OSCAM – US Navy's operating and support cost estimating tool

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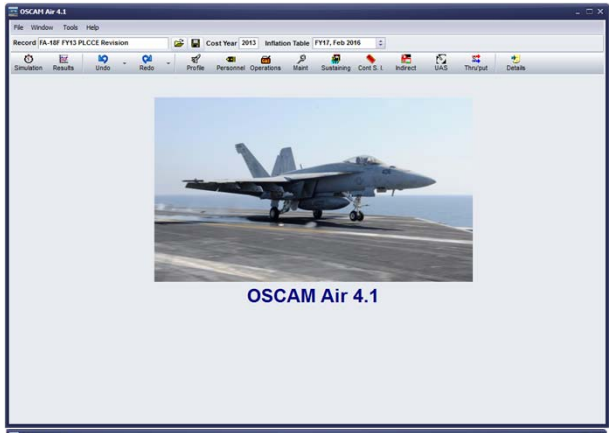
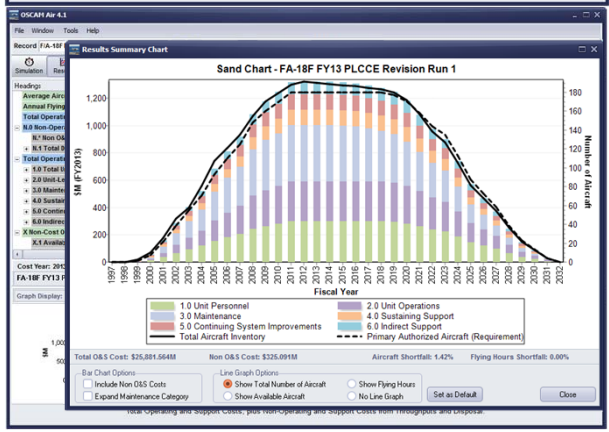
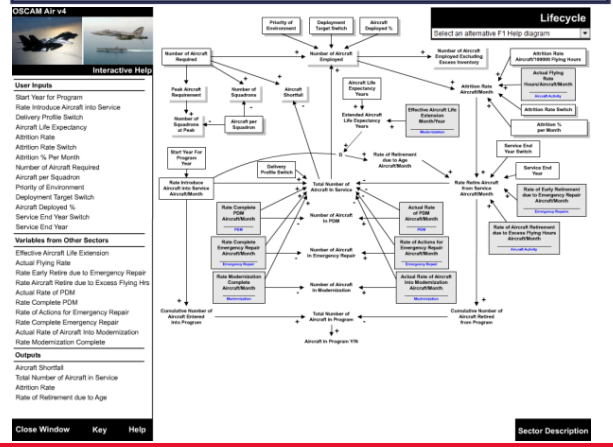
What is OSCAM?

- **O**perating & **S**upport **C**ost **A**nalysis **M**odel
- There are several OSCAMs in use by US DoD*:
  - The US Navy uses **OSCAM Ship**, **OSCAM Air** and **OSCAM Sys**
  - **OSCAM JSF** is used by the F-35 Lightning II Program Office
- It is a software tool
- It is used to generate operating and support cost estimates for equipment programmes
- It captures the business processes involved in operating and supporting a class of military platforms or systems
- At its core is a System Dynamics simulation model that steps through time (in months) and determines the costs generated each month based on the status and activities of the equipment
- It has a powerful front-end for data entry, analysis of results, comparison of different scenarios and analysis of uncertainty







* US Navy versions of OSCAM are sponsored and owned by US DoD Naval Center for Cost Analysis (NCCA)

Use of OSCAM in US DoD – example ship & submarine programmes

OSCAM is now used in the majority of ship procurement costs estimates, and has been used to generate milestone cost estimates for a range of US ship programmes including:

- T-AKE Solid Support Ship
- Virginia Class Block III Upgrade
- LPD
- LCS
- DDG1000
- Ohio replacement, Joint High Speed Vessel, Unmanned Naval Surface Combatant, Coast Guard National Security Cutter & Off-shore Patrol Cutter

Use of OSCAM in US DoD – example aircraft programmes

OSCAM is used by the US Navy Airforce (Navair) for a range of aircraft programmes, including:

- F-35 Lightning II
- V-22 Osprey
- Fire Scout MQ-8B
- P-8A Poseidon
- E-2D Advanced Hawkeye
- E/A-18G Growler

Use of OSCAM in US DoD – types of studies

Milestone submissions:

- Formal stages in the procurement process that are needed to advance to the next stage of procurement
- Milestones A, B, C – each requires increasing levels of precision
- Each includes the requirement for an operating and support cost estimate over the life of the programme, broken down into cost categories

