CHAPTER 4

1. Analysis & Comparison of T&E Structures and Processes

1.1 Introduction

As an addendum to the previous chapters, test and evaluation can be thought of as a cyclic process (Defence Systems Management College, 1995), that is based on the scientific method of observation and analysis. It takes issues from the acquisition process and inputs analysis and evaluations to decision makers. A summary of a typical test sequence is depicted in Figure 1-1. The fundamental purpose of test and evaluation in a defence system's development and acquisition program is to identify the areas of risk to be reduced or eliminated (DSMC, 1993). This process is depicted in Figure 1-2.

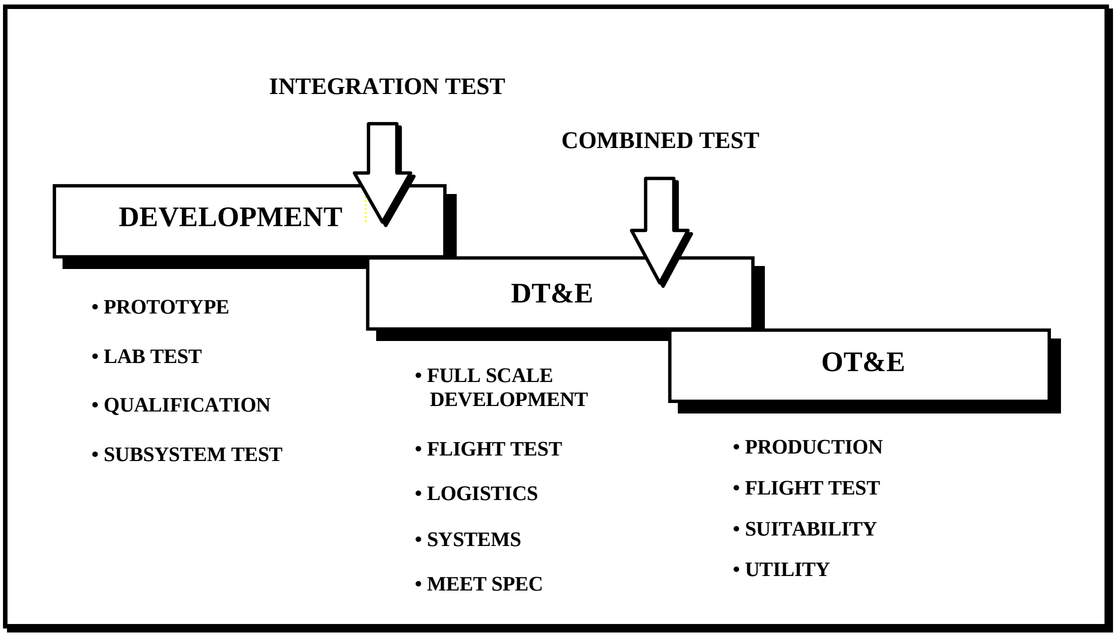

Figure 1-1 (Typical Test Sequence (based on DSMC, 1995))

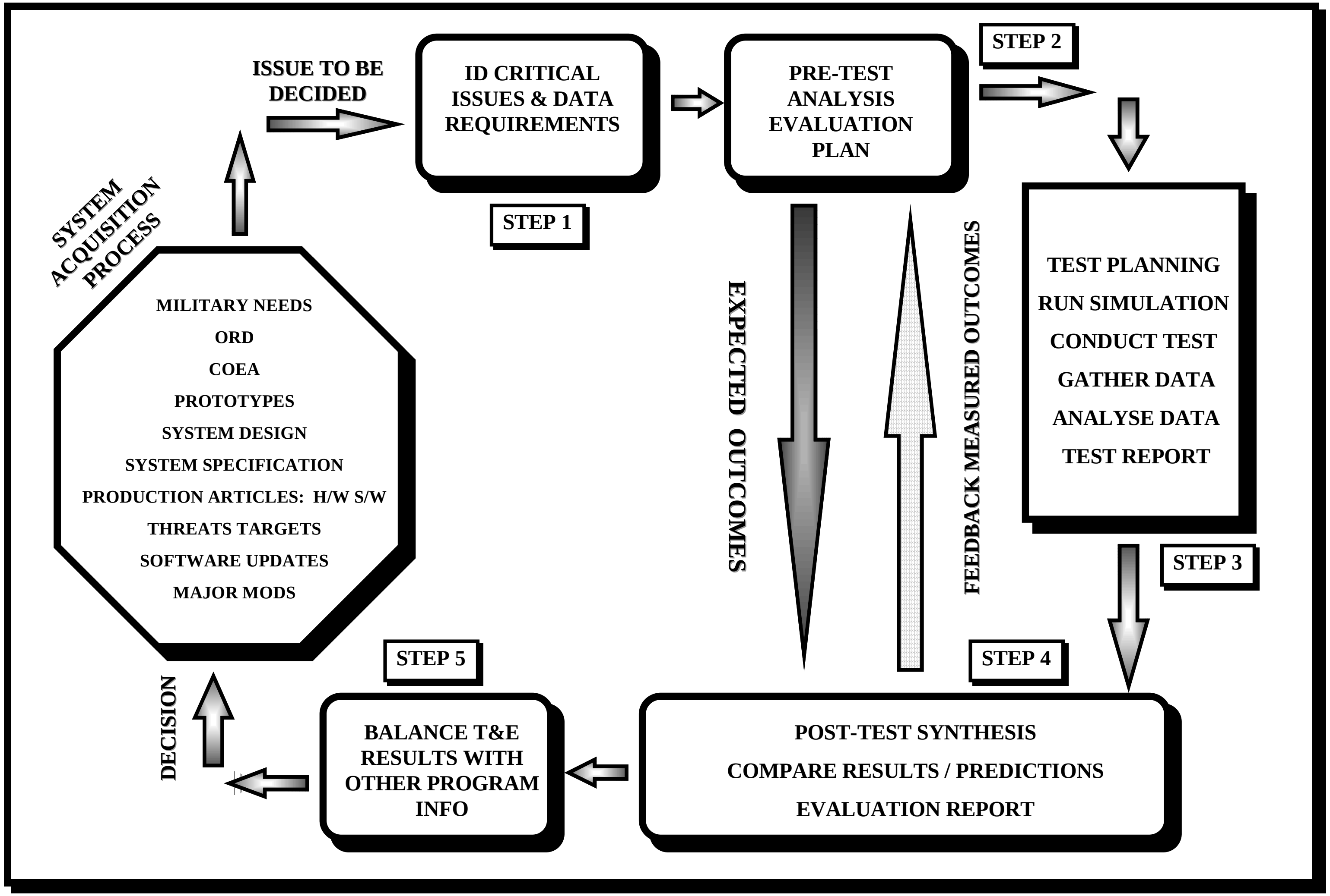

Figure 1-2 (Test and Evaluation Process (Defence Systems Management College, 1995))

1.1.1 Why Australia and the United States of America

As stated in chapter 2, the most well documented test and evaluation system is that of the United States Department of Defence. Because the United States is relatively well documented, many test and evaluation programs that are not US based have the tendency of adopting its basic principles, terminology, as well as its structure. Hence, the author has chosen to analyse and compare the United States and Australian test and evaluation processes. The following sections discuss the United States and Australian test and evaluation programs based on information obtained by the author to date.

