should be automated, which TFD call Supportability Audit.

While ***MAAP*** is the ideal vehicle to aggregate up a TLC estimate, its 'cost atoms' are also invaluable in driving down to identify the support cost and performance drivers in a support solution. By querying the core ***MAAP*** data, the cost drivers can be identified as the 'problem children' - the specific MEs (which are related to parts of the design) which are the main constituents of the basic availability equation and have:

- The worst combination of low reliability and long maintenance repair times?
- The longest maintenance downtime?
- The greatest administrative and logistic delay time (ALDT) because of under-resourcing?
- The greatest cost because of all the resources required?

The concept is illustrated below. By adjusting the data within ***MAAP*** to reflect a better solution (as suggested by the arrow in the picture below), the benefit that would accrue to the proposed measure can be deduced from the revised aggregate TLC. In this way, the effort can be focussed on the small proportion of MEs that most affect support cost and performance.



MAAP and ***mPOWER*** are extremely powerful tools to identify and optimise the support perfomance and cost drivers of a system. They provide:

- TLC Estimates
- Optimise all the support resources for system availability
- Identify support cost and performance drivers
- Evaluate the benefits of support improvements
- Maximise cost savings while minimising capability loss

MAAP and _mPOWER_ the answer to multi-resource planning, optimisation & continuous improvement

For more information about all TFD products please contact:
Email: tfde@tfdg.com **Tel: +44 (0) 1603 726660**

Q. Why Use SCO?
A. To Sustain Optimum Performance of Support Packages

You should you use SCO to:

- Identify the parts in a support package which will run out in sufficient time to take effective action.
- Identify the remedial actions that will prevent future support system default.
- Prioritise the remedial actions by cost and the lead time needed to take action.
- Justify the business cost benefits of early action.
- Predict future support package performance.

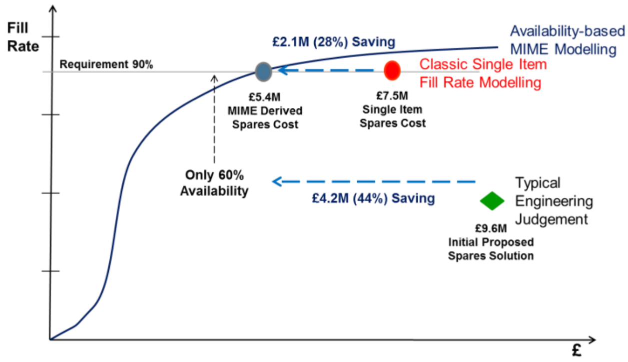
SCO provides near real-time intervention advice to restore and sustain optimum system performance

The aim of spares provisioning is to choose the spares that maximise Operational Availability (Ao) for an affordable cost, or minimises the cost for a required Ao. To preserve system availability, the spares stock must be sufficient to cover the time taken to replenish the stock with a serviceable item. The main drivers are failure rates, repair turn-round times and both purchase and repair costs.

There are 3 typical approaches to calculate stocks.

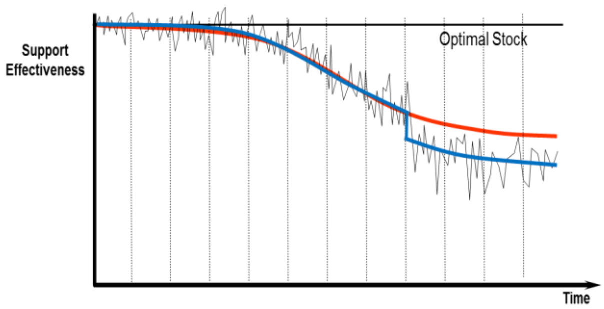
- Engineering judgement based on previous experience, but this is often flawed leading to shortfalls or expensive stock holdings.
- Single Item Modelling works at the item level treating each part independently. Typical measures of performance are Off-the-Shelf and Overall Satisfaction Rates that, in effect, describe the confidence of having a specific part available when required. These measures are also called Fill Rates. This approach can be described colloquially as "Happy Shelves".
- System-based modelling works at system level, addressing all parts simultaneously with overall system availability being the key performance metric. By choosing to hold the spare with the largest impact on system availability, at a cost, the overall risk or shortage is reduced for the overall system. Multi-Indenture Multi-Echelon (MIME) modelling incorporates these principles for complex environments where spares are required at multiple locations, with partial or full repairs at various levels. This approach can be described colloquially as "Happy Systems".

Over many years, Engineering Judgement has proven to be least effective and most expensive. Single Item Modelling is better but, for a given Ao, **System-based Modelling typically produces scales that are 25-30% cheaper, as illustrated below from recent MOD data.**



However, three effects will combine progressively to undermine the original effectiveness of the optimised solution as illustrated below.

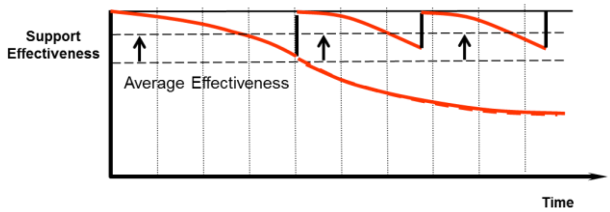
- **Gradual change** in underlying assumptions and conditions – reliability, price increases inflation, delay times, repair costs, NFF rates, technology obsolescence etc.
- **Major change** in the 'state of the world' or exogenous influences on the stock solution - fleet size, flying rate, rebasing or route network, operating profile and environments.
- **Short-term Fluctuation** in the probability distributions of attributes which determine steady state averages - failure distributions, actual delivery times, repair fractions, currency fluctuations.



The cumulative impact over time over time degrades inventory efficiency, increases cost and erodes profitability. This impact is well recognised and is the reason why Engineering Maintenance Policy Review should be conducted periodically followed by Scale

Reviews to adjust Spares Scales. Policy suggests that these reviews should be carried out at 5-yearly intervals, but this has withered and largely been forgotten because of a shortage of analytical resources and diminishing experience.

Periodic reviews, as illustrated below, shift average effectiveness depending on their periodicity. The more frequent the activity, the greater the average improvement. Thus ideally, the process should be automated and frequent to minimise degradation.



Re-provisioning

But there is another less well recognised factor in play. Once initial scales are established, stock levels are maintained automatically by algorithms within the various inventory management and ordering systems for re-provisioning (RP).

For consumables, RP is a relatively simple exercise of ordering in economic quantities sufficiently early for the remaining stock to last for the procurement lead time. For repairable items, the planned stock levels should be sufficient to maintain sufficient available serviceable items while unserviceable items are in the repair loop. In both cases, incorrect planning assumptions would lead to incorrect stock levels with either an increased risk of shortage or, just as bad but less immediately visible, excess stock from wasted investment. Using refreshed data would be sensible

RP uses historic consumption trends as the best indication of future need using Establishment Variation Factors (EVFs) to adjust stocks to anticipate future demand needs such as: the introduction of new equipment until a recurring consumption is established; increased consumption due to increased rates of effort; movements of squadrons or aircraft between units; and fleet run-downs. But EVFs are for special cases. In general, the automated algorithms work well provided that manual intervention by inventory managers or units is carefully considered to ensure that unwanted effects do not occur.

However, current RP algorithms are fundamentally Single Item Modelling approaches. All the benefits of adopting System-based Modelling initially will be progressively eroded leading, by a reversal of the previous logic, to 25-33% more expensive and less effective solutions from Single Item approaches.

Given the potential saving, System-based Modelling should be used for RP through-life.

Support Chain Optimisation - SCO

The ideal is to <u>combine very regular and automated periodic review</u> with <u>Availability-Based modelling</u> across the whole system. Fortunately, continuous availability-based RP is now possible through use of TFD's proprietary tool ***SCO***.

SCO takes regular feeds from customer transaction systems such as ERPs to establish '*What Is Where*' across the inventory range. Using transaction histories to derive up-to-date demand patterns, ***SCO*** simulates forward to assess '*What Will Be Where*' to suggest where, when and for what items future stock shortfalls may occur. But while warning of impending support failure is helpful, it provides no indication of how to avoid them. The third function of ***SCO*** is to optimise the system by assessing the comparative costs and benefits of a wide range of potential mitigation measures such as to move, repair, don't repair, expedite, buy, loan, exchange or take engineering action in order to achieve '*What Should be Where*'. Most importantly, ***SCO*** prioritises the candidate actions by cost effectiveness and identifies the available time to act (or wait and see). It identifies what should be done, in what order and in what timescale to avoid support failure and predict the benefit for future mission capability.

SCO provides automated advice perhaps weekly, or monthly for smaller systems. It provides <u>individual</u> inventory range mangers with advice on where to focus their attention for maximum <u>system-level</u> effect through an intervention action list ranked in order of exposure.

SCO provides continuous availability-based inventory optimisation that sustains mission capability at lower cost by preserving the initial benefits of a system-based optimisation, and avoiding normally unseen in-service cost growth.

By recognising and addressing the simple, fundamental weakness of single item management that is endemic within RP systems, ***TFD's SCO* provides a quantum step change in inventory management and offers very significant cost avoidance of 25-33%.**

Q. Why Use Tempo?

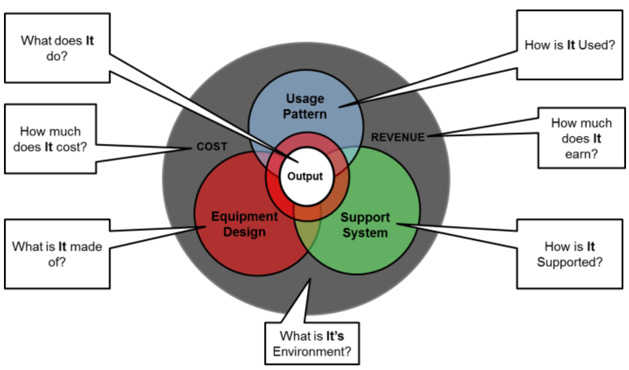
A. The First Spares Optimisation Tool to Deal Directly with Changes over Time

You should you use ***Tempo*** when you need to develop optimum spares scales to meet fleet availability targets where:

- The operational usage or fleet disposition changes over time through fleet expansion, re-basing, re-role or run-down
- Equipment design changes over time because of obsolescence, modifications, upgrades, or reliability improvement programmes
- Support arrangements change over time as maintenance and repair policies, contractors, their performance and price evolve
- While minimising wasted investment in stock with a short useable life.

Tempo – The Next generation Inventory Optimisation Tool

The cost and output of a Capability are defined by the interaction of its Usage Pattern, its Equipment Design (as described by the system structure and the related attributes such as reliability and maintainability), and the Support System.



The critical outcomes of operational performance (such as system availability and cost) are the result of the complex interaction of these three key features.

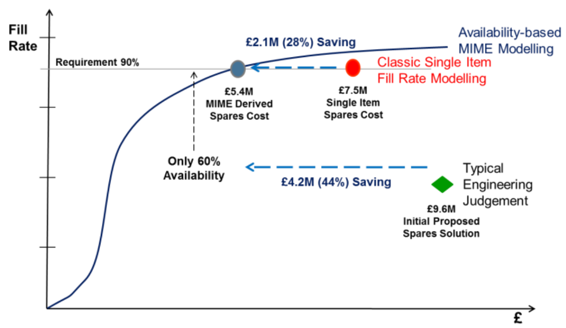
Spares Provisioning

The aim of spares provisioning is to choose the spares that maximise Operational Availability (Ao) for an affordable cost, or minimises the cost for a required Ao. To preserve system availability, the spares stock must be sufficient to cover the time taken to replenish the stock with a serviceable item. The main drivers are the failure rates, the repair turn-round times, if appropriate, and both the purchase and repair costs. Reducing repair turn-round times will minimise the need to hold spares to stock the pipeline.

There are 3 typical approaches to calculate stocks.

- Engineering judgement based on previous experience. This approach is often flawed, leading to shortfalls or expensive stock holdings.
- Single Item Modelling works at the item level treating each part independently. Typical measures of performance are Off-the-Shelf and Overall Satisfaction Rates which, in effect, describe the confidence of having a specific part available when required. These measures are also called Fill Rates. This approach can be described colloquially as 'Happy Shelves'.
- System-based modelling works at system level addressing all parts simultaneously with overall system availability the key performance metric. By choosing to hold the spare with the largest impact on system availability, at a cost, the overall risk or shortage is reduced for the overall system. Multi-Indenture Multi-Echelon (MIME) modelling incorporates these principles for complex environments where spares are required at multiple locations, with partial or full repairs at various levels. This approach can be described colloquially as 'Happy Systems'.

Over many years, Engineering Judgement has proven to be the least effective and most expensive approach. Single Item Modelling for each item is better but for a given availability level System-based Modelling typically produces scales that are 25-30% cheaper as illustrated below from recent MOD data.



However, all current spares optimisation tools are steady state and assume long-term, steady-state scenarios, which remain unchanged forever. In the real world, the situation always changes as basing, activity levels, support arrangements, even system configuration, evolve. Thus, current tools will be incorrect in calculating optimum scales for changing scenarios.

In a best attempt to address the issue, users of steady-state tools can chain together a sequence of runs. But each run is unaware of subsequent changes and optimises a permanent situation.

Why *Tempo* is Different

Tempo changes the game by addressing 'directly' and 'correctly' the complex impact of time. It creates a calendar of changes in such as operating pattern, hardware and support scenarios: basing, usage rates and Ao targets, configuration, lead times, reliability improvements and prices. For the first time, technological obsolescence and the remaining useful life of parts can be applied to directly influence future spares purchasing decisions and minimize waste from buying excessive parts that will be retired early.

Tempo automatically manages the changes to reduce time, labour and errors. It incorporates 7 important changes to take direct account of time:

- ***Tempo*** captures changes to key variables over time such as changes to hardware attributes (such as reliability and unit price), and changes to fielding scenarios (such as fleet size and usage rates).
- ***Tempo*** maintains a complex set of calendars to separate and account for specific points at which inventory solutions are required. These include budget cycles, delivery schedules, reliability growth or wear-out, and the Mean Technological Life (MTL) by class or item.
- ***Tempo*** considers the specific time period over which a spare part can be used which might be less than the whole system life because the procurement or repair lead times delay the delivery of benefit from a spare. Approaching the end of system life has the same effect. Obsolescence or MTL can shorten the usefulness and, thus, the Return on Investment of a spare.
- ***Tempo*** evaluates each increase in stock against hybrid and multiple performance targets to meet complex contractual frameworks that could include targets for Ao, fill rate and delay times.
- ***Tempo*** contains an enhanced analytical engine that uses an economic present value 'bang for buck' ratio for marginal optimisation.
- ***Tempo*** relieves the analyst of drudgery and reduces error-prone analytical tasks. Currently, analysts using steady-state models must split scenarios into multiple time-slices, one for each fixed condition, and load results from the last run as inputs to the next. As the volume of change increases, complexity, workload, time and the probability of error grow exponentially.
- ***Tempo*** delivers new time-based analytical outputs showing the comparative inventory and performance results through time.

Tempo is ideal for:

- Budget trade-offs between expensive, long-lead time parts that will be critical at some stage and inexpensive short lead time items that might provide immediate performance. ***Tempo*** determines the proper mix by comparing the cost and return corrected to Net Present Value.
- Complex, multi-period Performance Based Logistics environments with multiple metrics and KPIs. ***Tempo*** can optimise a complex mix of metrics by comparing the incentive reward against the cost.
- Obsolescence and Ageing Systems where technology insertion, mid-life upgrades and late-life spares requirements are inevitable. ***Tempo*** recognises the differences between the useful life of a part and that of the system in which it is fitted, and calculates their respective value.
- Scenarios of simultaneous new-fleet build-up and old-fleet retirement, characterised by changing Ao targets, operating tempos and basing. ***Tempo*** provides all solutions in a single run.
- Expeditionary temporary deployments, training exercises and other time-bound excursions requiring spares solutions integrated with long-term, normal deployment solutions.

A solution optimised in ***Tempo*** is superior to one provided by steady-state tools because it:

- Explicitly handles inevitable changing scenarios
- Avoids the errors implicit in steady-state models, including over-stocking of life-limited and long-lead time parts
- Maximises return on investment and avoids waste from market-driven obsolescence
- Optimises procurement timing to match fleet build-up, re-basing and run-down for lowest cost.
- Deals explicitly with time, eliminating the drudgery of hand-made multi-period calculations

Tempo is the next generation Inventory Optimisation Tool

Q. Why Use EDCAS?

A. For Equipment Front-End Design Choice, Cost Assessment and Level of Repair Analysis

You should you use ***EDCAS*** when you need to:

- Evaluate the Life-Cycle Cost (LCC) of an equipment design choice.
- Identify the optimum repair policy for an equipment design choice.
- Compare the LCC of alternative designs.
- Test the sensitivity of preferences when data estimates are uncertain.