In-service annual cost submissions:

- In-service programmes are expected to provide annual operating and support cost actuals, and estimates to the end of life

Analysis of Alternatives:

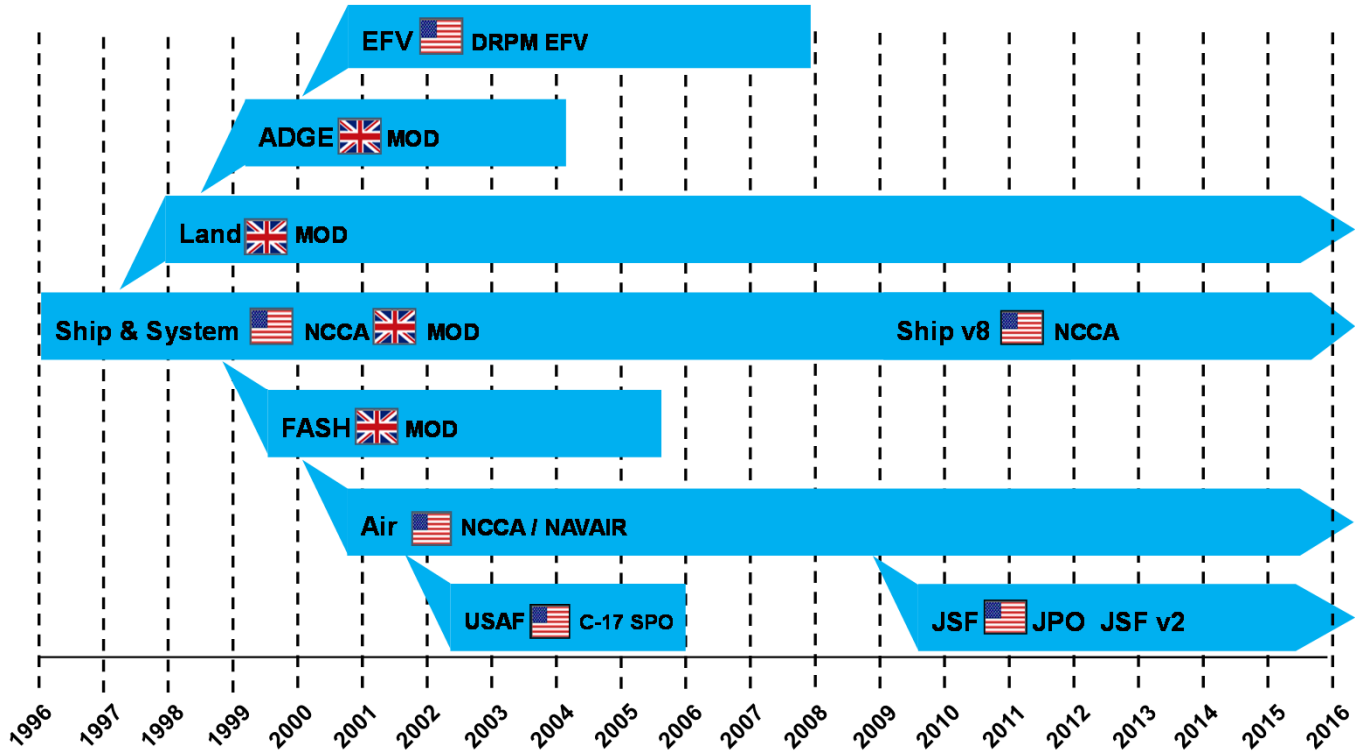
- Development of operating & support cost estimates at concept phase to analyse alternative concepts (e.g. nuclear vs conventional propulsion concepts)

Bespoke Studies:

- Use in bespoke studies, e.g. analyse impact of an equipment modernisation programme on operating & support costs for the fleet

A brief history of OSCAM

- First OSCAM Ship and System models developed in 1996, jointly for US DoD and UK MoD
- OSCAM Land variant developed in 1998, with some spin off models for specific vehicles
- OSCAM Air demonstrator developed in 1999. First full-scale tool developed for USAF in 2002. Adapted for US Navy aircraft in 2003. Joint Strike Fighter (F-35) version developed in 2010



- Current versions: OSCAM Ship v8.3, OSCAM Air v4, OSCAM Sys v7, OSCAM JSF v2
- Over 550 people trained for OSCAM Ship/System
- Over 400 people trained for OSCAM Air variants
- OSCAM Air v4.1 is currently in testing and will be released soon
- Plans for updates to OSCAM System and to develop a Land vehicles model for the US Marines

The user experience (1)