1.2 The United States

1.2.1 A Brief History of US Defence T&E and Acquisition

In the early 1970s the Department of Defence issued the first documents that described the role T&E should play in each system acquisition program. Toward the end of the 1960s, Congress and the Defence Department started paying much attention to the way systems are acquired (Reynolds and Damaan, 1994). In 1970 the Department of Defence set up a Blue Ribbon Panel to examine the entire Department of Defence. The staff of this panel looked closely at the problem of T&E and in July 1970 issued a report to the Secretary of Defence and the President (Stevens, 1986).

The President's Blue Ribbon Panel as of July 1970 states (Reynolds and Damaan, 1993):

> *"**Functional Testing** (often called engineering testing) is done to determine how well various systems markets and material meet design and performance contractual specifications - in other words, whether they meet technical requirements. By and large, functional testing in and for the Department of Defence appears to be fully understood and faithfully executed. Serious policy deficiencies are not apparent, and such failures in functional testing as occur can be primarily attributed to lack of technical competence, oversight, or procedural breakdowns. Functional testing is not considered to be a major problem area."*

> *"It would be extremely useful to replace or support critical assumptions with quantitative data obtained from realistic and relevant operational testing. Significant changes are essential if operational test and evaluation is to realise its potential for contributing to important decisions, particularly where the tests and decisions must cross Service lines. There is no assignment of overall responsibility for deciding what operational testing should be done … or insuring that results reach those who need them. The most glaring deficiency of operational testing is the lack of any higher-than-Service organisation responsible for overseeing defence operational testing as a whole."*

As a result of the report of the Blue Ribbon Panel (Stevens, 1986), the Defense Department developed a new set of guidelines to improve the quality of operational test and evaluation. The new policy was promulgated on July 13, 1971, in Department of Defence Directive Number 5000.1, the key passage of which reads as follows (Stevens, 1986):

> *"**Test and evaluation** shall commence as early as possible. A determination of operational suitability, including logistic support requirements, will be made prior to large-scale production commitments, making use of the most realistic test environment possible and the best representation of the future operational system available. The results of this operational testing will be evaluated and presented to the DSARC[1] at the time of the production decision."*

On January 19, 1973, the Defence Department (Reynolds and Damaan, 1993) issued DoD Directive Number 5000.3 on T&E. This Directive accompanies Directive 5000.1 on system acquisition policies and DoD Instruction 5000.2 on the procedures to implement those acquisition policies. DoD Directive 5000.3 was updated several times to accommodate organisational changes and amplify procedural requirements. The basic policies have remained the same and are highlighted in Figure 1-3.

⇒ T&E shall verify the attainment of technical performance objectives and shall verify that systems are operationally effective and suitable for the intended use.

⇒ Successful T&E results will be a key requirement for milestone decisions.

⇒ Each service will have one major independent OT&E agency.

⇒ Planning for each T&E program will be documented in a TEMP.

Figure 1-3 (Defence Department T&E Policies , DoDD 5000.1 & DoDI 5000.2 (Reynolds and Damaan, 1993))

Currently they are embodied in Part 8 of DoD Instruction 5000.2 of February 23, 1991, entitled Defence Acquisition Management Polices and Procedures (Reynolds and Damaan, 1993). These acquisition documents marked the transformation of the US procurement system into what is now world re-known as "Milestone Procurement". Table 1-1 summarises the primary T&E documents.

[1] Defence Systems Acquisition Review Council

DoD T&E DOCUMENTS	
∗ **DoDD 5000.1**	Defence Acquisition
∗ **DoDI 5000.2, PART 8**	Test and Evaluation
∗ **DoD 5000.2-M, PART 7**	Test and Evaluation Master Plan
∗ **DoD 5000.3-M-2**	DoD Foreign Comparative Testing (FCT) Program
∗ **DoD 5003-M-4**	Joint T&E Procedures
∗ **Live Fire Test and Evaluation (LFT&E) Guidelines (January 1994)**	

Table 1-1 (Summary of Primary DoD T&E Documents (DSMC, 1995))

1.2.2 The US Defence T&E Structure

This section provides an overview of the policy and structure that govern the conduct of T&E activities within the DoD and is primarily based on the DSMC (1993) and DSMC (1995). The DoD is required to provide to the Congress the following reports on T&E (DSMC, 1993):

- Congressional Data Sheets (CDS)
- Selected Acquisition Report (SAR)
- Annual System Operational Test Report
- Beyond Low-Rate Initial Production (BLRIP) Report
- Live Fire Test & Evaluation (LFT&E) Report

The US DoD T&E structure is illustrated in Figure 1-4. In the OSD, T&E oversight is performed by two primary offices (DSMC, 1995): the Director, Test, Systems Engineering, and Evaluation (DTSEE) and the Director Operational Test & Evaluation (DOT&E). The management of acquisition programs in OSD is performed by the Defence Acquisition Executive (DAE), who uses the Defence Acquisition Board (DAB) and subcommittees to process information for decisions. The Under Secretary of Defence for Acquisition & Technology (USD(A&T)) uses the DAB and its committees to provide the senior-level decision process for the acquisition of weapon systems.

1.2.2.1 Director Test, Systems Engineering and Evaluation (DTSEE)

According to the DSMC (1995) the DTSEE serves as the principal staff assistant and advisor to the USD(A&T) for T&E matters. The DTSEE has the authority and responsibility for all

DT&E conducted on designated major programs. During the testing and designated weapon systems, the DTSEE and Services interaction includes the following reporting requirements:

- A TEMP (either initial or updated, as appropriate) must be provided for consideration and approval before each milestone review, starting with Milestone I.
- Prior to a milestone decision or the final decision to proceed beyond LRIP, T&E results with conclusion and recommendations must be submitted to the DTSEE.

1.2.2.2 Director Operational Test and Evaluation (DOT&E)

The DSMC states that the director reports directly to the Secretary of Defence (SECDEF) and has special reporting requirements to the Congress. The DOT&E's responsibility to the Congress is to provide an unbiased window of insight into the operational effectiveness and suitability of new weapon systems. For DoD and DOT&E-designated acquisition programs, the Services provides the DOT&E the following:

- A draft copy of the Operational Test Plan for review.
- The final Initial Operational Test & Evaluation (IOT&E) Test Plan for approval.
- Significant Test Plan changes.
- The final Service IOT&E report is submitted to the DOT&E before the DAB Milestone III review.

