NOT MEASUREMENT SENSITIVE

MIL-HDBK-29612-3A
31 August 2001
Supersedes
MIL-HDBK-29612-3
30 July 1999

# DEPARTMENT OF DEFENSE HANDBOOK

# DEVELOPMENT OF INTERACTIVE MULTIMEDIA INSTRUCTION (IMI) (PART 3 OF 5 PARTS)

**This Handbook is for guidance only. Do not cite this document as a requirement.**

AMSC N/A AREA SESS

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

# FOREWORD

1. This handbook is approved for use by all Departments and Agencies of the Department of Defense (DoD). This handbook supersedes MIL-HDBK-29612-3.

2. This handbook is intended for guidance only. This handbook cannot be cited as a requirement. If it is, the contractor does not have to comply.

3. MIL-HDBK-29612-3 is Part 3 of 5 Parts. Part 3 provides guidance that may be used by DoD (all Services) and industry for the planning, design, development, implementation, evaluation, and management of Interactive Multimedia Instruction (IMI) products. Use of this guidance is not mandatory.

4. Part 1, MIL-HDBK-29612-1, DoD Handbook, Guidance for Acquisition of Training Data Products and Services, provides guidance for the preparation of solicitations and evaluation of solicitation responses for training. Part 2, MIL-HDBK-29612-2, DoD Handbook, Instructional Systems Development/Systems Approach to Training and Education, provides guidance on the Instructional Systems Development (ISD)/Systems Approach to Training (SAT) process and the analysis, design, development, implementation, and evaluation of instruction and instructional materials. Part 4, MIL-HDBK-29612-4, DoD Handbook, Glossary for Training, contains acronyms and definitions for commonly used training terms. Part 5, MIL-HDBK-29612-5 DoD Handbook, Advanced Distributed Learning (ADL) Products and Systems, contains guidance for the acquisition of ADL conformant products.

5. This handbook was developed within the DoD with the assistance of all Services as represented by the Joint Services Action Group – Interactive Multimedia Instruction (JSAG-IMI) and the Defense Training Standards Working Group (DTSWG).

6. Guidance provided in this handbook is not intended to supplement or duplicate policies and procedures in existing Federal, Department of Defense, and Military Service regulations. Should a conflict arise between this handbook and any of the previously mentioned regulations, the regulations take precedence. There are numerous ways to design, develop, implement, and manage the use of IMI products. The guidance contained herein may not be applicable to your specific organization.

7. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Air Warfare Center Aircraft Division, Code 414100B120-3, Highway 547, Lakehurst, NJ 08733-5100 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

CONTENTS

FOREWORD ..... i

1 SCOPE ..... 1
1.1 Scope. ..... 1
1.2 Application guidance. ..... 1
1.2.1 How to use this handbook. ..... 1

2 APPLICABLE DOCUMENTS ..... 1
2.1 General. ..... 1
2.2 Government documents. ..... 1
2.2.1 Specifications, standards, and handbooks. ..... 1
2.2.2 Other Government documents, drawings, and publications ..... 2
2.3 Order of precedence. ..... 3

3 DEFINITIONS ..... 3
3.1 General ..... 3

4 INTERACTIVE MULTIMEDIA INSTRUCTION PLANNING ..... 3
4.1 Introduction. ..... 3
4.2 What is IMI? ..... 3
4.2.1 IMI products. ..... 3
4.2.1.1 Source materials for development of IMI products. ..... 5
4.3 IMI and the Instructional Systems Development/Systems Approach to Training (ISD/SAT) process. ..... 5
4.3.1 IMI applications. IMI uses may include: ..... 5
4.3.2 Advantages of IMI. ..... 5
4.4 General rules for selecting IMI as an instructional media delivery system. ..... 5
4.5 When to use IMI. ..... 7
4.6 Quality improvement. ..... 7
4.6.1 Continuous improvement. ..... 7
4.6.2 Keep customer involved. ..... 7
4.6.3 Get buy-in. ..... 7
4.7 The IMI project team. ..... 8
4.7.1 IMI development team responsibilities. ..... 8
4.7.2 IMI implementation team responsibilities. ..... 9
4.7.3 IMI team training. ..... 10
4.8 Management and organizational support decisions. ..... 10
4.8.1 Management support. ..... 10

4.8.2 Evaluation of organizational support for IMI. 10
4.8.3 Facility support requirements. 13
4.9 Media selection. 13
4.9.1 Media selection process. 13
4.10 IMI application considerations. 13
4.10.1 IMI feasibility. 13
4.10.2 IMI exportability. 13
4.10.3 Authoring software selection. 14
4.10.3.1 Authoring software decisions. 15
4.10.4 IMI hardware configuration decisions. 15
4.10.4.1 Review policies and regulations. 15
4.10.4.2 Factors influencing hardware selection. 16
4.10.4.3 Hardware data collection. 16
4.11 IMI cost considerations. 18
4.11.1 Cost factors. 18
4.11.2 Estimating IMI development hours. 18
4.11.2.1 Assumptions for estimating development hours. 18
4.11.2.2 Affect of changes in variables. 19
4.11.2.3 Estimating costs for course configuration and maintenance. 20
4.12 How to plan an in-house IMI effort. 20
4.12.1 Outline the IMI effort. 20
4.12.1.1 Establish a development process. 20
4.12.1.2 Determine project deliverables. 22
4.12.1.3 Define staff positions and responsibilities. 22
4.12.1.4 Develop a master schedule. 22
4.12.2 Prepare the team. 22
4.12.2.1 Determine training requirements. 22
4.12.2.2 Provide documentation. 22
4.12.3 Develop quality control procedures. 23
4.12.3.1 QC team responsibilities. 24
4.12.3.2 QC job aids. 25
4.12.3.3 Documenting the discrepancy process. 27

5 SOURCE MATERIALS FOR INTERACTIVE MULTIMEDIA INSTRUCTION PRODUCTS 29
5.1 Text. 29
5.2 Audio. 29
5.2.1 Human hearing. 29
5.2.2 Audio technology. 29
5.2.2.1 How audio is digitized. 29

5.2.2.2 Audio quality. ..... 29
5.2.3 Audio technology progress. ..... 29
5.2.4 Digital audio in multimedia. ..... 30
5.2.4.1 Computer control. ..... 30
5.2.4.2 Sound-critical subject areas. ..... 30
5.2.4.3 Recording inputs. ..... 30
5.2.4.4 Computer presentations in the classroom. ..... 30
5.2.4.5 Speech therapy. ..... 30
5.2.4.6 Music. ..... 30
5.2.5 Examples of frequency ranges. ..... 31
5.2.6 Disk storage requirements. ..... 31
5.2.7 Hardware and software considerations. ..... 32
5.2.8 Advantages and disadvantages of digital audio considerations. ..... 32
5.3 Visual Information. ..... 33
5.3.1 The visual element. ..... 33
5.3.1.1 Improved applications. ..... 33
5.3.1.2 Digital still images. ..... 34
5.3.1.2.1 Still-image basics. ..... 34
5.3.1.2.2 Capturing still images. ..... 34
5.3.1.2.3 How a scanner works. ..... 34
5.3.1.2.4 Scanning slides. ..... 34
5.3.1.2.5 Scanner equipment. ..... 34
5.3.1.2.6 Frame grabbers. ..... 34
5.3.1.3 Image resolution. ..... 35
5.3.1.4 Memory and storage requirements. ..... 35
5.3.1.5 Digital camera. ..... 35
5.3.1.6 Digital video. ..... 35
5.3.1.7 Copyright issues for images. ..... 35
5.3.1.8 Analog versus digital. ..... 36
5.3.1.9 How video is digitized. ..... 36
5.3.1.10 Difficulties in digitizing video. ..... 36
5.3.1.11 The impetus for digitizing video. ..... 37
5.3.1.12 Current status and near-term changes. ..... 37
5.4 Graphics. ..... 37
5.5 Animation. ..... 38

6 INTERACTIVE MULTIMEDIA INSTRUCTION PRODUCT DEVELOPMENT ..... 38
6.1 IMI products. ..... 38
6.1.1 ICW. ..... 38

6.1.1.1 ICW design. 39
6.1.1.2 Develop the ICW specification. 39
6.1.1.2.1 Purpose of ICW specification. 39
6.1.1.2.2 Level of detail in the ICW specification. 39
6.1.1.2.3 Content of the ICW specification. 39
6.1.1.3 Determine the level of interactivity. 41
6.1.1.3.1 Learning levels. 41
6.1.1.3.2 Hierarchy of learning. 44
6.1.1.3.3 Sequencing of LOs. 45
6.1.1.3.4 ICW presentation category selection. 45
6.1.1.3.4.1 Levels of interactivity. 45
6.1.1.3.4.2 Learning levels and levels of interactivity. 46
6.1.1.3.4.3 Sensory stimulus requirement. 49
6.1.1.3.4.4 Identify instructional delivery mode and impact. 49
6.1.1.3.4.5 ICW presentation categories. 50
6.1.1.3.4.6 Considerations for ICW presentation category selection. 52
6.1.1.3.4.7 ICW presentation category selection data consolidation. 52
6.1.1.3.4.8 Guidelines for increasing interactivity. 53
6.1.1.3.5 Guidelines for student control. 54
6.1.1.3.5.1 Student control. 54
6.1.1.3.5.2 Influencing factors for student control. 55
6.1.1.3.6 Guidelines for feedback and remediation design. 56
6.1.1.4 Determine record keeping strategies. 57
6.1.1.4.1 Record keeping functions. 57
6.1.1.4.2 Record keeping capabilities. 57
6.1.1.5 Design of ICW tests. 57
6.1.1.5.1 Types of ICW tests. 57
6.1.1.5.2 Tips for ICW test design. 58
6.1.1.6 Determine instructional treatments. 59
6.1.1.6.1 ICW events of instruction. 59
6.1.1.7 Develop flowcharts and storyboards. 60
6.1.1.7.1 ICW flowcharts. 60
6.1.1.7.1.1 ICW flowchart guidelines. 60
6.1.1.7.1.2 Example of ICW flowchart. 60
6.1.1.7.2 General guidelines for programming. 62
6.1.1.7.2.1 Programming standards. 62
6.1.1.7.2.2 Guidelines for programming. 63
6.1.1.7.3 Storyboards. 64
6.1.1.7.3.1 Storyboarding techniques. 64
6.1.1.7.3.2 General ICW storyboard design principles. 64

6.1.1.7.3.3 Guidelines for implementing the general storyboarding principles. ..... 65
6.1.1.7.3.4 Guidelines for visual elements. ..... 68
6.1.1.7.3.4.1 Guidelines for video. ..... 71
6.1.1.7.3.4.2 Video storyboard guidelines. ..... 74
6.1.1.7.3.5 Guidelines for text. ..... 74
6.1.1.7.3.6 Guidelines for graphics and animation. ..... 76
6.1.1.7.3.7 Guidelines for audio. ..... 76
6.1.1.7.3.8 Storyboard checklist. ..... 79
6.1.1.8 ICW prototype lessons. ..... 84
6.1.1.8.1 Description of ICW prototype lessons. ..... 84
6.1.1.8.2 ICW prototype content. ..... 84
6.1.1.8.3 Why have an ICW prototype? ..... 85
6.1.1.8.4 ICW prototype guidelines. ..... 85
6.1.1.8.5 Elements involved in ICW prototype lesson development. ..... 86
6.1.1.9 How to develop ICW. ..... 87
6.1.1.9.1 Program the lessons. ..... 87
6.1.1.9.2 Produce visual displays and record audio. ..... 89
6.1.1.9.2.1 Visual displays. ..... 89
6.1.1.9.2.2 Guidelines for producing full-motion video. ..... 89
6.1.1.9.2.3 Guidelines for audio recording. ..... 90
6.1.1.9.2.4 Develop text, graphics, and animation. ..... 90
6.1.1.9.2.4.1 Guidelines for text, graphics, and animation displays. ..... 90
6.1.1.10 Develop supporting materials and comply with DoD ICW requirements. ..... 91
6.1.1.10.1 Purpose of supporting materials. ..... 92
6.1.1.10.2 DoD guidelines for ICW. ..... 92
6.2 Electronic publications. ..... 94
6.2.1 Electronic guides. ..... 94
6.2.2 Interactive Electronic Technical Manuals (IETM). ..... 94
6.2.2.1 Factors to consider when using IETMs. ..... 94
6.3 Electronic testing. ..... 94
6.3.1 About electronic testing. ..... 95
6.3.2 Benefits of electronic testing. ..... 95
6.4 Simulation. ..... 96
6.5 Electronic management systems. ..... 96
6.5.1 Electronic Performance Support System (EPSS). ..... 96
6.5.1.1 An EPSS can provide performance information. ..... 96
6.5.1.2 An EPSS can reduce training costs. ..... 96
6.5.1.3 User interface. ..... 96
6.5.1.4 EPSS considerations. ..... 96
6.5.2 Computer-Aided Instruction (CAI). ..... 97

6.5.2.1 What is CAI? 97
6.5.2.2 Reasons for using CAI. 97
6.5.2.3 CAI and instructor support. 97
6.5.3 Learning Management System (LMS). 98
6.5.4 Electronic job aids. 98

7 INTERACTIVE MULTIMEDIA INSTRUCTION EVALUATION 98
7.1 IMI quality process. 98
7.1.1 Verification. 98
7.1.2 Validation. 98
7.1.3 Acceptance. 99
7.1.4 Document lessons learned. 99
7.2 Develop a validation plan. 99
7.2.1 Purpose. 99
7.2.2 What is in a validation plan? 99
7.2.3 Getting ready to validate. 99
7.2.4 How to use a validation plan. 99
7.2.5 Measure against a standard. 100
7.2.6 Follow the plan. 100
7.3 Conduct technical accuracy reviews. 100
7.3.1 What should be reviewed? 100
7.3.2 How to conduct a review. 101
7.4 Conduct individual tryouts. 102
7.4.1 Purpose. 102
7.4.2 Select students. 102
7.4.3 Before an individual tryout. 102
7.4.4 During an individual tryout. 103
7.4.5 Typical problems. 103
7.4.6 After an individual tryout. 104
7.5 Conduct small-group tryouts. 104
7.5.1 Purpose. 104
7.5.2 Select students. 104
7.5.3 Number of students. 104
7.5.4 Time is a critical factor. 104
7.5.5 Before a small-group tryout. 105
7.5.6 During a small-group tryout. 105
7.5.7 After a small-group tryout. 105
7.6 Finalize the IMI program. 106
7.6.1 Purpose. 106
7.6.2 What needs to be updated? 106

7.6.3 Final quality check. ..... 106

8 NOTES ..... 106
8.1 Intended use ..... 106
8.2 CD-ROM destruction. ..... 106
8.3 Subject term (key word) listing. ..... 106

CONCLUDING MATERIAL ..... 108

LIST OF FIGURES

FIGURE 1 Frequency ranges of typical audio media and human hearing in Kilohertz ..... 31
FIGURE 2 Sample ICW course organization. ..... 40
FIGURE 3 ICW flowchart example ..... 61

LIST OF TABLES

TABLE 1 General rules for using IMI as an instructional media delivery system ..... 6
TABLE 2 IMI development team ..... 8
TABLE 3 IMI implementation team ..... 9
TABLE 4 General types of management support ..... 10
TABLE 5 Decision aid - evaluation of organizational support for IMI ..... 11
TABLE 6 Modification of support level ..... 11
TABLE 6 Modification of support level ..... 12
TABLE 7 Decision aid - organizational support re-evaluation ..... 12
TABLE 8 Decision aid - contractor support determination ..... 12
TABLE 9 Decision aid - exportable IMI feasibility checklist ..... 14
TABLE 10 Job aid - Hardware data collection ..... 16
TABLE 11 Types of costs ..... 18
TABLE 12 Variables affecting IMI development ..... 19
TABLE 13 Configuration control decision matrix ..... 20
TABLE 14 Example of a development list ..... 21
TABLE 15 Sample format for IMI review and approval ..... 24
TABLE 16 QC responsibilities of IMI development team ..... 25
TABLE 17 Sample format for courseware design review ..... 26
TABLE 18 Sample format for quality specialist final lesson review ..... 27
TABLE 19 Sample format for a discrepancy report ..... 28
TABLE 20 Sampling rates and storage requirements tradeoffs ..... 32
TABLE 21 Hardware/software considerations ..... 32
TABLE 22 Contrasting video technologies ..... 36

TABLE 23 Job aid for determining learning levels ..... 42
TABLE 23 Job aid for determining learning levels ..... 43
TABLE 23 Job aid for determining learning levels ..... 44
TABLE 24 Levels of interactivity ..... 45
TABLE 25 Interactivity levels and associated learning levels ..... 46
TABLE 26 Instructional delivery mode cost impact ..... 50
TABLE 27 Categories of ICW presentation ..... 51
TABLE 28 Job Aid - ICW presentation category selection data consolidation ..... 52
TABLE 29 Guidelines for increasing user interactivity ..... 53
TABLE 29 Guidelines for increasing user interactivity ..... 54
TABLE 30 Guidelines for designing student control of ICW ..... 54
TABLE 31 Guidelines for designing feedback for ICW ..... 56
TABLE 32 Guidelines for designing ICW tests ..... 58
TABLE 32 Guidelines for designing ICW tests ..... 59
TABLE 33 ICW events of instruction ..... 59
TABLE 34 Programming standards considerations ..... 62
TABLE 35 Guidelines for programming elements of a storyboard ..... 64
TABLE 36 Steps involved in storyboard development ..... 65
TABLE 37 Guidelines for storyboarding ..... 66
TABLE 38 Guidelines for storyboarding visual elements ..... 69
TABLE 39 Guidelines for storyboarding video elements ..... 72
TABLE 40 Guidelines for storyboarding text elements ..... 74
TABLE 41 Guidelines for storyboarding graphics and animation elements ..... 76
TABLE 42 Guidelines for storyboarding audio ..... 77
TABLE 43 Storyboard checklist ..... 80
TABLE 44 Prototype lesson development elements ..... 86
TABLE 45 ICW programming guidelines ..... 87
TABLE 46 Video production guidelines ..... 89
TABLE 46 Video production guidelines ..... 90
TABLE 47 Audio production guidelines ..... 90
TABLE 48 ICW display convention guidelines ..... 91
TABLE 49 Sample job aid for internal review ..... 101
TABLE 50 Sources of individual tryout information ..... 103

## 1. SCOPE

1.1 Scope. This handbook provides background information for the planning, design, development, implementation, evaluation, and management of Interactive Multimedia Instruction (IMI) products. IMI products include electronic products used in the delivery of instruction or supporting the delivery of instruction. See 4.2 for a further breakdown of IMI products. This handbook (Part 3 of 5 Parts) also provides acquisition guidance unique to IMI products and supplements general acquisition guidance provided in MIL-HDBK-29612-1 (Part 1 of 5 Parts).

1.2 Application guidance. This handbook is intended for guidance only. This handbook cannot be cited as a requirement. If it is, the contractor does not have to comply.

1.2.1 How to use this handbook. The guidance provided in this handbook applies to any IMI program development. It applies to IMI in weapons system or training system acquisitions. It also applies to IMI developed as a stand-alone training product. MIL-HDBK-29612-2 provides guidance for the selection of instructional media. When IMI is determined to be the best instructional media, the guidance in MIL-HDBK-29612-3 will assist in verifying whether or not IMI can be used and supported by the training activity. After verification, further guidance will aid in the design and development of an IMI program.

## 2. APPLICABLE DOCUMENTS

2.1 General. The documents listed below are not necessarily all of the documents referenced herein, but are the ones that are needed in order to fully understand the information provided by this handbook.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the latest issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-29612 Performance Specification, Training Data Products

DEPARTMENT OF DEFENSE HANDBOOKS

| | |
|---|---|
| MIL-HDBK-9660 | Department of Defense Handbook, DoD-Produced CD-ROM Products |
| MIL-HDBK-29612-1 | Department of Defense Handbook, Guidance for Acquisition of Training Data Products and Services |
| MIL-HDBK-29612-2 | Department of Defense Handbook, Instructional Systems Development/Systems Approach to Training and Education |
| MIL-HDBK-29612-4 | Department of Defense Handbook, Glossary of Training Terms |
| MIL-HDBK-29612-5 | Department of Defense Handbook, Advanced Distributed Learning Initiative (ADL) Products and Systems |

(Unless otherwise indicated, copies of military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein.

| | |
|---|---|
| DoD HLA | High Level Architecture (HLA) |
| DoD JTA | Joint Technical Architecture (JTA) |
| JIEO REPORT 8300 | Department of Defense Minimum Desktop Personal Computer Configuration |
| DoDI 1322.20 | Development and Management of Interactive Courseware for Military Training |
| OUSD Memo | DoD Joint Technical Architecture (JTA) |
| SCORM | Sharable Content Object Reference Model (SCORM) |

(The HLA can be downloaded from http://www.ntsc.navy.mil.)

(The DoD JTA can be downloaded from http://www-jta.itsi.disa.mil.)

(Copies of this JIEO Report may be obtained by written request to the Commander, Joint Interoperability Engineering Organization (JIEO), Attn: Code TP, Fort Monmouth, NJ 07703-5613.)

(Copies of the Department of Defense Instruction (DoDI) 1322.20 are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

(Copies of the SCORM may be downloaded from: www.ADLNET.org.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

## 3. DEFINITIONS

3.1 General. Definitions and acronyms are provided in MIL-HDBK-29612-4.

## 4. INTERACTIVE MULTIMEDIA INSTRUCTION PLANNING

4.1 Introduction. Managers achieve successful IMI design, development, acquisition, and management when they become involved with the using activities as soon as IMI requirements are identified. Deciding whether to use IMI requires careful planning and consideration. This section provides information and decision aids to help determine whether IMI can be used and supported by the training activity.

4.2 What is IMI? IMI is a term applied to a group of predominantly interactive, electronically-delivered training and training support products. IMI products include instructional software and software management tools used in support of instructional programs.

4.2.1 IMI products. IMI products are teaching tools and may be used in combination or individually. Used individually not all IMI products can be considered interactive, multimedia, or instructional. However, IMI products when used in combination with one another are interactive, multimedia, and instructional. IMI products include:

a. Interactive Courseware (ICW).
b. Electronic publications.

    (1) Electronic guides.
    (2) Interactive Electronic Technical Manuals (IETMs).
    (3) Electronic Technical Manuals (ETMs).

c. Electronic testing.
d. Simulation.
e. Electronic management systems including:

    (1) Electronic Performance Support System (EPSS).
    (2) Computer Aided Instruction (CAI).
    (3) Learning Management Systems (LMS).

(4) Computer Managed Instruction (CMI).
(5) Course Management System (CMS).
(6) Electronic job aids (e.g., templates, macros, etc.).

f. Other materials (digital or printed) including:

(1) Workbooks.
(2) Study guides.
(3) Job aids.
(4) Training manuals.
(5) Programmed instruction booklets.
(6) Technical orders.

g. Trainers. This data shall include descriptions of the trainer requirements, mission statement and objective, and an explanation of the sortie/exercise elements to be trained using the following trainers:

(1) Simulator trainers.
(2) Platform and component trainers.
(3) Combination platform and component and simulator (hybrid trainers).

h. ADL products including:

(1) On-line (e.g., Internet, intranet, extranet) courses including:

(a) Web-ready (e.g., Hypertext Markup Language (HTML), Extensible Markup Language (XML), synchronous, etc.).
(b) Web-deliverable (i.e., executable files launched via a browser).
(c) Web-based (i.e., asynchronous and synchronous instruction).
(d) Web-downloadable (i.e., content for off-line instruction).

