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# NAVAL POSTGRADUATE SCHOOL

## MONTEREY, CALIFORNIA

**WORKFORCE MODELING & SIMULATION EDUCATION AND TRAINING FOR LIFELONG LEARNING: MODELING & SIMULATION EDUCATION CATALOG**

by

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March 2007

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**13. ABSTRACT (maximum 200 words)**

This technical report describes the contents of a Microsoft Access database developed in support of the Workforce Modeling and Simulation Education and Training for Lifelong Learning project. The catalog contains searchable information about 253 courses from 23 U.S. academic institutions. While not exhaustive, the catalog captures a representative set of the existing training and education in Modeling and Simulation (M&S) available to the DoD acquisition workforce.

The Naval Postgraduate School was funded by DASN RDT&E to develop a learning architecture for an educational program that enables members of the DoD acquisition workforce to more effectively implement the use of Modeling and Simulation (M&S) throughout the system acquisition life cycle. In support of the requirements phase of this effort, a catalog of existing resources for M&S education has been constructed. This catalog will fulfill the following objectives:

1. Assist in the overall assessment of the availability of M&S education for acquisition workforce members.
2. Facilitate the gap analysis between desired educational skill requirements and the learning objectives accomplished by existing courses and programs.
3. Answer specific questions regarding the available education including delivery methods, costs and program lengths.

A detailed discussion of the catalog contents, how it is to be used, and a description of a future update expected in a later phase of the effort are included in this report. The background and overview of the project are provided in appendix A. The purpose of this technical report is to accompany the delivery of the database to the sponsor. Combined, this technical report and the education catalog serve to satisfy the first deliverable of FY07 for the project specified in ASN (RDA) CHENG Task Statement 6.4.3.1.

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# I. INTRODUCTION

The Modeling and Simulation (M&S) Education Catalog is a Microsoft Access database containing information on 253 courses from 22 U.S. academic institutions. Information about each course in the database includes the course description, delivery method, cost, target audience, classification and other details. This catalog represents the current state of M&S education and training available to the DoD acquisition workforce. It was developed in support of the Workforce Modeling & Simulation Education and Training for Lifelong Learning project described in Appendix A.

The purpose of the catalog is three-fold. First, the catalog served as a valuable tool in the initial assessment of the availability of M&S education for acquisition workforce members. Second, the catalog will facilitate the gap analysis between desired educational skill requirements and the learning objectives accomplished by existing courses and programs. Finally, the catalog will help answer specific questions regarding the available education as details about the delivery methods, costs and lengths of the desired programs are finalized.

In its current form, the M&S education catalog consists of searchable information, and represents the compilation of this data set. As the appropriate educational skill requirements (ESRs) are identified during later phases of the project, the analysis capability of the database will evolve. Course syllabi are currently being collected for all courses included in the catalog. From these syllabi and additional information, each course will be evaluated and tagged to support the gap analysis. The database contents will then be searchable based on these ESRs in addition to the current search capability, greatly improving the efficiency of the gap analysis. Details of this required update are provided in the following section.

The catalog will then provide the capability to answer such questions as:

- Given a set of required Learning Objectives, are there current education solutions? If so, sort them according to designated parameters (cost, delivery method, duration, etc.).

- If I have $50/student, and need online asynchronous courses that can be completed in 3 weeks to achieve a set of 4 learning objectives, what are my options?

The database provides rapid availability of answers to these types of questions and will be a valuable tool as the educational program is developed. The information will key the project performers into programs and institutions that are good candidates for partnerships in building and/or delivering the resulting educational program. It may also be used as a resource for seekers of these types of education.

In accordance with the ASN (RDA) CHENG task statement provided for this project (ref 1) and the associated Naval Postgraduate School Proposal for Research (ref 2), the first deliverable for FY07 is a collection and assessment of the current DoD M&S training and education opportunities, to include details of these various programs. This education catalog serves as the deliverable for this collection associated with the task. Since public training and education opportunities are also available to DoD employees and could potentially be part of the solution for the services, a survey of these resources was included in the data collection effort. An assessment of the collected information was also conducted and is provided in section IV. The combined submission of the database and this technical report is intended to satisfy the first deliverable in the FY07 efforts for this project.

This database and additional project information are available by contacting Jean Catalano at the Naval Postgraduate School, jmcatala@nps.edu.

# II. CONTENTS

The M&S education catalog contains a representative set of existing education in M&S available to the DoD workforce. While all of the graduate degree programs specifically defined for M&S are included, only a representative set of non-M&S programs are included. The reason for this is simply resource driven. The amount of effort required to include every college course that contains M&S learning objectives is greater than the available resources for this project, and does not add sufficient value to warrant the pursuit. However, the courses and programs included in the database are considered to be representative of the available M&S education. It is highly likely that the information contained in the database will be refined over time, and if it is deemed worthwhile, more information can be added to the database at a later date.

The database contains several tables of data, including institutions, programs, courses, topics, and learning objectives. Combined, they provide a searchable, complete resource for accomplishing the objectives of the M&S education catalog. Each of these tables is further described in the paragraphs that follow.

The institutions table contains basic information about the educational institutions included in the database, along with points of contact and location information. The 22 institutions included in the database are shown in Figure 1.