Core requirements by cost analysts

- Produce operating and support cost estimates to agreed DoD standard reporting structure
  - OSCAM produces outputs in agreed reporting structure (CAPE '14), and flexibility to roll-up or expand to different levels of details in cost breakdown structure
- Must be able to withstand detailed scrutiny by US DoD authorities
  - **Content, breadth, flexibility** - US cost analysts and SMEs involved throughout development
  - **Confidence in model** - verification and validation conducted and signed off by US cost analysts
  - Ability to **include recognised US Navy data sources** (VAMOSC database) for OSCAM inputs
  - **Analyst has clear understanding of business process used by OSCAM** – view appropriate interactive influence diagrams by selecting any input and output in the model and pressing F1 key
  - **Non-cost outputs** generated that show the levels of activity that drive the costs – allows **understanding of why** the cost outputs are being generated
- Include uncertainty analysis on inputs using probability distributions
  - OSCAM models have an Uncertainty Tool embedded:
    - specify input values as probability distributions
    - outputs are S-Curves for costs

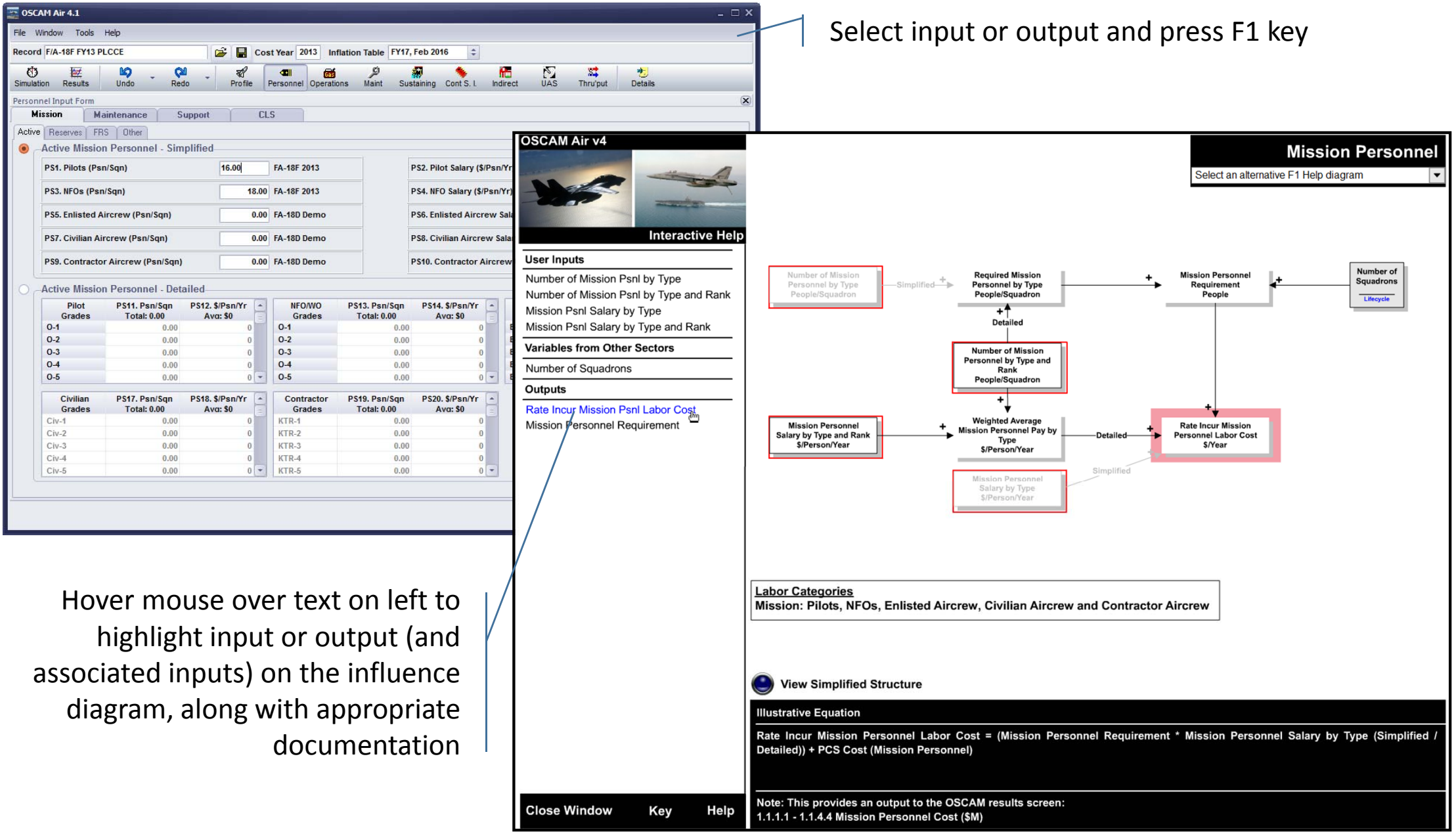
The user experience (2)