(2) Compact Disk-Read Only Memory (CD-ROM), Digital Versatile Disk (DVD), and other digital storage devices.
(3) Broadcast television (including cable and satellite).
(4) Video conferencing.
(5) Audio conferencing.

4.2.1.1 Source materials for development of IMI products. Types of source materials for development of IMI products include:

a. Imagery (e.g., animations, graphics, still photograph, 3-D, etc.).
b. Video.
c. Audio.
d. Text.

4.3 IMI and the Instructional Systems Development/Systems Approach to Training (ISD/SAT) process. The ISD/SAT process provides the framework for developing training (see MIL-HDBK-29612-2). Within the framework of the ISD/SAT process, training requirements are established and translated into appropriate instructional objectives. In the design phase, one of the most important tasks is that of selecting appropriate instructional delivery methods and media. After the methods and media are selected, the guidance provided in this handbook is applicable for the planning, design, and development of IMI.

4.3.1 IMI applications. IMI uses may include:

a. A stand-alone program that is suitable for use in supplementing a formal course of instruction or distributing to operational activities for use.
b. A program that supports presentation by an instructor.
c. A program that supports formal on-the-job training.
d. A program that supports personnel performance.
e. A program that supports the management of courseware.
f. A product that supports the ADL and provides instruction anytime-anywhere and on-demand.

4.3.2 Advantages of IMI. IMI may be a suitable instructional media delivery system for many training objectives. New ways of designing and developing educational and training materials are now possible due to the rapid development of computer technology. Computers can be used to deliver interactive, competency-based, individualized, multimedia instruction. IMI can tailor instruction to the individual student's needs, be deployable, and provide Just-In-Time (JIT) instruction.

4.4 General rules for selecting IMI as an instructional media delivery system. General rules that apply to using almost any form of IMI are shown in Table 1.

TABLE 1. **General rules for using IMI as an instructional media delivery system.**

| # | GENERAL RULE | RATIONALE |
|---|---|---|
| 1 | Use IMI to gather a large collection of multimedia material, such as slide collections or still photographs or a mixture of still-frame and motion sequences on film or video. | When the volume of slides and the demand for reproduction reach a certain point, the use of IMI may prove to be the most cost-effective means of distribution. Motion sequences, film and video reproduction, are in the long run much more expensive than IMI reproduction. Also, film and videotapes tend to deteriorate over time, where IMI will maintain the images at the same resolution for extensive periods. |
| 2 | IMI training should be considered when there are a large number of students distributed over time and place. | In this instance, a cost trade-off exists between self-paced, individualized training and lecture-based training. The break-point is achieved when the number of students is so large and/or widely distributed that it becomes more economical to use individualized training methods (e.g., Internet/intranet/extranet delivery). |
| 3 | Consider using IMI applications when it is necessary to allow students to practice a skill, and a simulator or real equipment is impractical or unavailable for this training. | If designed correctly, an IMI simulation can often greatly reduce the amount of time required in hands-on training on real equipment or a simulator. Real equipment or a simulator might not be available to provide every student with an opportunity to practice. Real equipment may be undesirable for hands-on training because it is too delicate for constant training use. |
| 4 | IMI can provide a safe, yet realistic, simulation of dangerous activities and situations. | When potentially hazardous procedures must be demonstrated or practiced, simulation often becomes a necessity. A case in point involves teaching maintenance personnel how to repair high voltage equipment. Simulation would allow maintenance personnel to practice proper procedures without exposure to actual dangers. An IMI simulation can show the effects of improperly performed procedures without damaging equipment or injuring personnel. |
| 5 | IMI is a particularly suitable instructional media delivery system when training requires continuous practice and/or retraining. | One of the most desirable features of IMI is the ease with which any portion of a course or lesson can be retrieved and reviewed. This characteristic is best illustrated by pilot training. Continuous practice is required because pilots must maintain near-perfect proficiency. |

TABLE 1. **General rules for using IMI as an instructional media delivery system - Continued.**

| # | GENERAL RULE | RATIONALE |
|---|---|---|
| 6 | IMI can be a very useful delivery method in training problem-solving and decision-making skills. | Since advanced or higher-order skills are usually learned "on-the-job," experienced workers are often forced to spend valuable time training unskilled workers, at the expense of their own jobs. IMI training could be substituted, thereby freeing skilled employees from the task of training others. |
| 7 | When a training situation is such that students vary in experience, learning style, and skill level, IMI instruction can provide different types and levels of instruction to different students. | Specific features can be designed into an IMI program to allow users to advance based on their skill levels. IMI programs can be designed to facilitate individual differences in students' learning styles. For example, if the students are visually oriented rather than spatially oriented, the IMI might contain motion video and animation. |

4.5 When to use IMI. Deciding when to use IMI requires a step-by-step examination process. IMI should not be selected simply for its technological appeal. This handbook provides additional information and decision aids to assist in identifying constraints that could influence the design of IMI products.

4.6 Quality Improvement. Quality Improvement (QI) is the continuous, organized implementation of beneficial change to the process of designing and developing IMI. The goal of QI is to promote continuous improvement in the IMI process and products.

4.6.1 Continuous improvement. Continuous QI of instructional programs is an ongoing initiative. The IMI development process is designed to lead managers and designers to ask the right questions and help focus on the customer’s needs in terms of requirements, schedules, and budgets. Focusing on the needs of the customer is a key element of continuous QI. Customer satisfaction is the number one goal; customer satisfaction translates into meeting instructional requirements in the most effective and efficient manner possible.

4.6.2 Keep customer involved. Once the requirements for the IMI program have been established and agreed upon, it is important to keep the customer involved in the process. There are several points in the development of an IMI program where the customer should be involved in the development and review of products that make up the IMI material.

4.6.3 Get “buy-in”. It is essential that the user organization "buy-in" to the IMI design and development process. If the user organization disagrees with the proposed solutions or ideas, it is

better to find out and make adjustments early in the process. If the user is kept involved throughout the process, there should be no surprises when the final product is delivered.

4.7 The IMI project team. Depending on the scope of the project and resources available, many different people can be involved in the IMI process.

4.7.1 IMI development team responsibilities. Each member of the IMI development team must know what is expected of them. The IMI development team needs to know what products are required and when, and how IMI products in the user organization look and function. IMI development requires team members with a variety of experience. Table 2 lists the IMI team functions, and describes the specific responsibilities assigned. Depending upon the scope and size of the specific IMI project and organization management, some of the responsibilities listed below may be combined.

TABLE 2. **IMI development team.**

| TEAM MEMBER | RESPONSIBILITIES |
|---|---|
| Instructional Designer | Designs lesson structure, and creates flowcharts and storyboards. Develops standards and instructional strategies for IMI lessons. Assists with lesson authoring when required. Reviews completed lesson designs, flowcharts, and storyboards for instructional integrity and conformance with standards and strategies. |
| Courseware Developer | Responsible for overall development and production of IMI products based upon the instructional design. Coordinates the creation/ identification of static and animated graphics, performance exercises, simulations, and interactive sequences to ensure the overall educational soundness of the program. Programs lessons with courseware development/authoring tool. |
| Subject Matter Expert (SME) | Provides information on project subject matter. Reviews lesson designs, flowcharts, storyboards, and programmed lessons for technical accuracy and currency. Authors lessons as required. |
| Courseware Programmer | Programs lessons with authoring languages. Develops static and animated graphics with authoring languages. Assists in converting American Standard Code for Information Interchange (ASCII) code when automatic conversion is unavailable. Develops subroutines. |
| Graphic Artist | Develops graphics and is the advisor for visual conventions. |
| Media Production Specialist | Films motion and still-frame sequences. Coordinates audio narration. Assists in planning pre-master media layout. |

TABLE 2. **IMI development team - Continued.**

| TEAM MEMBER | RESPONSIBILITIES |
|---|---|
| Information Technology (IT) Specialist | Provides guidance to managers during the courseware development process to ensure that managers are informed of software programs and programming languages that may be prohibited. Also provides guidance on the infrastructure requirements to support ADL. |

4.7.2 IMI implementation team responsibilities. After IMI is developed, a team of personnel with specific responsibilities is needed to implement the program. Table 3 lists the functions and responsibilities of the team members. Due to the type and use of a specific IMI program, some of the below listed responsibilities may need to be distributed to a different labor category.

TABLE 3. **IMI implementation team.**

| FUNCTION | RESPONSIBILITIES |
|---|---|
| Configuration Manager | Catalogs, stores, and distributes courseware materials including student guides, workbooks, flowcharts, storyboard hard copy, lesson design hard copy, flowcharts, lesson disks, backup disks or tapes, and version updates. |
| Courseware Administrator * | Enrolls students. Tracks student progress through LMS reports. Maintains records on student progression. Provides student progression records to instructors. |
| System Administrator | Sets up and runs computer laboratories. Contacts technicians for unscheduled maintenance. Trains staff to use the hardware system. |
| Class Monitor * | Assists students using IMI. Responds to operational questions and monitors performance using LMS. Updates instructors on student performance. |
| Instructor * | Provides individual remedial instruction and counseling. Tracks student performance through LMS. Schedules students for remediation. May also participate in IMI development as courseware developer, instructional design, or SME. |
| Information Technology (IT) Specialist | Manages the technical resources of the ADL system. (Will be thoroughly familiar with the infrastructure, hardware, and software requirements to support the ADL system.) Provides guidance on issues such as firewalls, encryption, and virus protection. Additionally, may possess the technical expertise to manage the network. |
| * This function may not be required in an exportable environment, but the responsibilities identified in this Table may be required. It may be necessary to redistribute responsibilities to another function on the exportable courseware implementation team. | |

4.7.3 IMI team training. A successful IMI design and development effort requires team members with skills in initial selection decisions, design, development, and implementation of IMI. The team should receive training in IMI design, development, and implementation.

4.8 Management and organizational support decisions. This section provides information on how to determine if organizational support for IMI exists. Successful implementation of IMI depends on sufficient management support and proper facilities.

4.8.1 Management support. There are three general types of management support required. Table 4 provides general descriptions of the three types of management support.

TABLE 4. **General types of management support.**

| TYPE OF SUPPORT | DESCRIPTION |
|---|---|
| Commitment of resources | Upper level management support is needed for successful IMI development and implementation. Management controls the resources. On IMI projects, resources may be needed for 1) purchasing hardware, software, and IMI, 2) training the IMI team, 3) facilities, and 4) support personnel. |
| Enthusiasm for project | Enthusiastic managers can serve as project advocates and promote an atmosphere of cooperation throughout the training organization. By their enthusiasm managers can reduce negative attitudes of other project members. |
| Meeting staffing demands | Management support is essential in meeting staffing demands. The selection, assignment, and training of personnel should be a major concern. Ideally, management should assign personnel to the project from start to finish. Although assignment longevity is hard to achieve in a military environment, it is a critical factor to the success of an IMI project. Personnel rotation can slow the IMI process because of learning curves for new employees, and different perceptions of what is needed. |

4.8.2 Evaluation of organizational support for IMI. This section provides decision aids to help evaluate the level of organizational support. The decision aids also help to identify an action and develop a plan for altering the level of organizational support, re-evaluate organizational support, and identify potential solutions for support issues.

a. Lack of support in any of the categories listed in Table 5 can lead to serious consequences, but a support deficit does not necessarily eliminate the option of IMI.

TABLE 5. **Decision aid - evaluation of organizational support for IMI.**

| SUPPORT CATEGORY | EVALUATION PROCEDURE | SUPPORT IS | |
|---|---|---|---|
| | | **Available** | **Unavailable** |
| Management support | Talk to managers to determine their support for IMI. | | |
| Staff support | Talk to staff to determine support for IMI. | | |
| Staff availability | Review future commitments for staff. Determine whether staff can be added. | | |
| Staff skills | Review staff resumes. Interview staff about prior IMI experience. | | |
| Staff dedication | Determine whether staff can be dedicated for the duration of the project. | | |

b. Use Table 6 to identify an action and develop a plan for altering the level of organizational support. Table 6 lists the critical support categories, the potential results of a support deficit, and suggested actions to reduce the deficit or increase the level of support.

TABLE 6. **Modification of support level.**

| SUPPORT CATEGORY | RESULTS OF SUPPORT DEFICIT | ACTION TO ALTER DEFICIT |
|---|---|---|
| Management support | May have resource availability problems. Lack of support may flow down through organization. | Inform management of IMI benefits and advantages. Involve managers in the decision process or planning phase. |
| Staff support | Instructors may resist the change and be uncooperative during implementation. | Provide training on IMI to reduce resistance. Convince staff that changing roles does not mean less responsibility. Involve staff in decision process. |
| Staff availability | May not have the force to develop IMI. | Add staff to current force. Defer current commitments. Contract out IMI development. |
| Staff skills | Learning curve may be high. Development may proceed slowly. | Train staff to perform IMI development. Contract out development. Add experienced staff to current force. |

TABLE 6. **Modification of support level - Continued.**

| SUPPORT CATEGORY | RESULTS OF SUPPORT DEFICIT | ACTION TO ALTER DEFICIT |
|---|---|---|
| Staff dedication | Lesson revisions increase with IMI staff changes. | Develop and enforce lesson standards to reduce potential for format changes. |

c. Organizational support re-evaluation. Use Table 7 to re-evaluate organizational support based on the data collected on Tables 5 and 6. If support is now available in three of five categories (one must be management), IMI may be pursued. If the re-evaluation still reflects a substantial support deficit and the decision is made to pursue IMI, be prepared for additional problems in meeting schedules.

TABLE 7. **Decision aid - organizational support re-evaluation.**

| SUPPORT CATEGORY | SUPPORT IS | |
|---|---|---|
| | **Available** | **Unavailable** |
| Management support | | |
| Staff support | | |
| Staff availability | | |
| Staff skills | | |
| Staff dedication | | |
| IT Specialist support | | |

d. Support deficit solutions. One potential solution to a support deficit in the area of staffing requirements is contracting IMI to a commercial training development company. Use Table 8 to determine if contractor support is a potential solution.

TABLE 8. **Decision aid - contractor support determination.**

| ITEM | DECISION FACTOR | YES | NO |
|---|---|---|---|
| 1 | Scope and schedule exceed in-house capability. (see Note.) | | |
| 2 | Inadequate staffing support for IMI (see Note). | | |
| 3 | Adequate staff available but inexperienced with IMI. | | |
| 4 | Staff dedication to IMI lacking. | | |
| 5 | Contract funding available. | | |
| NOTE: If the answer is “yes”, this may be adequate reason for pursuing contractor assistance. | | | |

4.8.3 Facility support requirements. A number of facility requirements affect implementation of certain IMI products. Three of the major factors are delivery system facility requirements, development system facility requirements, and special facility requirements. See MIL-HDBK-29612-2, Section 7 for further guidance on facility requirements.

4.9 Media selection. MIL-HDBK-29612-2, Section 7 provides guidance for the selection of media. The output of media selection identifies the appropriate media for supporting the specific Learning Objectives (LOs). The following paragraphs provide guidance on determining whether the use of IMI is feasible in the target environment. (For example, during media selection IMI was found to be the most effective media to support the LOs. However, during the IMI feasibility analysis, it was found that the course content was expected to be unstable for the next three years due to immaturity of the supported system. In this case, immediate development of IMI may not be the most cost effective solution, and the media selection should be conducted again with course content stability being used as a constraint.)

4.9.1 Media selection process. Media selection is a five step process and is conducted as follows:

a. Identify instructional concept and course and lesson strategy.
b. Identify sensory stimulus requirements for each LO.
. c. Identify sensory stimulus features for all available media.
d. Match the sensory stimulus requirements with the sensory stimulus features to identify a candidate list of media.
e. Select the delivery media (i.e., transparencies, printed materials, audio tape, video, film, ICW, CD-ROM, and web server) based on resource constraints, classroom logistics, and all other relevant considerations.

4.10 IMI application considerations. IMI can be applied across several levels of instruction, from entry-level to advanced refresher training. This IMI characteristic should be considered during the trade-off analysis. Design and development to support several training levels can significantly reduce overall life cycle costs because a greater number of training requirements can be satisfied with a single product. However, a single IMI product covering several training levels may cost more to develop.

4.10.1 IMI feasibility. The results of the media selection process should be analyzed to determine if the media selected is feasible for the intended instruction. A job aid for media feasibility is provided in MIL-HDBK-29612-2, Appendix E.

4.10.2 IMI exportability. Exportable IMI consists of products that are developed and/or managed at a centralized location, but delivered at more than one remote user facility. Use Table

9 to determine if exporting IMI to remote locations is feasible. The exportability decision aid has five parts. Guidance on the use of the five parts follows:

a. If you obtain a "yes" response to all three questions in Part I, go directly to Part III. If you obtain a "no" response to any of the questions in Part I, you need to complete Part II.
b. A "no" response to either question in Part II indicates that exportable IMI cannot be supported and should not be attempted until funds are allocated. "Yes" responses to Part II indicate that exportable IMI is feasible, and you should complete Part III.
c. "Yes" responses to the questions in Part III indicate that IMI is feasible.
d. "Yes" responses to the questions in Part IV indicate that ADL is feasible.

TABLE 9. **Decision aid - exportable IMI feasibility checklist.**

| EXPORTABILITY QUESTIONS | YES | NO |
|---|---|---|
| **PART I** | | |
| Is there existing hardware at the field unit that can support IMI training? | | |
| Is the number of hardware stations sufficient to train the number of students? | | |
| Is the existing hardware available for IMI training? | | |
| Is there an existing connection for access to the Internet or an intranet? | | |
| **PART II** | | |
| Are funds available for hardware procurement? | | |
| Are funds available for operating IMI? | | |
| **PART III** | | |
| Is IMI an appropriate media for presenting this content? | | |
| Do the target audience demographics justify IMI use? | | |
| **PART IV** | | |
| Is training required "anytime" and "anywhere"? | | |
| Is Just In Time (JIT) training required? | | |
| **PART V** | | |
| Is the course/module training concept suitable for exporting? | | |

4.10.3 Courseware development/authoring tool selection. Courseware development/authoring tools include prepackaged prompted aids, courseware templates, or menu driven editors designed to help developers create IMI without elaborate programming. The

courseware development/authoring tool used should provide standardized programming code to support most commonly required interactions, animated graphics, and common simulation elements to reduce the requirement for customized programming to the minimum required to support highly sophisticated interactivity, animated graphics, and simulations. This is essential to course maintenance and revision. Courseware development/authoring systems must be able to develop performance and performance-based exercises that provide adequate iterations of practice to develop mental skills required in job performance. Additionally, access to a repository for re-usable courseware objects should also be made available. Courseware development/authoring tools may include analysis, design, and pre-authoring course development capabilities. When selecting courseware development/authoring software it is necessary that the individual(s) selecting the software are experienced with programming, courseware development, and instructional design. Before examining various software systems, these individuals should become familiar with the acquisition process and review appropriate regulations such as MIL-PRF-29612, Performance Specification, Training Data Products. When IMI is intended for ADL use, the courseware development/authoring tool selected should conform with the Sharable Content Object Reference Model (SCORM). Refer to MIL-HDBK-29612-5 for information on the acquisition of ADL products.

4.10.3.1 Courseware development/authoring software selection. Among other functions, the courseware development/authoring tool should provide templates with the capability of defining and storing additional templates or customizing existing templates. MIL-HDBK-29612-5, Table 28 provides a sample checklist that can be modified and used to evaluate an existing courseware development/authoring tool or to document the desired functions and features of a courseware development/authoring tool that is to be procured.

4.10.4 IMI hardware configuration decisions. This section addresses hardware selection and describes the impact that hardware decisions have on IMI. The goal is to choose a configuration that supports a variety of parameters, including the previously selected IMI instructional features and the courseware development/authoring tool. Personnel with a hardware background are desired for this phase of the IMI decision-making process.

4.10.4.1 Review policies and regulations. The IMI hardware decision is based on a number of selection factors including, military acquisition restrictions, command regulations, and local directives and policies. Before examining various hardware systems, become familiar with the acquisition process and review appropriate regulations. Some sources for review would be DODI on IMI and computers, Defense Information Systems Agency (DISA) publications, commercial publications, and guidance provided in applicable Service documents.

4.10.4.2 Factors influencing hardware selection. After reviewing regulations and determining how restrictions affect the selection process, examine specific hardware systems for the following:

a. Interface with courseware development/authoring tool software.
b. Processing speed.
c. Capability to support multimedia.
d. Transportability.
e. Existing hardware.
f. Cost.
g. Vendor support and past performance.
h. RAM.
i. Standards.
j. Security.

4.10.4.3 Hardware data collection. Determining the hardware requirements is a two step process. The first step is to determine existing hardware capability. This data may be used to constrain the design of courseware. After determining what media the existing hardware will support, a determination needs to be made as to whether or not that design will satisfy the training need. If the media design will not satisfy the training need then the hardware will need to be upgraded or new systems procured. Selecting hardware is generally done by conducting a tradeoff analysis. MIL-HDBK-29612-5, Appendix B provides recommendations for hardware (and software) for the delivery of ADL courseware. Table 10 is an aid to be used in recording data on both existing systems and prospective systems.

TABLE 10. **Job aid - Hardware data collection.**

| **HARDWARE DATA COLLECTION INFORMATION REQUIREMENTS** | | | |
|---|---|---|---|
| **1. GENERAL INFORMATION** | | | |
| a. Name of hardware system. | | | |
| b. Reviewer's name and phone number. | | | |
| c. Review date. | | | |
| **2. HARDWARE CHARACTERISTICS** | **ON HAND** | **DESIRED** | **DELTA** |
| d. Processor type and speed. | | | |
| e. Installed RAM. | | | |
| f. Storage capability. | | | |
| g. Sound capabilities. | | | |
| h. CD-ROM speed. | | | |
| i. Operating system. | | | |
| j. Network support. | | | |

TABLE 10. **Job aid - Hardware data collection - Continued.**

| **2. HARDWARE CHARACTERISTICS - Continued.** | **ON HAND** | **DESIRED** | **DELTA** |
|---|---|---|---|
| k. Number of users supported by network. | | | |
| l. Speed of lesson access from network. | | | |
| m. Graphic and text plot speed. | | | |
| n. System response to input. | | | |
| o. Input devices supported by the system: | | | |
| • Joystick | | | |
| • Trackball | | | |
| • Mouse | | | |
| • Touch pad | | | |
| • Touch-sensitive monitor | | | |
| • Light pen | | | |
| • Keyboard | | | |
| • Key pad | | | |
| • Bit pad | | | |
| • Microphone | | | |
| • Other | | | |
| p. Type of monitor: | | | |
| • Screen resolution (640 x 480, etc.) | | | |
| • Dot pitch (e.g., .28) | | | |
| q. Cost of a different monitor if necessary. | | | |
| r. Graphics/video controller card with the system (e.g., CGA, EGA, VGA, SVGA): | | | |
| • On board memory (video RAM, number of MB or GB) | | | |
| s. Cost of a different graphics/video controller card if necessary. | | | |
| t. Cost of hardware system. | | | |
| u. What is included in this cost (e.g., specific components, documentation, user support, maintenance and system integration). | | | |
| v. Items that can be added later to extend the system (e.g., RAM, networking software, larger storage, higher resolution monitor, graphics/video controller cards, input devices, optical disk technology, etc.). | | | |
| **3. INFORMATION REQUIREMENTS** | | | |
| w. Standard maintenance offered as part of the purchase. | | | |
| x. Specific maintenance support included in a standard agreement. | | | |
| y. Components under warranty. | | | |
| z. Length of the warranty period. | | | |
| aa. Cost of extending the maintenance agreement. | | | |
| bb. Ongoing user support available at no additional charge (e.g., telephone support, user-friendly documentation). | | | |

4.11 IMI cost considerations. This section explains how direct and indirect costs can affect your decision to use IMI. This section also presents a methodology for estimating the amount of time it will take to produce one hour of finished IMI.