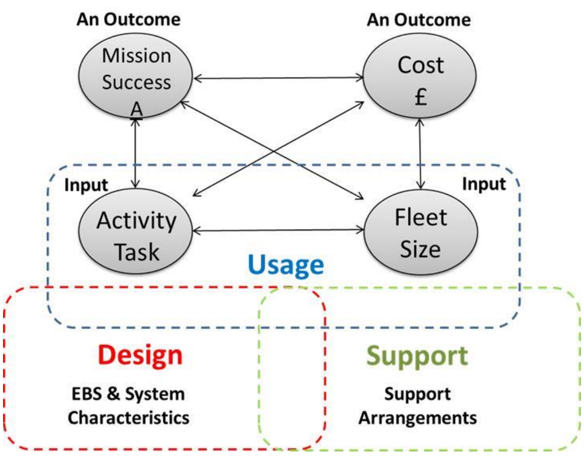
EDCAS - Equipment Designers Cost Analysis System

The International Standard for Front End Cost and Level-of-Repair Analysis

EDCAS is a software-based analysis tool to:

- Select the best design for new equipment based on Life-Cycle Cost
- Understand the impact on supportability and cost of part and configuration design trade-offs
- Define the best repair strategy
- Understand the cost and logistics performance of design alternatives

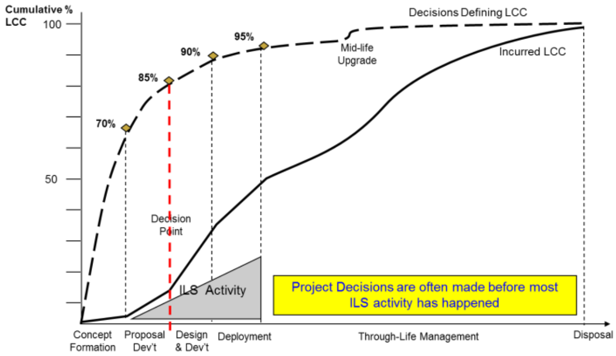
The cost and output of a Capability are defined by the interaction of its Usage Pattern, its Equipment Design (described by the system structure and related attributes such as reliability and maintainability), and the Support System. The critical outcomes of operational performance (such as system availability and cost) are the result of the complex interaction of these three key features.



EDCAS holds data about a system, its operational usage, its constituent components, and the resources (parts, tools and skills) required for its maintenance.

Front-End Analysis

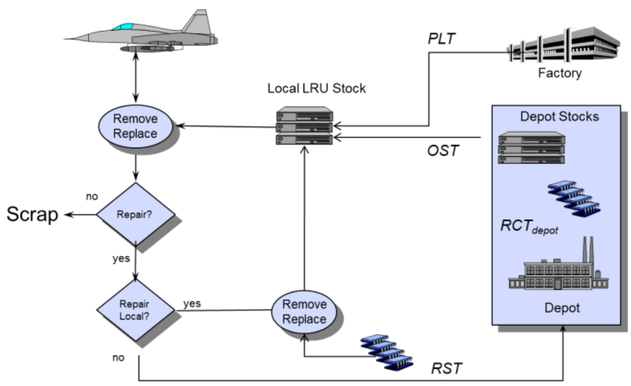
There is a very different phasing between the expenditure of cost in a programme and the point when that costs is committed. Decisions made early in the programme embed LCC that are extremely expensive to affect later. There is an old adage that what costs $1 to change in concept, costs £1000 in design, $1M in manufacture, $10Ms in modifications and $Bns through-life. To avoid this, programmes must spend money early to reduce downstream risk and cost.



This fact of life is the reason why Front-End Analysis is essential to take account of costs throughout the life cycle. ***EDCAS*** supports optimisation of Engineering Design, Reliability Engineering, Configuration management and the ILS disciplines of LCC, LORA and spare parts scaling. By determining in detail the resource costs of all viable options, ***EDCAS*** enables the user to make better decisions based on the LCC of the selected option.

Level-of-Repair Analysis (LORA)

A simple logistic system is illustrated below. When a system fails, the faulty part must be removed and replaced with a spare part from local stock.



The first critical question is whether the part should be repaired or scrapped. To determine if repair is the cheaper option, the cost of all the necessary piece parts, skills, test equipment, facilities, transportation times (Outward - OST and Return - RST) and production and repair lead times (PLT & RTRT), and the stock needed to fill the pipeline. This data informs choices about the optimum level or depth of repair and the optimum location, which become the repair policy. ***EDCAS*** supports LORA by evaluating all potential repair policies for the system and its major components by quantifying the LCC of the key cost drivers.

Inside *EDCAS*

EDCAS contains a complex mathematical LORA model to calculate to determine the most cost effective maintenance policy for an item. The choices are: user repair at Organisational, Intermediate or Depot site, Contractor repair, or Discard at Failure. The key elements are:

System Structure - During the early stages of a programme, ***EDCAS*** can be used to describe the system Equipment Breakdown Structure (EBS) or Bill of Materials. The hardware structure can be built progressively using Next Higher Assembly, Parent/Part Structure or Logistic Control Numbers (LCNs). The robust relational database structure of the TFD data Vault that underpins ***EDCAS*** ensures that this data view is logically valid.

Logistic Resources - *EDCAS* also uses data for all the associated logistic resources that drive cost:

- System configuration
- Fit (allowance for redundancy)
- Duty cycle
- Reliability and maintainability data, including frequency of scheduled and unscheduled maintenance events.
- Maintenance resources, skills, tools, test equipment, facilities data such as:
    - Production costs (initial and recurring)
    - Spares (initial and replenishment)
    - Repairs
    - Personnel skills and training
    - Technical Publications and Data
    - Test Equipment (initial and ongoing)
    - Facilities (initial and ongoing)
    - Packaging & Transportation
    - Disposal costs or salvage values

Specific data is preferable when available, but broad estimates can be used subject to sensitivity analysis.

Options Analysis - Analysts can use ***EDCAS*** to evaluate, include or exclude design and support options to focus limited and costly resources. For example, it is useful to know that one option is clearly cheaper than another. But it is also important to discover how and why those costs differ. This is particularly important when some of the design is already fixed and system cost savings must be made in other ways by finding the main cost drivers and evaluating alternatives.

Sensitivity Analysis - *EDCAS* contains powerful sensitivity analysis, which is quick and easy to use to re-calculate model outputs resulting from changes in a single model inputs. Fleet size, utilisation rates, deployment pattern, reliability and the frequency of scheduled or unscheduled events can be automatically adjusted to evaluate sensitivities. Inputs, such as cost, shipping, procurement and repair and lead times can be altered in a single or series of runs, to identify the thresholds at which changes become significant to allow analysts to identify automatically the most important factors.

Configuration Trade-Off Analysis A trade-off compares the outputs resulting from various changes to model inputs. ***EDCAS*** can hold unlimited configuration variants, deployed in unlimited locations, with unlimited different fleet sizes and usage rates within a single TFD database. These variants can be assessed in multiple runs to identify the best possible configuration. Or for a fixed scenario, ***EDCAS*** can support Configuration Trade-Off Analysis within a single run to identify the optimum configuration and LCC for that situation to allow suppliers to optimise designs for LCC.

Using *EDCAS* reduces LCC

EDCAS provides a rapid, intuitive tool to answer many design and supportability questions - to establish the expected system availability, LOR policy, spares analysis and LCC. It can:

- Cost the best design for new equipment
- Define the best level-of-repair strategy for the support solution
- Understand the impact on supportability and cost of part and configuration design trade-off
- Understand the logistics of design alternatives

Q. Why Use the TFD Data Vault?

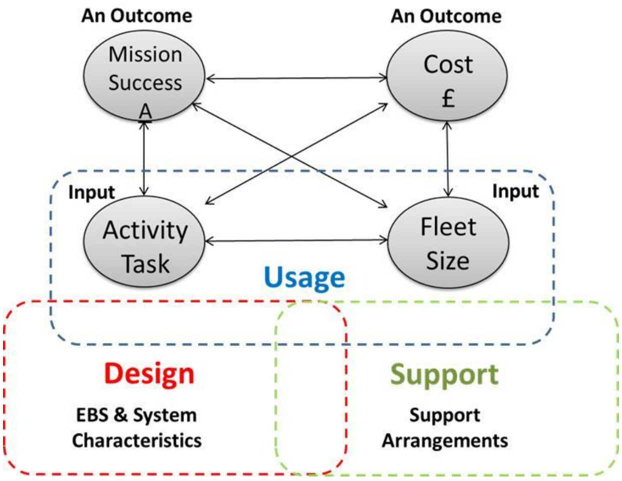
A. To Provide a Single Robust Source of Essential Data for Logistics Modelling & Analysis

You should you use the ***TFD Data Vault*** (***TFD dV***) to:

- Collate the data needed for logistics analysis and modelling for multiple systems
- Provide a controlled data store
- Centrally manage logistic data
- Protect the investment in good quality and trustworthy data

The *TFD dV* is a comprehensive, robust, common source repository for logistic data.

The cost and output of a Capability are defined by the interaction of its Usage Pattern, its Equipment Design (described by the system structure and related attributes such as reliability and maintainability), and the Support System. The critical outcomes of operational performance (such as system availability and cost) are the result of the complex interaction of these three key features.

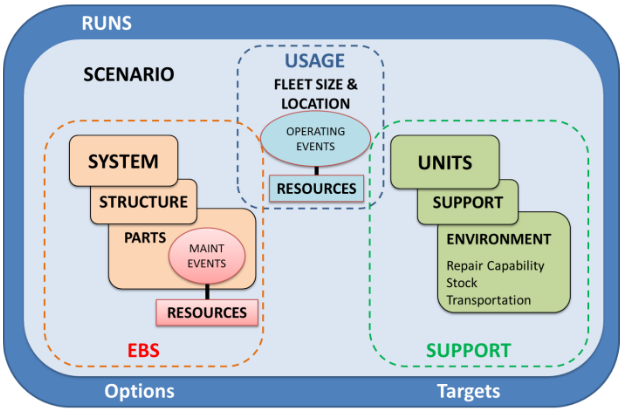


TFD dV

The ***TFD dV*** holds logistic data for systems, their operational usage, constituent components, and all the resources (parts, tools and skills) required for their maintenance in different scenarios. It contains the essential numerical subset of a traditional LSAR that is needed to make logistics decisions, but without the specific constraints of LSAR data standards. But all data is subject to rigorous validation on entry against business rules that ensure logic, consistency, coherence and completeness.

The ***TFD dV*** has been specifically designed and evolved over 30+ years to contain all the data needed for logistics analysis and modelling.

Logistic data is typically drawn from many and varied sources with disparate original purposes. While the old adage suggests "*collect data once, use many times*", it can be taken too far with data often misused out of context because it was available. The only true solution to this conundrum is to understand 'how and why' data has been captured, and in 'what' context. If it is then structured in true relational terms, the original meaning is preserved and then can be used. This requires very careful thought on how to structure the data repository.



Fortunately, TFD Group has developed and evolved the ***TFD dV*** as the single dependable source of trusted logistic data in a true relational database that has been specifically designed to contain the data needed for logistic decision making.

Data Sources

Because logistic data is typically drawn from many and varied sources with disparate original purposes, it is often inconsistent, incoherent and incomplete. It is frequently inaccurate because the sources have not been updated to reflect the latest physical state of the system or because data systems do not trap manual entry errors such as multiple versions of part numbers. On one aircraft system, the initial Bill of Materials was 440,000 parts; after cleansing and rationalisation, the real number was only 152,000.

Capturing, collating and assembling conflicting data from multiple sources to identify and select the true data in order to describe systems is, therefore, a potentially difficult and time-consuming task. It is also highly unlikely that all the required data will be available, assumptions and data creation are inevitable and a Master Data and Assumptions List under configuration control is a vital tool.

Data Quality Assurance

The need to assure data quality, by using agreed data standards and applying sound processes throughout the data life cycle, is well recognised. These ideals are not yet universal and most logistic data was either developed historically or is still not assured. Data standards are often 'tailored' locally which destroys their very purpose. This situation is likely to continue and we must accept the reality of having to use legacy data for very many years.

Fortunately, the ***TFD dV*** applies rigorous data validation checks to ensure that only legitimate and logical data can be entered. For example, uploading a recent 'standard' air platform LSAR to the ***TFD dV*** exposed 70,000 errors; this rate is quite common.

Data Cleansing

Data cleansing is, therefore, an inevitable and very laborious burden. But even if the data is cleansed before analytical use, unless the original data sources are also cleansed, the errors will perpetuate and all the good work will be undone when the next update is loaded. The ***TFD dV*** deals with this issue by assigning a Data Quality Attribute to each and every field. This can be set to protect cleansed data from subsequent automated updates. It can also be used to manage progress with the data cleansing process and focus attention on the data fields with the greatest business impact.

Initial Data Sets

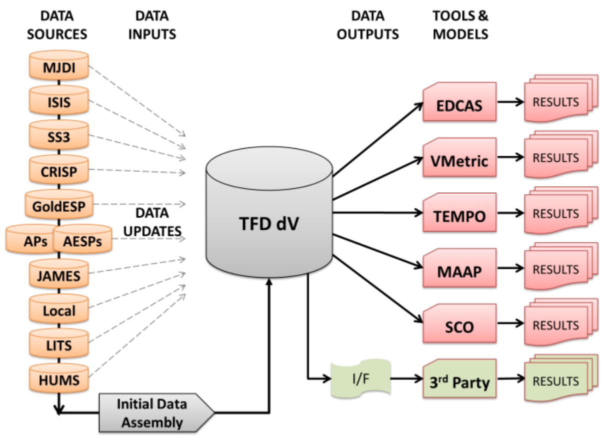
The inevitable data issues mean that building an initial system data set automatically is rarely if ever possible. The error trapping and correction algorithms would be so extensive and source specific for the effort to be futile. Therefore, building the initial data set is likely to be quicker and more straightforward if the task is conducted by a skilled analyst.

There is nothing like building a model of a system to refine the needs for data. Two very appropriate adages come to mind "*The more you use the data, the better it gets*" and *"It's better to model with some data than not to model at all."* To misquote General Eisenhower *"It's not about the model, it's about the modelling".*

That said, once the initial data set is constructed, it is possible to create automated or semi-automated interfaces to the data sources to capture updates. Data maintenance is a vital function which must be sustained. Having suffered the burden of building the initial system data sets for analysis, constant maintenance minimises is essential to minimise delays when further analysis is needed.

The maintenance task is eased by using the TFD Database Executive (***TDX***), a powerful software utility to manage the ***TFD dV***. Use of ***TDX*** minimises the need for specialist training allowing data maintainers to interact with the data in a natural and intuitive way. For large applications containing many systems, ***TDX*** is a cost-effective solution.

The ***TDF dV*** is the vital core of the powerful suite of logistic support decision tools in the ***TFD Supportability Workbench.*** It provides a trusted source of data for logistics models and analysis.



The ***TFD dV***:

- Was specifically designed and evolved over 30+ years to support logistic support decisions
- Contains logistic support data in its appropiate context for dependable reuse
- Enforces data quality during data entry and protects it subsequently from corruption through over-writing by automated uploads
- Drives the ***TFD Supportability Workbench***
- Can also drive Third-Party analysis tools

The TFD dV is the solution to your data problems.

TFD also provides skilled and experienced analysts who understand the logistic support business to solve your data problems.

Q. Why use Modelling for Logistic Decision Support?
A. To Deal with, rather than Sink Under, the Complexity of Logistic Support

Are you struggling to understand how modelling can help you to:

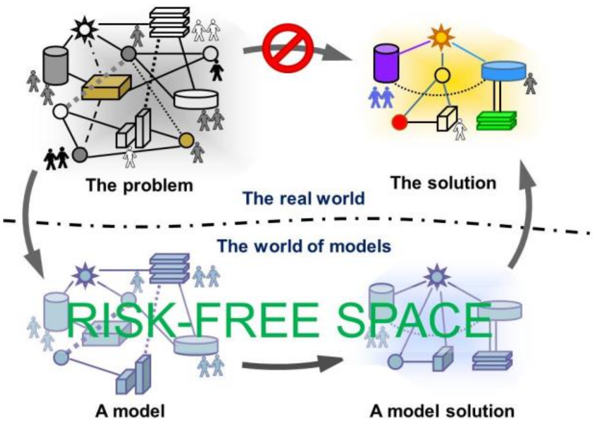
- Choose between equipment to minimise through-life cost?
- Evaluate optimum repair policies and locations?
- Maximise availability while minimising the cost of spares and repairs?
- Estimate all support costs through-life?
- Identify the support cost drivers and develop business cases to improve them?
- Maintain support solutions at peak efficiency?
- Evaluate how to manage future change?
- Make support decisions, set budgets or prices, agree service levels and manage costs
- Defining the best Support and Repair strategy?