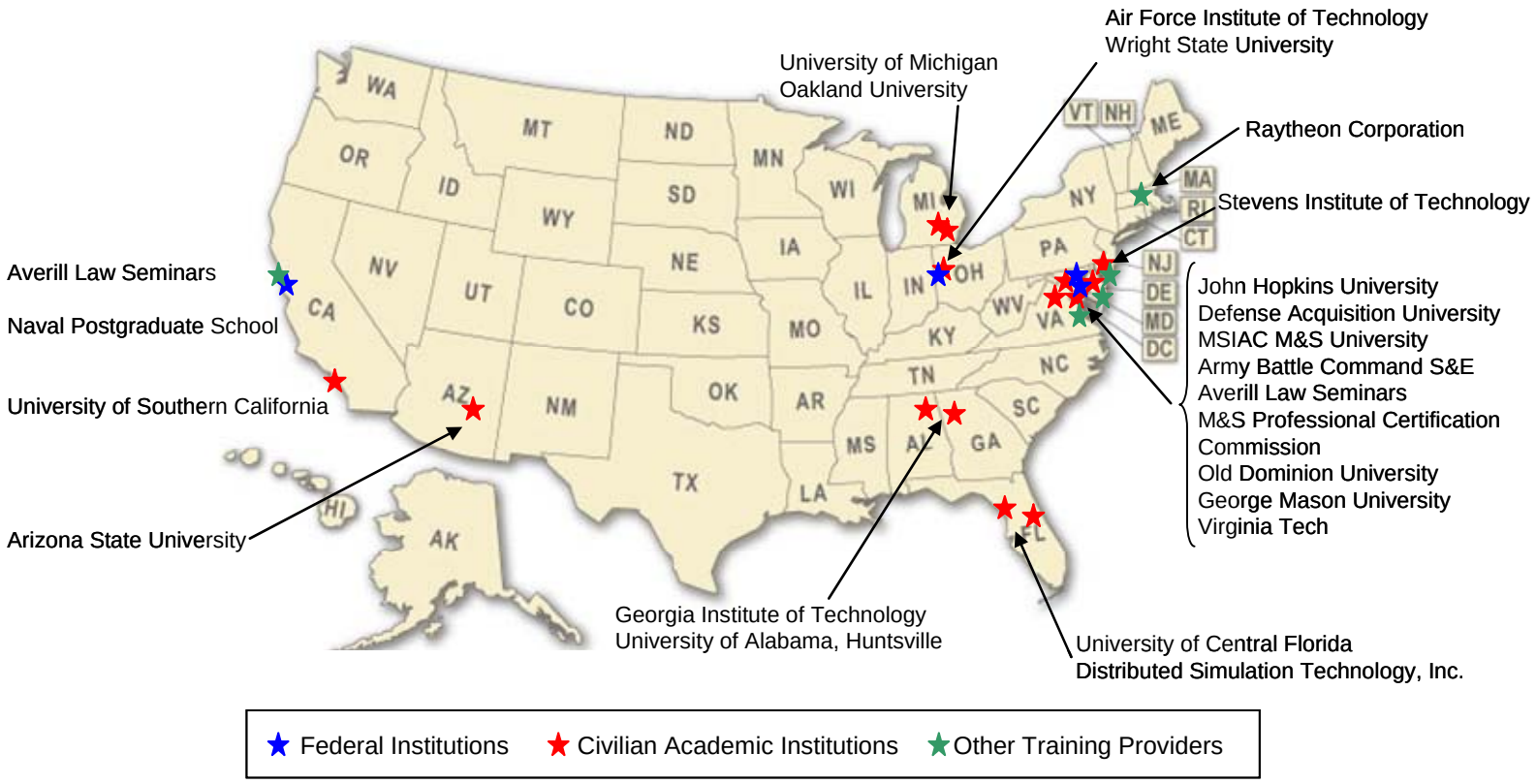



**Figure 1.** M&S Education Catalog Institutions

The programs table contains information for those programs that result in a degree or certificate in modeling and simulation. In cases where no specific M&S program was identified, the "program" represents the M&S courses in other programs at that institution and the program ID is labeled as "institutionCourses" rather than the degree name. This table includes the type of the program, the estimated number of courses and length of time required to complete the program, and the estimated cost range for the program. There are 29 programs included in the database.

The courses table is the substance of the database. Course content descriptions for over 250 courses has been collected and entered into the database. In addition to course content, the table contains information including delivery modes, length, costs, required prerequisites, points of contact and target audiences for each course. An example of the information collected for each course is presented in Figure 2.