4.11.1 Cost factors. The final decision about using IMI cannot be made until direct and indirect costs are known. Table 11 provides a description of direct and indirect costs.

TABLE 11. **Types of costs.**

| TYPE OF COST | DESCRIPTION |
|---|---|
| Direct Cost | A cost that is specifically identifiable to the project. Examples of direct costs are hardware and software purchases, travel and per diem, and time charges to a specific project. Other direct costs include reproduction costs of IMI materials including laser disc costs to copy floppy diskettes, video production costs, etc. |
| Indirect Cost | A cost that is not specifically identifiable to the project. Examples of indirect costs are payroll and administrative costs, electric bills, and basic overhead accounts. Another example of an indirect cost is the money required to train a programmer on a particular courseware development/authoring tool if the costs are not charged directly to a specific project. Moneys associated with modifying or constructing the IMI facilities could be indirect costs. |

4.11.2 Estimating IMI development hours. There are factors and variables that can effect the development time required per one hour of completed IMI.

4.11.2.1 Assumptions for estimating development hours. A list of factors that define a best case situation is provided below:

a. The IMI developer is familiar with the subject matter, and has in-house SMEs.
b. The subject matter is not highly complex.
c. The instructional content is stable; that is, the system for which the training is being developed exists and is not emerging. Also, the tasks selected for IMI training do not continually change.
d. The instructional content is well documented. A training needs assessment and task and learning analysis have been completed, giving the designer a good idea of the performance expected and the tasks to be trained. The technical materials supporting the content domain are accurate.

e. The IMI developer is familiar with the selected IMI courseware development/authoring tool.
f. The IMI developer is familiar with the target audience.
g. There is no requirement to document to a military standard such as MIL-STD-2167, and best commercial practices are accepted for software development and video production.
h. The IMI project team consists of individuals who are experienced with IMI management, design and development.
i. The selected IMI courseware development/authoring tool is mature and stable. No beta versions are used.
j. A lesson format and design strategy are agreed upon up front, and the customer has agreed. If possible, the customer has approved a prototype lesson. Also, the development process is standardized.
k. The customer works closely with the design team on a regular basis. The customer uses objective acceptance criteria and does not continually change the individual who is responsible for reviewing and approving the lessons.
l. All required resources are in place.

4.11.2.2. Affect of changes in variables. Many factors might affect the IMI development effort. There are degrees of risk associated with these factors. Table 12 shows a degree of risk associated with some variables that might impact the cost, timeliness, or educational soundness of the product. This list is not all inclusive. Individual programs may have different or additional variables.

TABLE 12. **Variables affecting IMI development.**

| **VARIABLES** | **RISK FACTOR** |
|---|---|
| 1. No in-house SMEs; must rely solely on use of customer SMEs. | medium |
| 2. Subject matter is highly complex. | high |
| 3. Instructional content is unstable. System for which IMI is being developed is emerging. Tasks for IMI constantly changing. | high |
| 4. Inadequate documentation. No training needs assessment performed. No task analysis or learning analysis data. Technical manuals non-existent or not helpful. | high |
| 5. Developer not familiar with IMI software/authoring package. | medium |
| 6. Developer not familiar with target audience. | low |
| 7. Best commercial practices not acceptable. | low |
| 8. Inexperienced project team: | |
| IMI designers inexperienced. | medium |
| IMI manager inexperienced. | high |
| IMI programmer inexperienced. | high |

TABLE 12. **Variables affecting IMI development - Continued.**

| VARIABLES | RISK FACTOR |
|---|---|
| 9. Using a beta version of the authoring package. | high |
| 10. No prototype exists, no agreement up front on design strategy, no standardized process followed. | high |
| 11. Customer not using objective and consistent acceptance criteria. Customer unsure of what he wants and does not communicate with developer. | high |
| 12. Required resources not in place at start of project. | high |

4.11.2.3 Estimating costs for course configuration and maintenance. Table 13 gives examples of the typical kinds of changes often encountered during IMI development. The Table shows the degree of effort commonly associated with minor, moderate, and major changes. The degree of effort can be used to help the IMI manager determine if the change will require additional funds to implement. Table 13 is based on a single instance. Multiple instances of the same occurrence will impact the degree of effort involved.

TABLE 13. **Configuration control decision matrix**.

| TYPE OF | DEGREE OF EFFORT | | |
|---|---|---|---|
| CHANGE | MINOR | MODERATE | MAJOR |
| Technical | Example: switch position is wrong. | Example: function of an entire component must be changed due to modification. | Example: introduce entire set of new tasks. |
| Instructional | Example: allow student 2 tries instead of 1. | Example: change 1 test from multiple choice to true/false. | Example: introduce entire new strategy on how to test. |
| Media | Example: change font. | Example: add 4 full-motion video shots. | Example: replace all graphics with video. |

4.12 How to plan an in-house IMI effort. The first step toward delivering a quality IMI program to the customer is to develop a project plan. Without a well-developed project plan, neither the developer nor customer will know what to expect, when to expect it, or how well it should work. Customer dissatisfaction at product delivery is often due to a lack of communication with the customer during the project. The project plan is a useful tool to use to communicate with the customer. This section describes all of the activities performed during the planning phase of an in-house IMI program.

4.12.1 Outline the IMI effort. Procedures for outlining the IMI development effort are described in this section.

4.12.1.1 Establish a development process. It is important to think through the entire development process and prepare a list of items required for each phase. Table 14 is an example

of such a list. Not all the items shown in this Table are needed for every project. Once the items have been selected, briefly document the following information:

a. Purpose of the item.
b. Products resulting from the item.
c. Documentation used in developing the products.
d. Personnel responsible for the item.
e. Review and approval process for the item.

TABLE 14. **Example of a development list**.

| ITEM | PHASE | ACTION | DESCRIPTION |
|---|---|---|---|
| 1 | PLANNING | Develop a process outline. | Document development process, staffing requirements, and completion schedule. |
| 2 | | Develop quality control procedures. | Document quality control process and staffing requirements. |
| 3 | | Prepare the development team. | Make staff assignments and determine resource and training needs. |
| | | | |
| 4 | DESIGN | Determine course structure. | Segment course objectives into lessons. |
| 5 | | Define instructional strategies. | Develop basic strategies for multiple lessons. |
| 6 | | Develop design specifications. | Define lesson components and document format and operation standards. |
| 7 | | Design databases. | Determine organization of project databases (graphics library, LMS, and storyboard). |
| 8 | | Develop lesson designs. | Develop/sequence subordinate objectives, practice items, feedback, and test items. |
| 9 | | Develop lesson flowcharts. | Plan/sequence individual lesson displays and make initial graphics/video designs. |
| 10 | PRODUCTION | Develop storyboards. | Fully develop text and narration; fully design graphics and video shots. |
| 11 | | Produce graphics. | Develop graphics for lesson and store in graphics library database. |
| 12 | | Initiate lesson programming. | Enter text, graphics, branching logic, etc., from storyboard to create an operational lesson. (Program all non-video lesson segments.) |
| 13 | | Produce visual material. | Shoot photographs and video of operational equipment, procedures, etc.; select best frames. |
| 14 | | Record narration. | Record narration using storyboard scripts. |

TABLE 14. **Example of a development list - Continued**.

| ITEM | PHASE | ACTION | DESCRIPTION |
|---|---|---|---|
| 15 | POST PRODUCTION | Select photographs or video frames. | Review all visual "takes" and select best shot. |
| 16 | | Edit video. | Perform video editing and create composites. |
| 17 | | Design video layout. | Plan placement of frames to reduce access time during lesson operation. |
| 18 | | Review master tape. | Perform quality control for final approval. |
| 19 | | Update storyboards. | Enter final frame numbers onto storyboard. |
| 20 | | Complete lesson programming. | Program video-dependent segments of lesson. |

4.12.1.2 Determine project deliverables. The project plan should clearly describe what products you will deliver to your customer. The most common IMI products are:

a. IMI treatment plan or course specification.
b. Storyboards and flowcharts.
c. IMI lessons.
d. Supporting materials.

4.12.1.3 Define staff positions and responsibilities. The make-up of the IMI development team (see Table 2) depends on the characteristics of the proposed IMI and the courseware development/authoring tool selected for the project. As part of the project plan, describe the positions and responsibilities of each IMI team member. Define individual assignments and how team members will work together to produce interim products and final lessons.

4.12.1.4 Develop a master schedule. Develop a master schedule as part of the process outline. Define completion dates for each interim and final IMI product. The IMI development team will use this schedule to pace its efforts. Management will use this schedule to track progress on the effort.

4.12.2 Prepare the team. Once the master schedule has been developed and the roles of all team members have been defined, the team needs to be prepared, as described below.

4.12.2.1 Determine training requirements. The key to determining team members' training requirements is to examine their experience. Determine the background of the team. If members do not have IMI experience, they are likely to need extensive training. If they are IMI experienced, training on the chosen software package may be needed.

4.12.2.2 Provide documentation. The development team members will need copies of documents that explain how they are supposed to do their jobs. They should also receive documents that are required to develop IMI, such as the development process outline, quality control procedures, IMI design specifications, and hardware and software user's manual.

4.12.3 Develop quality control procedures. The last activity performed during the planning phase is to develop the Quality Control (QC) procedures for the project team members. The QC procedures should be updated throughout the project to ensure that lessons learned in one part of the project are applied to work remaining to be accomplished. A review and approval process should be established to make sure that all products meet quality standards. Table 15 provides a suggested review and approval form for tracking review and approval processes. The form should be filled out and attached to each product associated with a lesson. As the product is reviewed and approved, the form should be signed by the approving authority. The form should be complete for each product associated with the lesson. The primary author should date the form to tell the reviewer when the review must be completed. The form should not be signed until all suggested corrections are made, checked, and approved. Unapproved products should be returned to the author for correction.

TABLE 15. **Sample format for IMI review and approval**.

| **IMI Review and Approval** | | **Page of Pages** | | |
|---|---|---|---|---|
| **TITLE/SUBJECT** | | **OPR** | **DATE** | |
| **No.** | **Item** | | | |
| Lesson Name:<br><br>Primary Author:<br>Start Date:<br>Final Due Date: | | SUSPENSE | INITIALS | DATE |
| PRODUCT | REVIEW AND APPROVAL | | | |
| Lesson Design | Courseware Developer | | | |
| | Instructional Designer | | | |
| | Subject Matter Expert | | | |
| | Courseware Programmer | | | |
| | Graphic Artist | | | |
| | Media Production Specialist | | | |
| | Quality Specialist | | | |
| Lesson Flowchart | Courseware Developer | | | |
| | Instructional Designer | | | |
| | Subject Matter Expert | | | |
| Storyboard | Courseware Developer | | | |
| | Instructional Designer | | | |
| | Subject Matter Expert | | | |
| Programmed IMI Lesson | Courseware Developer | | | |
| | Instructional Designer | | | |
| | Subject Matter Expert | | | |
| | Courseware Programmer | | | |
| | Quality Specialist | | | |
| | Project Manager | | | |
| Comments: | | | | |

4.12.3.1 QC team responsibilities. QC is the collected responsibility of the entire development team, and each member has specific review and approval duties. Table 16 shows

the general QC responsibilities for each team member. It also shows the importance of the review and approval.

TABLE 16. **QC responsibilities of IMI development team**.

| # | FUNCTION | QUALITY CONTROL RESPONSIBILITY | SIGNIFICANCE OF REVIEW AND APPROVAL SIGN-OFF |
|---|---|---|---|
| 1 | Instructional Designer | Authors an easy-to-understand, technically accurate lesson that is consistent with design documents. | Product has been reviewed and is judged to be satisfactory and consistent with design documents. |
| 2 | Courseware Developer | Reviews lesson products for instructional integrity and conformance with design documents. | Product has been reviewed and is judged to be instructionally effective and consistent with design documents. |
| 3 | Subject Matter Expert | Reviews lesson products for technical accuracy, currency, and completeness. | Product has been reviewed and is judged to be technically accurate, current, and complete. |
| 4 | Courseware Programmer | Programs lessons according to design documents and storyboard instructions. Manipulates graphics according to storyboard instructions. | Operational lesson has been reviewed online and is judged to be bug-free and to operate as specified. Static graphics are clear; animated graphics operate as specified and correct video and graphics are called into lesson at the correct location. |
| 5 | Graphic or Computer Artist | Develops clear, uncluttered, easy-to-read graphics according to storyboard instructions. | On-line graphics have been reviewed and are judged to be correct, clear, and easy to read. |
| 6 | Media Production Specialist | Produces high quality, clear videotape according to shot list and storyboard instructions. | Videotape has been reviewed and is judged to be high quality. |
| 7 | Quality Specialist | Reviews lesson products for instructional integrity and conformance with design documents. | Product has been reviewed and is judged to be instructionally effective and consistent with design documents. Operational lessons are user-friendly and consistent. |

4.12.3.2 QC job aids. The review checklist is the primary QC job aid. This checklist outlines each product to be reviewed in conjunction with the personnel responsible for each. A separate checklist should be made for each courseware product. Use the review checklists to track the completion of assigned reviews. Have reviewers sign, date, and return the completed

checklists to their supervisor. Products judged adequate are approved, and products judged inadequate are returned to the primary author for correction. Tables 17 and 18 show sample review checklists. Items on the checklists should be modified to reflect requirements in the design documents. IMI job aids may use some of the same information.

TABLE 17. **Sample format for courseware design review**.

| **COURSEWARE DESIGN REVIEW** | | **Page of Pages** | |
|---|---|---|---|
| **TITLE/SUBJECT** | | **OPR** | **DATE** |
| No. | ITEM | | |
| Reviewer Name: _____<br>Review Date: _____ | | | |
| REVIEW ITEM | COMMENTS | PASS YES | PASS NO |
| LOs related to lesson objectives | | | |
| LOs sequenced properly | | | |
| Practice items related to LOs | | | |
| Practice items at proper difficulty level for anticipated students | | | |
| Practice items provide adequate practice on LOs | | | |
| Practice item feedback identifies correct answer | | | |
| Critical LOs tested | | | |
| Test items related to LOs | | | |
| Test items at proper difficulty level for anticipated students | | | |
| Test item feedback identifies correct answer | | | |
| NOTES: | | | |

TABLE 18. **Sample format for quality specialist final lesson review.**

| **QUALITY SPECIALIST FINAL LESSON REVIEW** | | **Page of Pages** | |
|---|---|---|---|
| **TITLE/SUBJECT** | | **OPR** | **DATE** |
| **No.** | **ITEM** | | |
| Reviewer Name: _____<br>Review Date: _____ | | | |
| REVIEW ITEM | COMMENTS | PASS YES | PASS NO |
| Initiating routing commands accesses correct display | | | |
| Lesson routing conforms with design documents | | | |
| Text is easy to read and understand | | | |
| Graphics are clear and easy to read | | | |
| Video scenes match text | | | |
| Graphics match text | | | |
| Animated graphics appear to work properly | | | |
| Title page displays correct lesson title | | | |
| Lesson menu is consistent with sections | | | |
| Section contents match section titles | | | |
| NOTES: | | | |

4.12.3.3 Documenting the discrepancy process. Discrepancies indicate where products do not meet standards. QC procedures should also provide a means to document discrepancies. Table 19 provides a sample format for recording discrepancies. The form identifies the reviewer, review date, product type, discrepancy report number, lesson name, and discrepancy location. Space is provided to describe the discrepancy and suggest corrective actions, and a signature block showing resolution of the discrepancy.

TABLE 19. **Sample format for a discrepancy report**.

| DISCREPANCY REPORT | | Page of Pages | |
|---|---|---|---|
| TITLE/SUBJECT | | OPR | DATE |
| No. | ITEM | | |

Reviewer Name: _____
Review Date: _____
Product Type: _____
Discrepancy Report #: _____
Lesson Name: _____

Location of Discrepancy: Page: _____ Paragraph: _____
Line: _____ Screen: _____
Other: _____

Discrepancy Description: _____

_____
_____
_____

Suggested Corrective Action: _____

_____
_____
_____

| DISCREPANCY RESOLUTION SIGN-OFF | INITIALS | DATE |
|---|---|---|
| Correction Made: | | |
| Correction Verified: | | |
| Discrepancy Closed: | | |
| Discrepancy Remains Open: | | |

Corrective Action to Close: _____

_____

## 5. SOURCE MATERIALS FOR INTERACTIVE MULTIMEDIA INSTRUCTION PRODUCTS

5.1 Text. Printed matter is used in IMI to convey information that does not lend itself to a graphical environment. Printed matter may be used to supplement video, audio, graphics, or animation. Text may also be used alone to convey a thought, concept, or idea.

5.2 Audio. Sound is used in IMI to convey information that does not lend itself to a textual or graphical environment. For some training subject areas, the use of sound is critical for full achievement of LOs.

5.2.1 Human hearing. The hearing range of most humans is from approximately 20 hertz at the low end of the frequency spectrum to somewhere between 15 and 20 kilohertz (kHz) at the upper end. A hertz (Hz) is a unit of measure associated with frequency and is equal to one cycle per second; a kilohertz is 1,000 hertz.

5.2.2 Audio technology. Sound, which occurs naturally as an analog waveform, can be converted to digital signals, recorded and stored as a file that can be accessed by a computer. This process is called digitizing. The file can then be controlled by the computer program. It can be edited, otherwise manipulated, and accessed for near-instantaneous output. The output is converted from digital signals back to analog signals and played through output devices, such as speakers.

5.2.2.1 How audio is digitized. Sound is digitized through a process called sampling. At small, discrete time intervals, the computer takes a sample or reading of the waveform and records the frequency. The number of samples taken within a second is the sampling rate. The more samples that are taken during a second the greater the sampling rate. As the sampling rate increases so does the fidelity, or the faithfulness to the reproduction of the original audio.

5.2.2.2 Audio quality. The higher the sampling rate, the better the quality of the sound. Note however, that increasing the sampling rate (taking more samples per second) requires greater storage space. The controlling factor should be the quality of sound needed to meet the goals of the education or training. The sampling rate should be twice the highest frequency required.

5.2.3 Audio technology progress. Digital audio is a standard of multimedia systems. The addition of sound to the media capabilities of the computer-based systems is possible because:

a. Technological progress in Analog-to-Digital Converters (ADC) and Digital-to-Analog Converters (DAC) has made digital audio possible.
b. Audio recorded as numeric values allows digital computers to capture, manipulate, store, and distribute sound.

c. Advantages of using digital audio include:

(1) The quality of sound is maintained.
(2) Control of audio media is possible.

5.2.4 Digital audio in multimedia. Digital audio adds the true sound dimension to multimedia in its many and varied uses for educators and trainers. Potential uses are essentially limited only by the creativity of the instructor and course designer. Examples of applications and capabilities of digital audio are:

5.2.4.1 Computer control. With digitized sound, a computer treats a sound file just as it does a text file. Editing sound files is similar to editing in word processing programs. Precise control of quality sound to be delivered as part of multimedia programs gives the IMI designer and instructor flexibility in making instruction effective.

5.2.4.2 Sound-critical subject areas. Most education and training programs that cover subjects in which sound is a critical factor are enhanced by the use of digital audio. Some examples are:

a. Language training, including pronunciation drills by students.
b. Diagnosing mechanical operations by the sounds produced, such as jet engine runs and motor vehicle tuning.
c. Providing audible feedback to student inputs, such as simulated radio transmissions to aircrew members rehearsing missions.

5.2.4.3 Recording inputs. Instructors and students can record their own voices or sound inputs on the computer system, storing them for future reference or for providing immediate feedback or practice.

5.2.4.4 Computer presentations in the classroom. Computer-controlled presentations, in the classroom or other audience environment, now include audio as well as visual elements. The computer system becomes a versatile presentation tool for the instructor.

5.2.4.5 Speech therapy. Programs can be used by speech and language therapists to help people with speech impairments. Speech therapy programs digitize and analyze verbal characteristics such as pitch, loudness, and intonation. They also provide exercises on pronunciation, pitch, and speech timing.

5.2.4.6 Music. Digital audio capability on computers has quickly become an important means of creating and teaching music. Digitizing music will generally require greater sampling rates due to the greater frequency range of the source audio. Sampling rates of at least 11 or 12 kHz and

preferably up to 22 kHz are recommended. An international standard protocol for electronic music devices has been developed. It is called Musical Instrument Digital Interface (MIDI) (pronounced "mid-ee"). MIDI allows musical instruments, such as electronic keyboards, to be connected directly to a computer. MIDI is not digital audio but a means of providing an input that can be recorded digitally.

5.2.5 Examples of frequency ranges. Figure 1 shows the frequency ranges of human hearing and typical audio based media.

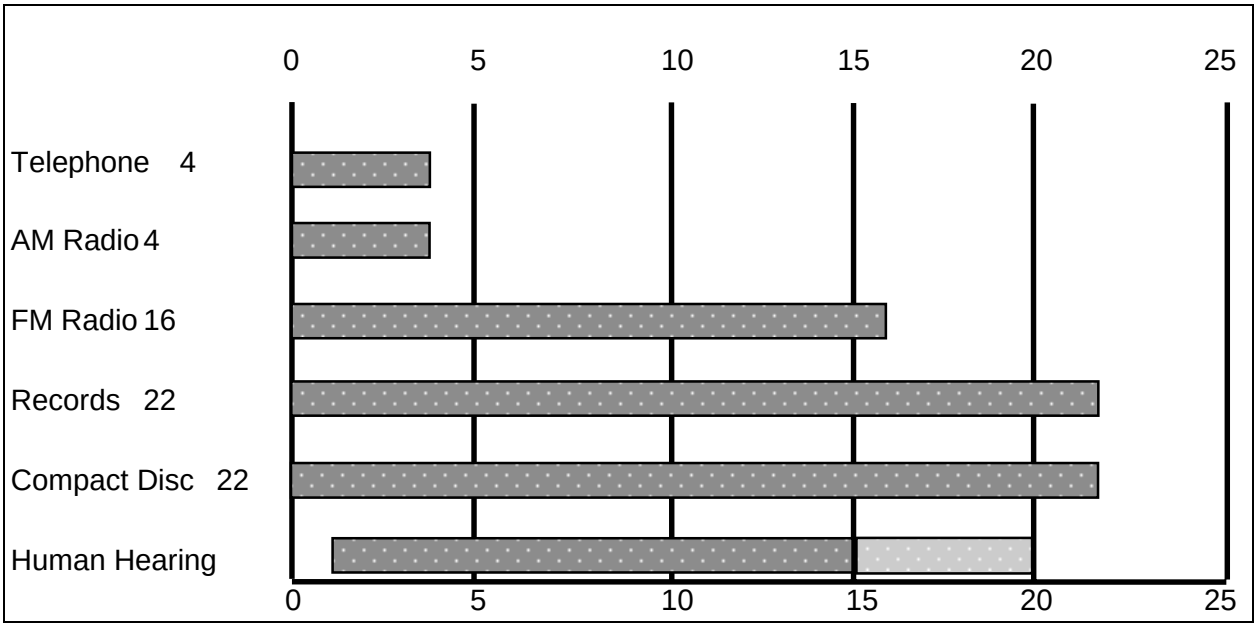


FIGURE 1. **Frequency ranges of typical audio media and human hearing in Kilohertz.**

5.2.6 Disk storage requirements. Decisions about the quality of digital audio also relate to available storage space. Table 20 illustrates the tradeoff between sampling rates and storage requirements.