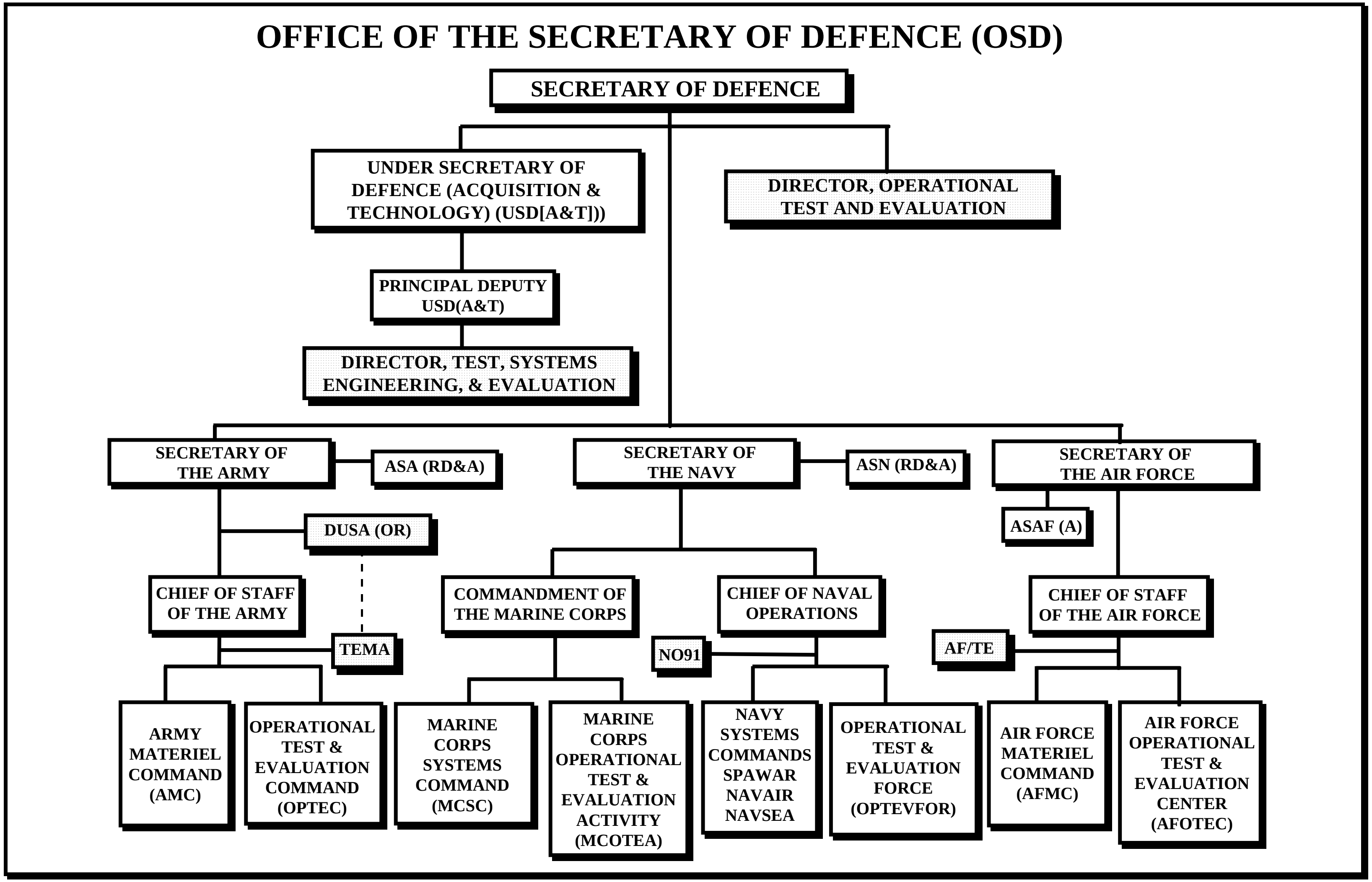

Figure 1-4 (US Defence T&E Structure (adopted from DSMC, 1995))

1.2.3 US Defence T&E Phased Acquisition Process

The defence system acquisition process was revised in 1991 to make it less costly, less time consuming and more responsive to the needs of the operational test and evaluation community. As it is now structured, the defense system life cycle consists of the following five phases as depicted in Figure 1-5 (DSMC, 1993):

1. Concept Exploration and Definition (CE)
2. Demonstration and Validation (DEM/VAL)
3. Engineering and Manufacturing Development (EMD)
4. Production and Deployment (PD)
5. Operations and Support (OS)

As is shown in Figure 1-5 these phases are separated by key decision points when a milestone (MS) decision authority reviews a program and authorises advancement to the next stage in the cycle. Thus T&E planning as mentioned in chapter 3, plays a vital role in the milestone review process.

An extremely comprehensive description of each milestone, phase and decision point of this milestone procurement process, known as the United States Test and Evaluation Phased Acquisition Process (USTEPAP) is detailed in the author’s software AutoTEMP©, beta version 2.0, in the form of a hypertext interactive software tutorial. This tutorial is the first of three software modules that make up AutoTEMP© and its hypertextability and human-computer interactivity as well as a detailed description is dealt with in more detail in chapter 6. Please refer to the Table of Abbreviations at the beginning of this thesis for a description of any terminology in the form of acronyms used in Figure 1-5, that may not be defined explicitly in the main text, but are defined by AutoTEMP©.

As an addition to the description in AutoTEMP©, an extension of certain terms are described in the next few paragraphs, the perspectives of which have been obtained from both Hoivik (1995) and DSMC (1993).