Stop Struggling!
TFD can solve these problems by modelling using our Supportability Workbench

The support of modern systems, regardless of their environment, has become very complex. Their use is more varied, demanding and with higher expectations that systems will work when required. Equipment has become increasingly sophisticated with systems having thousands of components. And Support needs have become more exacting with advanced technology and diverse supply chains. All the time affordability pressures are increasing to '***do More for Less***'.

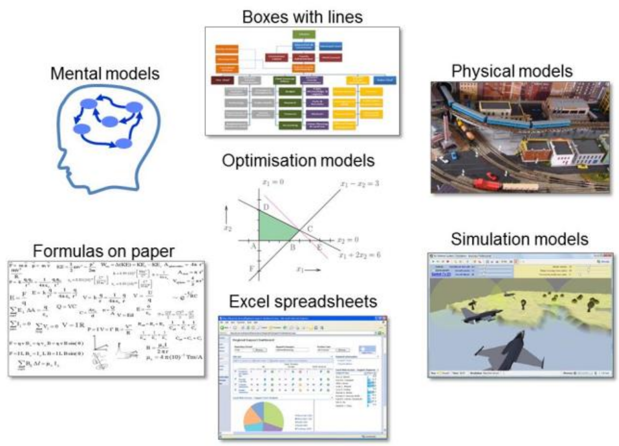
The elements describe an extremely large and complex problem with many uncontrollable, time-based but interconnected variables. Faced with this complexity, our ability to understand and evaluate the most effective solutions is becoming overwhelming. The system does not behave linearly but in unpredictable ways with planned actions having disproportionate or no effect in specific circumstances. Indeed, whatever you do, including doing nothing, changes the problem on you.' Analysis by traditional deterministic means is simply not possible as there are more potential solutions than atoms in the universe, calculations time would exceed the life of the universe, and there is no single right answer. It is not a puzzle but a clear example of a 'Wicked Problem'.

Modelling can help deal with this challenge. vModels may take many forms but they all have one key feature – they are abstractions of the real system. They represent the real world sufficiently to provide a risk-free space or 'sand box' in which to explore behaviour and experiment with solutions.



In the world of logistic support, the most useful models are software tools that hide the complexity from the user within the algorithms. The problem thus translates from a need to have a deep scientific understanding of how all the elements interact into a set of processes to use the tools and analytical techniques.

As an analogy, Airbus pilots do not know the full technical detail of their complex, software-based flight control and autopilot laws, but they can fly the aircraft easily, effectively and efficiently to their destination.

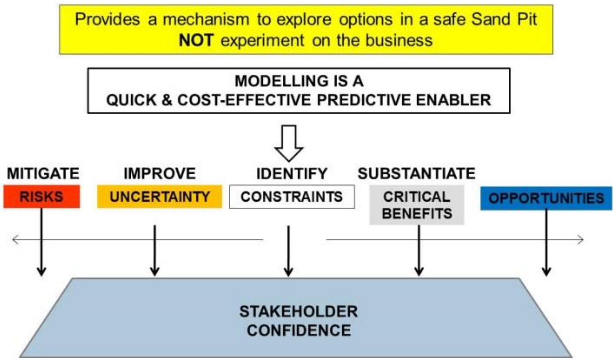


Modelling is the best way to deal with, rather than sink under, the complexity of typical logistic support challenges. Modelling simplifies the user's problem without ignoring the implicit complexity.

Modern equipment is carefully designed and exhaustively tested to ensure that it works as planned. Failures are analysed and measures are developed to control the impact of failure. Similarly, users are trained in both normal and system failure conditions to operate it safely and as effectively as possible. You would not dream of flying in an airliner that had not been fully tested and where the pilot was not regularly trained and tested in a flight simulator.

But often in business, particularly in logistic support, people routinely fail to test and evaluate the effectiveness of their support solutions before implementing them. Judgement or simple calculations substitute for effective analysis. Worse, the outcomes are often based on limited and uncertain data assumptions that are not assured. The outcome is often not as planned or, to control risks, excessive margins are added. In short, logistics Test and Evaluation is not normally conducted and the outcome is left to chance. There is no logistics 'flight simulator' in which to train.

Modelling can solve these issues to provide a mechanism to experiment beforehand in a safe 'Sand Box' ***not on the live business***. It allows constraints to be understood, bottlenecks to be identified, sensitivity analysis applied, and the maximum intrinsic capacity of the system to be determined. From this, the potential operational and financial impacts of alternative operating scenarios, such as stress conditions and risks, and improvement options can be evaluated. In essence, modelling is a low cost, rapidly deployable and effective tool for de-risking decision making without the need for lengthy, costly and uncertain practical trials.



Ideally, modelling is the basis for continuous improvement to enable not just planning but the control of logistic support.

The mission of an Integrated Logistic Support Manager (ILSM) is to:

> ***Plan, implement and improve through-life the effective support of a system to meet the required tasks, while seeking efficiencies to balance more output, with fewer systems at lower cost.***

This translates into the typical tasks below that can all be usefully informed by modelling.

- Periodically re-optimise support resources.
- Assess options to reduce costs while minimising loss of capability.
- Continuous improvement reviews of options to either improve availability, reduce the in-use fleet size, or reduce future costs.
- Logistic impact assessment of operational deployments while maintaining training.
- Supportability impact of task surges.
- Supportability impact of major fleet upgrades.
- Analyse Level-of-Repair strategy break points.
- Cross-platform use of shared repair facilities
- Evaluate new equipment design choices for obsolescence and upgrades.
- Benchmark and evaluate contract prices.

TFD's Supportability Workbench includes a suite of tools to meet all these needs:

- Plan the right Support Solution using ***EDCAS***.
- Optimise spares solutions using ***Tempo*** anticipating changes over time.
- Develop a detailed Life-Cycle Cost across all resources using ***MAAP***.
- Explore 'what if' scenarios using ***mPOWER***.
- Continue to achieve in-service KPIs despite real word events and changing scenarios by monitoring and actively sustainng support solutions using ***SCO***.

TFD's Supportability Workbench combines all these tools based on a single, integrated ***TFD dataVault*** for effective decision making through modelling.

TFD can provide the software, skilled and experienced supportability modelling analysts, and training to solve difficult logistic problems.

STILL Struggling?

Q. Are you Struggling with your Equipment Repair Strategy?
A. EDCAS - TFD's Design Optimisation & Level of Repair Analysis (LORA) Tool

Are you struggling with:

- Costing the best design for your new equipment?
- Defining the best level of repair strategy for your support solution?
- Understanding the impact on supportability and cost of part and configuration design trade-off?
- Understanding the logistics performance of design alternatives?

STOP Struggling!

Using TFD Group's *EDCAS* software product will solve these problems

The Equipment Designers' Cost Analysis System (***EDCAS***) is an analytical model used to identify and quantify cost-effective solutions to a number of Systems Engineering problems. It supports data collection optimisation of Engineering Design, Reliability Engineering, Configuration management and the ILS disciplines of Life-Cycle Costing (LCC), Level of Repair Analysis (LORA) and spare part scaling.

EDCAS calculates support resource life-cycle costs, facilitates sensitivity analyses and configuration and part trade-off studies. ***EDCAS*** aims to influence system design both of physical equipments and the support elements required to sustain them and thus reduce costs.

EDCAS holds data about a system, its constituent components, the resources (parts, tools and skills) required for its maintenance, together with details of its operating environment.

EDCAS is used to determine the level of repair policies for the system and its major components and provide analytical reports quantifying (in LCC terms) key cost drivers. The detailed life cycle cost output provides the initial, operating, support and disposal costs for each evaluated option. In addition to numerical reports, various graphs and charts can be generated showing the extent and proportion of LCC for each cost driver ***EDCAS*** can subsequently be used to undertake sensitivity, configuration / part trade-offs and other analyses to improve design, save cost and determine the impact of change.

All data is held in a relational database and can be imported or exported in multiple formats including spreadsheets.

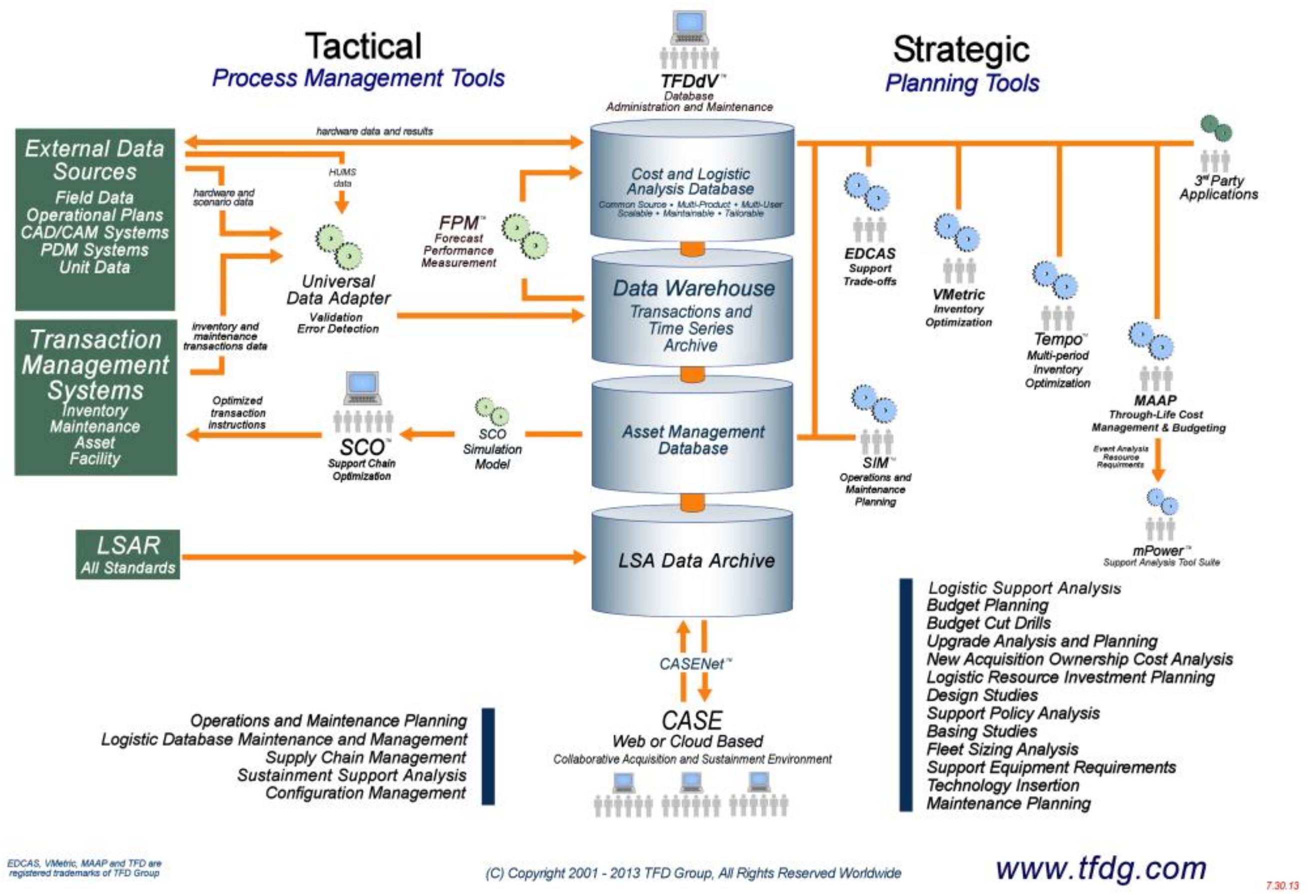
Image Courtesy of Eurofighter Jagdflugzeug GmBH

EDCAS has been mandated as the tool for life cycle support cost and level of repair analysis on many current systems including:

Eurofighter(Typhoon), Leopard II, EFV (formerly AAAV),Stryker, LPD 17 and Gepard ADS. It has also been widely used with many MoD and DoD military installations. EDCAS has also been awarded a UK MoD Verification and Validation (V&V) certificate.

EDCAS is part of the TFD product suite. A portfolio of Strategic and Tactical products combining to provide a complete supportability solution, as shown in the TFD Software Architecture figure overleaf:

TFD Software Architecture



- ***EDCAS*** - the international standard for front-end cost and level of repair analysis.
- ***VMetric*** - to plan competitively low-cost spares lists, identify inadequate or expensive spares recommendations and be sure of achieving target fill rate or availability levels.
- ***Tempo*** - accommodates changes over time in spares optimisation.
- ***SCO*** - for tactical Support Chain Optimisation.
- ***MAAP*** - a deterministic, event-based Total Ownership Cost model to provide the most reliable cost forecasts available and accurate resource requirements by time period and real-world location.
- ***TFD Data Vault*** - a common source database, optimized for use with analytical processes, to support both TFD products and those of other providers.

This unique and comprehensive suite of software tools, underpinned by the common source data vault, provide the full capability to support all your Integrated Logistics Support (ILS) supportability needs; either as software installations or through a service arrangement with TFD.

TFD: The Trusted Name in Logistics Decision Support

STILL Struggling?

Q. Are you Struggling with your Support Strategy?
A. TFD will provide a Service using our proprietary tool suite

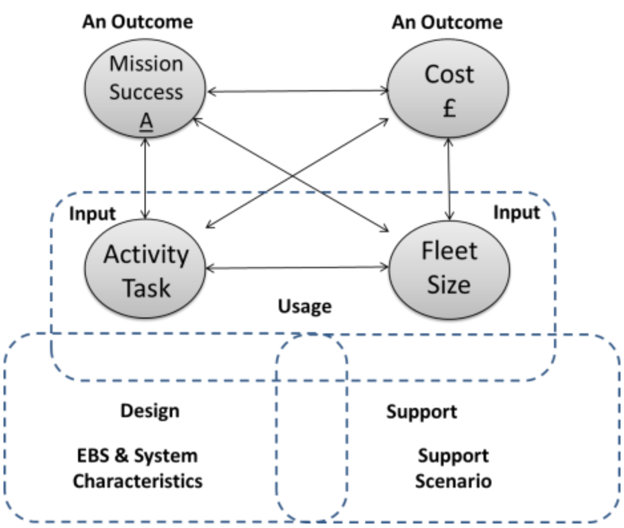
Are you struggling with:

- Defining the optimum Support Strategy?
- Feel that your Support Strategy could be better, but don't know how to form and test your ideas?
- Persuading your organisation to change the support strategy?
- Don't want to make a large investment in tools until you are sure of the return?
- Or haven't got time to buy and learn how to use the tools?

STOP struggling!
TFD Group can solve these problems quickly and economically using our tool suite

Deciding the optimum Support Strategy for a defence system is a complex business and is getting harder as customers demand "more, with less". It must take account of the system architecture, how it is used and how it is supported. These three elements interact to define, in practice, the effectiveness and efficiency of a given fleet size in providing operational capability, mission success or availability at a cost.

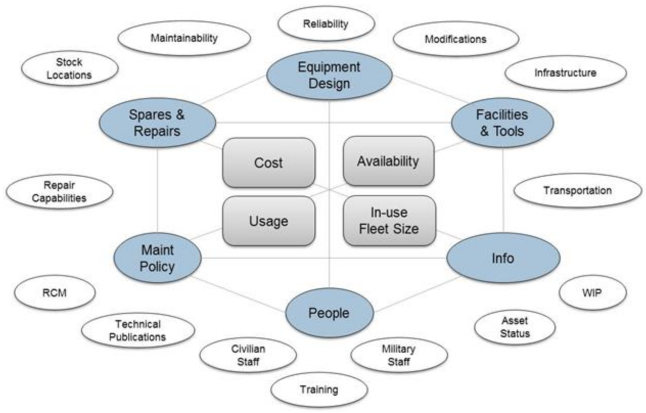
Support plans often prove to be sub-optimal in practice because equipment characteristics such as Reliability and Maintainability are different in reality, the systems may be used differently, and support performance often does not turn out as planned. This creates significant risk leading to poor availability, increased system cost and inadequate military capability.



While ideally the system, the activity level and the usage pattern could be adapted, in practice these are often fixed. Capability planners will always be reluctant to cut activity levels and will press the supportability community to do better seeing improvements in the support system as the only palatable opportunity. Indeed, the Support Strategy will have a significant impact on the size of the active fleet required for training and, to a lesser degree, for operations.

To address these issues, the Mission of an Integrated Logistic Support Manager must be to:

Plan, implement and improve through-life the effective support of a system to meet the required tasks, while seeking efficiencies to balance more output, with fewer systems at lower cost.



This definition captures the central need to deliver equipment availability, affordably for a required usage of an optimum in-use fleet. Any trade-offs are influenced by the main ILS functions, illustrated in blue, which in turn are defined by the outer ring of techniques, knowledge and detailed activities.

How then can a Support Strategy be optimised?