Core requirements by cost analysts

- Ability of Programme Offices to undertake numerous what-if studies prior to submission
  - OSCAM makes it **easy to** edit baseline estimates to **examine alternative scenarios** for use and design
  - **OSCAM handles knock-on impacts of changes** – e.g. impact of change in personnel numbers on training and facilities costs
  - **Rapid turnaround time for answers to what-if questions** is a couple of hours using OSCAM versus a couple of days for spreadsheet models
  - Comparative graphs (for up to 20 scenarios) and Delta results (difference between two results sets) can be generated to **highlight differences in cost and performance**
- Ability to add detail for later milestones
  - **OSCAM contains options for "Simplified" and "Detailed" representations**. Can use a mixture of simplified and detailed representations within the same model
  - Allows OSCAM to be **adopted early** and **for detail to grow over time** as knowledge of equipment increases
- Sharing and handover between cost analysts
  - **Standardised but flexible structure** – allows analysts to concentrate on validity of input data rather than trying to understand someone else's spreadsheet
  - OSCAM contains a number of **audit trail** features to support documentation

The user experience (3) – "F1 Help" for interactive influence diagrams

Select input or output and press F1 key



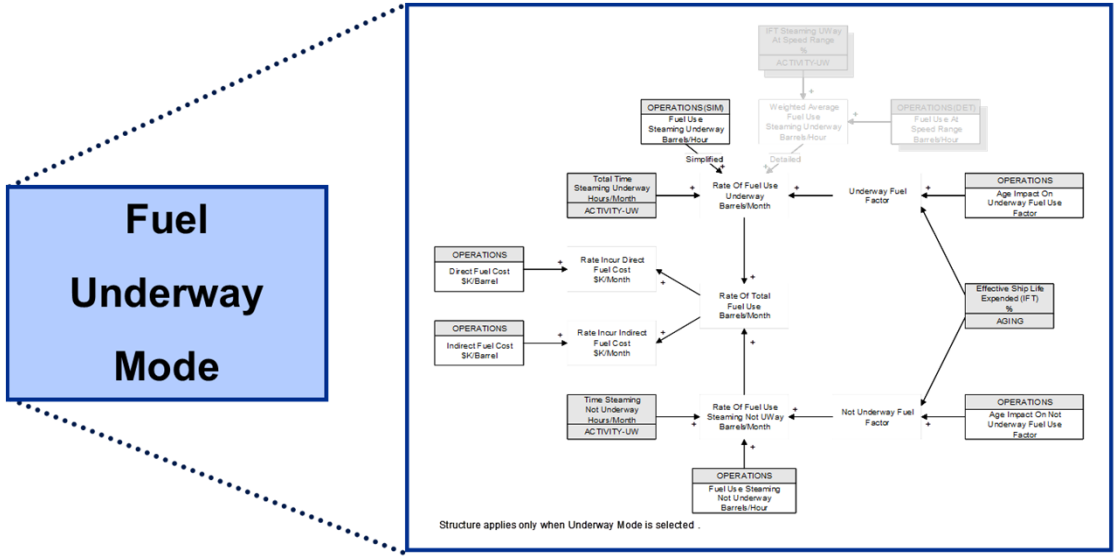
Hover mouse over text on left to highlight input or output (and associated inputs) on the influence diagram, along with appropriate documentation

How OSCAM works – System Dynamics simulation

- At the heart of an OSCAM model is a System Dynamics simulation model
  - It is **not a regression model**, all inputs are provided by user (but may be based on actuals)
  - **System Dynamics captures relationships** between elements as graphical influences and equations. It is used for a wide range of applications
- This steps through time, in 1 month intervals and determines what the equipment is doing:
  - Changes in fleet size: Introductions, retirements (possibly early), attrition
  - Temporary removal/return from/to service: overhauls, emergency repairs, modernisations
  - Activities: operating environments (Air), deployed/non-deployed, operating hours
- Calculate other non-cost impacts
  - Number of personnel, number of maintenance actions (and level of repair), etc.
- Calculate cost impacts
  - Uses US DoD CAPE '14 O&S cost elements structure (with extra detail)
- Cost and non-cost outputs are reported on an annual basis