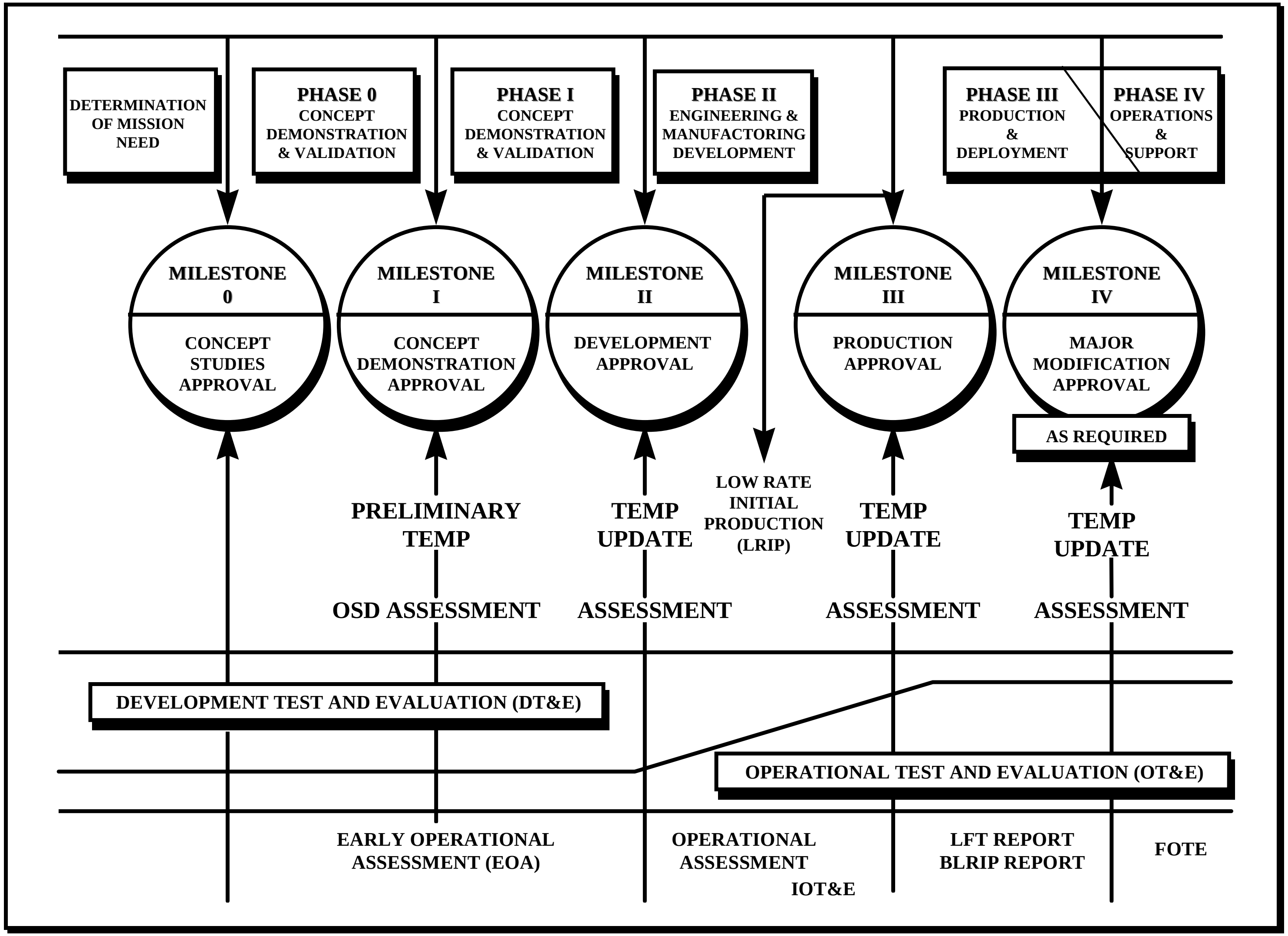

Figure 1-5 (US Test & Evaluation Phased Acquisition Process (DSMC, 1993))

With reference to Figure 1-5 Early Operational Assessment or EOA is an Operational Assessment (OA) which is conducted prior to, or in support of, a full scale development decision in the EMD phase. It's purpose is to provide operational input (a mission) to decision makers at early milestones, and also encompasses the following:

⇒ Forces early consideration by the Service Operational Testing Agencies (OTA's) of OT&E issues.
⇒ Provides the Program Manager (PM) with insight into future OT&E issues.
⇒ Helps OTA budget/plan for resources early in the piece.

EOA does not however evaluate technology, evaluate acquisition strategies, or look at DT&E funding. Operational Evaluation (OPEVAL) encapsulates:

- Operational Assessment (OA)
- Initial Operational Test & Evaluation (IOT&E)
- Live Fire Testing (LFT)
- Beyond Low Rate Initial Production (BLRIP)
- Follow on Test & Evaluation (FOT&E)

OPEVAL is the "Separate and Dedicated Phase" of OT&E in support of production of procurment decision. After the development command is certified the system is then ready for OPEVAL. OTA will conduct enough OT&E to evaluate the system's operational effectiveness and suitability and then reports these results to the decision authority, i.e., it is a *Production Representative System (PRS), with Typical Operators (TO), in "Real World Environment (RWE)"*.

Risk management is the means by which the program areas of vulnerability and concern are identified and managed (DSMC, 1993). Test and evaluation is the discipline that helps to illuminate those areas of vulnerability. The importance of T&E in the PAP is summarised well in a report produced in December 1986 by the General Accounting Office (GEA) of The Office of the Secretary of Defence (OSD):

> *"**OT&E** is the primary means of assessing weapon system performance. OT&E results are important in making key decisions in the acquisition process, especially the decision to proceed from development to production. OT&E results provide an indication of how well new systems will work and can be invaluable in identifying ineffective or unreliable systems before they are produced."*

Starting production before adequate OT&E is completed has some risks. If adequate OT&E is not done and the weapon system does not perform satisfactorily in the field, significant changes may be required. Moreover, the changes will not be limited to a few developmental models, but may also be applied to items already produced and deployed. In extreme situations, the DoD also risks (DSMC, 1993):

1. Deploying systems which cannot adequately perform significant portions of their missions, thus degrading their deterrent/defensive capabilities and
2. Endangering the safety of military personnel who operate and maintain the systems.

1.3 Australia

1.3.1 Introduction

The Australian Defence Force (ADF) is the equivalent of the US DoD and has been in the T&E business for sometime. T&E in one form or another is used in the ADF during the acquisition of weapon systems, as a decision mechanism during development and to test equipment after modification. The importance of T&E in the Australian Department of Defence dictates the need for good management to guarantee the proper selection of materiel and the tactical use of equipment (Griffin, 1994).

Australia has modest but well equipped Armed Forces. As a result, the number of major systems that are being designed and developed, and the number of existing systems requiring major modification at any one time are quite small in number. Past projects which commanded the attention of the Australian T&E community include the new ANZAC frigate project, the Collins-class submarine project and the Jindalee Over-The-Horizon Operational Radar Network (JORN) project, major aircraft modification programs such as the P3C Orion mid-life and the F-111C avionics upgrade projects (Crouch and Sydenham, 1993).

T&E conducted by the Australian Department of Defence is part of a rolling program to equip and maintain maritime, land, air, and sea forces that are capable of meeting the Defence Mission which is (Wallace, 1995): ***"To promote the security of Australia and protect its people and interests"***. The process of defining the equipment that is required by the ADF to fulfill mission starts with the strategic guidance provided by Government. Current strategic guidance is published in two principal documents (Wallace, 1995):

- **Strategic Review - 1993 (SR-93)** looks at Australia's political and economic position in South East Asia and the World and provides a strategic overview for the next five years.
- **Defending Australia - 1994 (DA-94)** defines how the ADF will develop over the next 15 years to meet both the perceived short term requirements of SR-93 and the longer term commitment to stability in our region and world peace.

1.3.2 A Brief History of Australian Defence T&E

The ADF encapsulates three military services, namely, the Australian Army, Royal Australian Navy (RAN), and the Royal Australian Air Force (RAAF). Griffin (1994) states that these three forces were conceived separately as the need arose to meet Australian defence requirements. Many of the practices and traditions were consequently "borrowed" from the relevant British Services, otherwise known today as the British Ministry of Defence (MOD). The ability to provide the services of these three forces (who work and cooperate as one in reality), serves a purpose as it generates Single-Service pride, and a willingness to function as a team, especially when the going gets tough, in peace time as well as war time. As with many other activities in the ADF, T&E has been developed from a Single-Service perspective.