TFD Group has an activity-based logistics resource supportability and analysis modelling tool called ***MAAP***. A ***MAAP*** model defines in detail when, where and why specific costs were incurred, to allow exploration of the linkages, interactions and outcome of potential changes to the input factors in dynamic operating profiles. It provides a flexible means of understanding the 'cost atoms' which, when aggregated, define the entire support system, when and where it is used and maintained, by whom, using what resources, at what cost, and what they deliver for system availability and task achieved.

MAAP is able to address multiple systems, at multiple maintenance levels over changing multiple year scenarios and considers all the support resources needed; manpower, skills, tools, test equipment, facilities, transportation and spares. ***MAAP*** also has an associated utility suite, ***mPOWER***, with 3 specific capabilities:

- **mBOSS (**MAAP Budget Optimised System Support) to optimise the Support System against a constrained budget.
- **mPIRIC (**MAAP Progressive Investment in Reliability Improvement Candidates) to identify the maintenance events that are the cost and availability drivers.
- **mBRACE (**MAAP Budget Response to Avoid Capability Erosion) to assess an existing Support System to suggest the actions that could be taken to reduce cost while minimising the effect on system availability.

The ***MAAP*** suite allows Support Managers to develop a robust model of their environment in which to assess the support implications of alternative scenarios. It provides the means of addressing 7 challenges and tasks which typically face them:

- Periodic re-optimisation of support resources.
- Options analysis to reduce costs while minimising loss of capability.
- Continuous improvement reviews of options to improve availability, reduce the in-use fleet size, or reduce future costs.
- Supportability impact assessment of options to deploy partial fleets on operations while maintaining training.
- Supportability impact of task surge requirements.
- Supportability impact assessment of major fleet programmes.
- Contribute to cross-platform assessments of shared level of repair and supportability analysis.

Together ***MAAP*** and ***mPOWER*** provide the capability for Support Managers to explore these challenges and provide answer through output reports. This level of understanding will empower Support Managers to take actions – to pull the levers – to plan and manage their systems more effectively and efficiently.

In a recent Case Study, a major European Defence customer wanted to review its overall maintenance policy for 2 categories of equipment for its armoured vehicles: the power packs, engines and gearboxes; and electronics such as radios, data systems and optical sights. The task was not to conduct a detailed Level of Repair Policy for each item in isolation, but to take a broader view of the optimum support strategy. Should generic repair capabilities be provided for field deployment in order to improve system availability and reduce overall cost by shortening repair loops, minimising the cost of stockholdings and, significantly for deployed operations, lowering the burden on expensive and scarce transportation pipelines, especially by air?

Using a ***MAAP*** model in a representative scenario, TFD was able to show conclusively that the Support Strategy of forward repair which they had adopted as doctrine for many years, was still true. While looking at each item in isolation, as might be expected by equipment Project Teams and their OEMs, justified a policy of return to the OEMs for repair, assessing all the items together showed that sharing the cost of creating and using generic repair assets in the field was considerably cheaper and more effective.

In sum, Support Managers should build and maintain a current baseline model of their system but, all too often, it is not available to them. But faced with an urgent need to make decisions, Support Managers do not believe they have the time available nor the capacity to explore the market, buy sophisticated tools, learn to use them, gather data, build models and conduct the analysis. Understandably perhaps, they turn to their prime suppliers for advice which they are unable to validate other than by judgement. It seems to be the only solution.

The alternative is to use people who are skilled and experienced experts in supportability analysis, who understand how to gather relevant data, and who bring powerful tools which have been validated and verified by the UK MOD. The answer is to turn to TFD who will provide the answer as a service.

STILL Struggling?

Q. Are you Struggling with Spares?
A. Tempo – The Next Generation of Inventory Optimisation Tool

Do you struggle with?

- Fleet build-up and run-down
- Obsolescence and technology refresh
- Reliability improvement impact on spares solutions
- How to spare aging systems
- Long lead-time versus short lead-time buys
- PBL incentive schemes with complex metrics
- Other future program changes such as Ao targets, operating hours and basing

STOP struggling!
Tempo solves these problems quickly, easily, automatically

Current spares optimisation methods worked reasonably well before the extensive use of COTS components in the 1990s when market-driven technological obsolescence started to become a common headache for inventory managers and planners.

Tempo is the first optimisation tool to deal directly and correctly with part obsolescence and a host of related problems – automatically.

A ***Tempo***-optimised solution is superior to those provided by steady-state tools because it:

- Explicitly handles inevitable changing scenarios
- Avoids the errors implicit in steady-state models including over-stocking of life-limited and long-lead time parts
- Maximises return on investment and avoids waste due to market-driven obsolescence
- Optimises timing of procurement to match fleet build-up, re-basing and run-down for lowest Life Cycle Inventory Cost
- Deals explicitly with time, eliminating the drudgery of hand-made multi-period calculations

Tempo is ideal for:

- Budget trade-offs between expensive, long-lead time parts that will be critical at some stage and inexpensive short lead time items that might provide immediate performance. ***Tempo*** determines the proper mix by comparing the cost and return corrected to Net Present Value.
- Complex, multi-period Performance Based Logistics environments with multiple metrics and KPIs. ***Tempo*** can optimise in a complex mix of metrics by comparing the incentive reward against the cost.
- Obsolescence and Aging Systems where technology insertion, mid-life upgrades and late-life spares requirements are inevitable. ***Tempo*** recognises the differences between the useful life of a part and that of the system in which it is fitted and calculates their respective value.
- Simultaneous new-fleet build-up and old-fleet retirement scenarios, characterised by changing operational availability (Ao) targets, operating tempos and basing. ***Tempo*** simplifies inputs and provides all solutions in a single run.
- Expeditionary deployments, training exercises and other time-bound excursions requiring spares solutions integrated with long-term, normal deployment solutions.

STILL struggling?

TFD Europe

Q. Are you Struggling with Support Costs?
A. MAAP

Do you struggle with budget planning?

- Fleet build-up and run-down
- Operating pace and environment change
- Reliability improvement impact
- Capability growth
- Combined Operational Effectiveness and Investment
- Appraisal
- Cost analysis for PBL

STOP struggling!
MAAP solves these problems with high fidelity and traceability

There are many cost analysis tools out there many of which are based on spreadsheet technology. Whilst these can appear quick and easy to use, where any volume of data is involved its management can be a real issue. This together with mathematical functions that are user accessible undermine confidence in results and the provenance of decision support information.

Like all the TFD software decision support tools MAAP has at its heart the TFD DataVault – a purpose built modelling data repository. Its robust structure keeps you in control of your data, your models and your results so you always know where you are.

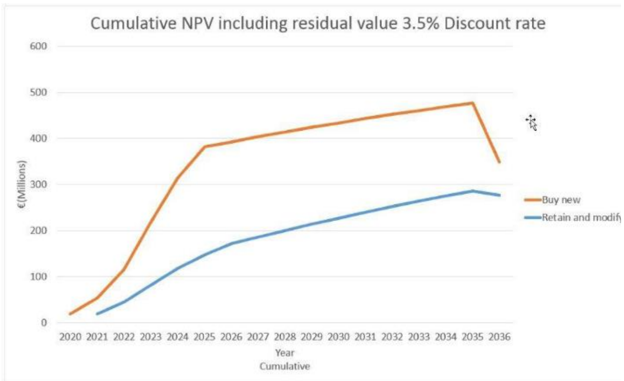
MAAP is a unique activity-based cost analysis platform that aggregates the cost of resources consumed in the operation of complex systems. You decide how a support ***event***, scheduled or unscheduled, triggers the consumption of resources and what costs are ascribed to each and all those resources. Operating the systems drives this consumption and costs are assigned to a Chart of Accounts.

A ***MAAP***-generated costing is superior to those provided by other tools because it:

- Explicitly handles profiled changing fleets and scenarios
- Works with as much or as little granularity as you want – e.g. a 'system' can be a ship or an air valve
- Unlike parametric tools, shows the effect on total support costs of a change in an embedded subassembly
- With its mPOWER add-on suite performs multi-resource optimisation – not just spares
- Produces auditable, repeatable results in readily exportable formats

MAAP is ideal for:

- Costing simultaneous new-fleet build-up and old-fleet retirement scenarios
- Through Life Capability Management of complex systems or systems of systems
- Supplier bid evaluation – put suppliers' pricing through your model under your terms and evaluate their contribution to your equipment support cost
- Business case analysis – derive repeatable evidence to underpin an investment and rate of return argument



STILL struggling?

Q. Are you Struggling with Sustaining Contract KPIs?
A. SCO

Do you struggle with the impact of system unavailability?

- Runs of bad luck spoiling your steady-state planning
- Changes in operations causing changing demand patterns
- Reliability better or worse than expected
- Support pipeline interdicted
- PBL Contract KPI scores impacting on profitability
- About negotiating contract terms

STOP struggling!

Support Chain Optimisation provides virtually real time intervention advice to restore optimum system performance.

Strategic (planning) analysis using any other analytical spares optimisation tool than TFD's ***TEMPO*** assumes life is steady state, which of course it isn't. But even where you know in advance about changes in operations, fleet size and mix, environment, support performance targets etc, there are still many ways that things can turn out different to the plan.

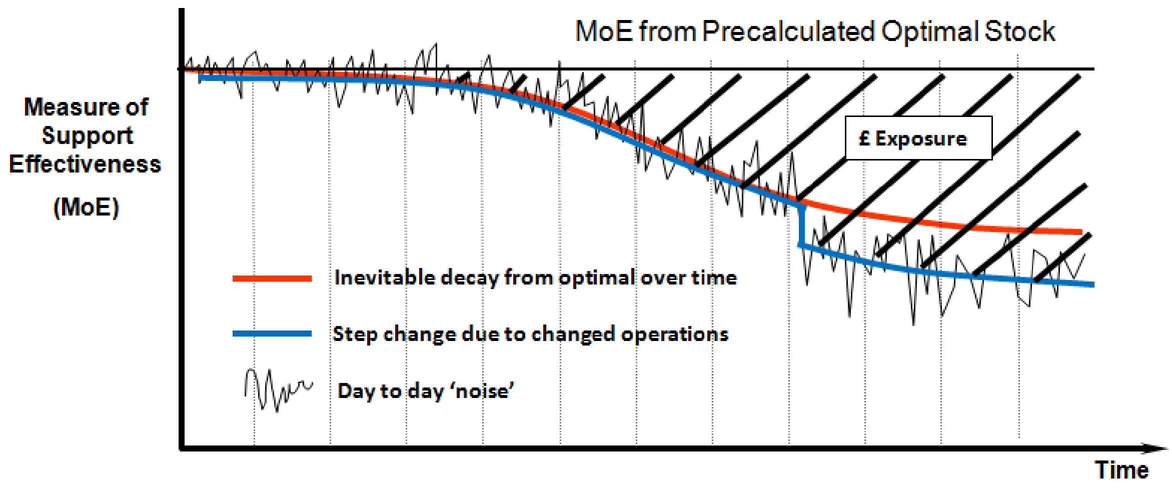
When the plan was cast, assumptions were made on many elements – parts prices, repair costs and turnaround times, reliabilities, maintenance periodicities – and even after allowances for variance suppliers won't always perform to standard, equipment will be more or less reliable and so on. Also, and especially in today's world of expeditionary activity, operating environments (including climate), pace, supply line strain and other influences will not stay long as per the basis of the plan. Consequently the support solution will no longer be optimal, the system availability performance will fall, and this will expose stakeholders to risk – to the supplier his revenue stream and to the customer his operational capability.

Even the sexiest dashboard is little more than a rear-view mirror. By the time a dial or a bar goes red it's usually too late to action a remedy. Lag indicators, especially those extrapolated into lead ones by trend algorithms, are at worst dangerous and at best of value only in retrospect. What is needed is a tactical lead indicator regime that anticipates the impact on system performance of a perturbation in the support chain and derives and presents actionable interventions that will ensure that the support chain will deliver the best return, in terms of performance, for the cost of executing them.

TFD's ***SCO*** does exactly that and, for the entirety of the systems within its boundary:

- Calculates what is where now, and what will be where if scheduled supply events happen as declared
- From the what will be where data calculates the impact on system availability of supply shortfalls
- From any predicted drop in availability calculates the potential exposure in £ due to the contractual reward/penalty mechanism
- Also calculates from pricing information the cost of executing each remedial intervention
- Presents to the Support Chain Manager an intervention action list ranked in order of exposure

In addition, because of the build up of transactional data SCO can present a rich performance picture of the support chain, the systems and the parts in it such as no ERP or asset management system normally does.



SCO is ideal for:

- Capability service providers contracted under Performance Based Logistics terms
- Spares range managers who want immediate responses to unexpected operating and support events
- Support managers who must balance exposure risk with the cost of recovering performance
- Support engineers who need business cases for recommending system modification and upgrade

STILL struggling?

Q. Are you Struggling with Data for Logistics Support Decision Making?
A. Use the TFD Data Vault as the Single Trusted Source of Logistics Data

Are you struggling with:-

- Not having the data?
- Having too much raw data to manage?
- Incomplete, incoherent and inaccurate data that can't be trusted?
- Spending too much time collecting and collating data that the analysis is too late to influence the decision?
- All of the above?

Stop Struggling! TFD can help you

Effective logistic support analysis requires the triad of tools, analysts and data. While powerful tools and skilled analysts are freely available, data is the critical element that underpins evidence-based decision making. Without data, only judgement is possible and that is frequently flawed.

So what can be done about the very common difficulties with obtaining dependable data to make logistic decisions for large, complex, critical and costly systems? To understand, we need first to dig into the root causes of the typical problems.

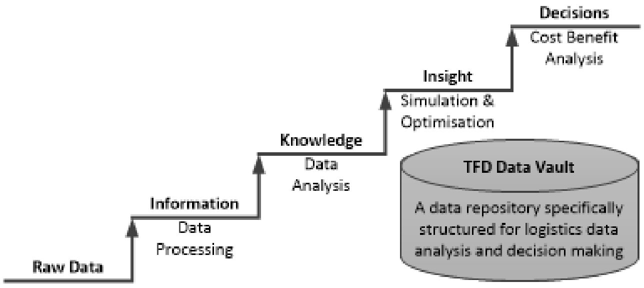
Data is an Asset

The importance of accurate and dependable logistic data is rarely disputed, and its value as a critical asset is widely recognised. On the one hand, industry carefully guards its data as intellectual property while seeking to gain as much feedback as possible of customer usage data.

Data itself is merely numbers or text, but the real value of data comes from the decisions that it informs. System and performance measurement enables business decisions with less inherent uncertainty and risk.

The Data Staircase

Sophisticated data exploitation strategy and management techniques are required to extract and cleanse the raw data, and develop useful information, knowledge and insight to support decisions. Moving up the Data Staircase, as illustrated, requires progressive data capture and processing, with analysis, simulation and optimisation, to inform cost benefit analysis about business decisions.



Data Sources

Logistic data is typically drawn from many and varied sources with disparate original purposes. While the old adage suggests "collect data once, use many times", it can be taken too far with data often misused out of context because it was available.

The only true solution to this conundrum is to understand how and why data has been captured, and in what context. If it is then structured in true relational terms, the original meaning is preserved and then can be used. This requires very careful thought on how to structure the data repository.

Fortunately, TFD Group has developed and evolved the TFD Data Vault (TFD dV) over 30 years as the single dependable source of trusted logistic data within a true relational database that has been specifically designed to contain the data needed for logistic decision making.

The TFD dV can be used to drive a wide range of analytical tools, including those of other tools providers, across the world. It is unique in both the approach and base of experience.

Data Currency

Out-of-date data is dangerous and can provide a misleading illusion of currency and dependability. A key data concept to manage this time-based problem is that of Static and Dynamic Data.

Static Data does not change unless the system design is changed: part numbers, tools, maintenance procedures are all fixed subject to configuration control. On the other hand, Dynamic Data will constantly fluctuate even in a fixed system design: usage, reliability, price and manpower costs all change and must be actively managed to maintain currency.

Data Assurance

The need to assure data quality, by using agreed data standards and applying sound processes throughout the data life cycle, is well recognised. These ideals are not yet universal and most logistic data was either developed historically or is still not assured.

Data standards are often 'tailored' locally which destroys their very purpose. This situation is likely to continue, and we must accept the reality of having to use legacy data for very many years.

Fortunately, the ***TFD dV*** applies rigorous data validation checks to ensure that only legitimate and logical data can be entered. For example, uploading a recent 'standard' air platform LSAR to the ***TFD dV*** exposed 70,000 errors; this rate is quite common.

Data Cleansing

Data cleansing is, therefore, an inevitable and very laborious burden. But even if the data is cleansed before analytical use, unless the original data sources are also cleansed, the errors will perpetuate, and all the good work will be undone when the next update is loaded.