TABLE 20. **Sampling rates and storage requirements tradeoffs.**

| Sampling Rate | Recommended For | Storage For 1 Second Of Sound | Seconds Of Sound (Per 1 MB Storage) |
|---|---|---|---|
| 22 kHz | Music quality | 22 Kilobytes | 45 seconds |
| 11 kHz | Other quality | 11 Kilobytes | 90 seconds |
| 7 kHz | Voice narration | 7 Kilobytes | 135 seconds |
| 5 kHz | Minimum for voice | 5 Kilobytes | 180 seconds |

5.2.7 Hardware and software considerations. Consider the hardware and software issues related to digital audio in an IMI system in Table 21.

TABLE 21. **Hardware/software considerations**.

| Hardware & Software Considerations | Personal Computers (PC) |
|---|---|
| Audio Recording Requirements | Requires that an audio card be installed or an external audio peripheral be added. |
| Audio Playback Requirements | Playback uses same audio card or peripheral, other playback devices must have cards/peripherals compatible with recording machine. |
| File compression | Optional on many audio cards. Compression of files saves storage but may degrade audio quality. |
| Speakers/Headphones | Required for output. Most are external to the system. |
| Microphones | May be built-in or be externally connected. |

5.2.8 Advantages and disadvantages of digital audio considerations. Digital audio offers many features for computer-controlled sounds some considerations include:

a. Random access. Digital audio enables audio to be retrieved and played instantly (on the order of milliseconds). In most systems, to access the audio, the user simply enters a "Play" command followed by the name of the file.
b. Ease of editing. Audio files are stored with a file name. Audio files can be deleted or replaced by using normal file command utilities. Tools enable users to "drop and drag" sounds to edit audio files. The process is as easy as using a word processor.
c. Cost. Moderate-cost, high-quality digital audio cards for computers are widely available.
d. Flexibility. Digital audio is not tied to a particular visual segment. Therefore, digital audio can be played in conjunction with any segment of computer generated visual images.

e. Lack of standardization of hardware. There is a distinct lack of standardization of file formats for digitizing audio (especially for MS-DOS machines). Audio files digitized with one type of audio board usually cannot be played back unless the same type or compatible board is in the delivery hardware.
f. Difficult to synchronize. Because audio files are usually loaded into RAM before they are heard, the amount of time needed to play a file fluctuates according to file size. This variation makes it very difficult to coordinate the audio with motion video.

5.3 Visual Information. Graphics, images, and video presentations are important parts of multimedia computer programs. A growing demand for interactivity and for the means to manipulate data are spurring progress in the digital capture and storage of the data. A quick look at the capabilities follows:

a. Capture devices are available to digitize inputs:

    (1) Scanners digitize text, graphics, photographs, slides, and other still images.
    (2) Video digitizers and software to convert analog motion image input from videotape, digital cameras, video cameras, and broadcast television.

b. Data manipulation, editing devices, and software programs are readily available for specialized applications and processes.
c. Computers can store, copy, and distribute image data without degradation of the data. Every image is as clear as the first. Data converted into images can be output:

    (1) Directly to the computer screen for inclusion in multimedia programs.
    (2) Through other playback devices such as television monitors, printers, or networks.

5.3.1 The visual element. Educators and trainers use visual aids to enhance the transfer of knowledge. From printed text to printed photographic materials, slide shows, films, and video the visual element has been a common means to effect the transfer of knowledge. Adoption of the computer to academic and training tasks has been paced by the emerging technology for computers. The computer industry's ability to digitize visual material is accelerating the use of computer systems for educational and training purposes.

5.3.1.1 Improved applications. The following educational and training applications of computer technology have benefited from digital image and digital video advancements:

a. Multimedia courses provide rapid access to a wealth of stored visual information.
b. Instructional development process for courses, illustrated materials, and training aids.
c. Research of and input from reference and resource visual databases.

d. Publishing of illustrated products for student and other uses, including sophisticated copies of student-produced products.
e. Exporting, networking and other distributive sharing of courses to other student sites.

5.3.1.2 Digital still images. Digital still images (single images, as opposed to a series of images that appear to have motion) are a mainstay of visual information systems used in education and training. Digital still images include photographs, drawings, charts, and other graphics normally found in print form or film.

5.3.1.2.1 Still-image basics. Computer systems work with digital information. The capture and conversion of images from analog to digital form is the first step. Once digitized, the data can be edited, manipulated, combined, stored, and then output in a means useful to the instructor.

5.3.1.2.2 Capturing still images. Still images can be captured with a graphics scanner, or other computer peripheral designed to convert print materials into digital data. The scanner works similar to a photocopy machine, except that its output is not a paper copy but rather a digital image transferred to a computer screen. Once on the screen, the image data can be changed, output to other storage devices, or stored in the computer memory.

5.3.1.2.3 How a scanner works. With the exception of multi-purpose facsimile machines and portable scanners, most scanners are flatbed scanners. As in photocopying, the graphic is placed on the glass surface, a light is passed under it, and the resulting signals are readable by a computer. When images or text materials are scanned, the computer sees a collection of dots. The dot is referred to as a pixel. Each pixel can be changed in color, brightness, location, and size. This control of the elements of what the user sees as an image is the greatest advantage offered by the digitization of visuals.

5.3.1.2.4 Scanning slides. Many flatbed scanners offer optional devices for digitizing slides. Specialized slide scanners offer better control and resolution of the image. The quality required of the of the finished image is the major factor driving the level of resolution.

5.3.1.2.5 Scanner equipment. Scanners come in many shapes and sizes, from inexpensive hand-held models to expensive, high-resolution, color-capable models with Optical Character Recognition (OCR) software. Some computers require installing an additional card in the computer, then cabling the scanner to the computer. The software required to read the scanned image normally comes with the scanner equipment.

5.3.1.2.6 Frame grabbers. Frame grabbing is a useful technique to capture a still photo or one frame of video motion, digitize it, and save it on the computer. The input signal goes through the digitizing card and is played in a window on the computer screen. When the wanted

frame appears, a keyed command grabs and stores the file. From this point, the image is a still image and can be worked accordingly.

5.3.1.3 Image resolution. The resolution or clarity level of the image to be scanned into the computer should be based on the eventual use of the image. For example, if it will become a product to be printed on a laser printer, a resolution of 600 or 300 Dots-Per-Inch (DPI) would be appropriate. However, if the image will remain a computer product, a lower resolution would work. The DPI selected to print will depend on the complexity of the image. Scanning at higher resolution rates impacts storage space.

5.3.1.4 Memory and storage requirements. Scanners require large amounts of RAM to capture images and larger amounts of storage space to store images (up to a megabyte for some images). These requirements dictate reasonable planning for the number of images and resolution required. The recommended technique is to scan only the area of the graphic needed, preview it on the computer screen, and then make adjustments before saving it to the computer storage.

5.3.1.5 Digital camera. Digital cameras store images digitally rather than recording them on film. Once a picture has been taken, it can be downloaded to a computer system, and then manipulated with a graphics program and printed. Unlike film photographs, which have an almost infinite resolution, digital photos are limited by the amount of memory in the camera, the optical resolution of the digitizing mechanism, and, finally, by the resolution of the final output device. Even the best digital cameras connected to the best printers cannot produce film-quality photos. However, if the final output device is a laser printer, it doesn't really matter whether you take a real photo and then scan it, or take a digital photo. In both cases, the image must eventually be reduced to the resolution of the printer. The big advantage of digital cameras is that making photos is both inexpensive and fast because there is no film processing. Images created using digital cameras are highly reusable.

5.3.1.6 Digital video. As with still images discussed earlier, the digitizing of video images represents a major advancement in computer technology an advancement of great use to educators and trainers. The capture and use of video images requires converting analog signals to digital data. A review of analog and digital issues, as they relate to video is useful at this point.

5.3.1.7 Copyright issues for images. It is of paramount importance to keep Copyright considerations in mind when using images from any source. Photographs, drawings, and text imported from a source outside your activity is almost certainly copyrighted. If the origin of the image is definitely from the Government, there is less chance of copyright violation. If the material was acquired by the Government from a non-government source, the copyright ownership and conditions need to be verified before use.

5.3.1.8 Analog versus digital. Analog video systems have been successful since their development in the 1930s. There was little consideration to converting television and the supporting video technologies from analog to digital formats until digital technology offered economic advantages. Technology is currently transitioning from analog to digital video. Table 22 identifies some of the important aspects of analog and digital systems applied to video.

TABLE 22. **Contrasting video technologies**.

| ANALOG | DIGITAL |
|---|---|
| Materials are in continuous form. Data is in waveform; cycling and flowing. | Views everything in discrete individual values. |
| Represents materials as continuous electrical signals. | Represents analog materials by sampling, recording precise values at each sampled point, and presenting the series of data points as very close approximations of the natural images. |
| Analog data can have any degree of brightness, and infinite numbers of colors, shades, and values. | Digital data are precise values, each represented by a combination of on/off electrical impulses. An example of a limitation: Video Graphics Array (VGA) boards are limited to 256 colors. |
| TV cameras convert images to continuous electrical signals. TV monitors deliver images by varying the intensity of light beams on the screen, giving the illusion of motion and unlimited colors. | Digitizing video has become possible as technology has developed Analog-to-Digital Converter (ADC) and Digital-to-Analog Converters (DAC), large storage capacities in magnetic and optical Disk media. |

5.3.1.9 How video is digitized. To digitize video from a camcorder, videotape, videodisc, or broadcast television, the input signal must be processed through a digitizing card added to the computer, or through a peripheral. This converts the analog video signals into digital bits of information for each pixel (picture element) of the computer screen. The software that comes with the digitization cards controls the process.

5.3.1.10 Difficulties in digitizing video. The difficulties still challenging the industry in the digitization of video are in these areas:

a. Acceptable range of colors and shades. Limited variation in colors and shades makes digital images appear to not blend well. Some images appear to have sharp, striped edges.

b. Sufficient memory and storage capability. Digital images (and sound) require large amounts of memory for processing and storage of digital data. The current compromise of recording data at lower quality levels is not always satisfactory.
c. Data transfer rates. Large digital files are difficult to display on the computer screen at the standard rate of 30 Frames Per Second (FPS), the accepted "full-motion" rate.

5.3.1.11 The impetus for digitizing video. Industry is committed to overcoming the difficulties in digitizing video for these reasons:

a. Error-free format. Digital systems, based on few, discrete values (usually 1 and 0), can reproduce and transmit data error-free.
b. Potential for interactivity. Digital systems, incorporating the excellent control capabilities of the computer, provide more intricate branching and integration possibilities. The result is systems that are largely individually tailored. The user is given a degree of control.
c. Ease of manipulation. Digital data may be resized, the color modified, be repositioned, and duplicated with relative ease and without the high costs of analog video editing equipment.
d. Durability. Digital data can be reproduced without any loss of quality. No "noise" ("snow" in video or "hiss" in audio) is introduced into copies. This is important when transmitting data over a network, such as in networked classrooms and local area networks at training facilities, or between them and students across the base.

5.3.1.12 Current status and near-term changes. Education and training managers must note that the television broadcasting industry is converting to digital format High Definition Television (HDTV). The Federal Communications Commission (FCC) has completed testing various HDTV systems proposed by industry. The four industry competitors have agreed to the specification proposed by the Advanced Television Standards Committee (ATSC). The FCC has announced all commercial television will broadcast HDTV by the year 2005 Public Broadcasting Stations (PBS) will broadcast HDTV by the year 2006. After 31 December 2006, 117 commercial television stations in 44 markets were broadcasting HDTV. These markets comprise 61.05% of US households. Computers, as digital devices, converge with digital HDTV television. Video technology essentially follows television technology. The developing standards will focus emerging digital video technologies. The impact on education and training is a natural follow-on. For decision-making, training materials managers should keep in mind the industry progress and trends as they promise impact 5 to 15 years in the future.

5.4 Graphics. Graphics (also called imagery) is a term used to denote any of the following:

a. A visual representation of an idea or object shown by means of lines, marks, shapes, and symbols. A still picture, illustration, symbol, shape, or other visual image.
b. A simple graphic is one equal to line drawings and outlines.
c. A complex graphic is a visual expression that more closely represents a photograph.
d. A visual image (graphics) generated by a computer. A computer display of symbols, shapes, and other images (e.g., charts, graphs, line drawings, illustrations, equipment panels, animation, 3D).
e. A visual or artwork prepared for a production.
f. Any pictorial representation (e.g., drawings, patterns, graphs, charts, or borders).

5.5 Animation. The simulation of movement produced by displaying a series of successive images on the screen. In computer graphics, animation can be accomplished in several ways, depending on the tools provided by the choice of programming language and on the working environment. One approach to animation involves drawing an image then erasing it and redrawing it in a slightly different place on the screen. Another approach makes use of the creation of entire screen frames (pages), which are drawn in memory and displayed in sequence on the screen. A third approach uses built-in screen-management tools that enable the user to specify an object, a start point, and a destination, and leaves the process of movement to the underlying software. Animation can be generated either in real time, in which each frame is created as the viewer watches, or in simulated time. In the latter, the computer generates still frames, which are then printed and photographed or are sent to a film or video animation camera. In this way, a computer can spend seconds, minutes, or hours generating each frame, but on replay the tape or film displays each frame in a fraction of a second. For successful animation sequences, images must replace one another rapidly enough to see continuous movement that is at least 14 FPS.

## 6. INTERACTIVE MULTIMEDIA INSTRUCTION PRODUCT DEVELOPMENT

6.1 IMI products. This section describes the products of IMI which include ICW, electronic management tools (e.g., CAI, LMS, EPSS, job aids, etc.), Learning Management Systems (LMS), electronic testing, electronic publications, and simulation. The first step toward the development of an IMI product should be planning. See Section 4 for details on IMI planning.

6.1.1 ICW. ICW is computer controlled courseware that relies on student input to determine the pace, sequence, and content of training delivery using more than one type medium to convey the content of instruction. ICW can link a combination of media, to include but not be limited to; programmed instruction, videotapes, slides, film, television, text, graphics, digital audio, animation, and up to full motion video, to enhance the learning process. ICW is one of the more complex components of the IMI family, and has the capability for providing excellent training in a variety of instructional settings.

6.1.1.1 ICW design. When designing ICW, products from the ISD/SAT process such as task lists, lists of LOs, media analysis data, and target audience analysis results will be used. This section contains guidance on how to develop the ICW specification, determine instructional strategies, determine LMS and testing strategies, and develop flowcharts and storyboards.

6.1.1.2 Develop the ICW specification. The ICW course/lesson specification describes in general terms how the ICW will look and function. This section describes how to develop the ICW specification.

6.1.1.2.1 Purpose of ICW specification. There are many purposes for the course/lesson specification. The ICW design team uses it to guide their efforts in meeting the customer's needs. It serves as a vehicle to get the customer to "buy-in" to the ICW efforts. If the customer does not agree with the approach in the design specification, changes can be made to the strategy that will not affect work already completed (like storyboards or programmed lessons). The design specification describes what is considered the "best approach" for presenting the ICW instruction.

6.1.1.2.2 Level of detail in the ICW specification. The most important aspect of the course/lesson specification is the amount of detail it should contain. Keep it short and sweet! If it takes more than 20 pages to describe how the course will look and function at this point, things have not been thought-out thoroughly enough. The specification is like an executive summary of the ICW, not a detailed description.

6.1.1.2.3 Content of the ICW specification. The specification should include:

a. An overview of the content of the course (course objectives).
b. A brief description of the instructional strategy. This is a very important aspect of ICW design. This section describes in detail how to determine the ICW instructional strategies.
c. A high-level description of how the ICW will work from the student's perspective. Take the task data and determine the number of modules and lessons that will be required to support the LOs. List the modules by name that will make up the course and break the modules into lessons, and give a name to each lesson. Remember, in the ICW design specification a lot of detail is not needed, just enough information to give developers and customers a feel for the ICW. A top-level flowchart is a useful way to describe how the ICW will work from the student's point of view. Figure 2 provides a sample of the organization of a typical ICW course.

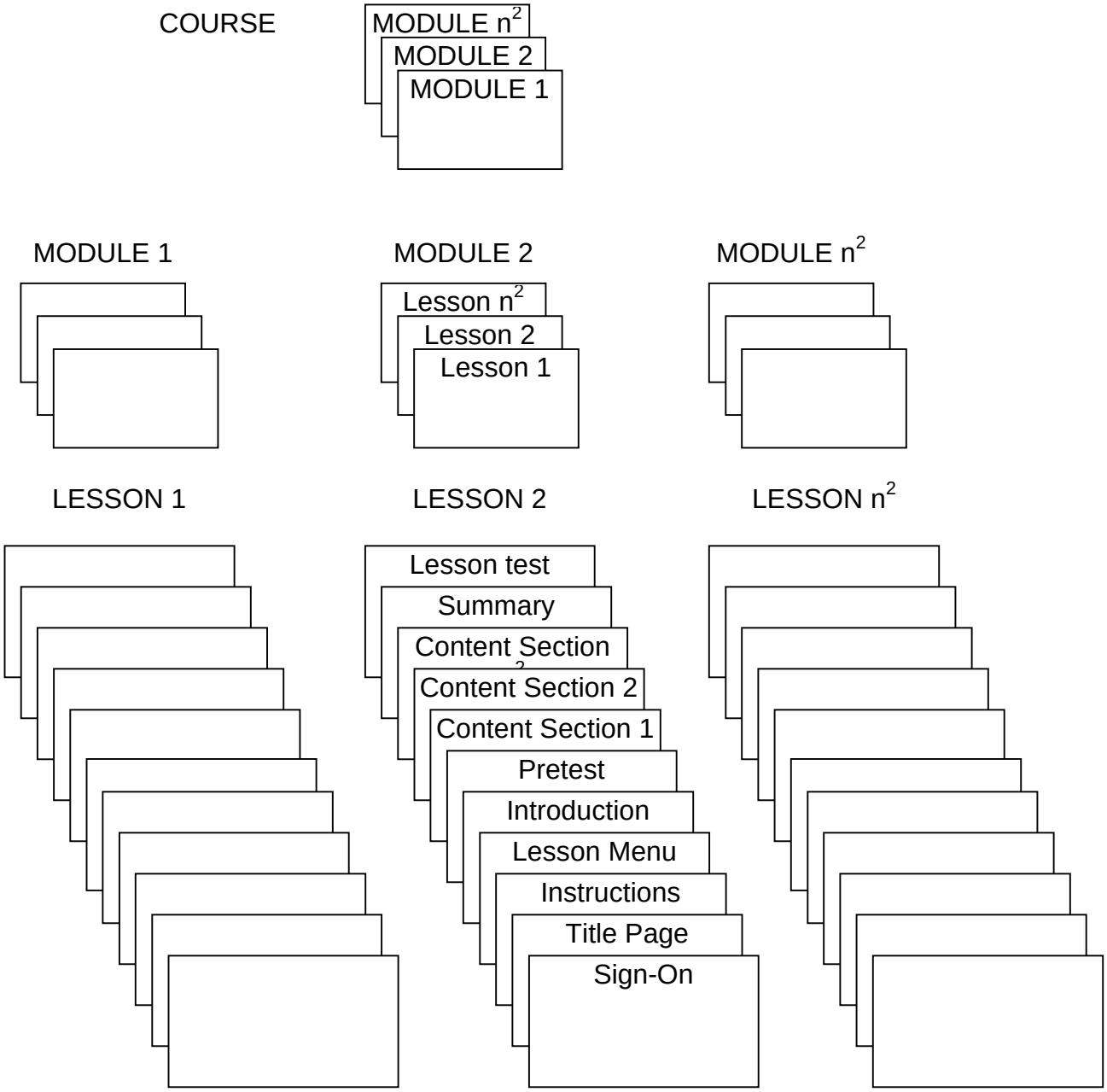


FIGURE 2. **Sample ICW course organization.**

6.1.1.3 Determine the level of interactivity. Interactivity involves two way communication between the courseware and a user. The following paragraphs provide guidance and tools that may be used in determining the interactivity needed to support the effective achievement of LOs.

6.1.1.3.1 Learning levels. Each LO is categorized as a learning type (e.g., knowledge, skill, or attitude). Table 23 is a job aid and indicates that each of the learning types is further classified by learning levels (e.g., fact learning, rule learning, etc.) and indicates the action verb associated with each learning level. The LO category and learning levels affect the design of lessons in terms of instructional strategy, instructional activities, level of interactivity, and performance measurement. Compare the LO action verb with the action verb/learning type/learning level listed in Table 23 to aid in determining the learning levels associated with the LO.