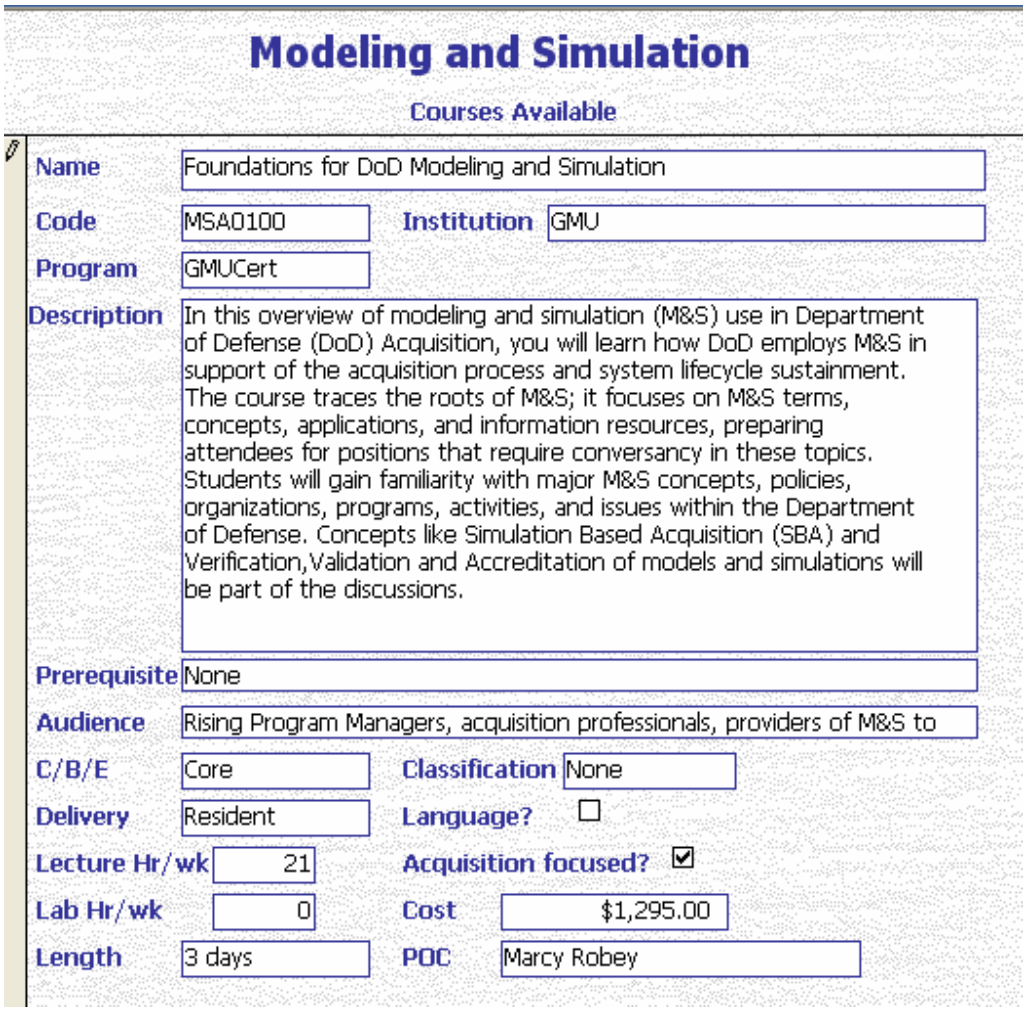



**Figure 2.** Course Information Example

The topics and learning objectives tables are primarily intended for use in a later version of the database. However, the topic table currently contains a set of 124 topics covered in courses included in the database. These topics will be replaced by the desired ESRs when they are developed, to provide standardized terminology for the topics and enable the required queries in the gap analysis.

# III. PLANNED UPDATE

In its current form, the database is simply a collection of the M&S training and education opportunities available to the DoD workforce. It is little more than the original envisioned catalog, which was to be a binder of sorts containing this information for reference during the gap analysis phase of the project. However, by entering the information into a database, the opportunity for using and reusing the information more efficiently and to meet several objectives is presented. In order to effectively use the information during gap analysis, two database improvements will be made.

First, the database must be updated to allow searching the database for courses that achieve particular ESRs. Once the desired ESRs for the acquisition and T&E workforce are developed and confirmed, these will replace the existing items in the topics table. The learning objectives table in the database will then be populated with the many-to-many mapping of courses to topics based on information contained in course syllabi or other sources. This information will also be supplemented with a level of mastery for each topic that a course is intended to achieve. An example of a mapped ESR is provided in Figure 3.

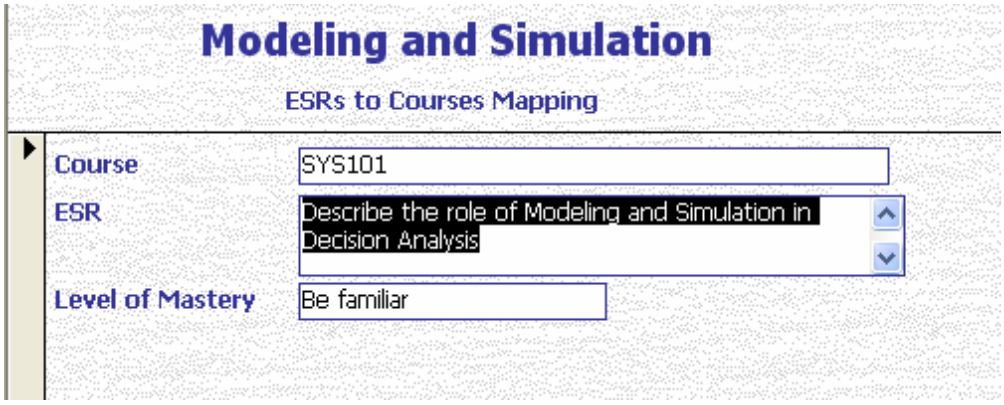



**Figure 3.** Learning Objective Mappings Example

Once populated, this mapping will enable the database to be searched based on ESRs. The learning objectives table ties ESRs (topics plus level of mastery) to courses and the information in the courses table is linked through primary keys to the institutions and programs tables using a one-to-many mapping (one institution to many courses, for