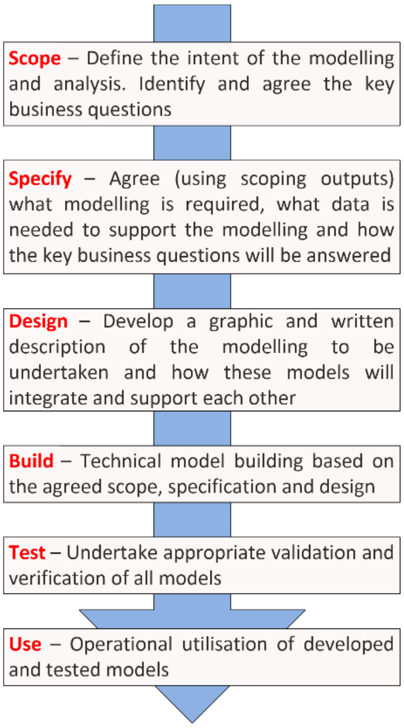
The ***TFD dV*** deals with this issue by assigning a Data Quality Attribute to each and every field. This can be set to protect cleansed data from subsequent automated updates. It can also be used to manage progress with the data cleansing process and focus attention on the data fields with the greatest business impact.

Modelling and Analysis

Supportability modelling and analysis provides information and insights to support evidence-based decision making for confidence in affordable operational delivery. Data is the key to designing and modelling support solutions; it enables the proposed solution to be tested before contract implementation to ensure that performance and cost targets will be met as shown opposite.

It is highly unlikely that all the required data will be available, assumptions and data creation are inevitable and a Master Data and Assumptions List under configuration control is a vital tool. However, there is nothing like building a model of a system to refine the needs for data.

Two very appropriate adages come to mind *"The more you use the data, the better it gets"* and *"It's better to model with some data than not to model at all."* To misquote General Eisenhower *"It's not about the model, it's about the modelling"*.



Using a common process to identify, quantify, report and manage Performance (KPI's and PI's) and a variety of Financial measures (NPV, ROI, DCF etc)

The ***TDF dV*** is the vital core of the powerful suite of logistic support decision tools in the **TFD Supportability Workbench**. It:

- Was specifically designed and evolved over 30+ years to support logistic support decisions.
- Contains logistic support data in its appropriate context for dependable reuse.
- Enforces data quality during data entry and protects it subsequently from corruption through over-writing by automated uploads.
- Drives the **TFD Supportability Workbench**.
- Can also drive 3rd Party analysis tools.

The *TFD dV* is the solution to your data problems.

TFD also provides skilled and experienced analysts who understand the logistic support business to solve your data problems.

STILL Struggling?

Q. Are you Struggling with Intelligent Asset Management?
A. SCO + GR-AWARE

Do you struggle with the impact on system unavailability through poor asset visibility and management?

STOP struggling! *Support Chain Optimisation* provides virtually real time intervention advice to restore optimum system performance by utilising *GR-AWARE (Edgeware)* technology to provide accurate and timely data capture to deliver intelligent asset management

Strategic (planning) analysis using any other analytical spares optimisation tool than TFD's ***TEMPO*** assumes life is steady state, which of course it isn't. But even where you know in advance about changes in operations, fleet size and mix, environment, support performance targets etc, there are still many ways that things can turn out different to the plan.

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- From the 'what will be where' data, calculates the impact on system availability of supply shortfalls
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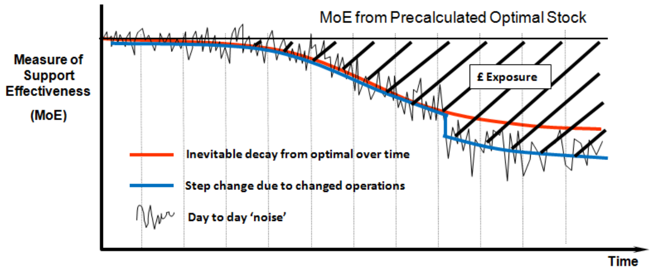


SCO is ideal for:

- Capability service providers contracted under Performance Based Logistics terms
- Spares range managers who want immediate responses to unexpected operating and support events
- Support managers who must balance exposure risk with the cost of recovering performance
- Support engineers who need business cases for recommending system modification and upgrade

GlobeRanger

GlobeRanger, a Fujitsu company, is a leading technology provider of enterprise sensor, IoT and Edge Computing software, and offers robust end-to-end solutions and professional services. The company's mission is to provide the most reliable, scalable, and flexible enterprise edge software infrastructure and solutions at the lowest total cost of ownership (TCO).

GlobeRanger has developed a suite of tools that enable businesses to exploit enterprise data by incorporating it in their management processes.

GR-AWARE from GlobeRanger (RFID-enabled asset management)

GR-AWARE provides a single, scalable platform to enable you to easily track and manage your business assets. These assets may include employees, IT equipment, furniture or other types of item that have been RFID-tagged.

GR-AWARE can easily incorporate asset management information into your existing legacy systems and business operations. It allows you to easily create business processing rules, trigger notifications and alerts, manage exceptions and generate a wide range of real-time reports.

Asset management solutions for industry

Whether you are managing assets in a manufacturing, office, healthcare or logistics environment, ***GR-AWARE*** provides a highly effective management system that really does pay for itself.

Within most large-scale industries, asset management has been proven to aid in the reduction of business costs. GR-AWARE has been proven in numerous industries including:

Benefits of GR-AWARE asset management

GR-AWARE can bring immediate benefit to your company, it can provide you with the ability to:

- Reduce the total cost of your asset ownership by improving control, availability and maintenance costs.
- Improve both your productivity and operational efficiency, by making a reduction in the time and resources lost searching for assets.
- Enhance the return on your capital through improved asset utilisation.
- Automatically identify, monitor and track your assets.
- Increase the visibility of assets across your customer locations to allow undisputed retention charging.
- Maintain optimal asset stocks across your logistics operation through improving end to end visibility.

Linking SCO and GR-AWARE

TFD and Fujitsu/GlobeRanger have teamed to develop a concept demonstrator that was displayed at DSEI 2015. The innovative concept is to reap the potential of the tools by an end-to-end (E2E) merging of the technologies. Doing this provides a quantum leap in accuracy of data to feed the analytical engine that calculates the consequences of even the smallest perturbation of anticipated support events. In turn this significantly enhances the accuracy of those forecasts and what is more, being presented in virtually real time any incipient risk will be identified before its full impact is realised.

TFD's ***SCO*** harnesses the Total Asset Visibility provided by the Edgeware solution enabling assessment of the future risk of shortages and tactical remedial action necessary to overcome them. ***GR-AWARE*** / ***SCO***, a powerful combination in effective E2E management.

Merging the technologies results in the automatic integration of the following data:

- Raw asset condition and performance data that is provided by GR-AWARE from sources such as live sensors
- Logistical support chain 'what is where' data derived from both historic and live feed of transactional and location data
- and the business rules that define the relationship between system performance and a revenue/ penalty regime

Followed by automatically calculated forecasts of support chain interventions, which

- if implemented in full would deliver the best possible performance for the least cost
- where tactical budget constraints exist would provide the support manager with the option to trade partial funding of remedial measures for a lesser performance restoration
- could be used to balance investment against the reputational risk from under performance

As an example of how this works, imagine a complex and costly major LRU, which is critical to the availability of its parent system and costly to acquire and hold as a spare, is in the repair loop. Suppose it is a light training aircraft fuselage assembly. To identify mishandling in transit among the sensors it has attached to it is one that senses g-force. In transit the container is mishandled at the dockside and the g-limit is exceeded. The support manager will immediately learn of that out of limits event, which renders the LRU unserviceable subject to an inspection.

Capture, Analyse and Decide

Defence organisations are implementing Joint Support Chains to reduce the cost of equipment support through contracting arrangements with industry. These support chains have many stakeholders: OEMs, sub-contractors, Defence support organisations and operational units to name a few. Each stakeholder will have a clear view of the distribution and status of assets within their own IS domain. However, obtaining a single version of the truth across all of these information silos remains elusive and prohibitively expensive. These multiple views create confusion and uncertainty, leading to increase risk and cost. It also undermines the quality of decision making, hinders continuous improvement and diverts attention from managing the business to managing the contract.

Critical to successful joint support chain management is accurate and timely data capture coupled with analytical tools that provide decision support.

Fujitsu's Edgeware (***GR-AWARE***) and TFD's ***SCO*** software together provide this Capture, Analyse and Decide capability to provide an End-to-End Support Chain Visibility that can be implemented incrementally and without changing legacy infrastructure.

Q. Are you struggling with identifying the benefits of your Support Solution?
A. TFD Group 'Right to Left' thinking and proprietary tool suite will help you

Are you struggling with:

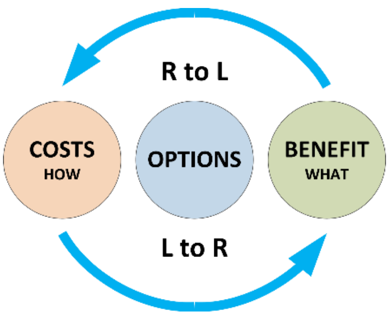
- Defining the optimum Support Strategy?
- Choosing between your options for a support solution?
- Identifying the availability and cost benefit of a proposed equipment modification?
- Proving your support business case?

STOP struggling!

TFD Group can solve these problems quickly and economically using our tool suite

Deciding the optimum Support Strategy for a defence system is a complex business and is getting harder as customers demand 'more, with less'. 'More for less' implies doing things differently.

It is relatively easy to work out the cost of something – a modification or a particular support approach. But all too often, the good idea for improvement comes first, and develops a head of steam, before the benefits are truly understood. Indeed, it is often hard to determine the benefits. This is a **'Left to Right'** approach: cost before benefit. It often leads to difficulty in proving a future support business case with demonstrable evidence since you can't measure what hasn't yet happened. The solution is to model the system's cost and availability.



While 'Left to Right' thinking is sometimes inevitable, the opportunity to conduct **'Right to Left'** thinking is often missed: identify the achievable benefit envelope before trying to define solutions that may not be worth it. In **'Right to Left'** thinking, you identify the cost and availability drivers, explore what benefits would be achieved if an improvement was made, *without knowing at this stage how it could be done.*

Having identified the achievable benefits, only solutions that cost less than the benefits are worth pursuing. Indeed, there may be no realisable benefit. In essence, identify **'What'** the benefit would be **before** assessing **'How'** to achieve it.

To find the drivers of a system, you can ask stakeholders through a survey since, in many cases, they know intuitively where the problems lie. This takes time, effort and can be misled by corporate mythology. On the other hand, you can ask your model since it represents the same system. TFD call this approach **Supportability Audit,** which is a structured set of logical questions, answered by specific output reports from the model. Once the drivers are identified, assume some level of improvement such as improved reliability, re-run the model, see the impact of that benefit and make your support choices. Then decide about how to achieve the solution within that benefits envelope.

TFD Group has a flexible activity-based logistics resource supportability and analysis modelling tool called ***MAAP***. ***MAAP*** models when, where and why specific costs are incurred. It models how the system is used and maintained, by whom, using what resources, at what cost, and what system availability and task are achieved. ***MAAP*** can address multiple systems, at multiple maintenance levels over changing multiple year scenarios and considers all the support resources needed; manpower, skills, tools, test equipment, facilities, transportation and spares. ***MAAP*** is the model.

MAAP, TFD Group can support **'Right to Left'** thinking to help you choose and prove your support business case.

STILL Struggling?

Q. How do I both Reduce the Cost of Support and Improve the Output of a System?
A. Use the TFD Supportability Audit (SA) Technique to find Opportunities

Are you struggling to:

- Identify Support Issues?
- Reduce costs without eroding Capability?
- Improve system availability?
- In short, Do More, for Less?

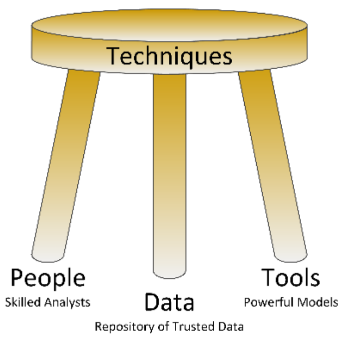
Stop Struggling! - TFD can help you

Support Managers for in-service equipment should always be seeking to: ***Identify, prove the business case and implement a set of actions that will continuously improve availability and/or reduce cost.***

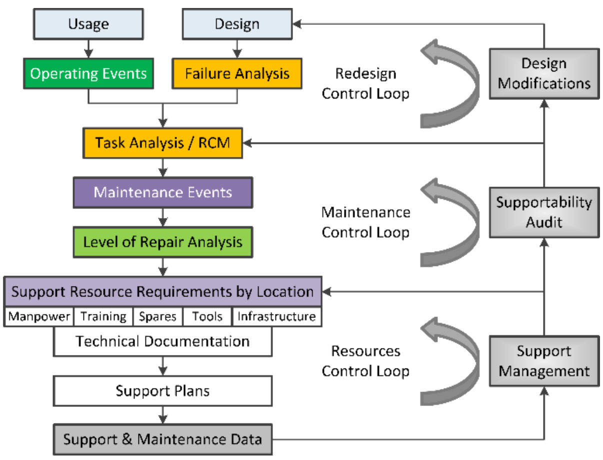
For example, they should be asking:

- Is the usage pattern driving excessive cost to meet peak demands?
- Which systems or components have excessive costs or impact on availability?
- Is the maintenance policy burdensome and creates poor availability and high cost?
- Are repair cycle timescales appropriate with repair at the optimum location?
- Are supply stocks appropriate to meet demands?

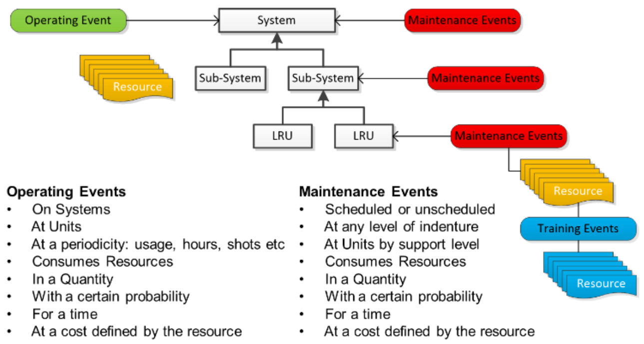
If not, or the answer is unknown, structured analysis is required. TFD's SA, using experienced people armed with powerful tools and trusted data, but most importantly employing appropriate techniques is the key



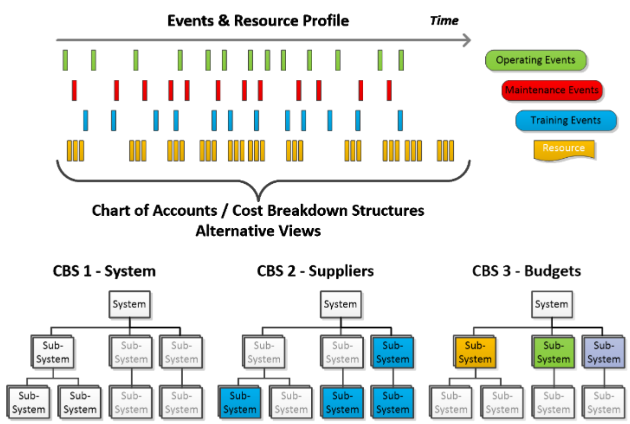
The systems engineering process to design and implement logistic support is illustrated below:



Equipment will fail, but the rate is dependent on the usage pattern of Operating Events (OE) which can be flights, days, cycles, miles, firings and all in combination. The OEs consume specified resources at units, at a periodicity, for a time, at a probability and at a cost. Reliability Centred Maintenance and other maintenance task analysis techniques identify the necessary Maintenance Events (MEs), which also consume resources at units, at a periodicity, for a time, at a probability and at a cost. Level of Repair analysis defines the optimum location to carry out the MEs. The collection of MEs and associated resources constitute the support plan, and the costs can be summed in any defined cost breakdown structure.



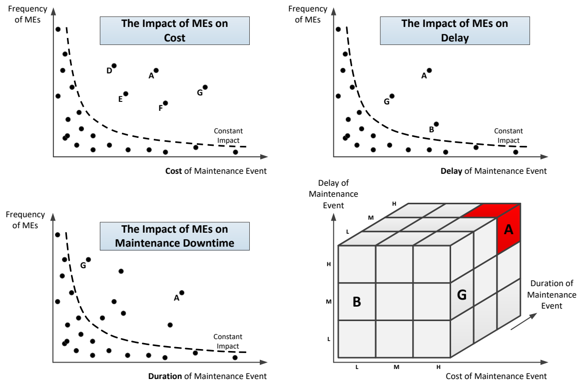
Collecting in-service support and maintenance data provides feedback that is vital for improvement. The data should describe achieved performance. It should identify both problem areas where the support plan is not performing as planned; too little or the wrong support causes visible support shortfalls whereas too much is largely invisible but costly waste. But the data should also suggest opportunities for continuous improvement. The problems could be the wrong resources, the wrong maintenance or, in extremis, the wrong design. The key metric to evaluate solutions is life cycle cost which is the summation over time of all the costs of the resources for all the OEs and MEs in the specified operating usage pattern.