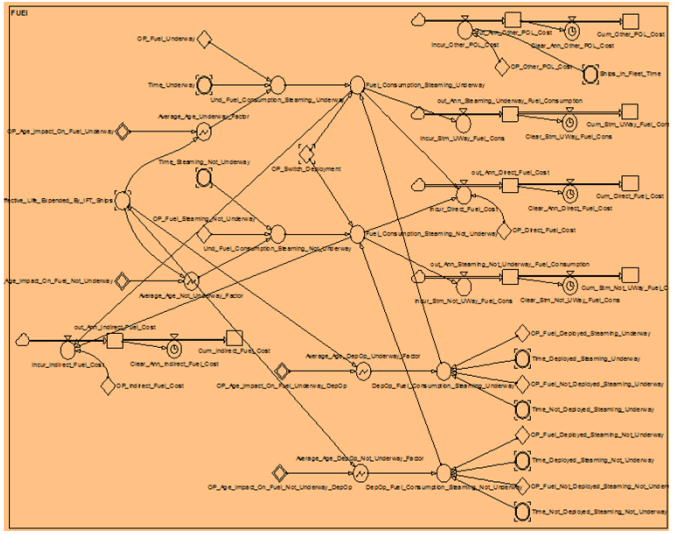
How OSCAM works – the building process

1) Determine functional areas (see next slide)
2) Workshops to determine and map out business processes (may have simplified and detailed options)

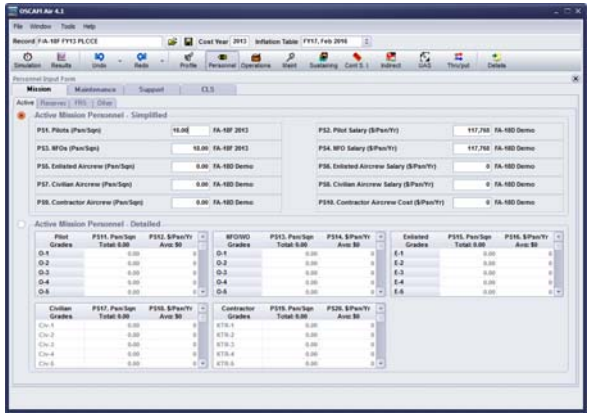


3) Develop Data Dictionary – captures all inputs and outputs and their properties (also generates software code)

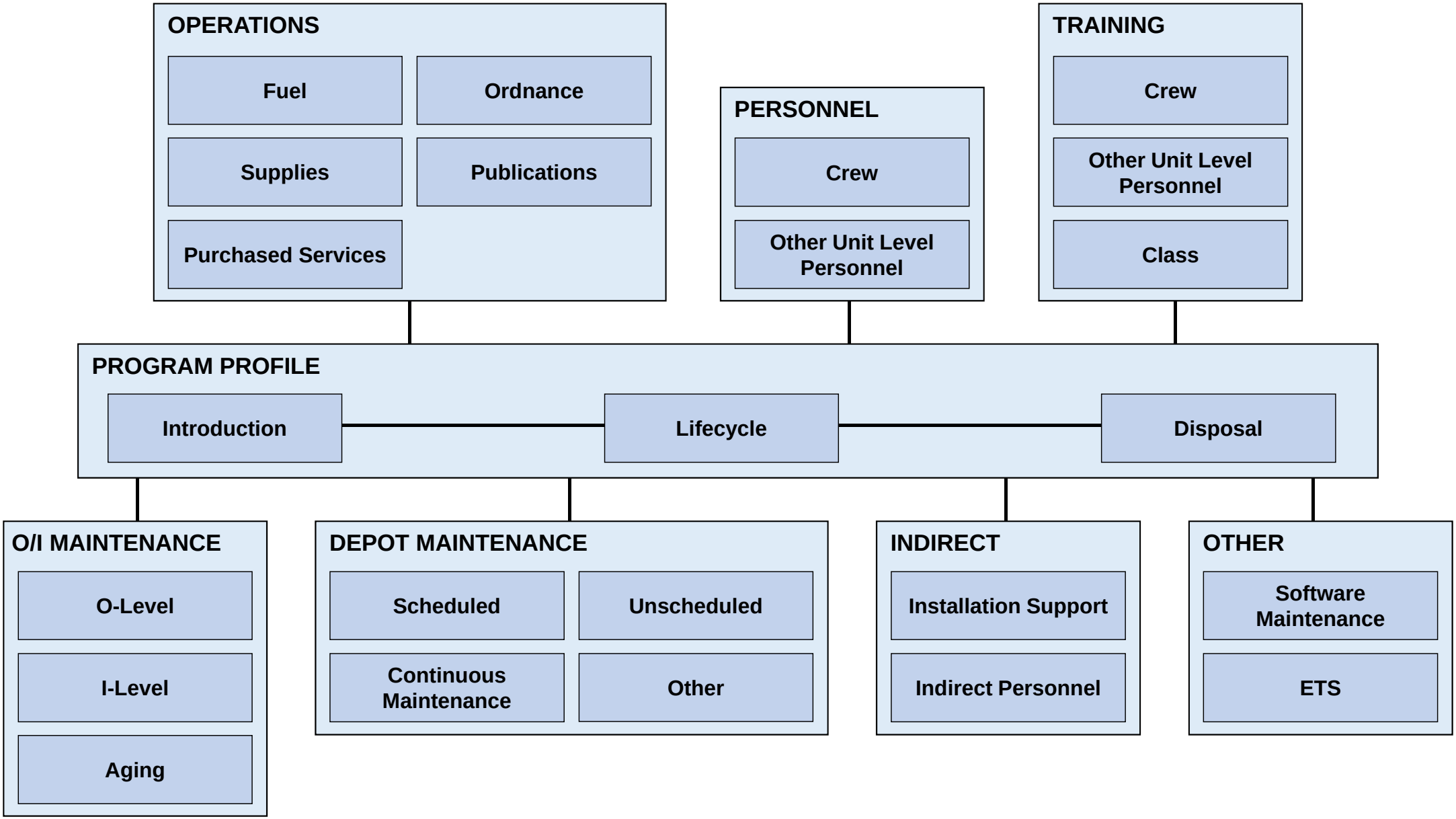
4) Develop stock-flow diagram in System Dynamics software
5) Write equation for each element in stock flow
   - Most equations simple – complexity comes from interaction between structure and simple equations