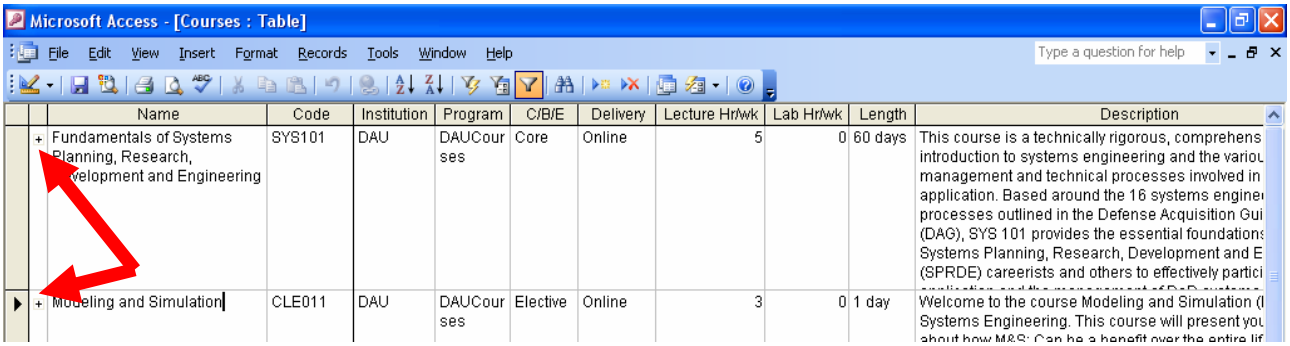
example). These links tie all of the information in the various tables together, allowing for detailed queries of the database.

The learning objectives table currently contains this association for the DAU courses to illustrate the linkage as shown in 0These are likely to be modified when the final topic list is populated, but are included for demonstration. In the learning objectives table, each topic is listed with a level of mastery and its associated course. Courses covering multiple topics require multiple lines of entry as shown. Similarly, topics covered in more than one course would also require multiple lines of entry. The level of mastery is an important distinction and will vary for each topic from course to course. These will be necessary in conducting gap analysis since members of the workforce will require various levels of mastery for each ESR depending on career field and level.

| ID | Topics | Level of Mastery | Course |
|---|---|---|---|
| 1 | Describe the role of Modeling and Simulation in Decision Analysis | Be familiar | SYS101 |
| 2 | Explain benefits of M&S and how it supports Systems Engineering | Dominance | CLE011 |
| 3 | Explain how to plan for effective use of M&S | Mastery | CLE011 |
| 4 | Use modeling and simulation (M&S) to support the Design Solution process | Understand | SYS203 |
| 5 | Examine how Modeling and Simulation can aid the SE process particularly in the pre-systems acquisition phases and during the SDD phase | Mastery | SYS203 |
| 6 | Explain how Modeling and Simulation can aid the SE process | Understand | SYS302 |

**Figure 4.** M&S Education Learning Objectives Example (DAU)

Information about these mappings is also available in the courses and topics tables. The first column in each of those tables contains a plus (+) symbol. By clicking on the symbol in the course table, the associated topics and levels of mastery are displayed. This is demonstrated in Figure 5. Similarly, by clicking on the symbol in the topics table, the associated courses and levels of mastery are displayed. Currently, this only applies to the topics associated with DAU courses for demonstration. All other associations are empty.