SA is structured to explore top-level questions to focus attention on areas of the greatest urgency for further, more detailed assessment, exploration and diagnosis of the mission and support system performance. These are:

- Does the system meet its operational target?
- Are the operational targets met within the identified cost and resource constraints?
- What, if any, operational and support shortfalls have been identified?
- During the assessment period, have there been any major deviations from the operational or support scenarios originally defined?
- Are there any major deviations envisaged in future from the operational or support scenarios originally defined?

From this insight, structured use of a data-driven, activity-based logistics resource model rather than by reactive inquiry. The graphics below plot data about the MEs to cover all the elements of the cost and availability equations to identify the major issues and what could be done.



Case Study 1

The Puma HC1 support helicopter study was conducted on behalf of the UKCeB; the joint MOD/Industry trade body for logistic support and information. This fleet was specifically selected as data quality and completeness were typical of in-service platforms, there were no commercial sensitivities as the fleet had recently gone out of service, and results could be corroborated. The Case Study, which is available from the UKCeB website, is summarised below.

RAF Puma Mk1 – Support Helicopter

Supportability Audit to identify potential support shortfalls and opportunities for improvement

- Number of aircraft on both 230 Sqn & 33 Sqn reduced by 3 aircraft but the total flying task was maintained at each unit; each aircraft flew more sorties
- Fleet operational availability (Ao) target increased from 75% to 80%
- Maintenance staff to receive either additional training, or maintenance procedures improved, to reduce maintenance task durations by 15%
- Suppliers to improve production lead times (PLTs) on first time demands by 15%
- Suppliers to deliver a price challenge of 15% challenge on purchase and repair prices
- RCM-based review of maintenance policy to reduce frequency of all unplanned corrective maintenance by 15%

Potential cost savings of £5.6M or 23% of annual costs AND 5% increase in availability delivering same task with 6 fewer aircraft

Case Study 2

This Case Study could not be more different. TFD was asked to assess a fleet of very mature, mass produced utility vehicles that were fully supported by the OEM to see what improvements could be identified from the data. Despite the severity of this test, significant benefits were identified as illustrated below.

Tgb 14/15 – Utility Support Vehicle

Supportability Audit to identify potential support shortfalls and opportunities for improvement.

Tgb 14/15 is a fleet of 347 vehicles used only in training and fully supported by Mercedes. The basic Geländewagen is a very mature vehicle that has been in production for 36 years. More than 200,000 have been built.

- Vehicle utilisation was low and up to 70 vehicles could have been placed in storage reducing maintenance costs by 11% while meeting availability levels and driving an additional 2,750Km.
- Despite the maturity, issues were identified with:
  - Air filter – this was traced to incorrect item identification data which was driving excessive and wasteful procurement
  - Central locking system which was an acknowledged intermittent system fault. The Audit quantified the cost enabling FMV to press Mercedes for a solution.

Potential cost savings of £250K over 10 years - 2.7% of annual costs through reduced maintenance while meeting availability over more Km using 70 fewer vehicles

Summary

In sum, Supportability Audit (SA) is a technique of data analysis, using the TFD Supportability Workbench suite of tools, to find the support issues and opportunities for improvement and to evaluate cost-effective solutions to underpin business cases.

SA is a powerful analytical technique that can find, assess and quantify the business case for significant support cost savings

SA can be applied cost effectively to most, if not all, systems covering a wide range of environment, technology and maturity

Extrapolating the benefits from these examples across Defence could make significant inroads into the cost of support

SA requires a small investment to build the models

A programme of SA projects will be better than self-funding

TFD can provide skilled and experienced supportability analysts, with powerful tools and techniques, to solve your difficult problems.

Q. How do I improve the Support Solution?
A. Allow effective decision support by implementing the TFD Supportability Audit.

Are you struggling to:-

- Identify Support Issues?
- Define the best Support and Repair strategy?
- Reduce costs without eroding Capability?
- Optimise resource demands?
- Feel that your Support Strategy could be better but don't know how to form and test your ideas?

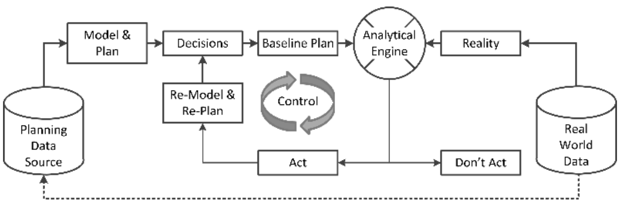
Stop Struggling!
TFD can help you decide

The need to 'Plan, implement and improve through-life the effective support of a system to meet the required tasks, while seeking efficiencies to balance more output, with fewer systems at lower cost' is at the heart of the Support Manager's roles.

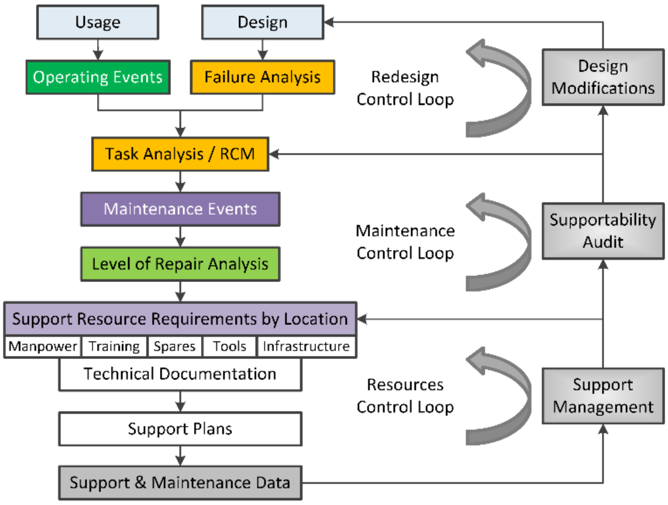
For several years, data has been collected from many sources by various means and placed into today's disparate information repositories. Some of this data is (and has) ultimately been used to guide the Support Manager's decisions based on the 'truth' provided by that data with varying degrees of success. Therefore the challenge facing today's Support Manager is threefold:

- Do I have enough of the right data?
- Can I justify my decisions using a repeatable and robust systems approach?
- Where do I start?

Planning AND Control are essential to create and then manage a support solution. The Supportability Audit is a methodology to assist the support agency in finding those items within an equipment that are causing pain and money.



The feedback loop is vital to the outcome of the process; by conducting a regular, structured audit of system performance and cost based on observed real-word performance against the established plan; a gap analysis, using the same analytical tools used to develop the baseline plan, allows the Support Manager to decide, on the basis of hard evidence, whether the issue should be addressed at what cost and benefit. The remedial action thus changes the baseline plan to provide the feedback loop that is essential for effective control of the system.



The SA is an overarching description of the process and uses a variety of tools and analysis techniques based on the integrated TFD Workbench. The Top-Level SA is used to focus attention on areas of the greatest urgency for further, more detailed assessment, exploration and diagnosis of the mission and support system performance.

- Does the system meet its operational target?
- Are the operational targets met within the identified cost and resource constraints?
- What, if any, operational shortfalls have been identified?
- What, if any, support shortfalls have been identified?
- During the assessment period, have there been any major deviations from the operational or support scenarios originally defined?
- Are there any major deviations envisaged in future from the operational or support scenarios originally defined?

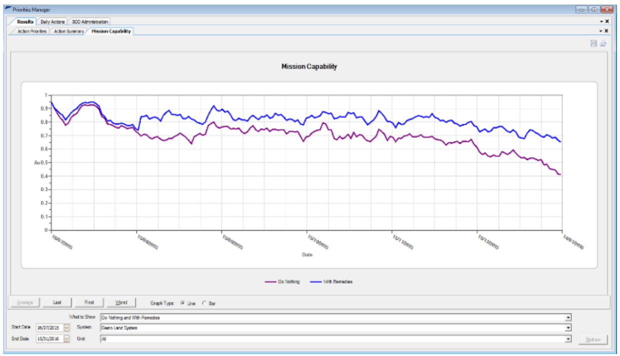
Using a system baseline to support understanding and structured exploration of the inter-connections between each logistic support discipline you can define in detail when, where and why specific costs are incurred and the outcome of potential changes in dynamic operating profiles.

Then through the structured use of a data-driven, activity-based logistics resource model rather than by reactive inquiry, the SA process is able to provide the right system insight to save time, money and headaches!

Use the SA to investigate the impact of:

- Changes to the support resources to implement the current support policy
- Changes to the support tasks (changed maintenance policy)
- Change the design

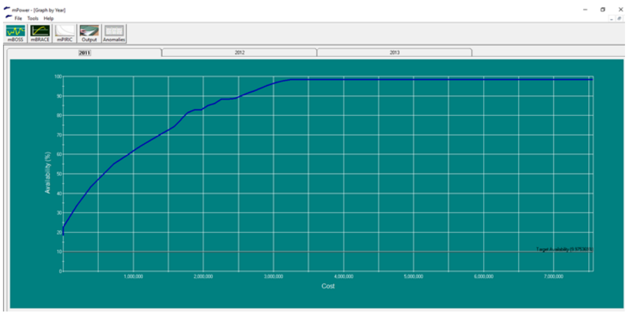
Identify how best to position and use limited resources to minimize exposure to risk and cost of support shortfalls using ***SCO***.



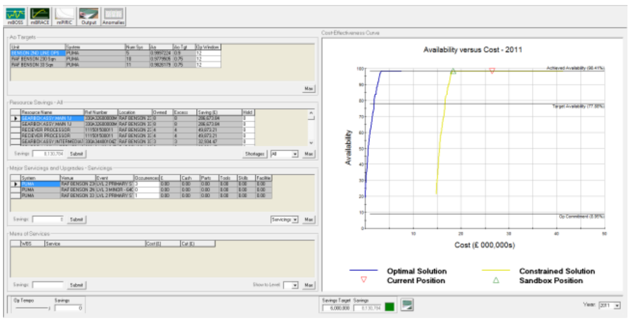
Inform your Business Case for changes to design in a 'R to L Thinking' way – 'benefit before cost' by using TFD's ***mPOWER*** suite.

Comprised of -

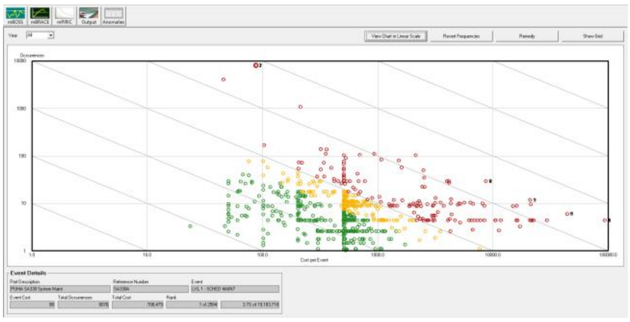
- ***mBOSS*** - provides marginal optimisation results across all resource types – people, parts, tools, facilities, fuel, etc. It answers the question: What is the least costly combination of all resources in locations to achieve a given Ao?



- ***mBRACE*** – calculates an ordered list of budget reduction actions that have increasing impact on operational capability.



- ***mPIRIC*** - identifies through cost, duration and delay, the most important MEs, and hence components, to address through engineering change, reliability improvement, revised maintenance policies or operating procedures. By reflecting the outcome of any prospective change in a revised input data, the benefit can be evaluated in refreshed results.



The complete suite enables post-processing of the results to identify the most significant detrimental combination of poor reliability, poor maintainability and logistic delay and, hence, the greatest impact on cost and availability. Effective support management WILL identify weaknesses and areas for potential improvement. Continuous Improvement, or Kaizen, is a vital part of an effective support strategy and by using the SA technique, the scale of the potential benefits can be understood and the need for changes to the maintenance regime or system modifications can be identified. The TFD workbench provides all the tools.

PLAN the right Support Solution using ***EDCAS***.

PROVIDE a detailed Life-Cycle Cost analysis for all resources using ***MAAP***.

EXPLORE 'what if' scenarios using mPOWER.

DELIVER a continuous optimised spares solution using ***SCO*** anticipating emerging threats.

Routinely **EXCEED** KPI's while being responsive to changing scenarios by monitoring and actively improving agreed Support Solutions with SA.

Alternatively TFDE can provide skilled and experienced supportability analysts, who understand the Logistic landscape and bring powerful tools to solve difficult problems. The answer is to turn to TFD who will provide the answer as a service.

STILL Struggling?

How Can you Measure and Improve Supportability?

What is Supportability?

Supportability is similar to Reliability (R), Maintainability (M), Testability (T) and Availability (A) but, while the term is widely used, it is not commonly defined.

We define Supportability (S) as the responsiveness to unreliability that prevents a system's use. In other words, *'when there's a problem on a system, how quickly can its utility be restored.'* S can be seen as the sum of all system downtime – the shorter the downtime, the better the S.

$$A = \frac{Uptime}{Uptime + Downtime}$$

$$= \frac{MTBA}{MTBA + MTTR + PM\ Time + ALDT}$$

The critical point is that S is indirectly linked to A, M & T, but is independent of R and cost. Improved R does not make a system more supportable. Spending money does not, of itself, make a system more supportable. However, they can mitigate the operational impact of poor S or, as we commonly know it, Un-supportability (US).

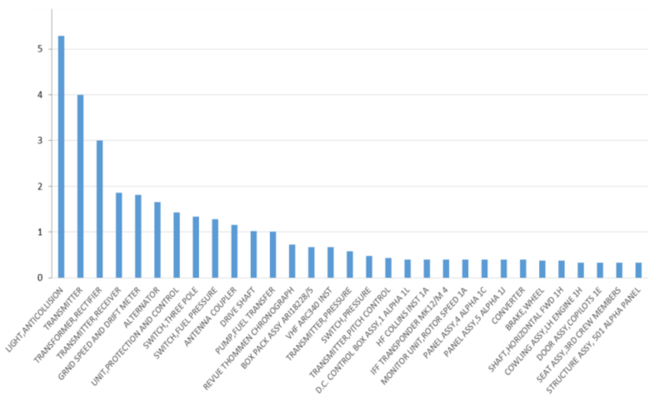
US is the sum of all *system downtime* for preventative and corrective maintenance including condition-based monitoring, and the associated Administrative and Logistic Delay Times (ALDT).

$$US = \sum(TTR + PM\ Time + CBM\ Time + ALDT)$$

Using US as a metric enables the most important and cost-effective improvements to identified.

Reducing US

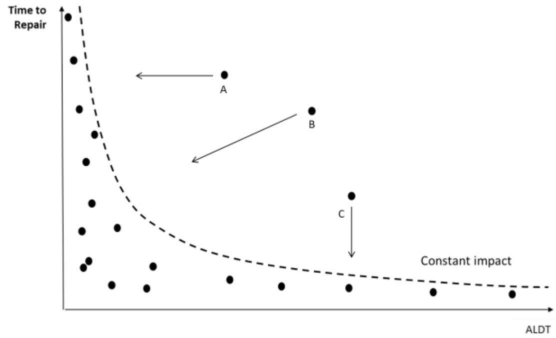
This approach allows us to identify which specific components have the worst US as illustrated below.



More importantly, measures to improve S must be considered **before** resorting to spending money on the only remaining mitigation of more resources.

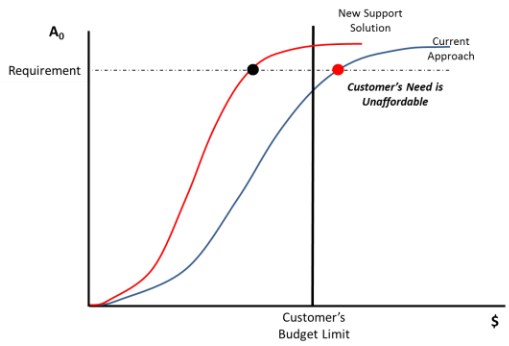
Evaluating Potential S Improvements

Ideally, one should evaluate the potential impact of improvements before knowing how those improvements would be achieved. The sum of the resources needed for all the maintenance activities is the remaining Through Life Cost (TLC) of the system. Postulating changes in the underlying data allows calculation of the revised TLC and informs the business case in a value for money filter.



Overall S Optimisation

Marginal analysis techniques introduce the economic factors to optimise resources to meet an A_o target by calculating the best possible choices to drive an optimum locus as illustrated below.



For a particular support solution, cost and availability are intrinsically linked. To achieve more availability for less money, a different support solution must comprise different maintenance activities. Of course, there is a balance between the cost of different maintenance and the cost of additional resources but that is an implicit part of the marginal analysis approach. Only, and only then, should the activities and resources be matched and optimised to ***Do More for Less***.

Data Quality and Decision Confidence

Logistics data is critical to making the correct decisions, but is widely recognised as being of variable quality. Much of the current Systems logistics data, across the globe, is uncertain, incorrect, incoherent or incomplete, leading to poor quality decision making.