TABLE 23. **Job aid for determining learning levels**.

| **KNOWLEDGE** | | | | |
|---|---|---|---|---|
| Verbs | | | | Learning Level and Definition |
| Advise<br>Answer<br>Brief<br>Calculate<br>Define | Elaborate<br>Express<br>Identify<br>Inform<br>Instruct | List<br>Name<br>Read<br>Recall<br>Recommend | Recount<br>Specify<br>State<br>Tell | **Learning Level:** Fact Learning<br>**Definition:** Verbal or symbolic information (e.g., names, formulas, facts). |
| Appraise<br>Compile<br>Compose | Compute<br>Encrypt<br>Estimate | Evaluate<br>Format<br>Forward | Measure<br>Outline<br>Route | **Learning Level:** Rule Learning<br>**Definition:** Using two or more facts in a manner that provides regularity of behavior in an infinite variation of situations. |
| Check<br>Condense<br>Edit | Delete<br>Implement<br>Initiate | Pause<br>Resume<br>Set up | Start<br>Stop | **Learning Level:** Procedure Learning<br>**Definition:** Performing step-by-step actions in the proper sequence. |
| Allocate<br>Arrange<br>Assign<br>Categorize<br>Classify<br>Collate<br>Compare<br>Confirm<br>Consolidate<br>Contrast | Correlate<br>Cross-check<br>Designate<br>Differentiate<br>Discriminate<br>Distinguish<br>Distribute<br>Divide<br>Eliminate<br>Extract | Finalize<br>Group<br>Label<br>Level<br>Match<br>Organize<br>Rank<br>Realign<br>Redistribute<br>Reexamine | Reorganize<br>Restate<br>Schedule<br>Select<br>Separate<br>Sort<br>Task<br>Template<br>Translate<br>Tune | **Learning Level:** Discrimination Learning<br>**Definition:** Grouping similar and dissimilar items according to their distinct characteristics. |
| Analyze<br>Annotate<br>Apply<br>Change<br>Combine<br>Conclude<br>Convert<br>Create<br>Criticize<br>Decide<br>Defend | Derive<br>Design<br>Determine<br>Diagram<br>Discover<br>Draft<br>Effect<br>Explain<br>Extend<br>Find<br>Generalize | Generate<br>Hypothesize<br>Illustrate<br>Infer<br>Investigate<br>Locate<br>Manipulate<br>Modify<br>Plan<br>Predict<br>Produce | Project<br>Resolve<br>Revise<br>Search<br>Solve<br>Summarize<br>Synthesize<br>Triage<br>Use<br>War game | **Learning Level:** Problem Solving<br>**Definition:** Synthesizing lower levels of knowledge for the resolution of problems. |
| **SKILLS** | | | | |
| Verbs | | | | Learning Levels and Definition |
| Detect<br>Feel | Hear<br>Scan | See<br>Smell | Taste<br>Visualize | **Learning Level:** Perception (Encoding)<br>**Definition:** Sensory stimuli that translate into physical performance. |
| Assault<br>Carry<br>Creep<br>Depart | Fall<br>Hold<br>Jump<br>Lift | Pull<br>Run<br>Stay<br>Swim | Throw<br>Turn<br>Twist<br>Wear | **Learning Level:** Gross Motor Skills<br>**Definition:** Manual dexterity in the performance of physical skills. |
| Advance<br>Control<br>Follow | Guide<br>Hover<br>Land | Maneuver<br>Regulate<br>Steer | Take off<br>Track<br>Traverse | **Learning Level:** Continuous Movement<br>**Definition:** Tracking or making compensatory movements based on feedback. |

TABLE 23. **Job aid for determining learning levels - Continued**.

| **SKILLS** | | | | |
|---|---|---|---|---|
| Verbs | | | | Learning Levels and Definition |
| Able<br>Assist<br>Challenge | Cross<br>Delay<br>Guard | Prepare<br>Prime<br>Ready | Set<br>Stand to | **Learning Level:** Readiness<br>**Definition:** Having readiness to take a particular action. |
| Access<br>Activate<br>Actuate<br>Adjust<br>Administer<br>Align<br>Archive<br>Arm<br>Assemble<br>Attach<br>Balance<br>Breach<br>Calibrate<br>Camouflage<br>Center<br>Charge<br>Clean<br>Clear<br>Close<br>Collect<br>Connect<br>Cover<br>Debrief<br>Debug<br>Decontaminate<br>Deliver<br>Destroy<br>Diagnose<br>Dig<br>Disassemble<br>Disconnect<br>Disengage<br>Dismantle<br>Dispatch<br>Displace<br>Display | Dispose<br>Disseminate<br>Drive<br>Egress<br>Elevate<br>Emplace<br>Employ<br>Engage<br>Energize<br>Enter<br>Establish<br>Evacuate<br>Exchange<br>Fill out<br>Fire<br>Fit<br>Fuel<br>Ground<br>Harden<br>Hoist<br>Initialize<br>Input<br>Insert<br>Inspect<br>Install<br>Integrate<br>Intercept<br>Isolate<br>Issue<br>Jack<br>Launch<br>Load<br>Log<br>Lubricate<br>Maintain<br>Manage | Mount<br>Move<br>Navigate<br>Obtain<br>Open<br>Operate<br>Order<br>Park<br>Perform<br>Place<br>Plot<br>Police<br>Position<br>Post<br>Press<br>Pressurize<br>Process<br>Procure<br>Provide<br>Publish<br>Raise<br>Range<br>Reach<br>Receive<br>Record<br>Reestablish<br>Refuel<br>Release<br>Relocate<br>Remove<br>Repair<br>Replace<br>Replenish<br>Reset<br>Retrieve<br>Return | Rotate<br>Save<br>Secure<br>Send<br>Service<br>Shut down<br>Sight<br>Signal<br>Splint<br>Squeeze<br>Stockpile<br>Store<br>Stow<br>Strike<br>Submit<br>Supervise<br>Support<br>Sweep<br>Take<br>Take charge<br>Tap<br>Test<br>Tighten<br>Trace<br>Transfer<br>Transmit<br>Transport<br>Treat<br>Troubleshoot<br>Type<br>Unload<br>Update<br>Utilize<br>Write<br>Zero | **Learning Level:** Mechanism<br>**Definition:** Performing a complex physical or mental skill. |
| Acclimatize<br>Accommodate<br>Adapt<br>Ambush<br>Attack<br>Bypass<br>Conduct<br>Deploy | Direct<br>Draw<br>Evade<br>Infiltrate<br>Lay<br>Lead<br>Map<br>Neutralize | Occupy<br>Orient<br>Pack<br>Patrol<br>Prevent<br>Program<br>Protect<br>Queue | Reconcile<br>Recover<br>Reduce<br>Relieve<br>Suppress<br>Tailor<br>Temper<br>Train | **Learning Level:** Adaptation<br>**Definition:** Modifying a complex physical or mental skill to accommodate a new situation. |

TABLE 23. **Job aid for determining learning levels - Continued**.

| **SKILLS** | | | | |
|---|---|---|---|---|
| Verbs | | | | Learning Levels and Definition |
| Cause<br>Construct | Contrive<br>Correct | Initiate<br>Invent | Make<br>Originate | **Learning Level:** Origination<br>**Definition:** Creating a new complex physical or mental skill to accommodate a new situation. |
| **ATTITUDES** | | | | |
| Verbs | | | | Learning level and Definition |
| Attend closely<br>Listen<br>Listen attentively | Monitor<br>Observe<br>Perceive<br>Recognize | Reconnoiter<br>Show awareness | Show sensitivity<br>Wait | **Learning Level:** Receiving (i.e., perception; situation awareness)<br>**Definition:** Demonstrating mental preparedness to perceive the normal, abnormal, and emergency condition cues associated with the performance of an operational procedure. |
| Accomplish<br>Achieve<br>Acknowledge<br>Announce<br>Ask<br>Communicate<br>Complete | Complete assignment<br>Comply<br>Demonstrate<br>Describe<br>Encode<br>Execute | Give<br>Indicate<br>Interpret<br>Notify<br>Obey rules<br>React<br>Report | Request<br>Respond<br>Resume<br>Show | **Learning Level**: Responding (Interpreting)<br>**Definition:** Demonstrating mental preparedness to encode operational cues as indicators of normal, abnormal, and emergency conditions associated with the performance of an operational procedure**.** |
| Alert<br>Appreciate<br>Approve<br>Assess<br>Authenticate | Belief<br>Cancel<br>Choose<br>Judge<br>Justify | Prioritize<br>Propose<br>Qualify<br>Reassess<br>Review | Share<br>Study<br>Validate<br>Verify | **Learning Level:** Valuing (Judgment)<br>**Definition:** Demonstrating the ability to judge the worth or quality of normal, abnormal, and emergency cues associated with the performance of an operational procedure. |
| Allow<br>Alter<br>Assume | Command<br>Coordinate<br>Enforce | Ensure<br>Influence<br>Prescribe | Serve | **Learning Level:** Competence (Application of resource management strategies and tactics)<br>**Definition**: Demonstrating the mental preparedness to make decisions using prioritized strategies and tactics in response to normal, abnormal, and emergency condition cues associated with the performance of operational procedures. |
| Conceive<br>Conjecture | Develop<br>Devise | Formulate<br>Imagine | Innovate | **Learning Level:** Innovation (Generation of new resource management strategies and tactics)<br>**Definition:** Demonstrating the mental preparedness to make decisions by generating the results expected upon completion of prioritized strategies or tactics in response to normal, abnormal, and emergency cues associated with performance of an operational procedure, and generating prioritized strategies and tactics in response to abnormal or emergency cues. |

6.1.1.3.2 Hierarchy of learning. Lessons are developed to support LOs that reflect different learning types and learning levels. In constructing lessons, facts should be taught before rules, and rules should be taught before discrimination. In other words, lower learning levels (i.e., facts, rules) should be taught before higher learning levels (i.e., problem solving). Compare the

LO action verb with the action verb/learning type/level of learning listed in Table 23 to aid in developing the hierarchy of learning. For further details about learning type and learning levels refer to MIL-HDBK-29612-2, Section 6.

6.1.1.3.3 Sequencing of LOs. The hierarchy of LOs ensures a complete list of LOs made up of each type and learning level required. The sequence of LOs combines the types and levels of LOs in a teachable arrangement. Groups of facts may be taught leading to the teaching of a set of rules or procedures and terminating in discriminations or problem solving. Related LOs from each of the other learning types are inserted into the sequence as appropriate. For further details about learning type and learning levels refer to MIL-HDBK-29612-2, Section 7.

6.1.1.3.4 ICW presentation category selection. ICW presentation categories range from linear formatted (page turner) to real-time simulation presentations. In determining the most appropriate presentation category to support a LO, the following process will be helpful:

a. Match the level of interactivity with the learning level (e.g., fact learning, rule learning, etc.) associated with the LO.
b. Identify the sensory stimulus requirements.
c. Select the instructional delivery mode (e.g., exportable ICW, ICW supporting training, network, etc.) based on the required level of interactivity.
d. Match the required level of interactivity, sensory stimulus requirements, and delivery mode with the appropriate category of ICW presentation.

6.1.1.3.4.1 Levels of interactivity. Interactivity is the degree of student involvement in the instructional activity. Descriptions of the four levels of interactivity are provided in Table 24.

TABLE 24. **Levels of interactivity.**

| LEVEL | DESCRIPTION |
|---|---|
| Level 1 - Passive. | The student acts solely as a receiver of information. |
| Level 2 - Limited participation. | The student makes simple responses to instructional cues. |
| Level 3 - Complex participation. | The student makes a variety of responses using varied techniques in response to instructional cues. |
| Level 4 - Real-time participation. | The student is directly involved in a life-like set of complex cues and responses. |

6.1.1.3.4.2 Learning levels and levels of interactivity. Using Table 23, select the learning level based on the action verb contained in the LO. Match the level of learning with the appropriate level of interactivity using Table 25.

TABLE 25. **Interactivity levels and associated learning levels.**

| INTERACTIVITY LEVEL | DESCRIPTION OF LEVEL | KNOWLEDGE | SKILLS | ATTITUDES |
|---|---|---|---|---|
| LEVEL 1 INTERACTIVITY<br><br>PASSIVE | Capable of computer-generated multimedia presentations of intellectual skills (facts, rules, procedures).<br><br>Capable of showing a procedure with computer-generated multi-media explanations of equipment operation.<br><br>Student interaction limited to those required to advance with the presentation. | Fact Learning. The learning of verbal or symbolic information (e.g., names, formulas, facts).<br><br>Rule Learning. Learning to use two or more facts in a manner that will provide regularity of behavior in an infinite variation of situations. | Perception (Encoding). Perception of sensory stimuli that translate into physical or mental performance. | |
| LEVEL 2 INTERACTIVITY<br><br>LIMITED PARTICIPATION | Capable of providing drill and practice.<br><br>Capability for providing feedback on student responses.<br><br>Capability for emulation of simple psychomotor performance.<br><br>Capability to emulate simple equipment operation in response to student action.<br><br>Computer evaluation of student intellectual skills by computer -based predictive and performance test items. | Fact Learning. The learning of verbal or symbolic information (e.g., names, formulas, facts).<br><br>Rule Learning. Learning to use two or more facts in a manner that will provide regularity of behavior in an infinite variation of situations.<br><br>Procedure Learning. Learning to perform step by step actions in the proper sequence. | Perception (Encoding). Perception of sensory stimuli that translate into physical or mental performance.<br><br>Readiness. Learning to have readiness to take a particular action.<br><br>Guided Response. Learning of a complex physical or mental skill by copying a demonstration. | Receiving. Learning and demonstrating the ability to perceive the normal, abnormal, and emergency condition cues associated with the performance of an operational procedure. Situational Awareness of operational condition cues.<br><br>Responding. Learning and demonstrating mental preparedness to encode operational cues as indicators of normal, abnormal, and emergency conditions associated with the performance of an operational procedure. |

TABLE 25. **Interactivity levels and associated learning levels - Continued.**

| INTERACTIVITY LEVEL | DESCRIPTION OF LEVEL | KNOWLEDGE | SKILLS | ATTITUDES |
|---|---|---|---|---|
| LEVEL 3 INTERACTIVITY<br><br>COMPLEX PARTICIPATION | Capable of providing complex branching paths based on student selections and responses.<br><br>Capable of presenting or emulating complex procedures with explanations of equipment operation.<br><br>Capability for student participation in emulation of psychomotor performance and extensive branching capability<br><br>Capability for limited real-time simulation of performance in the operational setting.<br><br>Computer evaluation of student intellectual skills and performance by computer-based performance and predictive test items.<br><br>Computer evaluation of student procedural performance includes the capability to generate time and error scores for performance test items. | Procedure Learning. Learning to perform step by step actions in the proper sequence.<br><br>Discrimination Learning. Learning to group similar and dissimilar items according to their distinct characteristics.<br><br>Problem-Solving. Learning to synthesize lower levels of knowledge to resolve problems. | Continuous Movement. Learning to track or make compensatory movements based on feedback.<br><br>Perception (Encoding). Perception of sensory stimuli that translate into physical or mental performance.<br><br>Readiness. Learning to have readiness to take a particular action.<br><br>Guided Response. Learning of a complex physical or mental skill by copying a demonstration.<br><br>Mechanism. Learning to perform a complex physical or mental skill with confidence and proficiency.<br><br>Adaptation. Learning to modify a complex physical or mental skill to accommodate a new situation. | Innovation. Learning and demonstrating the mental preparedness to make decisions by generating the results expected upon completion of prioritized strategies or tactics in response to normal, abnormal, and emergency cues associated with the performance of an operational procedure, and the ability to generate new actions in response to abnormal or emergency cues.<br><br>Receiving. Learning and demonstrating the ability to perceive the normal, abnormal, and emergency cues associated with the performance of an operational procedure. Situational Awareness of operational cues.<br><br>Responding. Learning and demonstrating the mental preparedness to encode operational cues as indicators of normal, abnormal, and emergency conditions associated with the performance of an operational procedure.<br><br>Valuing. Learning and demonstrating the ability to judge the worth or quality of normal, abnormal, and emergency cues associated with the performance of an operational procedure<br><br>Competence. Learning and demonstrating the mental preparedness to make decisions by using prioritized strategies and tactics in response to normal, abnormal, and emergency condition cues associated with the performance of an operational procedure. |

TABLE 25. **Interactivity levels and associated learning levels - Continued.**

| INTERACTIVITY LEVEL | DESCRIPTION OF LEVEL | KNOWLEDGE | SKILLS | ATTITUDES |
|---|---|---|---|---|
| LEVEL 3 INTERACTIVITY<br><br>COMPLEX PARTICIPATION (continued) | | | Origination. Learning to create a new complex physical or mental skill to accommodate a new situation. | |
| LEVEL 4 INTERACTIVITY<br><br>REAL-TIME PARTICIPATION | Capability for real-time simulation of performance in the operational setting.<br><br>Computer evaluation of student performance and intellectual skills by computer-based predictive and performance test items.<br><br>Computer evaluation of student procedural performance includes the capability to generate time and error scores for performance test items.<br><br>Employs state-of-the-art technology for simulation and communication. | Discrimination learning. Learning to group similar and dissimilar items according to their distinct characteristics.<br><br>Problem-Solving. Learning to synthesize lower levels of knowledge for the resolution of problems. | Mechanism. Learning to perform a complex physical or mental skill with confidence and proficiency.<br><br>Adaptation. Learning to modify a complex physical or mental skill to accommodate a new situation.<br><br>Origination. Learning to create a new complex physical or mental skill to accommodate a new situation.<br><br>Continuous Movement. Learning to track or make compensatory movements based on feedback. | Receiving. Learning and demonstrating the ability to perceive the normal, abnormal, and emergency cues associated with the performance of an operational procedure. Situational Awareness of operational cues.<br><br>Responding. Learning and demonstrating the mental preparedness to encode operational cues as indicators of normal, abnormal, and emergency conditions associated with the performance of an operational procedure.<br><br>Valuing. Learning and demonstrating the ability to judge the worth or quality of normal, abnormal, and emergency cues associated with the performance of an operational procedure. |

TABLE 25. **Interactivity levels and associated learning levels - Continued.**

| INTERACTIVITY LEVEL | DESCRIPTION OF LEVEL | KNOWLEDGE | SKILLS | ATTITUDES |
|---|---|---|---|---|
| LEVEL 4 INTERACTIVITY<br><br>REAL-TIME PARTICIPATION (continued) | | | | Competence. Learning and demonstrating the mental preparedness to make decisions by using prioritized strategies and tactics in response to normal, abnormal, and emergency condition cues associated with the performance of an operational procedure.<br><br>Innovation. Learning and demonstrating the mental preparedness to make decisions by generating the results expected upon completion of prioritized strategies or tactics in response to normal, abnormal, and emergency cues associated with the performance of an operational procedure, and the ability to generate new prioritized strategies and tactics in response to abnormal or emergency cues. |

6.1.1.3.4.3 Sensory stimulus requirement. Using MIL-HDBK-29612-2, Section 7, identify the sensory stimulus requirement necessary to support LOs. Assign a cost factor (low, medium, high) to each sensory stimulus requirement. The cost factors include:

a. Low. Commercially available or Government furnished materials (i.e., graphics, animation, audio recordings, digital video recordings, and photography). Costs are limited to physical integration into courseware.
b. Medium. Original materials or adaptation of existing materials required. Limited amount of resources required to produce. For example, two-dimensional graphics will probably be in the medium cost category.
c. High. Development of original materials is required. Complex effort and more resources required too develop than medium. For example, high fidelity computer generated graphics will probably be in the high cost category.

6.1.1.3.4.4 Identify instructional delivery mode and impact. The instructional delivery mode is the environment or instructional setting, (e.g., electronically distributed, instructor led, etc.) in which the ICW will be used. The following questions are cumulative in nature. When the answer to the last question has been derived use Table 26 to identify the impact on resources required for ICW development:

a. Who are the users?
b. Where will the ICW be used (e.g., classroom, on the job, overseas, etc.)?
c. How will the ICW be delivered (e.g., stand-alone PC, in support of instructor led presentations, integrated into a training device, embedded in operational systems, electronic distribution, active on-line multiple interactive users, etc.)?
d. What is the impact of the delivery mode on the IMI courseware package development costs?

TABLE 26. **Instructional delivery mode cost impact**.

| IMPACT | CHARACTERISTICS | RATIONALE |
|---|---|---|
| LOW | Stand-alone PC. | Costs limited to courseware development and software necessary to run the courseware. |
| MEDIUM | Integrated into a training device or support of instructor led presentations. | Additional ICW programming costs for integration. |
| HIGH | Active, on-line, multiple interactive users. | Extensive additional programming costs. |

6.1.1.3.4.5 ICW presentation categories. Table 27 provides descriptions of the different categories of ICW presentations. These descriptions are useful in determining the scope and development cost for different categories of ICW presentations.

TABLE 27. **Categories of ICW presentation**.

| CATEGORY | DESCRIPTION |
|---|---|
| Category 1 - Low Grade Presentation | This is the lowest (baseline) category of ICW development. It is normally a knowledge or familiarization lesson, provided in a linear format (one idea after another). Category 1 is primarily used for introducing an idea or concept. The user has little or no control over the sequence and timed events of the lesson material. Minimal interactivity is provided by selective screen icons and inserted into the lesson through typical input/output peripherals and programming protocols. This category may include simple developed graphics and/or clip art, customer provided video and audio clips. |
| Category 3 - High Simulation Presentation | This category involves the recall of more complex information (compared to Categories 1 and 2) and allows the user an increased level of control over the lesson scenario through peripherals such as light pen, touch screen, track ball, or mouse. Video, graphics, or a combination of both are presented simulating the operation of a system, subsystem, or equipment to the user. The lesson scenario training material typically is complex and involves more frequent use of peripherals to affect a transfer of learning. Operation and maintenance procedures are normally practiced with Category 3 scenarios and students may be required to alternate between multiple screens to keep pace with the lesson material. Multiple software branches (two to three levels) and rapid response are provided to support remediation. Emulations and simulations are an integral part of this presentation. This category may also include complex developed graphics, and/or clip art, and customer provided video and audio clips. |
| Category 4 - Real-time Simulation Presentation | This ICW category involves more in-depth recall of a larger amount of information (compared to Categories 1, 2, and 3) and allows the user an increased level of control over the lesson. Every possible subtask is analyzed and presented with full, on-screen interaction, similar to the approach used in aircraft simulator technology. The lesson material is extremely complex and involves more frequent use of peripherals to affect the transfer of learning. This category normally supports certification, recertification or qualification requirements. Complicated operation and maintenance procedures are normally practiced with Category 4 and involves all of the elements of Categories 1, 2, and 3 presentations plus the following:<br>• High degree of interactivity.<br>• Extensive branching (four or more levels).<br>• Levels of sophistication - short of artificial intelligence. |

6.1.1.3.4.6 Considerations for ICW presentation category selection. The categories of presentation are initially derived from the level of interactivity related to the LO. This drives the complexity of the computer programming. Typically, presentation category 1 would use level 1 interactivity with simple visuals and basic instructional delivery mode. In special situations, a level 1 interactivity may require complex visual (i.e., high fidelity computer generated graphics, space and photography) and complex instructional delivery mode (i.e., flight simulator). The category of presentation must be selected based on a common sense balancing of the level of interactivity, complexity of the visual requirements, and complexity of the instructional delivery mode.

6.1.1.3.4.7 ICW presentation category selection data consolidation. Table 28 provides a useful tool for recording decisions concerning the selection of the ICW presentation category for each LO. After recording decisions concerning the learning levels, levels of interactivity, sensory stimulus requirements, and instructional delivery mode, identify and record the category of ICW presentation in Table 28.

TABLE 28. **Job Aid - ICW presentation category selection data consolidation.**

| **JOB AID - ICW PRESENTATION CATEGORY SELECTION** | | | | | |
|---|---|---|---|---|---|
| LO No. | LEARNING LEVEL | LEVEL OF INTERACTION | SENSORY STIMULI/ COST FACTOR | INSTRUCTIONAL DELIVERY MODE/ COST FACTOR | CATEGORY OF ICW PRESENTATION |
| 1.1 | Fact | Level 2 | Graphic/ Low | Exportable/ Medium | Category 2 |
| 1.2 | | | | | |
| 1.3 | | | | | |
| 1.4 | | | | | |
| 2.1 | | | | | |
| 2.2 | | | | | |
| 2.3 | | | | | |
| 2.4 | | | | | |
| 2.5 | | | | | |
| 3.1 | | | | | |
| 3.2 | | | | | |
| 3.3 | | | | | |
| 3.4 | | | | | |
| 3.5 | | | | | |

6.1.1.3.4.8 Guidelines for increasing interactivity. A key feature of ICW is that it provides the opportunity to involve the student in a training program. It is important to design as much meaningful interaction as possible into an ICW program. Table 29 presents guidelines for increasing interactivity in ICW training programs.

TABLE 29. **Guidelines for increasing user interactivity.**

| GUIDELINE DESCRIPTION | RATIONALE |
|---|---|
| Provide opportunities for interaction at least every three or four screens or, alternatively, about one per minute. However, mandatory interaction with the computer should not be superficial. | Without interaction, the program is just a fancy electronic page turner. However, if an action required is somewhat superficial, the student may be distracted by it and become annoyed. Students prefer not to have superficial interaction. |
| Group the content into small segments and build in questions (with feedback), periodic reviews, and summaries for each segment. | Grouping content into smaller units and providing opportunities for interaction (e.g., questions) within each information segment allows students to interact with the program more frequently. |
| Ask as many questions as possible without interrupting the continuity of the instructional flow. | Questions:<br>• Produce immediate feedback to students regarding their own performance.<br>• Provide information for the system to evaluate student performance and take actions.<br>• Sustain student attention by keeping them mentally active in the learning process. |
| Ask a question after, but not immediately following, the related content. | A gap between a post-question and its related content forces students to mentally search for and review necessary information, rather than repeating what they were just taught. This searching and reviewing enhances retention. |
| Sometimes a straightforward presentation of new content can be boring. Ask students a question related to the content that has not been taught but the answer can be figured out using previously learned knowledge. | This adds variety, challenges students, and maintains their interest. |
| Ask questions at the application rather than the memory level. | Application questions enhance attention and comprehension and facilitate transfer of learning. |

TABLE 29. **Guidelines for increasing user interactivity - Continued.**

| GUIDELINE DESCRIPTION | RATIONALE |
|---|---|
| Use rhetorical questions during instruction to get students to think about the content or to stimulate their curiosity. Also use them as a natural transition between frames. | A rhetorical question is a question that does not require students to overtly provide an answer. It invites students to mentally interact with the content. Used as a transition aid, it can direct students' attention to what is coming up next. |
| Consider designs where the student is not presented with information in a linear format, but rather discovers information through active exploration in the program. | This adds variety, challenges students, and maintains their interest. |

6.1.1.3.5 Guidelines for student control. In many instances students can make appropriate decisions about the most effective way to proceed through a training program. Research suggests that students frequently do not choose the most effective route, therefore, careful consideration of student control issues is important in the design of ICW.