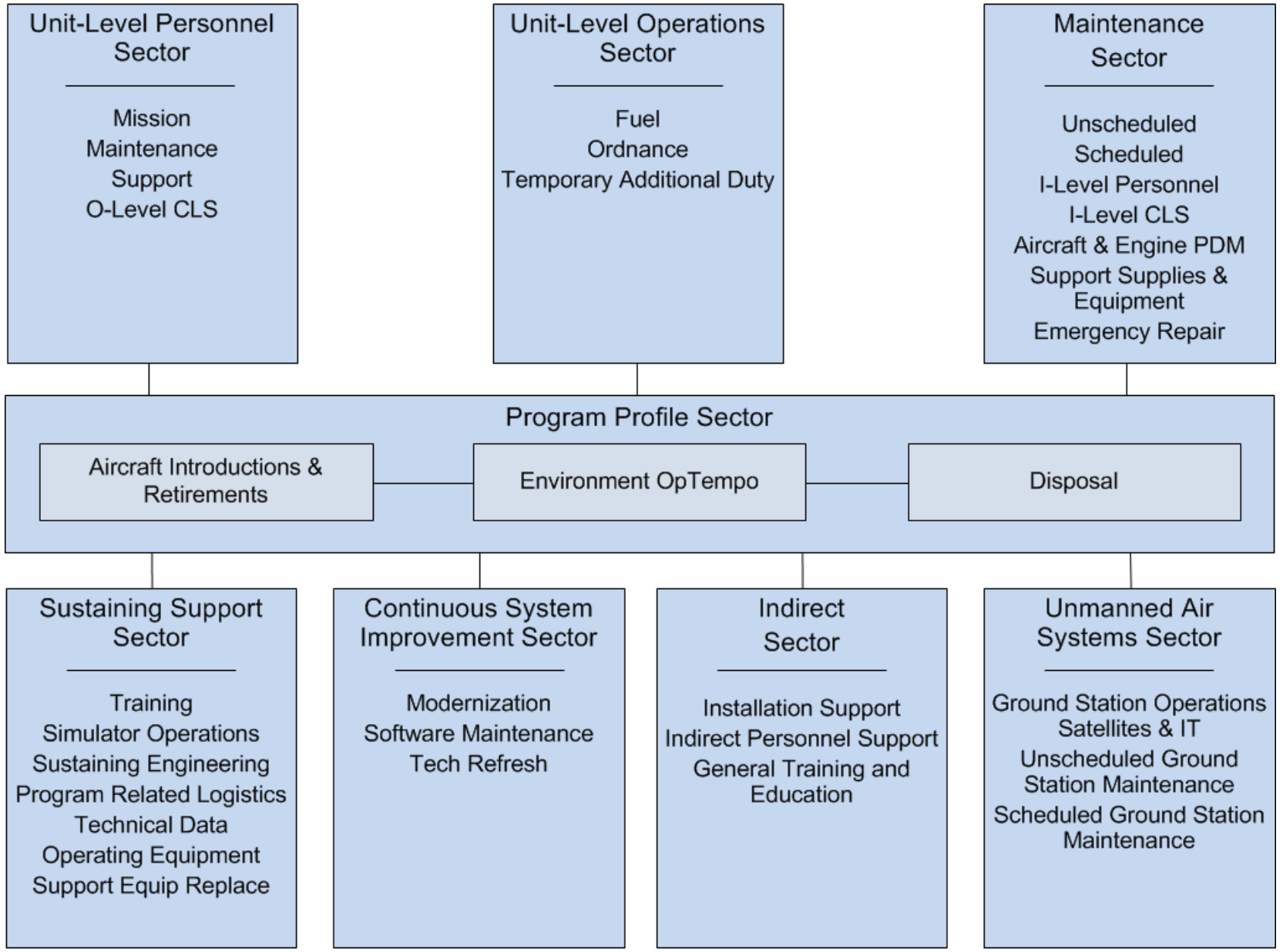
6) Develop front-end (generic framework, specific input and output properties)