Past requirements have dictated that the bulk of T&E associated with ships, land weapons, and aircraft is performed by the RAN, RAAF, and Army, respectively, in a fashion mirroring their different beginnings. The control of T&E is an individual service responsibility, and policy, practice, and procedure are well developed in the services. Each service has a major unit that performs T&E, collectively employing over 1,000 ADF and defence civilians. There are also some 66 defence establishments (e.g., proof and test ranges) where T&E is performed subsidiary to major roles. The majority of these establishments belong to the Defence Science and Technology Organisation (DSTO) (Griffin, 1995).

Griffin (1995) states that the Directorate of Trials (DOT) is a small section in the DSTO, separate from the services, which offers a coordination and advisory service, should the services seek help outside their own T&E capabilities. The DOT is sometimes involved with major and lengthy projects, but its contribution to the overall management of T&E is relatively small as the services are largely self-supporting.

1.3.3 Australian Defence T&E Structure

Documentation on any Australian Defence is somewhat fragmented as mentioned previously, a discussion of Australian Defence T&E structure is perhaps best accomplished by focusing primarily upon T&E within the DSTO and the three Services, namely, the Army, the RAAF, and the RAN, or land, air, and sea defence forces respectively.

1.3.3.1 DSTO Trials Directorate

Wallace (1993) states that the origin of the DSTO Trials Directorate can be traced to 1952 when the Army's Technical Services Establishment agreed to conduct Centurion Tank tropical trials on behalf of the UK Ministry of Defence (MOD). Over the years the Technical Services Establishment became the Army Design Establishment (ADE) and which conducted major trials and equipment evaluations for the Department of the Army. A Directorate of Trials and Evaluation (DTE) was established in 1972 as part of the Army reorganisation recommended by the Hassett Report. The Directorate's task was the management and coordination of Army trials using the facilities of the ADE.

In 1973, the Tange Report noted that the Service Laboratories and some Supply Laboratories conduct similar functions, but in a fragmented and uncoordinated manner. In order to overcome this problem, the report proposed the establishment of a Trials and Evaluation Division within the newly created DSTO.

In January 1975 the Service Laboratories absorbed the DTE and became the Directorate of Trials Planning (DTP) and was augmented by the addition of Navy, and Air Force and civilian officers, thus becoming a tri-service organisation. The division was renamed the Directorate of Trials Planning. Later in 1975 the office title was shortened to Directorate of Trials (DTRIALS). The current organisational structure of DTRIALS is shown in Figure 1-6.

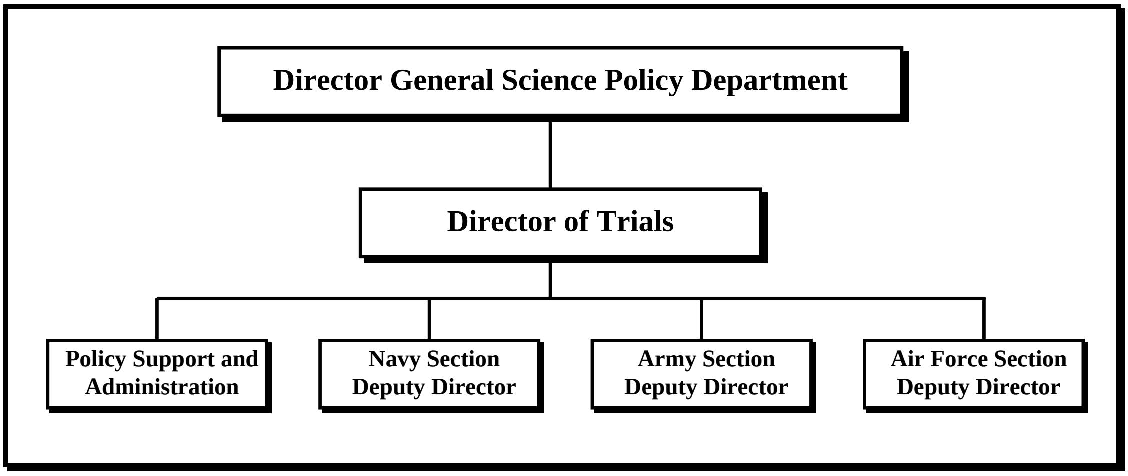

Figure 1-6 (DSTO Trials Directorate Structure (based on Wallace, 1993))

According to Wallace (1993) the mission of DTRIALS is to provide the Defence Organisation with an autonomous bureau service to efficiently and effectively manage and report on defence trials, to coordinate Service support for DSTO laboratories, and to coordinate scientific support and analysis for joint exercises. The objectives of DTRIALS are to:

- Ensure that the aims, objectives and methodologies of Defence Trials are valid and compatible with ADF objectives;
- Coordinate support requirements for and manage the conduct of Defence Trials;
- Ensure the timely production of Defence Trials Reports;
- Advise on the capabilities of DSTO Laboratory Divisions;
- Coordinate the allocation of ADF assets in support of DSTO activities;
- Coordinate the participation of Scientific Agencies in Joint Exercies; and
- Assist in the Scientific Adviser function by providing a direct liason link between the DSTO Laboratory Divisions and Headquarters ADF (HQADF), Defence Central and the Service Offices.

1.3.3.2 Defence T&E Facilities

To undertake T&E, the DoD has a number of integral facilities. DSTO is principally a research and development (R&D) organisation but it undertakes T&E in support of its own R&D and in support of the Army, Navy, and Air Force. DSTO has two laboratories (Wallace, 1995):

- Aeronautical and Maritime Research Laboratory (AMRL) with five divisions:

⇒ Airframes and Engines
⇒ Air Operations
⇒ Ship Structures and Materials
⇒ Weapon Systems, and
⇒ Maritime Operations

- Electronics and Surveillance Research Laboratory (ESRL) with six divisions:

⇒ Land Space and Optoelectronics
⇒ High Frequency Radar
⇒ Microwave Radar
⇒ Information Technology
⇒ Electronic Warfare, and
⇒ Communications

The **Navy** has three major T&E organisations, RAN Test & Evaluation Group (RANTEG), RAN Ranges and Assessing Unit (RANRAU) and the RAN Aircraft Maintenance and Flight Trials Unit (RANAMFTU).

The **Army** has two major T&E organisations belonging to Materiel Division (Mat Div) and a number of smaller T&E centres belonging to Headquarters Logistic Command (HQ Log Comd) (Wallace, 1995):

- **The Mat Div T&E organisations are:**

⇒ The Army Technology and Engineering Agency concerned with the engineering assessment of new equipment and DT&E for the product improvement of in-service equipment, and

⇒ The Maintenance Engineering Agency, concerned with the OT&E for the whole of life support of military equipment.

- **HQ Log Comd has:**

⇒ Static and mobile calibration facilities in major logistic units to service Army's calibration requirements Australia wide.