6.1.1.3.5.1 Student control. Student control refers to the degree to which students are allowed to take charge of the aspects of the instruction and their learning environment (i.e., what to learn and how to learn it). Table 30 presents some guidelines for designing student control of content, sequencing, and pace of ICW training programs.

TABLE 30. **Guidelines for designing student control of ICW.**

| GUIDELINE DESCRIPTION | RATIONALE |
|---|---|
| **Provide student control over pace when:** | |
| Students believe that spending appropriate time on a topic will increase their success. | Students are often more satisfied with a program when they can choose the pace because they can spend appropriate time on the topics that relate to their personal needs and goals. |
| You believe that students will benefit from additional time, (that is, their performance will improve). | Additional time may allow students to integrate new information with previous knowledge. |
| **Provide student control of sequence when:** | |
| Lengthy instructional programs are introduced with no specific presentation order. | Control over sequence will help maintain student motivation and interest. |
| Students are familiar with a topic and are able to make appropriate sequence choices. | Students can choose information that will be relevant to them. |

TABLE 30. **Guidelines for designing student control of ICW - Continued.**

| GUIDELINE DESCRIPTION | RATIONALE |
|---|---|
| The learning type includes cognitive strategies or higher-order problem solving. | Sequence control will allow students to make selections that may facilitate flexible and novel thinking. |
| Determine the amount of student control based on your resource availability as well as these guidelines. | The more control allowed the student over content, pacing, and sequence, the more development work and therefore the more resources will be required. |
| Do not provide sequence control to students in situations where the materials have a specific prerequisite order. | Learning could be inhibited if the sequence is improperly chosen. |
| **Provide full student control of content if:** | |
| Students have significant previous knowledge of the content. | Presentation of known materials could be irrelevant and uninteresting to students. |
| Students have higher ability (that is, they are "sophisticated learners"). | "Sophisticated learners" may be better able to make content choices based on their needs. |
| There is a high probability that students will succeed in learning the content regardless of the chosen content. | Students will perceive through feedback that success is under their personal control and is in fact relatively independent of the chosen content. |
| Cognitive strategies and higher-order problem-solving (rather than facts) are being taught. | This guideline supports individual differences in learning style. Different students may see the relevance of different content and will be able to use this information effectively in novel ways during the learning of cognitive strategies and higher-order problem solving. |
| The skills are not critical, the training is optional, and student motivation is high. | This guideline will help to enhance learning for highly motivated students. |
| Do not provide full student control of content when all topics in the instructional presentation are required for successful completion of the program or when there is a hierarchical order to the materials. | The student may skip over relevant information. |

6.1.1.3.5.2 Influencing factors for student control. The following factors may influence decisions regarding the amount of student control designed into the ICW:

a. Knowledge of the target audience.
b. Learning skills of the target audience.
c. Motivation of the target audience.
d. Type of content.
e. Criticality of training.
f. Available resources.

6.1.1.3.6 Guidelines for feedback. Another important aspect of good ICW design is the use of feedback to the student. Feedback refers to the process of informing the student about the accuracy of their response. Feedback can be used to address any possible student misconceptions or lack of prerequisite knowledge. Feedback can be used to help students learn, enhance retention, and measure how much they have learned. Table 31 presents guidelines for designing feedback for ICW. Feedback may consist of:

a. Knowledge of results (correct or incorrect).
b. Explanation why the selected response is correct or incorrect.
c. Branching to remedial session (optional or forced).

TABLE 31. **Guidelines for designing feedback for ICW.**

| GUIDELINE DESCRIPTION | RATIONALE |
|---|---|
| Keep feedback on the same screen with the test item and student response. | Reduce memory load. |
| Provide feedback immediately following a student response. | Information about test results is an important element in the learning process. Delayed feedback can confuse students. |
| Provide feedback to verify the correctness and explain why. | It may not be clear to students why their responses are correct or incorrect. Therefore, in addition to knowledge of results, feedback should provide specific information about why a response is correct or incorrect. |
| For incorrect responses, give the student a hint and ask the student to try again. | Without the hint, students may fail again and feel frustrated. The hint helps students recall relevant information to answer the test item. |
| Tailor the feedback to each student's response. | Feedback should address the misconception a student may have by selecting a particular incorrect response. |
| Provide positive feedback. However, do not provide the type of feedback that may encourage incorrect responses. | Feedback, when properly used, can provide students with the motivation to learn. Cynical or negative feedback may discourage a student. |
| Add instructional feedback to simulation responses to explain why the simulated world reacted in a certain way or to provide a hint. | Instructional feedback guides the student through the simulation. In simulation, feedback is embedded in how the simulated world responds to a particular student action. Later it can be phased out to facilitate transfer. |
| If possible, allow students to print out a copy of their test results. | Often students like to maintain a hard copy record of their performance. |

6.1.1.4 Determine record keeping strategies. An important aspect of ICW development is the design of record keeping functions. Record keeping functional requirements for a specific program should be developed in coordination with the user and ICW team.

6.1.1.4.1 Record keeping functions. Record keeping functions may include, but are not limited to, any or all of the following:

a. Registration of the student in an ICW course.
b. Point-of-entry for the student to the course, often based on a pre-test performance or previously "bookmarked" location. Students should be able to leave a lesson and return to the same point at a later time.
c. Collection of data regarding the student's performance on tests and practice exercises.
d. Determination of student mastery of LOs.
e. Reporting of information.
f. Disenrollment of student from the course.

6.1.1.4.2 Record keeping capabilities. Prior to designing the record keeping capability for an ICW course, review the courseware development/authoring tool selected to determine the kind of data collection and analysis that is possible.

6.1.1.5 Design of ICW tests. Electronic tests are developed to measure a student's knowledge, skill, or attitude on a particular subject.

6.1.1.5.1 Types of ICW tests. Many types of tests can be administered electronically. The types of tests usually developed in ICW courses are pre-tests and criterion tests. A few tests that lend themselves well to ICW are:

a. Pre-test. The pre-test is used to measure the student's knowledge and skills for diagnostic purposes.
b. Criterion test. The criterion test is used to measure the student's attainment of the LOs. Analysis of test results over a period of time can be used as a measure of the effectiveness of the ICW.
c. Simulated performance tests. The test simulates the on-the-job environment, and requires the student to interactively complete the simulation. The student accomplishes this through the application and synthesis of knowledge and skill LOs presented in the instructional materials. The test requires the student to perform the simulated job task to established performance standards.
d. Simulated part-task performance tests. Simulated part-task performance tests measure critical sub-sets of job task performance. Simulated part-task performance tests should meet the same construction criteria as simulated performance tests.

e. Heuristic tests. Heuristic or discovery tests will present problem-solving simulations that emulate the on-the-job environment. These tests present the student with stimulus information that is inadequate, incomplete, ambiguous, or irrelevant to the simulated environment. The student will be required to synthesize knowledge and apply training received in order to solve the job performance simulation.
f. Simple gaming tests. Simple gaming tests will present the student with fill-in-the-blank, multiple choice, matching, completion, and true/false test items formatted and presented in a gaming style.

6.1.1.5.2 Tips for ICW test design. Table 32 provides guidelines for designing ICW tests.

TABLE 32. **Guidelines for designing ICW tests.**

| GUIDELINE DESCRIPTION | RATIONALE |
|---|---|
| Use a student's pre-test score to branch the student to "need to know" information. | This reduces student boredom by not forcing them to learn things they already know. |
| Use the student's pre-test score to gauge deficiencies in entry-level or prerequisite skills and knowledge. | The pre-test will stimulate recall of relevant prior knowledge (one of the "events of instruction"). |
| For pre-tests, explain that the students are not expected to know all the answers. | This will put students "at ease" with the new instruction. |
| Introduce the test by telling students how many test items they will see and how long it should take them to complete the test. | This will help students gauge how extensive the test is. |
| Let students "back out" of taking a pre-test if they know they do not know the content. | Forcing students to take a test when they know they do not know the content can introduce unnecessary stress into a learning situation. |
| Provide good instructions for taking the test. | This reduces the possibility of students making errors when they actually have mastered the LO. |
| Provide a method for students to review their completed test. | If students responded with a wrong answer and subsequently realize it, they should be able to correct the answer, just as they can in a paper-and-pencil testing situation. |
| Provide feedback to students' answers in the same order that they answered the test items. | This reduces confusion. |

TABLE 32. **Guidelines for designing ICW tests - Continued.**

| GUIDELINE DESCRIPTION | RATIONALE |
|---|---|
| Design the program so that the computer works through a problem with students instead of just giving the correct answer. | This reduces learning time because a student may have a partially correct answer. The computer should identify the point where the student is in error and invite the student to continue from there. |
| If test items are drawn from a pool of test items, remove correctly answered test items from the pool. | The learning criterion has been achieved and students should not be required to answer these test items again. |

6.1.1.6 Determine instructional treatments. Instructional treatments are the general instructional concepts for lessons in an ICW course. In determining instructional treatments, ensure that:

a. The ICW design facilitates learning and processing of information.
b. The ICW design accommodates the types of information or content of the program.
c. Interactivity is addressed.
d. Degree of student control is addressed.
e. Feedback is appropriate for enhancing learning and transfer.

6.1.1.6.1 ICW events of instruction. Particular activities or events can be designed into ICW programs to help ensure that learning occurs. Table 33 lists the ICW events of instruction and describes the purpose of each. Examples are included for each event.

TABLE 33. **ICW events of instruction.**

| EVENT | PURPOSE | EXAMPLES |
|---|---|---|
| Gain attention | • Focus student attention on key information.<br>• Motivate. | • Use humor as appropriate.<br>• Show consequences of certain actions. |
| Inform student of LOs | • Tell students what they are about to learn. | • Tell.<br>• Demonstrate.<br>• Ask rhetorical questions. |
| Stimulate recall of relevant prior knowledge | • Help students retrieve background and prerequisite information. | • Ask rhetorical questions.<br>• Present a review.<br>• Remind students. |

TABLE 33. **ICW events of instruction - Continued.**

| EVENT | PURPOSE | EXAMPLES |
|---|---|---|
| Present information | • Teach students the required knowledge/skills. | • Use audio, text, video, and graphics.<br>• Compare similarities and differences.<br>• Point out critical and distinctive features. |
| Provide guidance | • Enhance comprehension and retention. | • Ask questions appropriately in areas the student is likely to experience trouble.<br>• Give students hints or options for help.<br>• Use mnemonics, job aids, checklists. |
| Assess performance | • Determine if students have mastered the LOs. | • Test on knowledge/understanding.<br>• Test on task performance. |

6.1.1.7 Develop flowcharts and storyboards. This section presents guidelines for flowcharts and storyboard development.

6.1.1.7.1 ICW flowcharts. Prior to the development of the ICW storyboard it is helpful to have a flowchart of the content for the program. Storyboards are then created for each item included in the flowchart. The flowchart also serves to provide order for the instructional sequence. ICW flowcharts are developed to show the layout of the entire ICW course. To save time and effort the use of a flowcharting software tool is recommended. This tool allows a user to build a flowchart very quickly because it creates an image file and flowcharting symbols instead of using the more typical line-draw function.

6.1.1.7.1.1 ICW flowchart guidelines. An ICW flowchart outlines the flow through the course. Very little detail is presented other than module and lesson names. Listed below are some guidelines for developing an ICW flowchart:

a. Keep it simple. It should be understandable to a person without ICW experience.
b. Do not show individual screens on the flowchart.
c. Represent entire segments of the lesson by a single entry.
d. Show just enough detail on lesson branching to depict the overall flow.
e. Do not indicate specific menus, feedback, remediation, or help screens.
f. Show the suggested sequence of the modules and lessons.

6.1.1.7.1.2 Example of ICW flowchart. Figure 3 provides an example of an ICW flowchart.

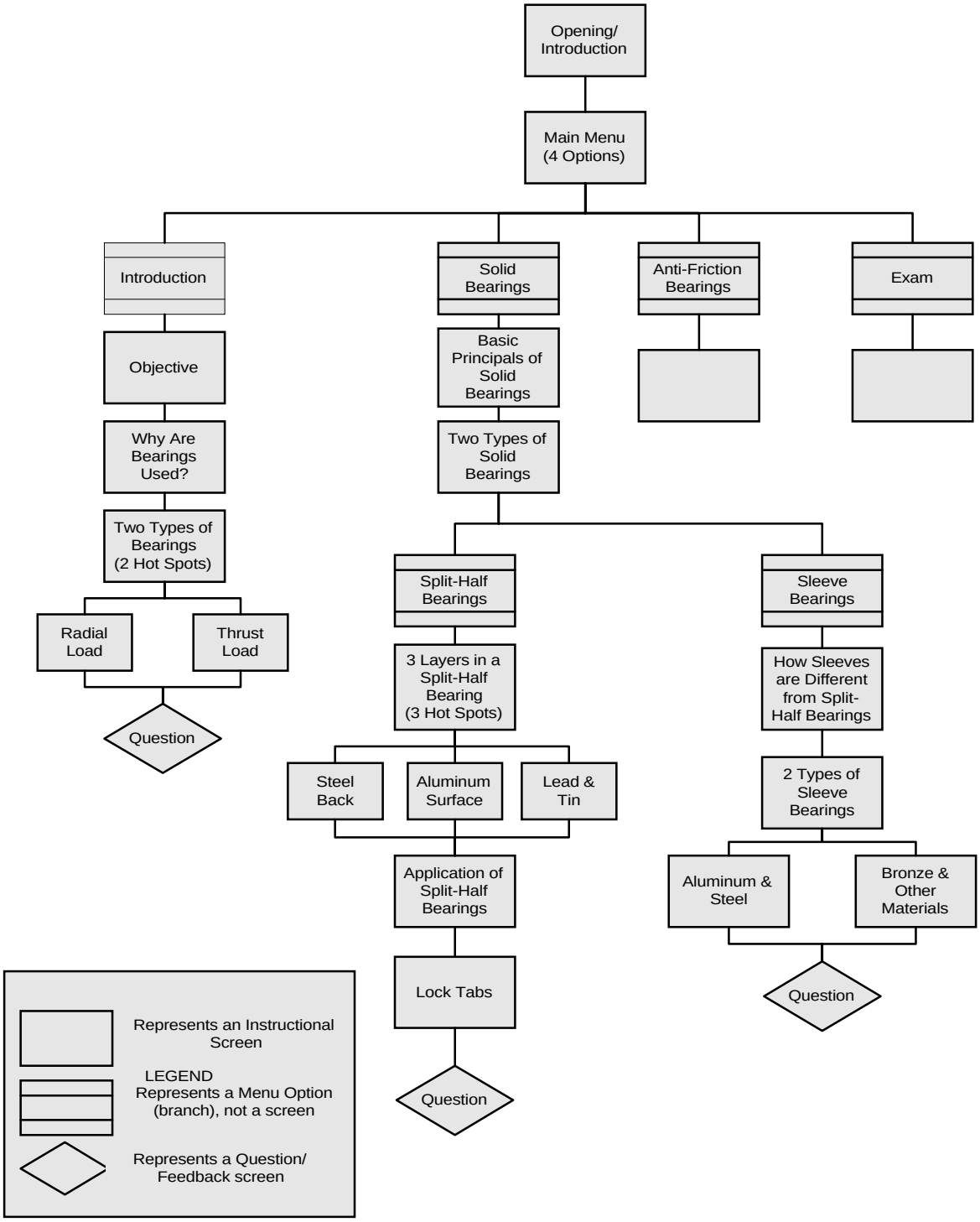


FIGURE 3. **ICW flowchart example.**

6.1.1.7.2 General guidelines for programming. The programming or authoring of an ICW program typically occurs in the development phase. However, consideration needs to be given to a number of programming issues during storyboard design.

6.1.1.7.2.1 Programming standards. It is wise to establish programming standards before beginning to develop the storyboard. Although a certain degree of flexibility is necessary, and changes may occur along the way, standards establish consistency throughout the entire ICW program. Table 34 shows the programming standards that should be considered.

TABLE 34. **Programming standards considerations.**

| CONSIDER STANDARDS FOR: | PROGRAMMING STANDARDS CONSIDERATIONS |
|---|---|
| Screen Type | • Course/lesson/subject title screen.<br>• Introduction/overview screen.<br>• Instructional screen.<br>• Inserted test item and feedback screen.<br>• Review screen.<br>• Summary screen.<br>• Practice/exercise screen.<br>• Test screen.<br>• Help screen. |
| Screen Layout | • Amount of text.<br>• Text placement.<br>• Headings.<br>• Margins.<br>• Text font and size.<br>• Captions.<br>• Color (e.g., text, background, emphasis, borders).<br>• Attention-getting cues.<br>• Paragraph indentation.<br>• Buttons<br>  • Function (navigation, content, help)<br>  • Format (icons or text)<br>• Menus (e.g., structure, labels).<br>• Windows. |

TABLE 34. **Programming standards considerations - Continued.**

| CONSIDER STANDARDS FOR: | PROGRAMMING STANDARDS CONSIDERATIONS |
|---|---|
| Test items and Feedback | • Presentation of test items (e.g., text, audio, graphical, or combination).<br>• Type of student responses required (e.g., pointing, selecting, or text entry).<br>• Number of tries allowed.<br>• Hint.<br>• Type of feedback for each try (e.g., knowledge of result, explanation, remediation).<br>• Presentation of feedback (e.g., text, audio, graphical, or combination).<br>• Type of test item (e.g., multiple choice, short answer, matching, etc.). |
| Presentation Sequence in each Segment | • Title screen.<br>• Opening (e.g., motivational video segment).<br>• List of LOs.<br>• Main body of instruction with inserted test item and periodic reviews.<br>• Summary.<br>• Exercise, practice, and test. |
| Miscellaneous | • Naming conventions for video segments and files.<br>• Transition.<br>• Sign-on procedures.<br>• Cursor placement on each new screen.<br>• Voice (e.g., referring to students as "YOU" and the program as "I" or a third person).<br>• Movement instruction (given via audio channel or buttons on the screen). |

6.1.1.7.2.2 Guidelines for programming. Table 35 shows a few specific guidelines for programming considerations during the storyboard development event.

TABLE 35. **Guidelines for programming elements of a storyboard.**

| GUIDELINES FOR PROGRAMMING ELEMENTS OF STORYBOARD | | |
|---|---|---|
| **#** | **GUIDELINE DESCRIPTION** | **RATIONALE** |
| 1 | Prepare a flowchart for the overall flow of the program. | • It provides a top-level organizer to guide the development of storyboards.<br>• It conveys the complex instructional flow in an interactive program to the programmer during the development phase. |
| 2 | Define the abbreviations to be used in the storyboard and communicate them to all production team members (e.g., GR for graphics, MV for motion video). | Defining abbreviations ensures that all production team members use and have the basis for understanding the abbreviations. |
| 3 | Follow the program standards, unless a convincing argument can be offered as to why the standards are not applicable to the design. | • Standards save time; they eliminate the need for reinvention and modification.<br>• Standards promote clarity and consistency.<br>• Standards should be periodically reviewed, evaluated, and changed if necessary. |

6.1.1.7.3 Storyboards. Storyboards provide explicit information on how the ICW lessons will look and function. Consideration is given to general principles and visual, audio, and programming elements. Storyboards are used to develop the screen presentations for ICW.

6.1.1.7.3.1 Storyboarding techniques. Storyboards can be developed in print format or automatically using a special purpose storyboarding tool.

6.1.1.7.3.2 General ICW storyboard design principles. There are a number of general ICW design principles that should be considered when developing the ICW storyboards. Examples are:

a. User friendliness.
b. Menu-driven design.
c. Browsing alternatives.
d. Help functions.
e. Record tracking.
f. Navigation.
g. Impact of type of input devices.

h. User messages.
i. Cues.
j. Capabilities of selected courseware development/authoring tool.

6.1.1.7.3.3 Guidelines for implementing the general storyboarding principles. Table 36 shows the basic steps involved in storyboard development. Table 37 shows specific guidelines for applying the general storyboard principles and a rationale for implementing each principle.

TABLE 36. **Steps involved in storyboard development.**

| STEP | ACTION |
|---|---|
| 1 | Define the scope of the program and collect content:<br>• Know the audience.<br>• List LOs.<br>• Identify types of content.<br>• Obtain content.<br>• Verify content.<br>• Identify context of the content (before and after). |
| 2 | Agree on program standards (if they do not already exist). |
| 3 | Determine program structure and requirements:<br>• Menu structure.<br>• List of lessons, subjects, and topics included.<br>• Navigation options.<br>• Available help functions.<br>• Program flowchart. |
| 4 | Determine a high-level instructional treatment for the program. |
| 5 | Group information into smaller segments. |
| 6 | Determine a detailed instructional treatment for each segment (e.g., text, video, graphics, animation). |
| 7 | Document the designs in a storyboard following the guidelines provided in this reference:<br>• Design instruction for each segment.<br>• Design inserted questions, reviews, and summaries for each segment.<br>• Design practice exercises and/or test items (criterion referenced) for larger unit of instruction. |
| 8 | Constantly communicate with the production crew to fine-tune the design and to make sure it is can be implemented. |
| 9 | Involve subject matter experts at major milestones in validating the program:<br>• Completion of storyboards for one topic.<br>• Completion of video segment, graphics, etc.<br>• Completion of a prototype lesson. |

TABLE 37. **Guidelines for storyboarding.**

| # | GUIDELINE DESCRIPTION | RATIONALE |
|---|---|---|
| 1 | Develop a user-friendly system. A user-friendly system should:<br>• Be self-explanatory.<br>• Make the system functions evident to students.<br>• Give students a sense of control.<br>• Acknowledge student input (audio or visual).<br>• Be interruptible at any point (e.g., pause and continue, exit program).<br>• Permit easy reversal of actions. | A user-friendly system prevents students from becoming frustrated with the system and allows them to concentrate on learning the content of the program. |
| 2 | Provide a menu-driven system using the following guidelines:<br>• Menus should be distinguishable from the rest of the display.<br>• Menus should be consistent in design and display.<br>• Use meaningful labels for menu items. | Menus display available functions so students do not have to know or remember what is available at any point. They simply select from the range of possibilities offered to them. |
| 3 | Provide a browsing alternative. | First-time students can browse through the entire program to get a feel of the content. Students who have gone through the program can use the feature for a quick review or as a reference on the job. |
| 4 | Allow the student to request and receive information so that the action to request help does not affect the student's course of action. | Help functions should provide the student with supplemental information, explanations, or assistance without affecting the student's ongoing performance. |

TABLE 37. **Guidelines for storyboarding - Continued.**

| # | GUIDELINE DESCRIPTION | RATIONALE |
|---|---|---|
| 5 | Clearly identify screen objects. | An object should only be displayed symbolically when its meaning is absolutely clear. If symbols are used, they should convey enough information as to their purpose so that students will not be confused by their function. |
| 6 | Provide instructions that describe screen functions. | Students need appropriate and clear navigational tools and instructions for using the tools to investigate even the most effectively designed programs. |
| 7 | Provide student record tracking. | This feature allows student performance records (e.g., scores on tests, time spent on a particular task, etc.) in a training program to be collected and analyzed. |
| 8 | Provide an optional navigation lesson for new students including:<br>• Overview of the content.<br>• Special features of the program.<br>• Menu structure.<br>• How to use a mouse.<br>• How to get around in the program. | Students can concentrate on learning the content rather than the navigation mechanism. |
| 9 | A mouse is an excellent alternative input device. If a mouse is used, make sure students learn how to use it. | A keyboard is good for text input. A mouse is convenient for:<br>• Selecting an object for manipulation.<br>• Positioning an object on a display.<br>• Making a choice from a menu. |
| 10 | When a mouse is used, make the acceptance area larger than the button for faster and easier selection, especially when the button is small. Do not overlap the acceptance area of different targets. | Students may click a little off the target and nothing will happen:<br>• Overlapping acceptance areas may cause incorrect actions to occur. |
| 11 | Provide intermediate feedback when the wait to get a response from the computer is longer than will be comfortable for the student. | Students should never be left wondering if they are supposed to do something or wait for something to happen on the screen. |

TABLE 37. **Guidelines for storyboarding - Continued.**

| # | GUIDELINE DESCRIPTION | RATIONALE |
|---|---|---|
| 12 | Provide error messages that are informative and low-key. Error messages should:<br>• Be specific about the nature and the cause of an error.<br>• Be given immediately after an error occurs.<br>• Inform students of the correct course of action to take.<br>• Be non-threatening. | When an error occurs, students should never be left wondering what happened and should be informed as to how they should respond. |
| 13 | Provide cues to students at the end of an instructional unit. However, cues may not be appropriate when the students are in a browsing mode or when they have total control over the instructional sequence. | These cues provide a sense of closure and fulfillment, and keep students oriented. |
| 14 | Know the capabilities and limitations of the authoring language. Do not design some features that cannot be implemented. Always talk to the programmers. | Do not waste time designing IMI that cannot be developed due to limitations of the authoring language. |

6.1.1.7.3.4 Guidelines for visual elements. Visual information in an ICW course serves to enhance the effectiveness of the training program. Visual elements include video, text, and imagery (e.g., graphics, animation). Table 38 presents general guidelines to consider for visual elements of ICW. The rationale for the guideline is also described.