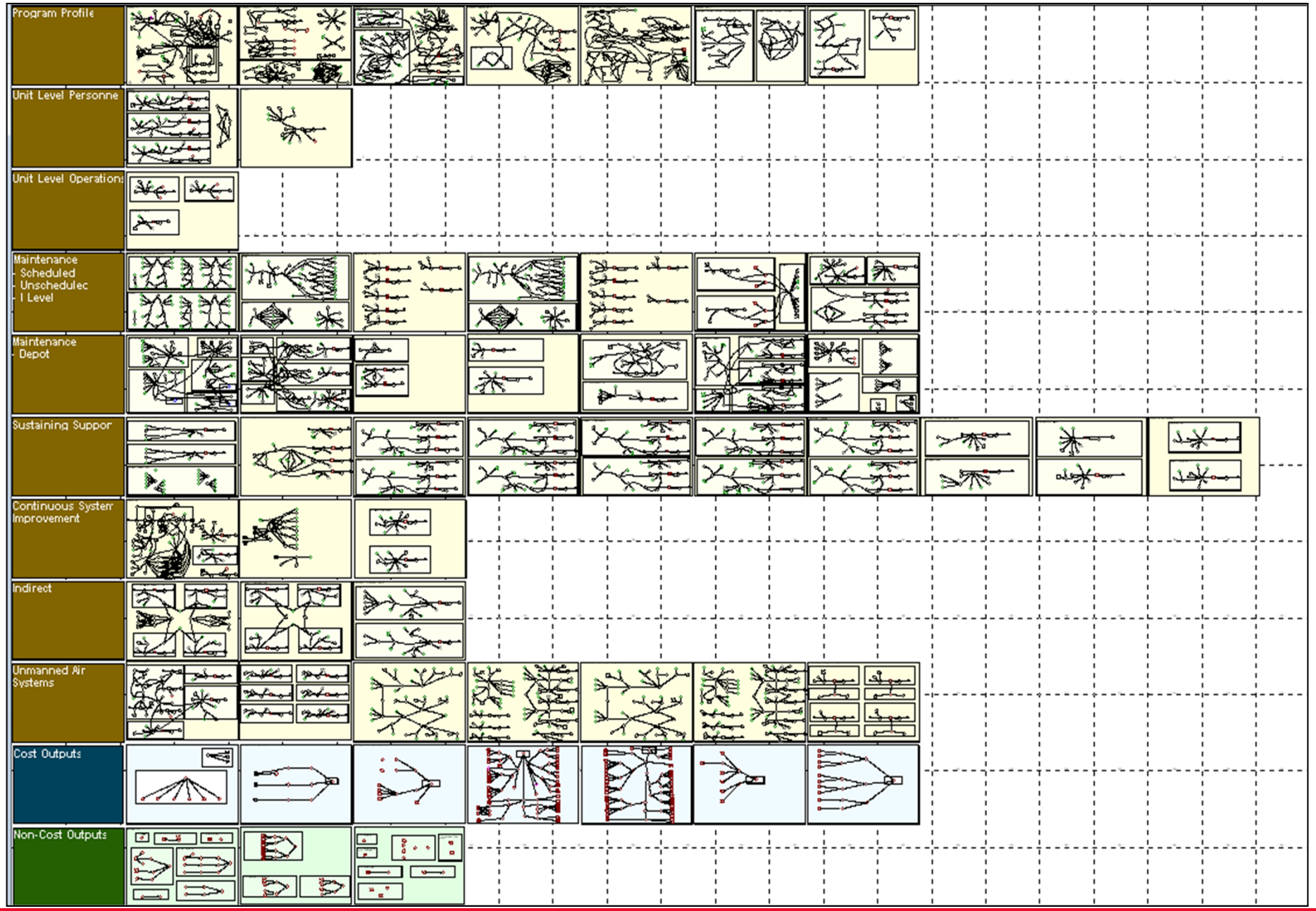
How OSCAM works – OSCAM Ship input sectors