⇒ Cells in major logistic units to provide specialist maintenance DT&E support for specific equipment such aircraft, tanks, and combat radios, and

⇒ The Packaging Development Centre which undertakes R&D into packaging for the storage and transportation of stores and munitions.

The **Air Force** has two major T&E organisations and a number of specialist T&E centres belonging to Air Headquarters Australia (AHQAUST) but located in operational units to provide dedicated equipment support (Wallace, 1995):

- Aircraft Research Development Unit (Figure 1-7) concerned with the DT&E for air safety of in service equipment.
- Air Movements Training and Development Unit concerned with DT&E for aerial delivery equipment.
- AHQAUST specialist T&E centres are:

⇒ The Integrated Aircraft Software Support Facility which provides software development support to FA-18 aircraft.

⇒ The Weapons System Support Facility, that provides systems development support to F-111 aircraft, and

⇒ The Non-Destructive Inspection Laboratory, that provides general support for the development of aircraft non-destructive inspection methods.

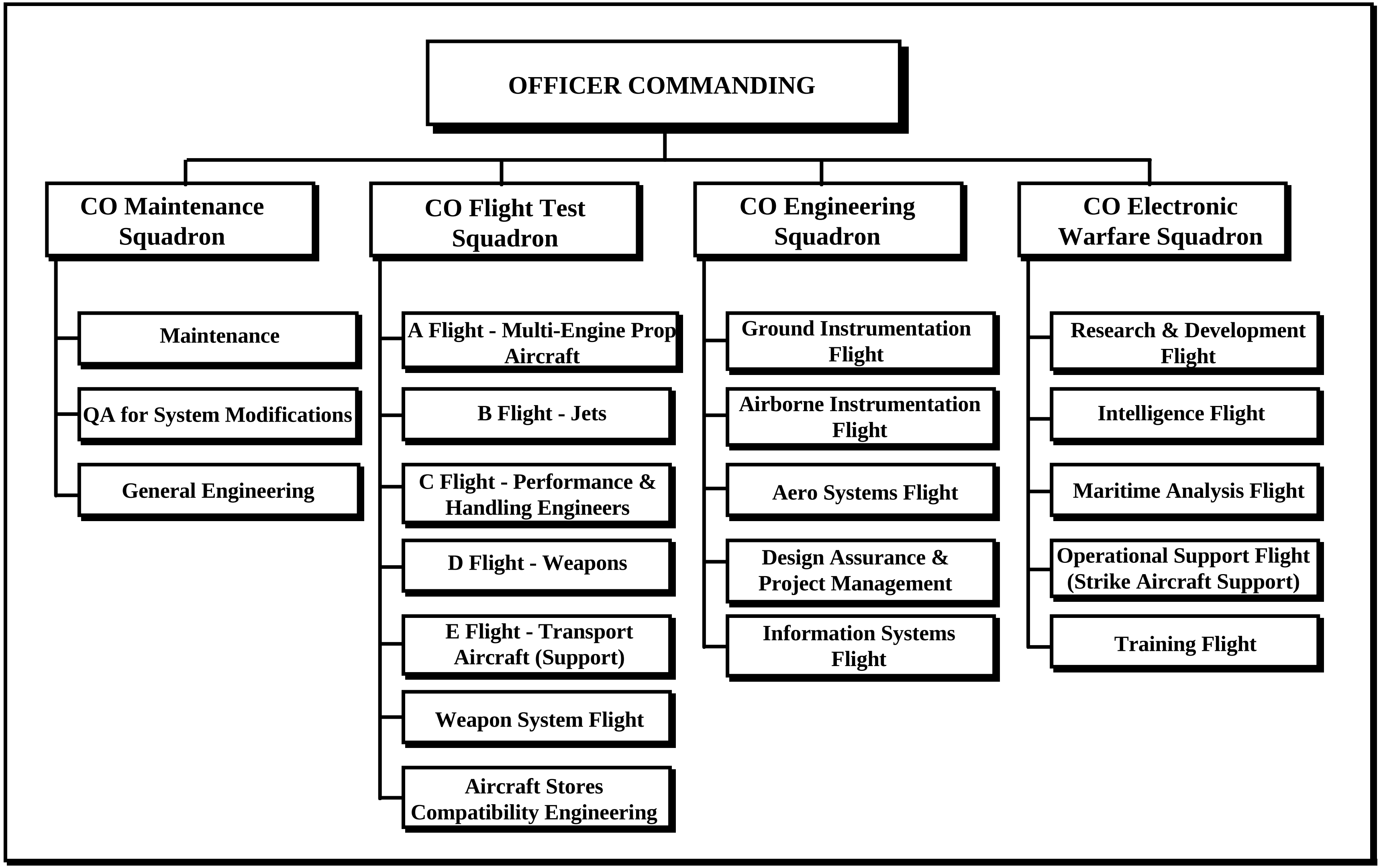

Figure 1-7 (The ARDU Organisational Structure (Dvorak, 1996))

1.3.4 The Australian Defence T&E Acquisition Process

The Australian defence T&E acquisition process is based on the well known United States paradigm described previously with a few minor variations. The Australian defence T&E acquisition process can be best described by an example that the author has conceptualised (based on an experimental model developed by Professor Sydenham), disciplined to aircraft flight test, and is depicted in Figure 1-8. The next section will describe this model in more detail and why it has evolved in the manner that it has, keeping in mind that to this day, there is no formal textbook on the Australian acquisition process, and hence documentation of a model is non existent to the author's knowledge. Therefore this is a major part of the author's contribution to knowledge and Australia.