TABLE 38. **Guidelines for storyboarding visual elements**

| GUIDELINE DESCRIPTION | RATIONALE |
|---|---|
| Do not crowd a screen with too much information at any one point. | Cluttered screens reduce learning efficiency and effectiveness (i.e., more time to learn and more errors). |
| When presenting a large amount of relevant information, display small groups of information one at a time through:<br>• Screen build-up.<br>• Window overlay.<br>• Icon buttons. | • To reduce memory load.<br>• To facilitate recall and comprehension.<br>• To avoid overwhelming or intimidating students with a large amount of information. |
| Use windows to group or separate certain information from the rest of the display. | • To draw students' attention to a particular set of data.<br>• To reduce the density of display on the screen by superimposing one display on top of another.<br>• To establish student expectancy that certain data will always appear in a certain format and location. |
| Icon buttons work best for concrete concepts that can be represented pictorially in miniature. | Icon buttons represent information that is available in a compact, easy-to-understand, pictorial format; and upon request of a student, discloses that information. |

TABLE 38. **Guidelines for storyboarding visual elements - Continued.**

| GUIDELINE DESCRIPTION | RATIONALE |
|---|---|
| Consider presenting information graphically and spatially (e.g., in a diagram or a flowchart). | • Relationships among content or the overall program structure can be more easily visualized and remembered.<br>• A student's path through the program can be easily displayed and remembered. |
| Techniques to keep students oriented:<br>• Place certain information in constant locations.<br>• Provide consistent layout for same types of screens.<br>• Maintain a constant perspective in a series of visuals. If a change of perspective is necessary, cue students to the change.<br>• Use letter sizes, colors and shapes as cues.<br>• Provide signposting information about a student's current and past locations, what lies ahead, and how to get there, all available for reference without moving from the current location.<br>• Provide a bird's-eye view or long shot before zooming into details. | Knowing where they are, how they got there, what they can do, where they can go and how they can get there gives students a sense of control. Making this information available allows students to concentrate on the program content rather than the navigation mechanism.<br><br>Establishes a frame of reference. |
| To position information on a screen:<br>• Present key information in prominent areas (e.g., away from the border).<br>• Present information that changes from display to display (the body of the instruction) in the center of the screen.<br>• Present recurrent information (e.g., menu bars) in constant locations.<br>• Present navigation buttons near the borders of the screen. | Position information on a screen to establish expectancy and reduce memory load. |

TABLE 38. **Guidelines for storyboarding visual elements - Continued.**

| GUIDELINE DESCRIPTION | RATIONALE |
|---|---|
| To differentiate key information and attract/direct attention, these cueing techniques are available:<br>• Arrows, labels, narration.<br>• Display density, white space.<br>• Separation of information into distinct objects.<br>• Windows.<br>• Color, shape.<br>• Highlighting, bordering, underlining.<br>• Mixed type sizes and fonts.<br>• Blinking. | |
| Guidelines for using the cueing techniques:<br>• Reserve blinking for critical situations requiring immediate student attention or action.<br>• Borders should be distinct from the object enclosed.<br>• Highlighting can be achieved by either brightening the area of interest or dimming the background.<br>• Limit highlighting to 10% of the display for effectiveness.<br>• Avoid using too many cues at one time.<br><br>NOTE: Over-saturation reduces the effectiveness of these techniques. | Helps the student focus on critical elements of the instructional content. |
| Guidelines for using colors:<br>• Too many colors on a display reduce effectiveness and aesthetic quality.<br>• Use yellow, green, or white for text. Blue is an excellent background color. But do not use blue for text, edges, narrow lines, or small objects.<br>• Ensure enough contrast between the text color and background color.<br>• Avoid distinctions based on the color cue only. When using colors, always use a second cue (e.g., label, shape, texture) for color-blind students. | Proper use of colors helps to focus the student's attention to relevant instructional content. |

6.1.1.7.3.4.1 Guidelines for video. Video is often a major element of ICW. A high level of detail is necessary in the storyboard to ensure that the video producer has sufficient information to get an accurate video shot. Table 39 presents video guidelines and the rationale for each guideline.

TABLE 39. **Guidelines for storyboarding video elements.**

| GUIDELINE DESCRIPTION | RATIONALE |
|---|---|
| Tips for preparing video storyboards:<br>• Present all information in three-shot sequences (long, medium, and close-up) to establish visual orientation.<br>• Close-up shots grab attention and imply that something is important; long shots establish frames of reference.<br>• A zoom-in focuses attention on a particular object while maintaining visual orientation, providing a similar effect to a three-shot sequence.<br>• A low camera angle looking up at a person implies that the person is strong, powerful, and authoritative.<br>• A high camera angle looking down on a person makes the person appear weak and inferior.<br>• Try to avoid static shots when shooting motion video.<br>• When showing something new, the subject must be focused long enough for the audience to register what is being shown. Once the audience has seen the subject in the shot, do not focus on it as long the next time it is shown.<br>• Keep the main subject well lit and watch for possible background distractions. | Professional conventions for video production.<br><br>The eye focuses better on light instead of dark areas and movement instead of static images. |
| Consider the following motion video formats:<br>• Facility/event walk-through (with an off-screen narrator).<br>• Lecture (talking head).<br>• Demonstration (show and tell).<br>• Interview.<br>• Talk show.<br>• Panel discussion.<br>• Dramatization.<br>• Simulation.<br>• Hybrid format. | Use appropriate format for the content presented and to maintain interest. |
| Two types of simulation:<br>• First-person simulation: The program creates as closely as possible an actual situation (e.g., operating a piece of equipment or trouble-shooting).<br>• Third-person (directed) simulation: The student vicariously experiences some situation by directing a person in the program to do whatever the student wants to do. | The third-person simulation may be more appropriate when you want the students to explore the consequences of both right and wrong behaviors in a high-risk situation. |

TABLE 39. **Guidelines for storyboarding video elements - Continued.**

| GUIDELINE DESCRIPTION | RATIONALE |
|---|---|
| • Use audio and video to reinforce each other. Never present two unrelated or clashing pieces of information in the two channels.<br>• Design a visual message appropriate to the content. Make sure that each visual ties in directly to the accompanying audio. | Presenting unrelated or clashing information or a visual that is inappropriate can confuse the student. |
| Quickly present a series of visuals prior to or at the end of instruction. | • Quick visual inserts presented before instruction stimulate recall of prerequisites, serve as an advance organizer, direct attention to key information, and heighten interest.<br>• Quick visual inserts presented after instruction remind the audience of the key information (what is repeated is more important) and enhance retention (what is repeated is remembered better). |
| Provide a quick showing of future events or consequences of unacceptable performance (e.g., disaster caused by human errors) prior to instruction. | • To impress the audience with the serious outcomes associated with unacceptable performance.<br>• To motivate the audience to adopt acceptable behaviors or practice. |
| Show the same program content repeatedly in either an identical format or a different perspective to draw attention heighten interest, and enhance retention. | • What is repeated is remembered better.<br>• The mere fact that something is repeated implies that it is important. |

TABLE 39. **Guidelines for storyboarding video elements - Continued.**

| GUIDELINE DESCRIPTION | RATIONALE |
|---|---|
| Criteria to determine the use of motion video versus still frame:<br>• Use motion video if the content requires motion to clearly depict the point.<br>• Motion video adds motivational value to training.<br>• Use still frames if production resources are limited without compromising instructional effectiveness.<br>• Be aware of the storage limitation of the hardware: motion video takes up more storage space than still frames. | Motion video can be used to represent reality and help the student achieve a high degree of transfer from training to on-the-job performance. For this reason, motion video is often used to support affective domain LOs and simulations. |

6.1.1.7.3.4.2 Video storyboard guidelines. A video storyboard usually includes sketches of the shots and camera lenses, angles, and movements. Some sample standard shot abbreviations are:

CU = Close-Up
LS = Long Shot
MS = Medium Shot
OS = Over-the-shoulder Shot

6.1.1.7.3.5 Guidelines for text. Text may be the primary method for presenting content to the student or it may serve to highlight certain information. Table 40 presents text guidelines and the rationale for each guideline.

TABLE 40. **Guidelines for storyboarding text elements.**

| # | GUIDELINE DESCRIPTION | RATIONALE |
|---|---|---|
| 1 | Limit amount of text on screen. | It is more difficult and takes longer to read text on a screen than in print. People read text on a computer screen at a rate 28% slower than reading from a book. |

TABLE 40. **Guidelines for storyboarding text elements - Continued.**

| # | GUIDELINE DESCRIPTION | RATIONALE |
|---|---|---|
| 2 | • Regular text should be left-justified only. Center headings and titles.<br>• Use paging (not scrolling) when presenting large amounts of text.<br>• Upper case should be reserved for emphasis and titles only.<br>• Do not use hyphenations to break words except for compound words. | Research data indicates that these guidelines make it easier for students to read and comprehend text. |
| 3 | • Provide generous white space to separate blocks of information.<br>• Use headings to summarize contents as navigation aids.<br>• Convert sentences containing serial items to lists.<br>• Organize complex information into tables to help students integrate program content. | Makes information more legible. |
| 4 | Use attention-getting techniques:<br>• Limit highlighting or boldface to 10% of the display.<br>• Underlining is best for titles or headings.<br>• Use reverse video or blinking with extreme discretion.<br>• Use mixed type sizes or fonts to differentiate screen components.<br>• Use no more than three attention-getting techniques on a single screen.<br>NOTE: Over-saturation reduces the effectiveness of these techniques. | Helps to focus the student's attention on key information. |
| 5 | Verify the appropriateness of the colors used for text under simulated presentation conditions. | The clarity of colors used for text will vary depending on such factors as lighting of the room where the ICW stations are and proximity of the students to the machine. |

6.1.1.7.3.6 Guidelines for graphics and animation. Graphics and animation can be included in an ICW program to enhance learning. Table 41 shows the guidelines for using graphics and animation and the rationale for each guideline.

TABLE 41. **Guidelines for storyboarding graphics and animation elements.**

| **GUIDELINES FOR GRAPHICS AND ANIMATION ELEMENTS OF STORYBOARDS** | | |
|---|---|---|
| **#** | **GUIDELINE DESCRIPTION** | **RATIONALE** |
| 1 | Use graphics or animation when:<br>• A realistic presentation (i.e., video) may overwhelm the audience with too much detail.<br>• Conditions or problems to be portrayed occur so infrequently that a video presentation is not possible. | Graphic or animation presentation can direct audience attention to essential information by highlighting the relevant and omitting the irrelevant. |
| 2 | When a graphic is used for the purpose of reducing irrelevant details and highlighting key information, video may be used together with or following the graphic presentation. | Graphics can make a link to the real world and enhance learning transfer. |
| 3 | Avoid biases or stereotypes in graphics or animation (e.g., gender, ethnic groups). | Students might find it insulting. |
| 4 | Use exaggeration and humor appropriately to heighten student interest and to facilitate recall. | Increases motivation. People often remember exaggerated or humorous information better. |

6.1.1.7.3.7 Guidelines for audio. Audio is often a major element of an ICW program. The audio part of a storyboard is used by a narrator during audio production. Table 42 presents audio guidelines and the rationale for each guideline.

TABLE 42. **Guidelines for storyboarding audio.**

| # | GUIDELINE DESCRIPTION | RATIONALE |
|---|---|---|
| 1 | Guidelines to determine the use of text or audio for primary presentation of the program content:<br>• Use text when the message is long, complex, or uses technical or unfamiliar terms.<br>• Use audio when the message is short, simple, requires immediate student response, or when the visual channel is overloaded.<br>• To be most effective, audio and text should complement, not compete with, each other. Audio should not interfere with reading from the text and vice versa. | Research data indicates that these guidelines make it easier for students to comprehend and process information. |
| 2 | Audio should support rather than contradict or interfere with visuals. A long silence may confuse students as to what to do. When the video channel is presenting something crucial, do not let the audio compete for attention. | Research data indicates that these guidelines make it easier for students to comprehend and process information. |
| 3 | Stick to the message. Tell the students only what is relevant. | Production of irrelevant information is a waste of money and time. |
| 4 | Keep production limits in mind (i.e., budget, time, technical capabilities). Allow time for audio rework, which could happen as the development effort proceeds. | Avoid reaching a point in the development effort where you have run out of funds and are not quite finished with the program. |
| 5 | Provide students with headphones. | Students in lab environment will not be distracted by the audio from other student stations. |

TABLE 42. **Guidelines for storyboarding audio - Continued**.

| # | GUIDELINE DESCRIPTION | RATIONALE |
|---|---|---|
| 6 | Guidelines for scripting narration:<br>• Think visually.<br>• Consider students' language ability, subject matter knowledge, and vocabulary.<br>• Use appropriate style and tone.<br>• Write the script for the ear, not the eye.<br>• Keep the language simple, active, and direct.<br>• Use short sentences.<br>• Avoid acronyms, technical jargons, and unfamiliar terms. Define them if used.<br>• Make the transitions from one concept to another clear.<br>• Every piece of narration needs a corresponding visual.<br>• Avoid long pauses in visuals waiting for extended narration to finish.<br>• Select appropriate narrators.<br>• Consider alternating male and female voices to provide variety and to maintain audience attention.<br>• Test the script by reading it out loud to yourself. | These guidelines will make it easier for the narrator or professional talent to record or read the ICW audio. |

TABLE 42. **Guidelines for storyboarding audio - Continued.**

| # | GUIDELINE DESCRIPTION | RATIONALE |
|---|---|---|
| 7 | Keep the script short and simple. If the message is too long, break it into groups separated by instructional activities (e.g., quizzes, reviews, hands-on exercises). | • Students may become bored if they receive information passively from the program for an extended period of time.<br>• Short audio segments are easier to program. |
| 8 | Script format for professional talent/narrators:<br>• Always have the script typed.<br>• Number all pages in the upper right-hand corner.<br>• Use all caps.<br>• Specify how acronyms should be read.<br>• Spell out all numbers.<br>• Spell difficult words and names phonetically.<br>• Separate each letter in an abbreviation with a hyphen (e.g., I-C-W).<br>• Describe nonverbal cues in parentheses.<br>• Indicate pauses by the word “PAUSE” in parentheses.<br>• Indicate emphasis in parentheses if inflection is not obvious.<br>• Double or triple space between lines.<br>• The script should not exceed three inches in length and should use a legible type size. | These guidelines will make it easier for the narrator or professional talent to record or read the ICW audio. |
| 9 | Use sound effects as cues:<br>• A beep or other audio cue to clue students that they have done something incorrectly on the screen (e.g., response formatted incorrectly).<br>• A tune associated with a certain event in the program (e.g., quizzes inserted in the instruction, feedback for incorrect responses). | Once the link between a sound effect and a specific event is established, the sound effect serves as an efficient navigation aid. |

6.1.1.7.3.8 Storyboard checklist. Table 43 provides a checklist for use in evaluating and improving the quality of storyboards.

TABLE 43. **Storyboard checklist.**

| Directions: Place a check in the middle column if the corresponding guideline is included in the program. If a guideline does not apply, indicate so with "N/A" for not applicable. Document with comments where appropriate. | | |
|---|---|---|
| **I. OVERALL PRINCIPLES** | **►** | **COMMENTS** |
| 1. Program includes the events of instruction or a rationale for omitting an event. | | |
| 2. The instructional treatment is appropriate for the content type. | | |
| 3. Practice provided is appropriate for the content type. | | |
| 4. LOs provide complete coverage of content to be taught. | | |
| 5. Instruction and test items correlate with LOs. | | |
| **II. INFORMATION TO BE INCLUDED IN A STORYBOARD** | **►** | **COMMENTS** |
| 1. Identification information is complete. | | |
| 2. Programming notes are complete. | | |
| 3. Audio script is complete. | | |
| 4. Video information is complete. | | |
| 5. Graphic information is complete. | | |
| 6. Text information is complete. | | |
| **III. INSTRUCTIONAL DESIGN GUIDELINES** | **►** | **INCREASING INTERACTIVITY COMMENTS** |
| 1. Provides ample opportunities for meaningful interaction. | | |
| 2. Content is grouped into small segments with test items, including periodic reviews, and summaries built in. | | |
| 3. Numerous test items are included, but do not interrupt the continuity of the instructional flow. | | |
| 4. Test items follow the instruction to force students to search for and review necessary information. | | |
| 5. Students are asked questions related to content that has been taught, requiring them to use previously learned knowledge to answer them. | | |

TABLE 43. **Storyboard checklist - Continued.**

| | | |
|---|---|---|
| 6. Questions are at the application rather than the memory level. | | |
| 7. Rhetorical questions are included to get students to think about the content, to stimulate their curiosity, or as a transition between frames. | | |
| 8. Opportunity is provided where the student may discover information through active exploration. | | |
| **STUDENT CONTROL** | **►** | **COMMENTS** |
| 1. Students are given the appropriate amount of student control. | | |
| 2. Student control designed can be implemented within available resources. | | |
| 3. Students are always given control over the following elements: pacing, support information, navigation, and termination. | | |
| **FEEDBACK DESIGN** | **►** | **COMMENTS** |
| 1. Feedback is on the same screen with the test item and student response. | | |
| 2. Feedback immediately follows the student response. | | |
| 3. Feedback verifies correctness and explains why. | | |
| 4. For incorrect responses, students are given a hint and the opportunity to try again. | | |
| 5. Feedback addresses student misconceptions or lack of knowledge/skills. | | |
| 6. Feedback is positive and does not encourage incorrect responses. | | |
| 7. In a simulation, instructional feedback is provided in addition to simulation responses. | | |
| **IV. STORYBOARD DEVELOPMENT GUIDELINES** | | |
| **GENERAL PRINCIPLES** | **►** | **COMMENTS** |
| 1. The program is user-friendly. | | |
| 2. The program is menu-driven. | | |
| 3. A browsing alternative is provided. | | |
| 4. Help functions are provided. | | |
| 5. Student record tracking is provided. | | |
| 6. An optional lesson on navigation is provided. | | |
| 7. A lesson on mouse operation is provided when necessary. | | |

TABLE 43. **Storyboard checklist - Continued.**

| | | |
|---|---|---|
| 8. Messages are provided when the wait to get a response is long. | | |
| 9. Error messages are informative and low-key. | | |
| 10. Cues are provided to indicate completion of an instructional segment. | | |
| 11. The authoring language is capable of implementing all features designed. | | |
| 12. The program provides clear instructions on how the student is to respond. | | |
| **PROGRAMMING** | ► | **COMMENTS** |
| 1. Programming acronyms are defined. | | |
| 2. Program standards are followed (e.g., screen type, screen layout, test items and feedback, sequence of presentation within subjects). | | |
| **AUDIO** | ► | **COMMENTS** |
| 1. The script is appropriate for the target audience (language, knowledge, vocabulary). | | |
| 2. The style and tone are appropriate for the target audience. | | |
| 3. The script is conversational in nature. | | |
| 4. The script language is simple, active, and direct. | | |
| 5. Sentences are short. | | |
| 6. Abbreviations, technical jargon, and unfamiliar terms are avoided or defined if used. | | |
| 7. Transitions between concepts are clear. | | |
| 8. Every piece of narration has a corresponding shot. | | |
| 9. There are no long pauses in a visual waiting for an extended narration to finish. | | |
| 10. The audio supports the visual rather than contradicting or interfering. | | |
| 11. The script is written in a format suitable for professional talents/narrators. | | |
| 12. Sound effects are used as cues. | | |
| 13. The script is short and simple. | | |
| 14. Information is grouped appropriately. | | |
| 15. Only relevant information is included in the script. | | |

TABLE 43. **Storyboard checklist - Continued.**

| | | |
|---|---|---|
| 16. Audio designed can be implemented within production limits. | | |
| **VISUAL: GENERAL** | ► | **COMMENTS** |
| 1. Screens are not cluttered. | | |
| 2. Windows are used to group/separate information on the screen. | | |
| 3. Methods are used to orient students in the program (e.g., placement of information, consistency of screen layout). | | |
| 4. When appropriate, information is presented graphically. | | |
| 5. Small groups of information are presented one at a time through use of windows, icon buttons, and screen buildup. | | |
| 6. Cueing techniques are used to attract/direct student attention (e.g., arrows, labels, color, highlight). | | |
| 7. Attention-directing cues are gradually faded to facilitate learning transfer. | | |
| 8. Color is used appropriately. | | |
| 9. Information is positioned appropriately on the screen (location of key information and menu bar). | | |
| **VISUAL: VIDEO** | ► | **COMMENTS** |
| 1. Sketches of shots, camera lenses, angles, and movements are included. | | |
| 2. The motion video format used is appropriate for the content (e.g., demonstration, simulation, lecture). | | |
| 3. Audio and video reinforce each other. | | |
| 4. The visual message (e.g., graphics, animation, still frame, motion video) is appropriate for the content. | | |
| 5. Shows content repeatedly in either an identical format or different perspective to draw attention, heighten interest, or to enhance retention. | | |
| 6. Program appropriately uses motion video vs. still frame. | | |
| **VISUAL: TEXT DISPLAY** | ► | **COMMENTS** |
| 1. Text is left-justified (no right justification). Headings and titles are centered. | | |

TABLE 43. **Storyboard checklist - Continued.**

| | | |
|---|---|---|
| 2. Paging (not scrolling) is used for large amounts of text. | | |
| 3. Upper case is used only for emphasis and titles. | | |
| 4. Hyphens are not used except for compound words. | | |
| 5. There is plenty of white space separating blocks of information. | | |
| 6. Headings are used as content summaries and navigation aids. | | |
| 7. Lists are used for serial items. | | |
| 8. Tables are used for presenting and integrating complex information. | | |
| 9. Attention-getting techniques are used appropriately (e.g., highlight, bold, underline, color). | | |
| 10. Spelling, grammar, and punctuation are correct. | | |
| **VISUAL: GRAPHICS/ANIMATION** | **►** | **COMMENTS** |
| 1. Use of graphics/animation is appropriate for the content. | | |
| 2. When appropriate, video is used following a graphic to enhance learning transfer. | | |
| 3. Biases or stereotypes in graphics and animation are avoided. | | |
| 4. Exaggeration and humor are used appropriately to heighten student interest and to facilitate recall. | | |

6.1.1.8 ICW prototype lessons. This section presents guidelines for developing ICW prototype tests and lessons. A major part of the instructional media design is a prototype of the tests and lessons to be developed. This can provide for staff reviews while the remainder of the instructional media design is being completed.