Click on the plus signs in the far left column of the course row

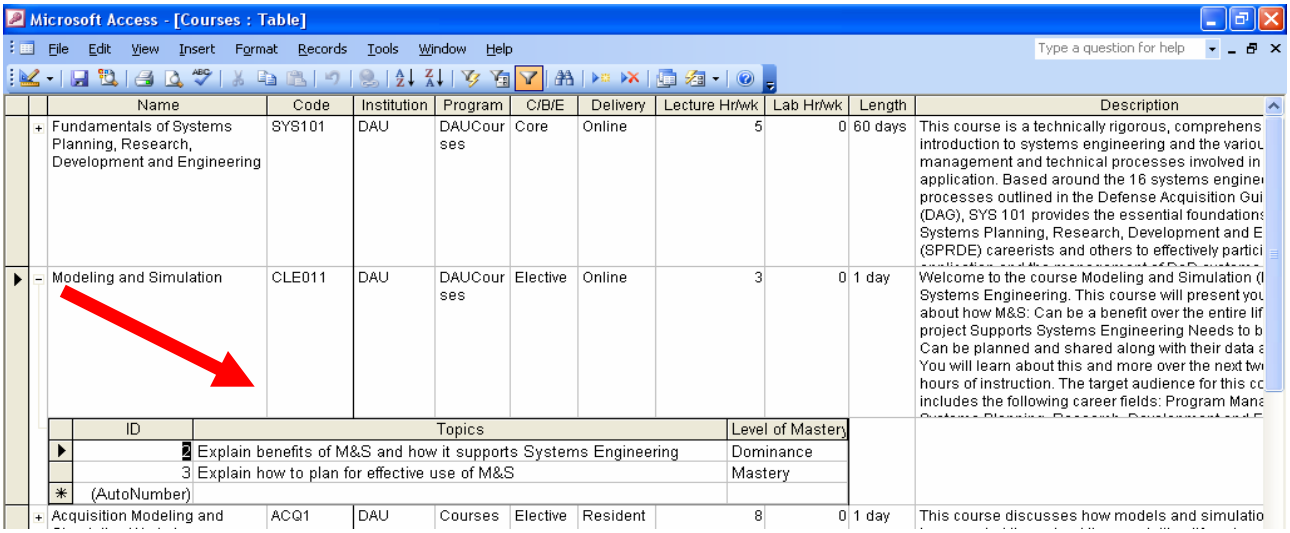



Table of associated ESR's (topics plus level of mastery) is displayed.

**Figure 5.** ESR Mappings display in Courses Table

The second improvement to the database involves the development of the queries that will be required to answer the appropriate questions about the available education. For example, a necessary query during gap analysis will be the ability to produce a listing of courses that satisfy a desired ESR. The mappings described above enable this type of information to be drawn from the database, but the queries must be developed to enact the information retrieval and display. Additional queries will be developed as deemed appropriate.

# IV. M&S EDUCATION ASSESSMENT

An assessment of the available education was conducted as the catalog was developed. The number of courses by institution is presented in Figure 6.

| Courses by Institution | |
|---|---|
| **Institution** | **Number of Courses** |
| Air Force Institute of Technology | 24 |
| Arizona State University | 8 |
| Army Battle Command, Simulation and Experimentatio | 2 |
| Averill M Law Seminars | 4 |
| Defense Acquisition University | 5 |
| DiSTI | 5 |
| George Mason University | 2 |
| Georgia Institute of Technology | 11 |
| Johns Hopkins University | 9 |
| M&S Information Analysis Center | 12 |
| Naval Postgraduate School | 49 |
| Oakland University | 2 |
| Old Dominion University | 13 |
| Raytheon | 12 |
| Stevens Institute of Technology | 6 |
| University of Alabama at Huntsville | 7 |
| University of Central Florida | 39 |
| University of Michigan | 17 |
| University of Southern California | 13 |
| Virginia Tech | 11 |
| Wright State University | 2 |

**Figure 6.** Courses by Institution

In general, there are two types of M&S programs available. Existing post-graduate modeling and simulation degree programs produce engineers capable of developing M&S, rather than focus on the required knowledge to *use* the M&S for acquisition (ODU, NPS, and UCF). Of the 253 total courses, there are 101 belonging to these programs and only 9 mention acquisition in the course descriptions (9%, see Figure 7). In contrast, there are some certificate programs that include short introductory courses of a few days in length providing a basic understanding of the use of M&S (MSIAC, GMU, GAT, and UAH). Some of these programs do focus on M&S in acquisition and target acquisition professionals as their target audience. There are 65 short courses in the catalog, 20 of which are acquisition focused (31%).

| | Short Courses | Standard Courses | Totals |
|---|---|---|---|
| **Total** | 65 | 188 | 253 |
| **Acquisition** | 20 | 9 | 29 |
| **% Acq-focused** | 30.77% | 4.79% | 11.46% |

**Figure 7.** Courses focused on Acquisition

There are also programs available that are not M&S programs, but seem to focus on M&S in their curriculum such as the Systems Engineering and Engineering Management programs at Stephens, JHU, and AFIT. 87 courses of this type are included in the database. It should be noted that there could easily have been many more courses of this type. For example, it was not the intention of the effort to list every available course covering linear programming in the United States, although some example courses were included. While the format of the educational program(s) resulting from this project will be based on the requirements and has therefore not been decided, it seems likely that these types of programs may be primary targets for improvement. In other words, it may be most advantageous not to develop a new M&S curriculum, but to develop systems engineering and program management curricula that heavily incorporate M&S.

The costs of the education are of major concern. With an average course cost of $1,271.17, it seems unlikely that extensive course work will be affordable by many smaller commands. A plot representing the cost breakout is depicted in Figure 8.

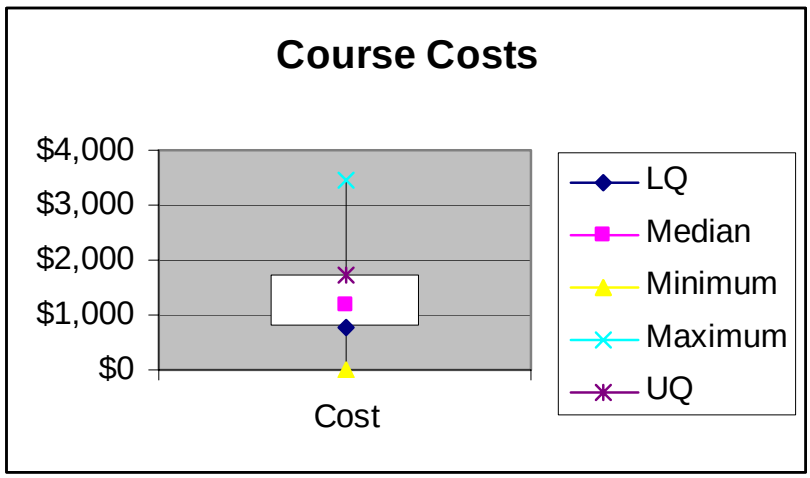



**Figure 8.** Course Cost Data

Although the detailed gap analysis has not yet been completed, the conclusion of the assessment is that in their current form none of the existing programs are likely to