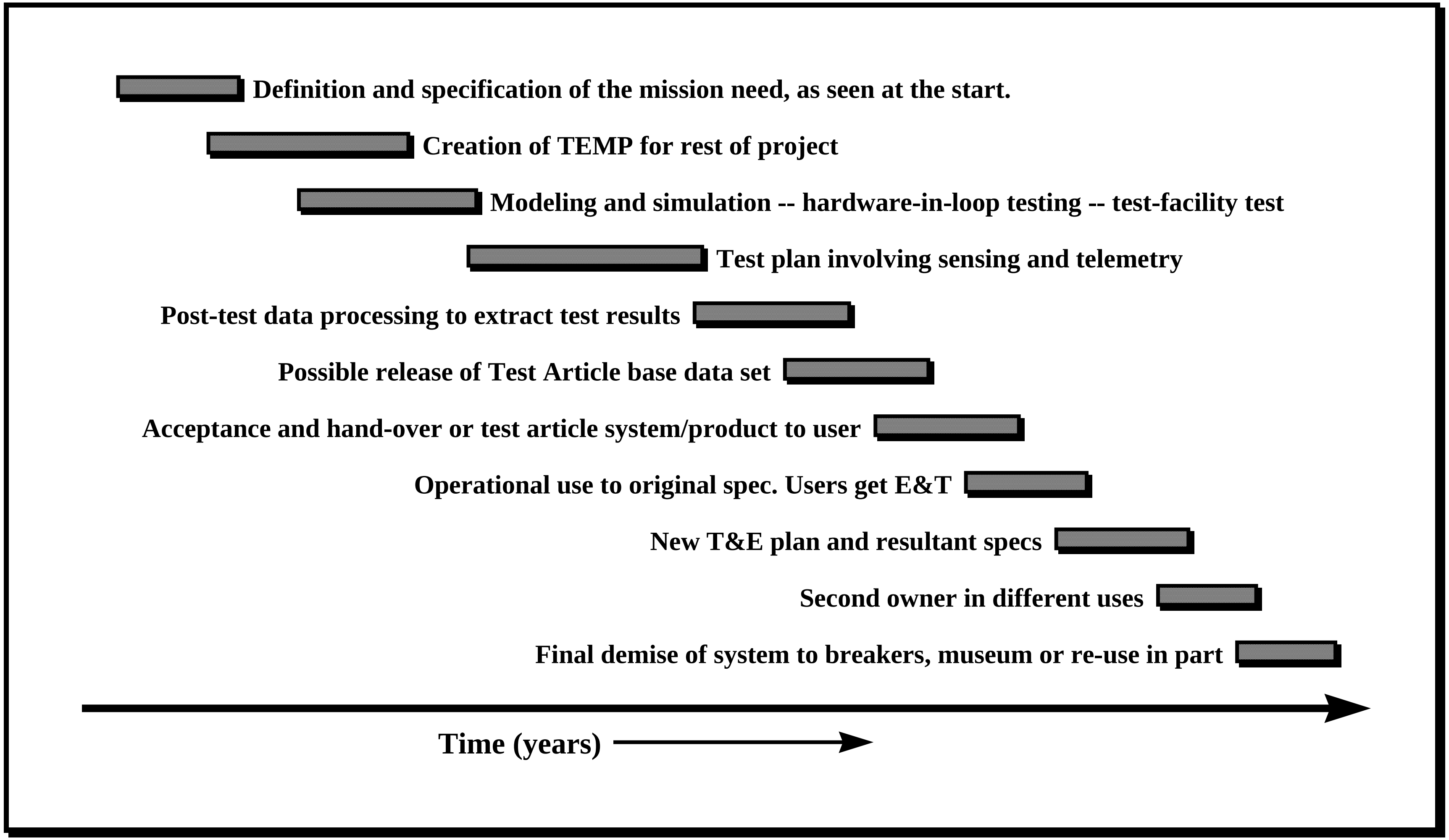

Figure 1-8 (Australian T&E Acquisition Process (adopted from Nissyrios, 1994c))

1.3.4.1 T&E Process Model - Generic Description

The above model can be described by referencing the annotated points along the model as follows:

a) Definition and specification of the mission need, as seen at the start of any prototype. From this comes the decision to acquire.
b) Creation of the Test and Evaluation Master Plans for the rest of the project. Definition of all tests are carried later in the process, however must be specified at this stage.
c) Modeling and Simulation is carried out using an ensemble of modeling software packages. Using techniques such as hardware-in-loop testing, whereby one develops as they model, test a little, then redesign, and so forth and so on, much like concurrent engineering and waterfall models which are out of the realm of this research.
d) Test plan is then constructed from the TEMP and SOR involving sensing and telemetering information needed and to test facilities such as instrument plans, data cycle map, etc.
e) There is now post-test data processing to extract the results of the test carried out on System Under Test (SUT). This action is actually an ongoing process, and not exactly unique to this step.
f) At this final DT&E phase there is possible release of test article base data set. This is where Verification and Validation (V&V) occurs by independent persons, as well as calibration but usually incomplete and with many errors yet unknown. This phase is the completion of all DT&E issues, which in turn gives rise to the instigation of OT&E.
g) At the beginning of this OT&E phase PAT&E occurs, whereby there is acceptance of the test article and hand over of the system/product to the user.
h) In this phase operational use of the system/product is carried out according to its original specification, part (a). After the completion of this the users will need some Education and Training (E&T) as they are not expected to be experts or knowledgeable users. Use of the system/product out in the field, its operational environment establishes its shortcomings, which are then documented.
i) As an occurrence of this document there is a new T&E plan made along with resultant specifications which are usually needed as the use of the system/product changes due to modification or altered mission needs, i.e., FOT&E is carried out still in the hands of the first user. This completes all DT&E and OT&E requirements.

j) This phase is merely where a second owner could possibly take possession of the system/product after many years in service and possibly by a different country even with different methodologies and practices or variation in mission needs.

k) Finally, the system/product has been over ridden with a later version, an upgrade many years down the track and the owners consider the demise of the system to applicable breakers, a museum or re-use of the system/product in parts as appropriate.

1.3.4.2 Relationship Between T&E and M&I Process

The above model gives birth to a relationship between T&E and Measurement and Instrumentation (M&I), in the form of measures, as illustrated in Figure 1-9. Crouch & Sydenham (1994) claim that the relationship has it's apex of demand in performance evaluation and its roots of supply in capability to traceable test artifacts to get physical data. Furthermore, neither the military or the civil strategists think in terms of performance measures that can be directly measured - but rather, they think in terms of complex relationships that stand on the things that can be directly measured. As an example of this theory, they state that the M&I world thinks in system behavioral terms such as how high? Or how fast? And how do you measure that with an ascribed error budget?. Whereas the T&E world usually thinks in terms of how do you measure that with known confidence?.

As a corollary to the above argument, Nicholas & White (1995) state that because measurement is often seen as a purely objective technical process there is a tendency to ignore or omit its conceptual foundation. Purpose implies some level of subjectivity, which is usually considered undesirable and therefore ignored rather than treated. Thus in the view of Nicholas & White, many measurements become virtually purposeless, with any purpose being sought after the event rather than before. Purposeless measurements of say flight test data, typically result in:

- Difficulties in the interpretation of the data
- Failure to collect important data
- Collection of data that later proves to be unimportant