Lack of confidence in logistic data erodes the credibility of modelling and analysis, analysis outcomes are often ignored and, at worst, modelling and analysis is not even carried out leaving only questionable judgement.

To recover confidence in modelling and analytical recommendations, the supporting data must be Dependable, Objective and Evidence-based. How can this be achieved?

The long-term solution will be to implement ISO 8000 for Reference or Master Data Quality, but its implementation will take years to deliver full effect. In the meantime, most of the logistic data supporting decisions for current and future Systems for at least a decade ahead is already corrupt. As more than half of UK MOD DE&S spend is on support (£12.3Bn annually), it will perpetuate poor decision making, waste and excess cost for at least a decade. However, the data cleansing problem is massive – a truly Herculean task – and without improving current data systems, they will continue to re-corrupt cleansed data. Nevertheless, legacy logistic data must be cleansed.

The size of the problem means that the cleansing effort must be focused on the critical data that has a direct impact on the key logistic outcomes of A_0 and cost through the equations that derive them.

And once cleansed, mechanisms must be introduced to protect the quality of data.

The current situation cannot be ignored, but neither can we afford to wait a decade for fundamental process change to work through - that must happen - but is something must be done urgently to impact near-term affordability shortfalls and recover confidence in modelling and analysis.

A comprehensive quality approach is required to drive quality into every stage of the analytical process: the data sources through cleansing; structuring data repositories to protect cleansed data; and using trustworthy, verified and validated analysis. This is in line with the Her Majesty's Treasury Aqua Book - *guidance on producing quality analysis for government*.

The Aqua Book outlines a sensible, achievable set of principles that will help ensure that analysis can be trusted to inform good decision making. It sets out the following principles of analytical quality assurance that will help to support commissioning and delivery of fit-for-purpose analysis:

Proportionality of response: The extent of the analytical quality assurance effort should be proportionate in response to the risks associated with the intended use of the analysis. These risks include financial, legal, operational and reputational impacts. Where analysis is used frequently to support decisions, more comprehensive analytical quality assurance is required.

Assurance throughout development: Quality assurance considerations should be taken into account throughout the life cycle of the analysis and not just at the end. Effective communication is crucial when understanding the problem, designing the analytical approach, conducting the analysis and relaying the outputs.

Verification and validation: Analytical quality assurance is more than checking that the analysis is error-free and satisfies its specification (Verification). It must also include checks that the analysis is appropriate and fit for the purpose for which it is being used (Validation).

Analysis with *RIGOUR*: Quality analysis needs to be: **R**epeatable; **I**ndependent; **G**rounded in reality; **O**bjective; have understood and managed **U**ncertainty; and the **R**esults should address the initial question robustly. In particular, it is important to accept that uncertainty is inherent within the inputs and outputs of any piece of analysis and we must establish how much we can rely upon the analysis for a given problem.

As the Aqua Book points out, we need to create an environment where the skills and time to deliver analysis is respected, and a culture that values it is encouraged. Data underpins all of this quality approach and similar rigour must be applied.

Only then, will managers have confidence in the results and outputs from modelling and analysis.

Reversing the Data Creation Flow

The Logistics Support Analysis Record (LSAR) has sat at the heart of supportability modelling and analysis since its conception under MIL-STD 1388-2A in 1973. Other standards have emerged such as DEFSTAN 00-60, 00-600, GEIA-STD-0007 and ASD 3000L. All have the same purpose to create a single, uniform approach to improve supportability of military weapon systems by defining the required operational support plans and resources during acquisition and development. But over time, use of the LSAR has evolved for 2 primary purposes as:

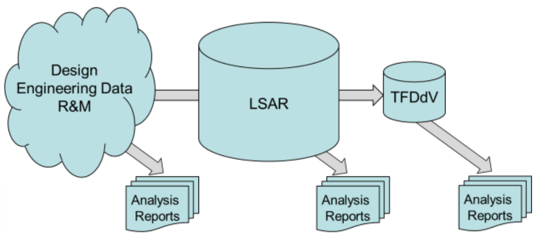
- A repository of all logistic support data, and
- A vehicle to transfer logistic support data to Government systems.

A full LSAR comprises more than 500 data elements in 104 tables in a relational database structure of many Gb. However, only a limited subset of that data is needed to make the key logistic decisions that drive availability (A_0) and cost which are the 2 most critical characteristics of a weapon system that are needed **to make executive decisions** and set support budgets. While the volume of logistic data within LSARs is very large, much of it does not influence logistic decisions but, rather, is the consequence of those decisions.

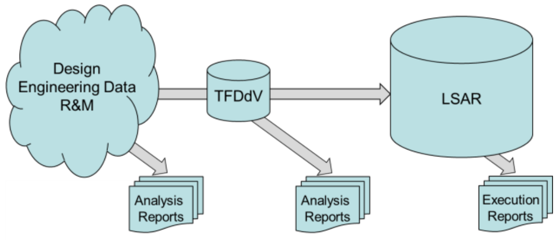
Many of the LSA disciplines and key support decisions are made before traditional ILS activities, including supportability Modelling and analysis, to complete the LSAR are conducted. **Decisions often come before analysis.**

The rest of the LSAR, indeed the bulk, merely implements the detail of those decisions. For example, prices, reliability and turn-round times are critical to inform support policy decisions, but the name and address of the contractor, pilferage codes and the like are only needed **to enact logistic bureaucracy through IS**.

Traditional data creation flows FROM the LSAR TO the small set of critical data needed for analysis.



But as that small critical data core is available before the full LSAR, it raises the prospect of reversing the traditional flow of data creation FROM the essential set of critical data TO seed the LSAR.



This fundamental process change offers:

- **System-based Analysis.** The TFDdV, and the analytical tools it supports, takes a systems rather than individual part view of A_0 and cost – ***Happy Systems*** not ***Happy Shelves***.
- **Lower Data Creation Costs**. Data generated for analytical models is stored in the TFDdV without additional effort. Data errors are identified for correction during data entry. These reduce the time and effort required to develop LSA data.
- **Data Availability.** Data is readily available from the TFDdV for a range of analytical models - both TFD and 3rd party products - avoiding repeated extraction from original sources for each new analysis.
- **Data Re-use between Programs.** The TFDdV is multi-system, multi-indenture and multi-echelon which supports re-use of data for modelling complex systems using multiple technologies across air, land and sea. Early in the design cycle, data can be used from benchmark systems in design trade-offs.
- **Timely Proposal Support.** LCC estimates with detailed resource needs can be produced quickly for operating and deployment scenarios. Using data within the TFDdV, the time and cost to produce proposals is focused on analysis not collection (typically 80% of the effort).
- **Better Logistic Decisions.** Setting multi-period provisioning budgets, delivery planning and obsolescence management are enabled.

In short, reversing the data creation flow FROM a logistic data repository TO support analysis is a much better creating the LSAR initially.

Customer: Royal Navy & British Army
System: Westland Lynx Helicopters

Scope: To perform an optimisation experiment to demonstrate the business case for using TFD tools to produce a VMetric spares model for 4 Lynx helicopter variants

Benefit: The analysis identified an immediate £1.2M saving by recommending the cancellation of the purchase of 2 main rotor gearboxes. It also highlighted that the existing airframe spares holdings were over-stocked by 100%, leading to £8M excess stock being identified for sale. Overall, it demonstrated that operational availability could have been achieved for half the cost; £55M viz £105M. Whilst the experiment cost £500K, it generated a return-on-investment ratio exceeding 10:1

Customer: British Army
System: Armoured Fighting Vehicle Support

Scope: Use of a MAAP model for a review of the Equipment Support Policy for Armoured Fighting Vehicle engines, gearboxes, communications equipment, optical sights and EW systems, to identify potential savings from Forward repair in the field

Benefit: The review identified potential savings exceeding £180M (for engines and gearboxes) and £450M (for electronics equipment) over a 20-year period through the enhancement of Forward repair facilities

Customer: Lockheed Martin
System: F-22 Raptor

Scope: To conduct business case analysis, perform spares optimization, create a data interface, and to support the development of new Supplier Management processes for the USAF F-22 programme

Benefit: With TFD support, which included education and guidance in PBL contracting, Lockheed Martin was able to adopt emerging US Air Force contracting initiatives to maintain or increase performance while decreasing overall cost. TFD's spares analysis led to significant cost savings through the optimization of production-phase inventory requirements. TFD also created process, system and interfaces for 'eSupport' Supplier Management and improved performance and cost savings under new contract environment. Overall, the business case analysis provided by TFD helped established guiding principles for future PBL contracts, as well as leading the way for many valuable sustainment cost-saving practices

Customer: Babcock International
System: White Fleet Vehicles

Scope: To develop a bespoke simulation tool (using vehicle telematics data) to optimise fleet numbers, contract mix and location to meet the service requirement for the Phoenix II programme; a programme to re-bid for the provision of more than 17,000 lease cars, vans and light transport vehicles of circa 400 types for use by the UK MOD at all locations across the UK, Europe and overseas garrisons

Benefit: The TFD model identified savings opportunities of up to 25% in the contract cost (circa £600M). Babcock subsequently won the contract

Customer: Vector Aerospace
System: Chinook Helicopter

Scope: To support Vector Aerospace in the development of a holistic engineering and ILS management capability in preparation for its bid to provide a comprehensive engineering and support service for the RAF Chinook's T55 engine

Benefit: In addition to the provision of ILS guidance and mentoring, TFD was able to define the required ILS tasks and how they should be discharged, develop the internal organisational model, and develop internal ILS plans in support of the Vector Aerospace bid

Customer: Dstl
System: Combat Air Training System

Scope: To develop bespoke simulation to model the Royal Air Force pilot training system, with which to determine the optimum balance between live flying training in aircraft, virtual training in simulators and constructive training using synthetic agents such as airborne early warning aircraft

Benefit: Using AnyLogic simulation software, the study suggested that up to 50% of flying training could be 'down-loaded' from live flying with improved training benefit. The simulation was initially populated with RAF Typhoon data, but was capable of extension to include all fast jet platforms including Tornado, Lightning II (F35) and UAS (Reaper etc)

Customer: MSI-DS / Daewoo Shipbuilding & Marine Engineering (DSME)
System: DW 3000F Class Frigate

Scope: To produce a life-cycle costing model and provide spares provisioning recommendations to DMSE (through MSI-DS) for the 30mm DS30M gun systems fitted to Royal Thai Navy DW 3000F Class Frigate.

Benefit: Using VMetric, TFD was able to build a number of models to determine and recommend the optimized 'on-board' and 'dockside' spares solutions for the gun system in a range of operating scenarios. By employing marginal analysis techniques, the use of VMetric ensured an optimized solution that would deliver best value-for-money whilst also maintaining required levels operational availability. TFD also used MAAP to build a thirty-year life-cycle cost model, which included provision for a one-year initial warranty period and a two-year initial provisioning of spares.

Customer: Montreal Metro
System: Infrastructure (New Control Room)

Scope: Use of a TFD VMetric model to conduct spares analysis for a new control room for the Montreal Metro

Benefit: The analysis identified opportunities to reduce the spares investment by Canadian $500K

Customer: UN Comprehensive Nuclear Test Ban Treaty Organisation
System: Global Monitoring Station Network

Scope: To provide TFD software tools, as well as deliver ILS, modelling and support analysis training and mentoring to UN CTBTO staff

Benefit: The tools and services provided by TFD has enabled the UN CTBTO to develop, maintain and exploit highly complex VMetric and MAAP models of the logistics support for its network of over 330 sensors

Customer: **Finland Defence Forces Logistics Command (DFLC)**
System: **F/A-18C Fighter Replacement Programme**

Scope: To support the Finland DFLC develop and maintain a life-cycle cost model of the current logistics support arrangements for its F/A-18 fleet to provide a baseline comparator for use in the Finland Fighter Replacement Programme

Benefit: By having a defined baseline model of the current F/A-18 logistics support solution, DFLC has been able to insist that OEMs provide a pre-defined data set that will be used to build like-for-like models for each of the competing platforms in the Finland Fighter Replacement Programme. By doing this, DFLC will be able to objectively compare each of the OEM's priced proposals, as well as providing life-cycle cost models of the replacement aircraft to support the procurement business case and for logistics analysis once the winning platform has entered service.

Customer: **KBR UK**
System: **Military Flying Training Service (MFTS)**

Scope: To carry out an independent analysis to demonstrate to investors that service levels (ie aircraft availability) would be achievable under the MFTS Private Finance Initiative

Benefit: VMetric spares models were created to validate OEM proposals for the spares packages for the MFTS Grob T120, Beechcraft Texan T6C and Embraer Phenom 100 aircraft fleets. Alternative scenarios were also stress-tested using bespoke simulation modelling

Customer: **Japan Maritime Self-Defense Force (through Fujitsu TSL)**
System: **Acquisition and Sustainment Management System**

Scope: To conduct a concept study for interfacing TFD Datavault with the JMSDF 'Acquisition and Sustainment Management System' for the purpose of exploiting logistics analysis data

Benefit: To study concluded that interfacing the 'Acquisition and Sustainment Management System' with the TFD Datavault was feasible, leading the way for JMSDF to exploit its logistics analysis data using tools within the TFD Supportability Workbench

Customer: **Swedish MOD Material Command (FMV)**
System: **Tgb 14/15 – Utility Support Vehicle**

Scope: To conduct a Supportability Audit to identify potential support shortfalls and opportunities for improvement

Benefit: The audit identified that the size of the vehicle fleet was such that, despite a low utilization rate, it was resulting in an unnecessarily high maintenance burden. Other findings included highlighting an example of incorrect part identification data that resulted in excessive and wasteful procurement, as well as identifying and quantifying a cost driver relating to a long-standing intermittent fault issue; which ultimately forced the OEM's hand to introduce a long-overdue technical resolution. Overall, the audit identified potential cost savings of £250K over a 10-year period, through reduced maintenance, while meeting availability targets, while achieving greater driving distances, and while also deploying a significantly reduced 'in-use' fleet size

Customer: **Joint GlobeRanger / TFD Initiative**
System: **GlobeRanger RFID-enabled Asset Management System**
Scope: To develop a 'proof of concept' for harnessing the asset tracking capability of GlobeRanger with the logistics analysis capability of TFD
Benefit: TFD worked closely with GlobeRanger (a Fujitsu Company) to develop a proof of concept, as well as a working demonstration of a GlobeRanger/TFD Supply Chain Optimization (SCO) integrated solution. Customer awareness of these integrated capability was raised during the Defence & Security Equipment International (**DSEI**) arms fair in 2015

Customer: **Northrop Grumman**
System: **MQ-4C Triton**
Scope: To provide Northrop Grumman with engineering logistics, modelling, software and decisions analysis expertise in support of its proposal for the MQ-4C Triton production programme.
Benefit: Through the use of TFD logistics analysis tools and expertise, TFD support in generating a support plan for MQ-4C Triton was a key element in Northrop Grumman achieving contract award. TFD also assisted with the subsequent execution of logistics support, and in establishing strategies for maintaining, supporting and forming annual budget projections and plans

Customer: **European Space Agency (through Vitrociset)**
System: **Galileo Global Navigation Satellite System**
Scope: To provide TFD tools for use in the modelling of the logistics support for the Galileo GPS Satellite programme grounds stations and control rooms
Benefit: Through the use of TFD tools, European Space Agency is now equipped to apply relevant and objective supportability analysis process in support of this complex and critical system

Customer: **US Navy / Maritime Helicopter Support Company (MHSCO)**
System: **H-60 / S-70 Blackhawk**
Scope: To perform Total Ownership Cost (TOC) modelling for the helicopter flight deck and flight/mission computer
Benefit: The analysis helped determine the need for a staged approach to PBL contracting, starting with a focus on individual PBL contracts for individual major systems only, but progressing towards combining contracting vehicles in the longer term to gain additional support potential and cost savings. Using TFD TOC modelling, the United States Navy and MHSCO, as well as sub-tier contractors such as Northrop Grumman, were able to create win-win performance metrics for H-60 tip to tail, H-60R & S and many systems PBLs arrangements, which subsequently became the template for a successful total aircraft PBL

Customer: **Japan Ministry of Defence (through Fujitsu TSL)**
System: **Logistics Support**
Scope: Development and delivery of specialist logistics education and training to JMOD and JGSDF personnel
Benefit: Intensive 10-day education and training courses have been developed to equip the JMOD and JGSF with the knowledge to implement effective PBL and Logistic Support Strategy

Customer: UK MOD
System: BAE Systems Nimrod MRA4

Scope: In addition to supplying the UK MoD with TFD's MAAP software tool to develop a Value for Money comparator for the initial five years of Nimrod MRA4 support, TFD was asked to design an 'in-house' solution for use as a benchmark against which to compare the BAE Systems priced proposal

Benefit: Whilst the BAE Systems price was over £800M, the TFD analysis suggested (with full evidence) that the price should have been circa £350M. BAE Systems consequently reduced its price in negotiation by £200M