satisfy the requirements that will be developed for this particular program. The M&S degree programs are not generally targeted at the same audience intended for this project. On the other hand, “user-focused” programs, which are possibly intended for the right target audience, are high level and probably insufficient for enabling the workforce. In the end, these programs may be desirable as part of an overall program for life long learning. In all cases, a solution that is less costly to the student is desired. Further insight into the suitability of existing education and training for incorporation into the final curriculum will be provided in the deliverables associated with the gap analysis.

# LIST OF REFERENCES


1) FY07 ASN (RDA) CHENG Task Statement, Task Title 6.4.3.1 RDA-NPS: Incorporating M&S into SE Curriculum, Sep 2006.
2) Naval Postgraduate School Proposal for Research, Educating the Acquisition and Test Workforce: Workforce Modeling & Simulation Education & Training for life long learning, Nov 2006.
3) Modeling and Simulation Coordination Office, Modeling and Simulation Steering Committee Common and Cross Cutting Business Plan, Draft Version 1.1, Nov 2006.
4) Systems Engineering Forum, Department of Defense Acquisition Modeling and Simulation Master Plan, Apr 2006.

# APPENDIX A: EDUCATING THE WORKFORCE PROJECT OVERVIEW

## BACKGROUND

The need for Modeling and Simulation (M&S) education is recognized by the Department of Defense (DoD) M&S community. The Modeling and Simulation Steering Committee Common and Cross-Cutting Business Plan (ref 3) identified gaps in M&S requirements and capabilities spanning all communities and services that employ M&S to achieve their mission. Among these are four gaps in the area of workforce development. These include:

- Lack of clearly articulated competency statements.
- Lack of a widely accepted disciplinary specification or body of knowledge.
- Lack of structured implementation of training and education vehicles.
- Lack of a widely applied process for certifying professionals based on a community-accepted disciplinary specification.

This need is also recognized by the acquisition community. The appropriate and correct implementation of M&S throughout the acquisition lifecycle benefits the government in cost savings, better decision making, and faster time to production. In the Acquisition M&S Master Plan (ref 4), the Acquisition M&S Working Group (AMSWG) described five objectives to enable the accomplishment of their goal to assist Program Managers (PMs) and acquisition professionals by improving the utility of M&S in the acquisition of capabilities. Under the "shape the workforce" objective, the group prescribes the development of M&S education and training as a necessary action.

Current training of the acquisition workforce does not provide workforce members with the ability to incorporate the proper use of these tools in decision making. The desired education and training programs should enable the workforce to determine which M&S tools to use, how to use them, and when to use them across the acquisition life cycle. The Naval Postgraduate School has been sponsored by ASN (RDA) CHENG to develop a curriculum that will satisfy this gap.

## PROJECT SCOPE

The scope of this education program is bounded by the specific audience targeted as potential students, as shown in Figure 9. While M&S education is desired for all of the communities employing M&S to accomplish their mission, the objective of this program is to satisfy the M&S educational needs of the acquisition community. Although the Modeling and Simulation Coordination Office (MSCO, formerly DMSO) recognizes test and evaluation (T&E) as a separate community, the Navy tends to group T&E into the acquisition process. Therefore, we consider both these communities as addressed together. The program does not intend to develop a specific educational program for the training, planning, analysis, and experimentation communities. However, the process model for the development of a needs-based curriculum for multiple career fields and levels can then be applied to the remaining communities if desired. Additionally, some of the educational elements that are developed will be relevant to the other communities and readily imported into follow on curriculum development projects.