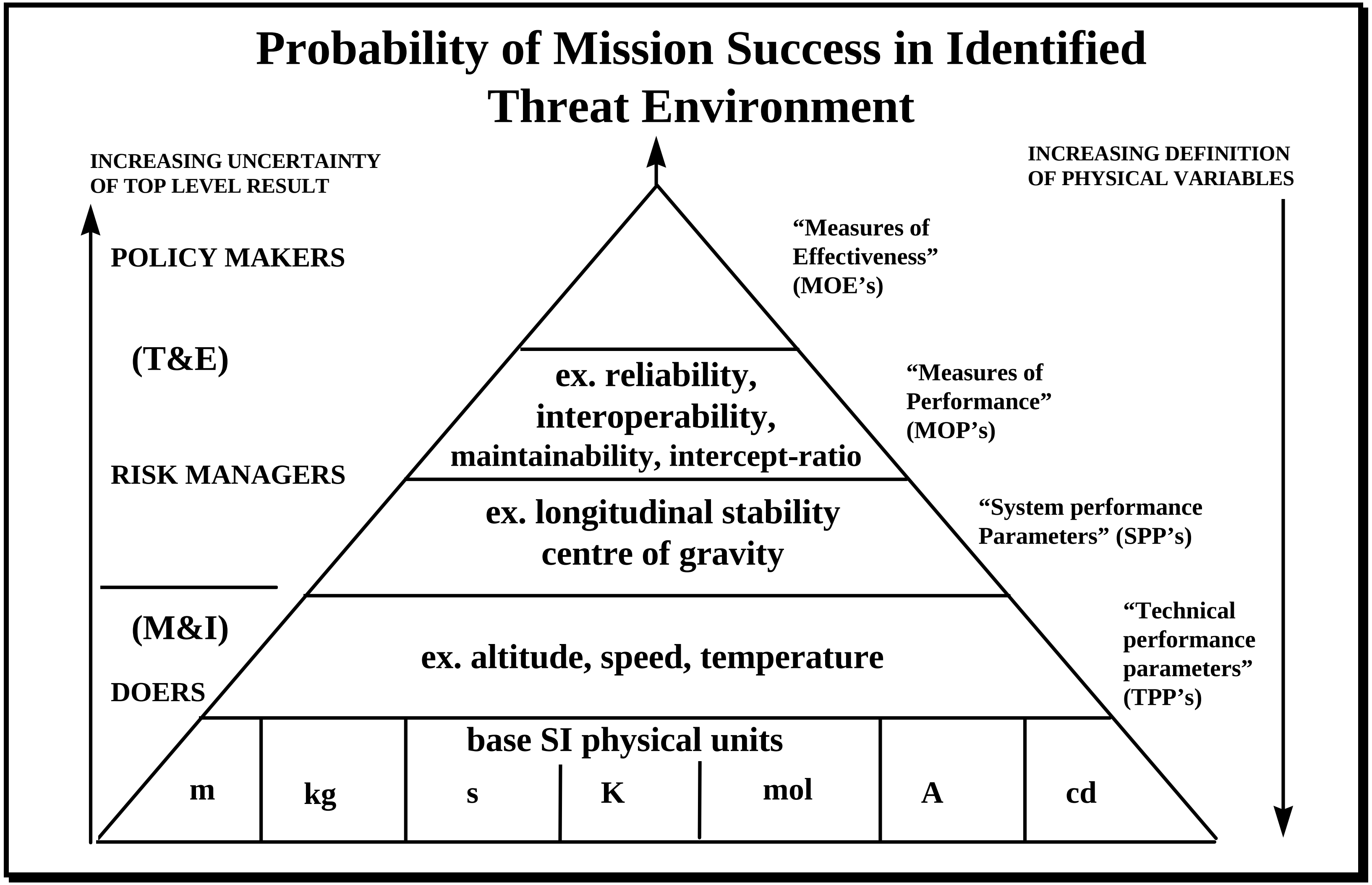

Figure 1-9 (Layered Pyramid of T&E and M&I Disciplines (Crouch & Sydenham, 1994))

The DSMC (1995) states that a "*measure is a numeric relation or element that describes the operation or efficiency of a system*". The DSMC define Measures of Effectiveness (MOE's) as operational capabilities stated in terms of engagement or battlefield outcomes. In the modeling process, they are also tools that assist in discriminating among a number of alternatives. They show how the alternatives compare in meeting functional objectives and mission needs. MOE's should be selected which relate directly to a System's Performance Parameters (SPP's) and to mission accomplishment. Decision makers need to know the contribution of the system to the outcome of battle, and not just how far it can shoot or how fast it can fly.

Whereas, MOP's are technical data elements supporting a MOE. Cost and Operational Effective Analysis (COEA) must assess how each alternative performs the functional objectives. As mentioned previously models and simulations (M&S) are normally used to predict performance and outcomes. Models are merely a representation of an actual or conceptual system that involves mathematics, logical, or computer simulations, which are known as Technical Performance Parameters (TPP's). Intuitively these four measures can be described in Table 1-2.

MEASURE	DESCRIPTION
MOE	What do you want to know? (effectiveness)
MOP	How will you know you have got it? (performance)
SPP	How well does the system have to work?
TPP	How well do the components of the system have to work?

Table 1-2 (An Intuitive Comparision of MOE's, MOP's, SPP's and TPP's)

Kass (1995) states that a good measure is one that conveys the essential information without ambiguity or excess baggage. He goes on to say that ambiguity and excess wording of measures detract from the ability to clearly understand the data required from the T&E. Examples of measure expressions that are used frequently are (Kass, 1995):

1. Criterion measures
2. Mean measures

3. Data requirement measures
4. Technical measures
5. Question measures
6. Caveat measures
7. Double measures
8. Scope measures
9. Paragraph measures

A measure is phrased as a question and constructed with two components - a measure and a threshold, for example: “the system must detect 90 percent of the targets”, or “time to set up cannot exceed 2 hours”, or “mean time to repair should not exceed 1.5 hours”.

1.4 Analysis and Conclusion

This chapter has presented and compared the United States and Australian T&E structures and their respective processes. It was found that the United States Armed forces have been more rigorous in their methods, considering their strong foundations, and formalities. Their defence is by far probably one of the most strongest in the world, due to their well documented approach, leadership, and impeccable efforts in thorough T&E, via their well renown phased acquisition process, depicted in Figure 1-5.

For the above reasons, their Australian counterparts, and respective DoD, have based their methods on that of the United States of America. Due to this well known fact, the author feels that Australia has been using the T&E acquisition process captured in Figure 1-8, the foundations of which emanated through M&I (as depicted in Figure 1-9) and Systems Engineering as outlined in chapter 2, for many years without realising that in actual fact they took part in all types of T&E, namely, DT&E and OT&E, PAT&E, FOT&E, and so forth.

The next few paragraphs compares US and Australian budgets for capital equipment, and comparing it to the ratio of people in their respective T&E communities, as seen by Wallace (1995).

Looking at the annual US DoD budget for capital equipment (Wallace, 1995), approximately $US63,200M, and comparing it to Australia’s $A2,300M, the ratios of people engaged in integral T&E activities per $M expended on capital equipment and the relative percentage costs are shown in Table 1-3.

T&E COST	**COUNTRY**	
	UNITED STATES	**AUSTRALIA**
PEOPLE/$M	0.8	1.4
% OF CAP EQUIP	13.1	13.3

Table 1-3 (Comparison of T&E Costs US/AUS (Wallace, 1995))

Wallace states that the ratios for Australia of people engaged in integral T&E per $M expended on integral T&E and per $M expended on capital equipment are probably distorted a little by including the DSTO enabling technology activities; however, they do indicate that the Australian Department of Defence conducts more in-house T&E then the United States DoD.

The next chapter will look at the need for automating the generation of TEMP's, as required, and in doing so thus contributing to the automation of the T&E process, and gives a comprehensive description of the conceptualisation of the TEMP format that was used to carry out this action.