How OSCAM works – OSCAM Air input sectors



How OSCAM works – modular design, modular implementation



The relationship between OSCAM and VAMOSC

OSCAM is not a parametric model and is not dependent on data to define its relationships. However, having evidence of costs for existing equipment makes it much easier to estimate costs for future equipment

- The US Navy VAMOSC database is used to collect and disseminate operating and support costs for in-service ships, submarines, aircraft and major sub-systems (e.g. weapons systems)
- The Naval Center for Costs Analysis (NCCA) is the sponsor for both OSCAM and VAMOSC
  - A major re-development of VAMOSC took place in late 90's at the same time as the first OSCAM models were being developed. The business process mapping developed for OSCAM had a major impact on the data collected for VAMOSC
- VAMOSC collects both cost and non-cost data
  - Non-cost data is vital for establishing costs in relation to activity or scale, e.g. **$/Flying Hour**, **$/Overhaul**, **$/Ship/Year**, **$/Person/Year**. These types of metrics are vital for O&S cost estimating
- Historical datasets are produced for OSCAM for in-service (and a number of retired) ships, submarines, aircraft and major systems which can be loaded directly into OSCAM. These can be used as OSCAM inputs to act as benchmarks and starting points for cost estimates for new equipment

"Past performance is not a guide to future performance" (but it's a good place to start!) – the role of actuals in estimates

- Mostly OSCAM is being used during the procurement process for equipment, or early in the production/deployment phase, and actuals are not available or are very limited
- Most equipment is new design, or a variant of an existing design
  - It will differ in its parameters, and activities compared with the existing in-service equipment
  - Programme teams, designers, engineers may have a view on how the design will impact costs
- Cost estimates for milestones will be subject to several layers of scrutiny – Cost estimators will be forced to justify their models and assumptions

- VAMOSC-based data for actuals provides a benchmark – this will often be used by scrutineers as a sanity check against cost estimates for new equipment
- It is easier to start from actuals for existing equipment, and explain how it differs for the new equipment
  - Must be **at right level of granularity** – too high and the analogy is too abstract, too low and the discussion gets lost in the weeds
  - For O&S you must **separate base cost from its scaling factor**, and then justify both parts
  - **OSCAM provides the calculation engine** for putting these parts together, **analyst focus is put on the data** rather than the validity of the calculation (cf a spreadsheet model) - programme team estimators and NCCA scrutineers often both use OSCAM but source the input data independently

Equipment support cost forecasting in the UK - challenges

Getting the CASP (Command Acquisition Support Plan) right is critical for Levene's defence reforms of acquisition to work – it should be affordable and coherent to the Command's strategic budgets

- £7.7.Bn on support vs £6.2Bn procurement over next 2 years – *DE&S Corporate Plan*
- CAAS has estimated only 48% of support costs covered by specific cost estimates – *NAO MPR 2015*
- "Our validation work continues to show that cost forecasts are not as well developed for support projects" – *NAO MPR 2015*
- "…. DE&S must work with contractors to deliver the equipment and support in the Equipment Plan to time, cost and quality, and achieve over £6 billion of savings built into the Plan, which primarily relate to equipment support. While DE&S has improved its understanding of equipment procurement costs, its understanding of its equipment support costs is less well- developed and achieving these savings will require a step-change in its performance. " – *NAO Strategic Finance in MoD 2015*

Data needs for budgeting and cost estimating differ – but can both use the same raw data

Commands have been investing in in-service cost data collection as part of budget management

- but CAAS has stated that the lack of good equipment support cost data is a major impediment to effective ESP cost estimating
- ESP cost estimating is required for procurement gates, the 10 year plan, and the annual budget cycle

Budget management and cost estimating needs differ. If data is only available in budget format it cannot be used effectively for cost estimating

- Budget categories do not provide enough granularity to allow costs to be allocated to activities
- Non-cost measures must also be collected to allow the activity costs to be given a scale and transformed into a measure that allows cost estimating for future activity

Data collection for cost estimating need not require much more extra effort than for budget management

- Can mostly use the same raw data, but needs to be bucketed differently

The required format for O&S data is already known in US DoD, and much of that information is in the public domain

- The basic business process for operating and supporting equipment do not differ much between UK and US – MoD should be making better use of that information to improve ESP cost estimating

Questions & discussion

Over to you!

Authors

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Thank You

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