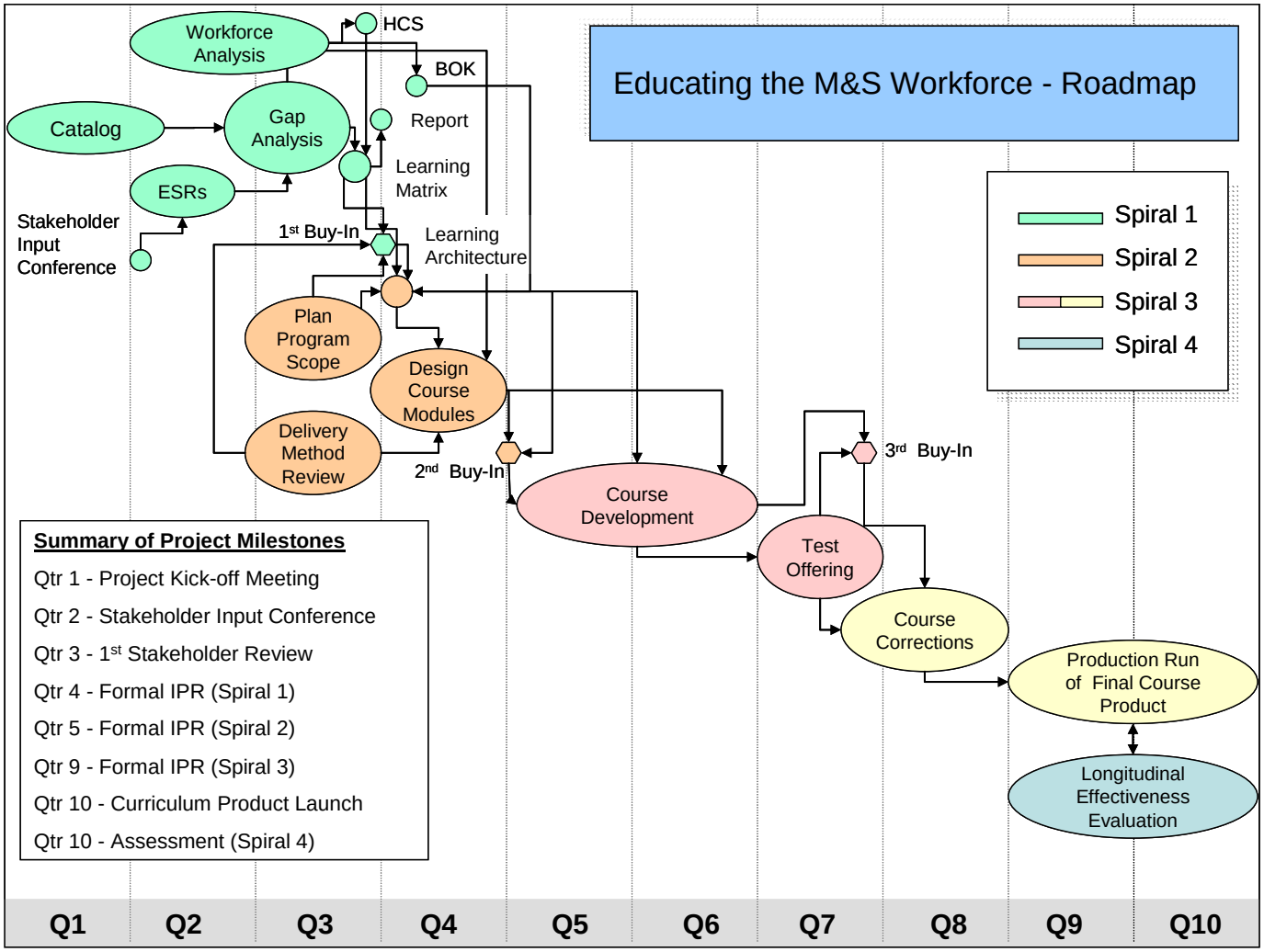



**Figure 9.** Educating the Workforce: Acquisition Workforce Segmentation

To aid in the appropriate scoping of the project subtasks, the target audience for this project is described as the users (vice developers) of M&S in the acquisition workforce. As Figure 9. indicates, these include members of all 13 acquisition career fields. For this project, the initial focus will be on the career fields of Program Management, Systems Engineering, and Test and Evaluation since these are the fields in which M&S is most extensively employed. Elements of the learning architecture will also be applicable to the remaining career fields, and specific learning architectures can be developed for those fields in later iterations. Within each career field, four career levels were identified to distinguish between the depths of knowledge required for workforce members at different stages in their career. These include the general awareness, application, management and executive levels. The goal is to develop a program for lifelong learning that enables acquisition workforce members to employ M&S more effectively throughout their careers.

**PROJECT APPROACH**

To accomplish project goals, principle investigators for the project have segmented the tasks into 4 spirals (see Figure 10. ).