Customer: Morgan Advanced Materials (MAM)
System: Buffalo mine-protected clearance vehicle

Scope: To conduct a Level of Repair Analysis (LORA) and spares optimisation review of the British Army Buffalo fleet for MAM (as the PDS contractor) on behalf of the DE&S Protected Mobility Vehicle Team as part of the system's introduction into Core

Benefit: The task required the collection and collation of disparate and sparse data, for all the many vehicle marks and configurations, to identify the preferred maintenance and repair policies and the consequent impact on extant spares holdings that had been procured through Foreign Military Sales under UOR. The analysis revealed that circa £300K of current stock was excess to requirements, but also that £110K of additional items would be required. Overall, the analysis identified that savings of £740K were achievable

Customer: Babcock International
System: Defence Support Group (DSG)

Scope: Following Babcock's winning of the competition to purchase the DSG (the depot for UK Land equipment) from the UK MOD, together with contracted work including heavy vehicle fleet maintenance and spares procurement, TFD was asked to create a high-level MAAP model of the Army ORBAT to demonstrate its tools and capability. At that time, the DSG operating costs were circa £400M pa, within LAND equipment support costs of £2Bn; the British Army 'enterprise' costs circa £8Bn pa

Benefit: The consequent model was able to identify and evaluate 'levers' with potential to enhance the effectiveness of DSG and reduce overall Army costs within an Incentivised Fleet Management programme

Customer: Japan Ground Self-Defense Force (through Fujitsu TSL)
System: Battle Training Apparatus (BATRA) Systems

Scope: To develop a Concept of Analysis for a 5-year programme to implement progressively increasing levels of PBL for laser-based battlefield training systems for the JGSDF

Benefit: In addition to developing the Concept of Analysis, TFD provided specialist education and training (covering PBL contracting, logistics, ILS and support analysis) to the JGSO. Also, with Fujitsu Tokki Systems Ltd (Fujitsu TSL) acting as an intermediary in the delivery of this project, TFD provided guidance, training, support and mentoring to Fujitsu TSL personnel for building MAAP and TEMPO models of the BATRA systems

Customer: **AAR International**

System: **BAe 146**

Scope: To support AAR in its bid to become the Prime Contractor (with Marshall Aerospace) to provide a comprehensive availability contract for the RAF's BAe 146 fleet

Benefit: TFD provided ILS guidance and mentoring to AAR and Marshalls Aerospace staff, and as well as developing the ILS plans (Integrated Support Plan, Supportability Analysis Plan and the initial Supportability Case) required to support the bid

Customer: **Swedish MOD Material Command (FMV)**

System: **Tgb 360 – Armoured Fighting Vehicle**

Scope: To conduct a Supportability Audit to establish a modelling baseline, while also identifying current weaknesses and potential areas for improvement

Benefit: Although this AFV fleet was yet to enter service and with limited available in-service data, the audit identified scope to review the maintenance policy (by location and interval) with potential to reduce resources by 8% with a 2% reduction in preventative maintenance cost. It also identified significant errors and omissions in the supplied maintenance data, which highlighted potential risk of system under-performance and erroneous procurement. The audit also identified several major materiel cost drivers that suggested the need and benefit of introducing 2 product improvement modifications by the OEM prior to the vehicles being delivered. Overall, this activity confirmed the majority of key support metrics, as well as having identified annual cost savings of >2% on SEK29M. A_0 was also protected through the identifying of key data errors

Customer: **Dstl**

System: **British Army Training Unit Suffield (BATUS)**

Scope: To conduct a spares optimization review (on behalf of Army HQ and DE&S SEOC) for the major platforms used at BATUS

Benefit: The review quickly identified that there were significant issues associated with the availability and quality of the data required to perform the spares optimization; disparate multiple data sources (including MJDI, JAMES, SS3 Gun Records and local records), in many formats and often minimally populated with poor quality data. The scope was consequently amendment to conduct a study by TFD to identify and quantify these issues. TFD presented its findings and recommendations

Customer: **UK MOD / Defence Industry**

System: **Defence Acquisition and Support**

Scope: Membership of the UK Council for electronic Business (UKCeB); now known as Team Defence Information (TD-Info)

Benefit: As a joint UK MOD/Industry body that aims to transform secure information sharing for through-life collaboration in defence acquisition and support, it provides focus on improving collaboration across the boundaries between organisations in defence, including the MOD. As a member of the 1* Defence Industry Support Chain Optimisation Group (DISCOG), TFDE chairs the sub-ordinate Support Modelling & Analysis Working Group (WG) and participates in the Supply & Support Engineering WG

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Customer: AAR Corporation
System: USAF Joint Primary Aircraft Training System (JPATS)

Scope: To support AAR Corporation in its joint bid with Beechcraft for the USAF competition for the provision of technical and supply support for JPATS; comprising 750 Beechcraft T6 trainer aircraft for the USAF, USN and US Army

Benefit: Although a long-standing user of the TFD VMetric software tool, AAR Corporation had insufficient internal resource available at the time to use the software effectively. TFD was able to provide the necessary modelling and analysis support using its own experienced specialists

Customer: Swedish MOD Material Command (FMV)
System: Logistics Decision Support System

Scope: To provide TFD MAAP software and provide on-going support in the development and maintenance of MAAP models for weapons systems operated by the Swedish armed forces

Benefit: FMV has now put the TFD's central 'common source' structured database (TFDdV) at the heart of its logistics information and decision support system. TFD has also built interfaces to enable data to flow between the TFDdV and analysis tools (including those from 3rd parties) and is now developing an interface to feed data from existing logistics data systems, including SAP, into the TFDdV

With TFD's support, FMV has developed MAAP models for a number of weapons systems, including: Tp84 (C130E/H); C130J; Tgb14/15 (Mercedes G-Wagen); Tgb 360 (Protected Mobility Vehicle); CV90 (Armoured Fighting Vehicle); Strf122 (Leopard II Main Battle Tank); Combat Boat 90 (Naval Vessel); Hkp14 (NH90 helicopter); and Hkp10 (Puma EC225)

Customer: Japan General Staff Office (through Fujitsu TSL)
System: Depot Level Maintenance

Scope: In anticipation of the need to commence outsourcing maintenance support, TFD was asked to provide guidance to the JGSO to help improve its understanding of how to outsource military deport-level maintenance activities

Benefit: Based on real-life examples, TFD compiled and delivered several case study reports covering: Depot Service Outsourcing; Private Sector methods; and Public-Private Infrastructure Frameworks

Customer: British Army HQ
System: Forward Repair

Scope: To review the British Army doctrine for Forward Repair to ensure that it remained fit for purpose

Benefit: Using evidence that substantiates why, when and where Forward Repair has contributed to a battle winning strategy, it is equally important to understand when, and in what circumstances, it is not appropriate and has wasted resources. Using this as the basis, TFD developed and delivered comprehensive guidance to assist deciders understand when Forward repair is appropriate to deliver maximum combat power. This guidance included the need to adopt a holistic approach to Level of Repair Analysis

ARMY

Customer: Japan Ground Self-Defense Force (through Fujitsu TSL)
System: UH-1J Replacement (UH-X)
Scope: In preparation for the procurement programme to replace the current UH-1J fleet with UH-X (a Bell 412 derivative), TFD was asked to provide guidance to the JGSDF to help improve its understanding of how to plan for, and the benefits of, implementing PBL or IOS style contracts

Benefit: TFD compiled and delivered case study reports: one covering the Private Finance Initiative (PFI) to provide an availability-based contract for the RAF's Griffin (Bell 412EP) helicopter; and another outlining processes for the Optimal Procurement for Initial Provisioning for new helicopters, such as Bell 412 variants. Base of real-life and proven examples, these reports provided the JGSDF with an improved understanding of the development of effective PBL/IOS contracts that can deliver high availability and reduced maintenance costs

Customer: Joint TD-Info (UKCeB) / TFD Venture
System: Puma Mk1 Helicopter
Scope: As part of a TD-Info (UKCeB) sponsored study to develop generic methodology and guidance for Supportability Audit, TFD to deliver a case study using the RAF Puma Mk1 as a representative example

Benefit: The Supportability Audit performed for this case study identified a number of improvements that, if implemented, could deliver significant cost and performance benefits. The improvements included: reducing the number of aircraft operated by each operational sqns by 3, while also achieving total flying task; increasing the fleet operational availability (Ao) target from 75% to 80%; reducing maintenance task durations by 15% through additional maintainer training and/or or improved maintenance procedures; stretching suppliers to improve production lead times (PLTs) on first time demands by 15%, as well as a price challenge of 15% challenge on purchase and repair prices; and an RCM-based reduction in the frequency of all unplanned corrective maintenance by 15%. The case study concluded that such improvement measures could deliver potential cost savings of £5.6M (or 23% of annual costs) at the time as a 5% increase in availability, while delivering the same task with 6 fewer aircraft

Customer: General Dynamics UK
System: AJAX Armoured Fighting Vehicle
Scope: To provide LORA, spares modelling, life-cycle cost modelling and on-going support to General Dynamics UK and the DE&S AJAX Delivery Team for the AJAX programme

Benefit: The application of relevant and objective supportability analysis process throughout the detailed design of all vehicle variants, and their evolution towards introduction to service

Customer: Kawasaki Heavy Industries (KHI) Ltd (through Fujitsu TSL)
System: MCH-101
Scope: To train KHI in the use of Tempo for spares optimisation

Benefit: TFD training enabled KHI to improve its spares optimisation processes (and opportunity for increased profit margins) for the MCH-101 PBL Support Contract

Customer: Northrop Grumman
System: X-47 Unmanned Combat Air System (UCAS)
Scope: To deliver expertise and support in the logistics modelling and decision analysis for the X-47 Unmanned Combat Air System (UCAS) programme
Benefit: Through the application of support analysis of the maintenance plan, test & support equipment, supply support, and packaging, handling, storage and transportation, TFD was able to provide recommendations and decision support to the OEM for use in determining measurable program objectives for meeting both internal and external customer's cost and performance goals. TFD also provided education and guidance to the Integrated Programme Team for how spares optimization and total ownership modelling should be employed when contracting for maintenance support in the future

Customer: MTU Aero-engines
System: EJ200 Turbofan Engine
Scope: To develop a bespoke evolution of TFD's generic spares and maintenance activity-based life cycle costing tools for MTU Aero-engines, specifically designed to manage serially numbered parts for the EJ200 engine installed in all Eurofighter Typhoon aircraft
Benefit: The SIM software tool was developed and delivered, which enables users to forecast the likely forward demand for spares, repairs and facilities taking into account failure rates, FOD, secondary damage and minimum issue lives for modular engines

Customer: Government Department
System: Strategic Weapons System
Scope: As the consequence of existing contract logistics KPIs that had significant potential to drive the wrong behaviour by the supplier, the scope was to evaluate the KPI regime at the higher contract level to identify customer and contract 'sweet spots', as well as to help identify risk margins to inform future contract negotiations
Benefit: Using simulation techniques drawing data from MAAP models for the weapons system, the task helped establish contract KPI that would deliver an acceptable balance between delivering required levels of operational availability, while also providing adequate incentivisation for the supplier; the route to a 'Happy System', as opposed to 'Happy Shelves'

Customer: UK MOD (DE&S)
System: Chinook Helicopter
Scope: To conduct a Supportability Audit of the RAF's Chinook fleet to identify the drivers adversely impacting aircraft availability, and to make recommendations for progressively incremental increases in fleet flying achievement
Benefit: The audit identified and substantiated a number of key drivers including: disparate and incoherent support contracts; inefficient operational and support policy; inadequate technical information; sub-optimal supply chain; and insufficient exploitation of usage data. Having initiated many of the audit's recommendation, the target of increasing annual flying achievement from 12500 FH to 16500 FH was reached within 12 months

Customer: US Air Force / Northrop Grumman
System: E-8 Joint STARS
Scope: To develop LCOM interfaces to the programme's universal database for all programme secured data files and compiling, and to support data migration, cleansing and quality assurance. Also, to equip the programme with TFD tools for modelling Total Ownership Cost (TOC), Spares Optimization and Equipment Designer's Cost Analysis

Benefit: Both the US Air Force and Northrop Grumman have profited by investing in logistics interfaces. The interfaces created by TFD ensured that correct and timely data was realized, as well as utilized for monitoring and making decisions that exceeded programme criteria and goals

Customer: MAN SV Trucks
System: British Army transport vehicle fleet
Scope: To develop a spares optimization model for the British Army MAN SV Truck fleet to identify the size and location of optimum spares holdings to deliver maximum vehicle availability during deployed military operations

Benefit: TFD provided MAN SV trucks with its recommendations for the optimal spares inventory for this large and diverse fleet

Customer: MSI Defence Systems
System: Naval Gun Systems
Scope: To support MSI Defence Systems in the modelling of spares for the 30mm naval gun systems fitted to ships of the Royal Navy and other overseas nations

Benefit: TFD has equipped MSI with the tools and capability to define and optimize the logistics support arrangement for its produce range. TFD was also able to provide life-cycle cost modelling support to MSI in its bid to contract for the support of the 4.5-Inch Naval Gun fitted to Royal Navy Type 23 frigates

Customer: United States Air Force
System: KC-46 Pegasus
Scope: To provide spares optimization capability for the USAF KC-46 procurement programme

Benefit: Through the use of TFD Tempo, the programme is delivering cost effective and optimised spares inventory solutions

Customer: UK MOD
System: Distributed Training System
Scope: To develop a bespoke simulation software to model individual training; the student population was for circa 350,000 personnel of all 3 Services and civilians for approximately 1.5 Million man-training days per year

Benefit: Using AnyLogic, the TFD solution was able to identify the optimum balance between residential training in centralised schools or distributed to students in either geographic regional learning centres, at Units or to their home address. Using 6 case studies, the project concluded that that significant benefits could be delivered through distributed training in appropriate cases

Customer: Mitsubishi Heavy Industries (through Fujitsu TSL)
System: F-15J
Scope: To conduct a spares inventory optimization and supportability improvement study
Benefit: TFD supported MHI in a research project to evaluate the benefits of using its software analysis tools for future application within the F-15J PBL support contract. The scope also involved providing education, training and mentoring support to MHI and EvaAviation

Customer: Bell Helicopters
System: Bell Helicopters (Various platforms)
Scope: To provide an enterprise licence for TFD tools and assist in the development and implementation of data interfaces for current Bell platforms
Benefit: The introduction of TFD tools and interfaces has enabled Bell to adopt a consolidated approach to the logistic support arrangements for its products, including V280, V-22J and UH-X

Customer: US Navy
System: F/A-18 Hornet
Scope: To deliver support and guidance to the US Navy procurement programme for research, analysis and verification of business case analysis, including the provision of alternative plans and performance measurements for use in future PBL contracts
Benefit: TFD's business case analysis guidance to the US Navy during the F/A-18 initial program support phase was key to achieving programme and contracting objectives, as well as leading to the development of successful F/A-18 operation, maintenance and sustainment plans

Customer: Northrop Grumman
System: RQ-4 Global Hawk
Scope: To provide guidance and support to Northrop Grumman in the creation of data collection systems and total ownership cost modelling. Also to develop program objectives and logistics criteria for managing support chain optimization, through the adoption of a tactical approach to spares provisioning
Benefit: TFD assistance to this critical programme enabled Northrop Grumman in being able to provision optimum equipment, spares and support, and at the right locations, to ensure required levels of operational readiness and mission success

Customer: US Air Force Materiel Command
System: Center of Excellence, Air Force Command Studies and Analysis
Scope: To establish a teaming arrangement with the US Air Force Materiel Command to develop new and innovated ideas for the application of logistics analysis and support within government and industry
Benefit: By teaming with such customers, TFD has helped identify opportunities for improvement in support documentation and enhancements in logistics support practices, procedures and sustainment concepts, that will produce better equipped economical support for the future

Customer: **US Air Force System**
System: ***B-2B Joint Capability and Performance***
Scope: To develop a Support Chain Optimization (SCO) system, along with a cost and performance system, for the B-2B Spirit
Benefit: The creation of the support chain optimization tool allowed for increased programme performance and minimized unforeseen problems which, over time, could have resulted in significant increases to budget and delays in achievement of program and mission goals. The US Air Force benefitted through implementation of a total sustainment contract that increased readiness, while also decreasing cost

Customer: **Japan General Staff Office (through Fujitsu TSL)**
System: **Eurocopter EC225LP Helicopter**
Scope: To support the JGSO in a proposal study by Eurocopter Japan (ECJ) to assess the potential benefits of adopting PBL (through a 5-year PBL trial), when compared with 'Business as Usual'
Benefit: Using a MAAP model, TFD helped demonstrate that similar costs would be incurred under PBL during the trial period. However, analysis also revealed that support costs would soon escalate since many expensive overhauls would become due during the subsequent period. The ECJ proposal for the trial period was consequently assessed as being not good value for money