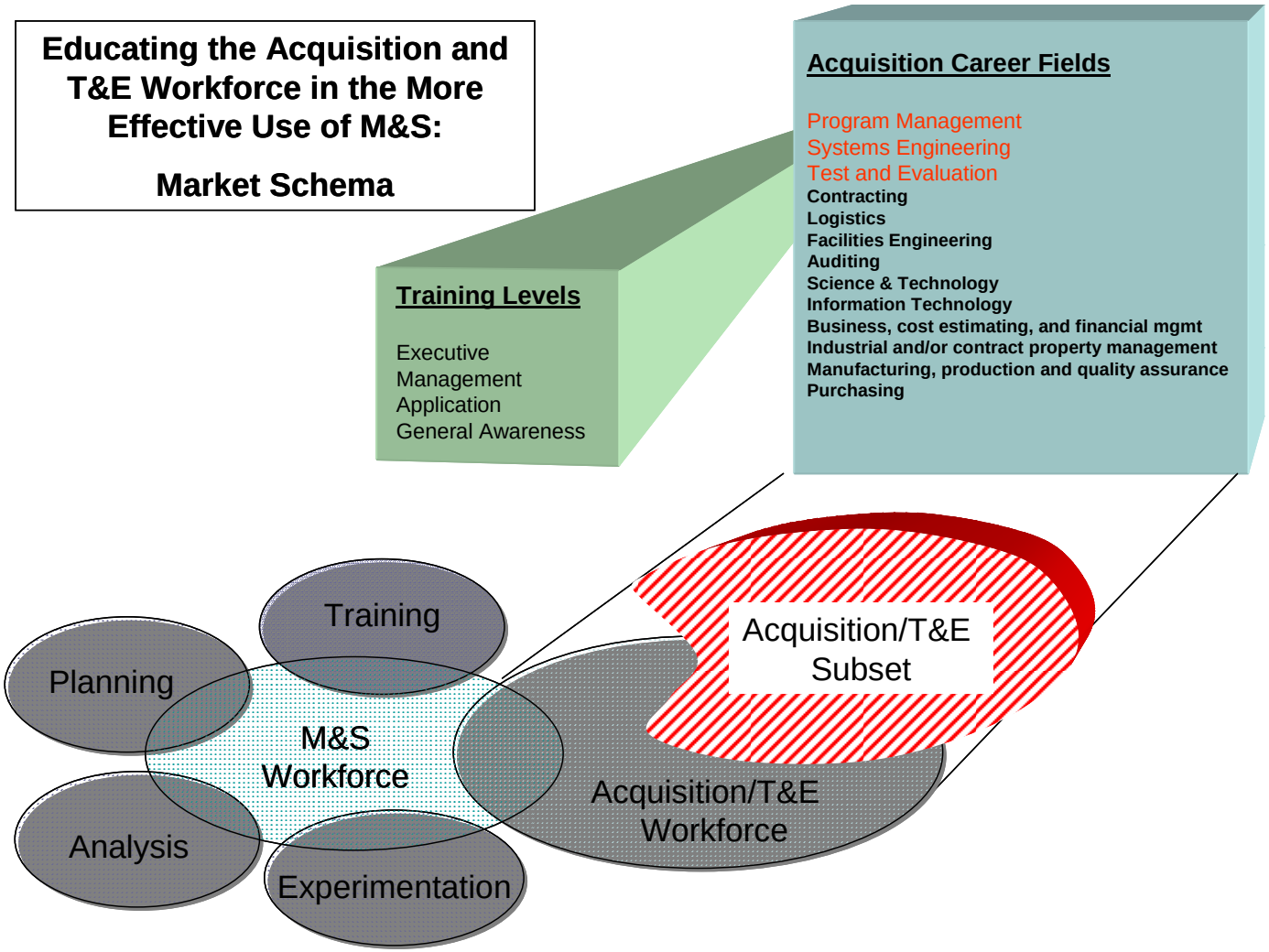



**Figure 10.** Educating the Workforce: Four Spiral Approach

### 1. Requirements (Spiral One):

During the first spiral, a learning matrix will be developed. The learning matrix will outline the desired instructional content based on Educational Skill Requirements (ESRs) developed for the acquisition workforce. ESRs consist of knowledge elements and desired proficiencies, or levels of mastery, and will be developed for each career field and level. Additionally, desired delivery methods and scope requirements will be incorporated into the matrix to guide the spiral two activities.

Once the desired ESRs are identified, a gap analysis will be conducted to determine if existing educational opportunities are sufficient to provide the desired learning elements for the program. In some cases, it may be appropriate to incorporate portions of existing educational resources into the resulting program to maximize collaboration and reuse whenever possible. The education catalog described in this report will be used in conducting the gap analysis.

### 2. Development (Spiral Two):

Based on the learning matrix developed in spiral one, the development phase will result in a learning architecture. The learning architecture is an instructional framework that assembles the appropriate educational contents into the correct delivery packages. The types of curriculum will be deliberated and may include degree or certificate programs as well as continuous learning modules. The framework will also likely include a mixture of delivery methods including resident courses, asynchronous web-based courses and synchronous distance learning options such as VTC or webcast. The results of spiral two will be course content modules, containing the level of detail similar to that found in course syllabi.

### 3. Integration (Spiral Three):

In spiral three, the specified curriculum will be developed. A prototype curriculum will be offered, and feedback incorporated into the final production. Once the curriculum is developed, it will be delivered to the offering institutions. The goal is to work with academic and inter-service partners to ensure that the curriculum or portions

thereof, can be made available through multiple institutions such as DAU, NPS, academia and the Services.

#### 4. Assessment (Spiral Four)

The fourth spiral involves the continuous assessment and improvement of the program as it is offered. A Longitudinal Curriculum Effectiveness Evaluation will be developed and applied to ensure the curriculum achieves its goals, and sustains effectiveness and relevance over time.

## PARTNERSHIPS

The project performers recognize the importance of establishing and fostering relationships with critical partners throughout the project. To enable this collaboration, a stakeholders group has been established that includes members of the acquisition and T&E communities from multiple services, as well as Naval Postgraduate School faculty representatives from all relevant disciplines. Frequent interaction among this group enables multiple perspectives during product development and valuable feedback to intermediate products. Additionally, as part of the project team, the Air Force Agency for Modeling and Simulation (AFAMS) is developing a Human Capital Strategy for Defense M&S workforce members, as well as a Defense M&S Body of Knowledge (BOK). These products will contribute material to be leveraged in the curriculum development phase.

Important relationships are also being formed with partners in academia. Alliances with institutions possessing expertise in modeling and simulation as well as acquisition are desired to leverage previous work and experience, and to enable multiple delivery venues of the resulting program. The development of the educational catalog described here has played a significant role in identifying those institutions best suited for these partnerships.

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