6.1.1.8.1 Description of ICW prototype lessons. An ICW prototype may include but is not limited to the following:

a. A small sample of a lesson, up to a complete lesson.
b. A segment of a module pre and post-test.
c. A segment, up to an entire lesson progress test.

6.1.1.8.2 ICW prototype content. The prototype is a sample of the tests and lessons illustrating:

a. All user screen design and media conventions.

b. Training/branching and remediation/reinforcement strategies for tests and lessons.
c. Learner control features.
d. Typical instructional activities with dramatic treatment, continuity, and motivational approaches.
e. Computer management and record keeping functions to be used.

6.1.1.8.3 Why have an ICW prototype? Most customers have difficulty visualizing the finished product without seeing a prototype of a small segment of the ICW. The following are some reasons for developing a prototype:

a. Unproductive arguments may occur between the developer and customer regarding interpretation of statements in the instructional media design documentation. To avoid this situation develop a prototype that shows exactly what the statements mean.
b. Color and design of the screen may sound good on paper, but when presented on the screen look unappealing to the customer.
c. Planned dramatic treatments, and motivational and continuity approaches may sound exciting, but may look amateurish or insulting to the customer on the screen.
d. If any of the above situations occur, the developer would have to modify everything under development to provide the customer with a desirable product.

6.1.1.8.4 ICW prototype guidelines. Ensure that the prototype lesson is the standard for all future course development as follows:

a. The prototype is not to exceed the team's ability within the allotted time and training constraints.
b. Review all components of the prototype with the team members. Finalize conventions, standard frames, groups, and templates at this time.
c. After any requested changes or corrections have been incorporated, provide all team members with a copy of the approved prototype for reference in construction of other lessons/tests.
d. The prototype needs to have been demonstrated to and approved by higher-level management and/or the customer before proceeding.
e. The prototype should also be used to gain approval of specific narrators and background music.
f. Encourage comments and discussion at this stage so that any reservations are addressed before lesson development begins.
g. Establish up front as many testing, gaming, simulation, and decision-making templates as possible for use by developers throughout the development cycle. Incorporate as many as are reasonable in the prototype.

6.1.1.8.5 Elements involved in ICW prototype lesson development. Table 44 shows the basic elements involved in developing a lesson/test prototype.

TABLE 44. **Prototype lesson development elements.**

| ELEMENT | ACTION |
|---|---|
| 1 | Define the scope of the program and collect content as follows:<br>▪ Know the audience.<br>▪ List LOs.<br>▪ Identify types of content.<br>▪ Obtain content.<br>▪ Verify content.<br>▪ Identify context of the content (before and after). |
| 2 | Set/agree on program standards (if they do not already exist). |
| 3 | Determine program structure and requirements:<br>▪ Menu structure.<br>▪ List of lessons, subjects, and topics included.<br>▪ Navigation options.<br>▪ Available help functions.<br>▪ Program flowchart. |
| 4 | Determine an instructional and testing strategy for the program. |
| 5 | Group information into smaller segments. |
| 6 | Determine a detailed instructional strategy for each segment (text, video, graphics, animation). |
| 7 | Document the designs in an instructional media design/prototype following the guidelines provided in this reference:<br>▪ Design instruction for each segment.<br>▪ Design inserted test items, reviews, and summaries for each segment.<br>▪ Design practice exercises and/or test items (criterion referenced for larger units of instruction). |
| 8 | Constantly communicate with the imaging personnel/production crew to fine-tune the design and ensure that it can be implemented. |
| 9 | Involve subject matter experts at major milestones when developing the program for:<br>▪ Completion of storyboards for one topic.<br>▪ Completion of video segment, graphics, etc.<br>▪ Completion of prototype lesson.<br>▪ Completion of tests.<br>▪ Completion of each lesson and/or module. |

6.1.1.9 How to develop ICW. This section addresses how to develop and produce an ICW course as specified in the ICW storyboards. When developing ICW there are concerns to be considered regarding production requirements, as discussed in the following paragraphs.

6.1.1.9.1 Program the lessons. Quality programming is a key element to maintaining the courseware. The guidelines presented here have been designed to improve the supportability of ICW lessons and to decrease the amount of time required to program the lessons. Table 45 lists various programming guidelines, what the guidelines mean, and the rationale for implementing the guidelines.

TABLE 45. **ICW programming guidelines.**

| GUIDELINE | RATIONALE |
|---|---|
| Develop templates for recurring routines. | Many ICW lessons will follow the same structure and will function in a similar manner. Try to reuse as much code as you can to reduce time. Develop template or shell screens and copy them as needed. |
| Develop object libraries. | Group recurring screen elements (such as graphics that appear in many lessons) into object libraries for easy reuse and modification to save time. |
| Use built-in LMS functions if possible. | Some ICW courseware development/authoring tools have built-in LMS functions and routines to track data. Use these features to save time. |
| Avoid excess use of LMS capabilities. | If your courseware development/authoring tool does not have built-in LMS features and you have to develop your own routines for record keeping and data analysis, you may find that you are using excessive capabilities. Develop LMS to meet the requirements in the storyboard and tailor back the design if your programming system will not easily support it. The minimum data you should collect is test result data, total score, score represented as a percentage, and whether the student passed or failed according to the training standards. |
| Standardize the file names for LMS data. | This allows easy data consolidation and analysis across students and classes. |
| Keep track of the size and storage requirements for LMS files. | The size of the files will determine what storage medium is (e.g., floppy disk, CD-ROM, etc.) used. |

TABLE 45. **ICW programming guidelines - Continued.**

| GUIDELINE | RATIONALE |
|---|---|
| Keep good software documentation. | One of the most important and costly aspects of ICW is maintenance. Detailed and accurate program documentation is critical to lesson maintenance. Keep lists of all program variables used, indicate their location, and purpose. Follow standard screen-naming conventions. Clearly identify any libraries used and the specific items within the libraries. Establish controls to keep those items from being modified without coordination. Assign a single person to function as librarian. Configuration management is critical to success. |
| Maintain master copies of all program data. | Keep in one package a set of master lesson disks and all lesson specifications. |
| Implement DoD-STD-2167A Defense System Software Development, for programs developed outside of a courseware development/authoring tool. | Often, your courseware development/authoring tool will not support a function required for the ICW program and you will have to use an external program. When external programs are used, their structure, documentation, and integration become important factors in the usability and support of the courseware. External programs must be well documented within the code itself. DoD-STD-2167A outlines both the software development process and the documentation required for DoD software. |
| If programming in a courseware development/authoring tool's language, program within a screen. | Some courseware development/authoring tool provide an internal programming language to supplement the basic functions of the tool. If you can program within a screen, you will significantly reduce access times while running the lesson. |
| Ensure the integrity of students' files. | Students' files should be protected so that not just anyone can get access to their records. Files can be easily password-protected with most ICW software programs. |
| Formatively evaluate the ICW software before implementing the program. | Even though most ICW programmers will take painstaking efforts to ensure the program's flawless execution, bugs can still exist. Programming flaws that cause unintentional directional flows or unanticipated characters to appear can cause a student to think the entire program is poorly designed. |

6.1.1.9.2 Produce visual displays and record audio. This section presents guidelines for producing all ICW visual displays and recording audio.

6.1.1.9.2.1 Visual displays. The visual displays include full-motion video, still-frame video or photographs. Each visual display required in the ICW will be described in detail on the storyboard.

6.1.1.9.2.2 Guidelines for producing full-motion video. Using full-motion video in ICW is a very effective way to present information. Motion sequences are often recommended for demonstrating operational procedures. Producing full-motion video can be expensive, especially if professional talent is used, crews need to tape on location, special effects are used, and post-video production (editing) is extensive. Table 46 presents some guidelines for video production and rationales for implementation.

TABLE 46. **Video production guidelines.**

| # | GUIDELINES | RATIONALE |
|---|---|---|
| 1 | Ensure that actors follow directives on dress and appearance while in uniform. | Service policy. |
| 2 | Ensure that sets are appropriate to actual work environment. | Enhances realism of ICW. |
| 3 | Ensure that actors comply with Occupational Safety and Health Administration (OSHA) directives. | Law. |
| 4 | Use consistent camera angles, lighting, and distance to emphasize similarities between objects. For analog Interactive Videodisc (IVD), show differences between objects by using the same shot and varying only the item that changes. | Reduces confusion for student and can reduce amount of time required to produce video. |
| 5 | If analog IVD is produced, tape and edit "cause and effect" sequences one after the other so they will appear side by side on the videodisc. | Provides a much smoother transition between video scenes, and a quicker response time back to the student. |
| 6 | Use the techniques "up from black" at the beginning and "fade to black" at the end of each video sequence. | Allows smooth transitions between scenes and from video to graphics or text. |
| 7 | Provide transition screens when moving from a wide-angle to an extreme close-up and highlight where the next screen will focus. | Helps to reinforce the relationship from wide-angle to close-up view. |
| 8 | Use video or graphic window overlays to show extreme close-ups of small objects such as knobs and switches in the context of the wide-angle view. | Allows the student to see things in detail. |

TABLE 46. **Video production guidelines - Continued.**

| # | GUIDELINES | RATIONALE |
|---|---|---|
| 9 | Store all video for an analog IVD in the LaserVision format. | Service requirements. |
| 10 | If the storyboard is automated, use a laptop computer with the storyboard during video production to immediately enter Society of Motion Picture and Television Engineers (SMPTE) codes for selected shots onto storyboard. | Provides an automated edit-decision list and greatly reduces amount of time needed in post-video production. |

6.1.1.9.2.3 Guidelines for audio recording. Table 47 provides a few guidelines for audio production.

TABLE 47. **Audio production guidelines.**

| # | GUIDELINE | RATIONALE |
|---|---|---|
| 1 | If analog IVD is being produced, use one sound track for narration and the other for sound effects. | Cost-effective. Narration can be recorded on one track while sound effects are recorded on the other. |
| 2 | In some instances, use both tracks to record narration. | Narration can be selectively presented. For example, narration in English can be stored on track 1 and narration in another language can be stored on track 2. |
| 3 | When analog audio is used, match the audio with the associated visual. | The visual must be displayed for the same length of time as the audio presentation. |
| 4 | Use a professional narrator and recording studio during production. | Greatly increases quality of ICW and reduces costs during production. While there are costs associated with using professional talent, money is often saved because it does not take them as long to learn and deliver their lines. |

6.1.1.9.2.4 Develop text, graphics, and animation. This section presents guidelines for text, graphics, and animation production.

6.1.1.9.2.4.1 Guidelines for text, graphics, and animation displays. Table 48 provides guidelines for production of text, graphics, and animation displays in an ICW program.

TABLE 48. **ICW display convention guidelines.**

| TYPE OF DISPLAY | GUIDELINES | RATIONALE |
|---|---|---|
| Text | 1. Follow specifications in storyboard for color and font.<br>2. If analog IVD is produced, avoid pressing text onto the laser disk. | • Product will be produced to match specification.<br>• Hard to make changes. |
| Graphics | 1. Follow sketches or drawings shown in storyboard.<br>2. Use computer to generate graphics when possible.<br>3. Identify graphics library code.<br>4. Program graphics to appear on the screen before text or captions.<br>5. Program large or complex graphics to appear on the screen in logical sections. Each section should finish drawing before the next begins.<br>6. Program graphics so that the layer farthest away from the viewer is drawn first and finish with the items that are closest to the viewer.<br>7. Use an arrow instead of a box or circle to highlight graphic objects. | • Product will be consistent with specification.<br>• Can get better detail and more sophisticated-looking graphic.<br>• Other developers can access the graphic for their lessons.<br>• Easier for the student to comprehend presentation information.<br>• Makes it easier for the student to view and understand what is being presented.<br>• Will help to avoid alignment problems between hardware systems. |
| Animation | 1. If motion is the point of an animation, do not begin the animation until the entire screen appears, then prompt the student to begin the animation.<br>2. If the result of motion is the focus, draw the object and then begin the animation. After the animation occurs, add labels, captions, and text on the screen. | • Supports student control guidelines.<br>• Helps to focus the student's attention on key elements. |

6.1.1.10 Develop supporting materials and comply with DoD ICW requirements. Instructor and user guides are often developed to support an ICW program. This section explains the purpose of supporting materials, and describes current DoD guidelines that apply to all ICW programs.

6.1.1.10.1 Purpose of supporting materials. Supporting materials should outline and describe all manual procedures required to load, start, and complete the ICW program. The guides should also describe procedures for managing the ICW program.

6.1.1.10.2 DoD requirements and guidelines for ICW. DoD guidelines and requirements for ICW include:

a. Compliance with the DODI 1322.20, Development and Management of ICW for Military Training.
b. Compliance with the DoD Joint Technical Architecture (JTA).
c. Compliance with the DoD High Level Architecture (HLA).
d. Use Defense Instructional Technology Information System (DITIS) to determine if existing programs can be used or modified to satisfy requirements.

    (1) Add information about ICW course topic and structure within 30 days of starting program development.
    (2) Add information about the development software used and supporting hardware requirements within 30 days after completing ICW development.
    (3) Update the database if the ICW program is revised or taken out of service.

e. Programming requirements to include:

    (1) Arranging for free and unlimited (for government purpose) rights to execute and distribute ICW. Paying royalties or run-time fees for execution or distribution of the courseware is prohibited. These rights must allow others to operate, distribute, or maintain the ICW on the government's behalf.
    (2) ICW programs should comply with MIL-PRF-29612.
    (3) ICW programs should comply with the DoD JTA, which is a document that mandates the minimum set of standards and guidelines for the acquisition of all DoD systems that produce, use, or exchange information. The JTA shall be used by anyone involved in the management, development, or acquisition of new or improved information systems within DoD. The JTA defines the underlying technical standards and data relationships. This information forms the basis for system architecture design and ensures the commonality of effort in the system design process.
    (4) ICW lessons programmed in a software language, simulation models or unique device drivers must comply with the procedures and requirements of DoD-STD-2167A. This does not apply to programs generated using a courseware development/authoring tool.

(5) ICW programs intended for ADL should meet DoD Data Architecture (DDA), Defense Data Dictionary System (DDDS), SCORM, and LMS guidelines.

| |
|---|
| NOTE: The DDA has replaced the DDM. The DDA is grouped by functional area rather than by subject area as they were in the DDM. The DDDS is the DoD repository containing Standard Data Elements (SDEs), definitions of SDEs, and the SDE structure. The DDDS allows for the development, approval, and maintenance of metadata for DoD data standards. The DDDS provides the capability to update, delete, query, and print and generate reports. The DDA model views and the DDDS software may be downloaded from: http://www-datadmn.itsi.disa.mil. |

f. Adhere to life cycle management requirements including:

(1) Develop a comprehensive logistics support package and documentation for your ICW program. This information will detail the procedures necessary to update, reproduce, and modify the ICW throughout its entire life cycle.

(2) A single office should be assigned the responsibility for life cycle management of ICW programs. That office should keep:

(a) A set of reproducible masters of the ICW program and all associated documentation masters.

(b) A circulation copy of the ICW and all materials needed to execute and conduct the training. This material must be available for other government agencies to review to determine if they can use the materials to meet their instructional needs.

(c) The life cycle management office must ensure the availability of tools and libraries, assemblers or compilers, ICW source code, and documentation.

g. Other reporting requirements include:

(1) Submit media selection analysis and training evaluation reports through command channels for placement into the Defense Technical Information Center (DTIC) data banks within 30 days of completion.

(2) Validate and evaluate all ICW programs using students from target population, including guard and reserve students as appropriate.

(3) Advertise proposed procurement of ICW courseware or hardware and announce contract awards in the Commerce Business Daily (CBD) under "Training Services" or "Training Aids and Devices."

(4) Service specific directives, handbooks, pamphlets, and guidance.

6.2 Electronic publications. An electronic publication is a document, prepared in a digital form, for electronic display to an end user. Two examples of electronic publications are electronic guides and IETMs.

6.2.1 Electronic guides. Training guides were traditionally paper-based documents and contained several hundred pages. Even a short guide could contain large numbers of drawings, schematics, and tables. There could also be many technical manuals containing thousands of pages including large numbers of graphics and schematics used in the guides. To develop an automated guide to aid instruction, ask the following questions:

a. What guides are appropriate for automation of instructional presentations?
b. How can we automate these materials most effectively and efficiently?
c. Are there software tools available to support this development?
d. What are the anticipated benefits of this development?
e. What impact will this development have on student performance?
f. What are the requirements for staff support and training?

6.2.2 Interactive Electronic Technical Manuals (IETM). An IETM is a technical manual delivered electronically. The IETM possesses the following three characteristics:

a. An IETM can be presented either on a desktop workstation or a Portable Electronic Display Device (PEDD).
b. The elements of technical data constituting the IETM are so interrelated that a user's access to the information is achievable by a variety of paths.
c. The IETM can function to provide procedural guidance, navigational directions, and other technical information required by the user.

6.2.2.1 Factors to consider when using IETMs. Factors to consider when using IETMs in a training environment are:

a. Early involvement with the logistics acquisition manager for IETMs is necessary to ensure compatibility in a training environment.
b. Acquisition of IETMs with closed architecture (i.e., proprietary) metadata tags should be avoided as it can create problems accessing the necessary information in a training environment within the required timeframe. One way around this issue is to add a requirement for SCORM conformance in the contract.

6.3 Electronic testing. Electronic testing is a general term used to encompass all methods for applying computers in the assessment and reporting of human attributes, knowledge, and

skills. Most forms of electronic testing tailor or adapt the sequence, content, or difficulty of test items to the responses of the person being tested.

6.3.1 About electronic testing. Some IMI testing uses computer adaptive testing. As the individual is being tested the computer presents test items in response to the individual's actions. The electronic testing method utilizes branching to select test items based on the answers given while the test is being administered. Electronic testing involves adjustment of presentations, fidelity, and scenarios for simulation-based testing and adaptive selection of the tests themselves when a battery of tests is being administered. An important form of simulation-based testing is job-sample testing, which can be used to better classify personnel for job categories and specific jobs within them. Also notable is the use of electronic testing to administer items that can only be presented by computer, such as items requiring animated displays and precise timing of responses.

6.3.2 Benefits of electronic testing. Some of the benefits of electronic testing are the following:

a. Reduced time for testing. By adapting in real time to the responses being made, computer adaptive testing can focus more quickly on attributes or levels of capabilities possessed by the person being tested.
b. Reduced costs for administration. Many administrative costs of recording, assessing, and interpreting responses and of reporting results are automated and can be avoided because test responses in electronic testing are recorded by computer as they are made.
c. Increased test integrity. Electronic testing provides the ability to more carefully control the administration of tests and test items and therefore the tests have more integrity than is possible with paper-and-pencil testing or with tests administered by individuals.
d. Improved training. Electronic testing provides more accessible and frequent assessment of learning during training and thereby allows better management of the progress of individuals toward instructional objectives.
e. Improved assessment of crews, teams, and units. Electronic testing using simulations can provide measurement and assessment of crews, teams, and units that is currently unavailable or impracticable.
f. Increased range of assessment. Electronic testing is likely to increase substantially the range of human attributes, knowledge, and skills that can be reliably measured and assessed with precision.
g. Ease of checking test item validity. Automated test item response analysis allows writers of test items to more easily identify test items that do not accurately measure student knowledge or performance.

6.4 Simulation. Interaction with the surrounding environment is often a critical part of a task that must be trained. For real-time interactive training, environments must sometimes be simulated. Typical applications include aircraft piloting, air traffic control, ship navigation, driving a tank, gunnery, and missile control.

6.5 Electronic management systems. Electronic management systems are computer programs that aid in the instructional process. Programs in this category include LMSs, decision support aids, tools to support the conduct and administration of instruction, and job aids.

6.5.1 Electronic Performance Support System (EPSS). An EPSS is an integrated electronic environment that is available to and easily accessible by each user. An EPSS is structured to permit performance with minimal support and intervention by others and provide immediate, individualized access to a broad range of:

a. Information.
b. Software.
c. Guidance and assistance.
d. Data.
e. Images.
f. Tools.
g. Assessment and monitoring systems.

6.5.1.1 An EPSS can provide performance information. An EPSS is any computer software program or component that improves a user's performance by reducing the complexity or number of steps required to perform a task. The EPSS can either provide the user with performance information required to perform a task, or provide a decision support system that enables a user to identify the action that is appropriate for a particular set of conditions.

6.5.1.2 An EPSS can reduce training costs. An EPSS can help an organization to reduce the training costs while increasing productivity and performance. It can empower a user to perform tasks with a minimum amount of external intervention or training. By using this type of system a user will be able to complete their work more quickly and accurately.

6.5.1.3 User interface. An EPSS should use a simple and consistent means of allowing the user access to information. Access to information should be gained by the same means as often as possible.

6.5.1.4 EPSS considerations. An EPSS is not always an acceptable instructional delivery method. Some factors to evaluate when considering an EPSS are frequency of performance, difficulty of performance, criticality of performance, and difficulty of learning.

6.5.2 Computer-Aided Instruction (CAI). CAI involves using computers to aid in the delivery of instruction. CAI exploits computer technology to provide for the storage and retrieval of information for both the instructor and student. Some CAI systems may be defined as an EPSS. To be considered an instructional EPSS the CAI system must provide the instructor immediate and tailored access to the full range of information, advice, and tools needed to perform instructional tasks with minimal support from outside sources.

6.5.2.1 What is CAI? CAI is the use of computer technology in the classroom. This may vary from a single instructor station used to enhance instructor performance to a fully networked classroom. In a fully networked classroom, instructor and student stations are set up so that the instructor has complete control of the training environment. The instructor may observe each student station, lock out student functions, or assist a student from the instructor station. CAI may include a mix of IETMs and ICW.

6.5.2.2 Reasons for using CAI. Information technology advances are changing the way DoD personnel operate and maintain equipment. IETMs are beginning to be used in the operational environment. The same technical manuals are used for classroom training. Therefore, DoD schoolhouses must incorporate IETMs into their training curricula to prepare personnel before they are assigned to operating activities. It makes sense to develop CAI where instructors and students can make use of advances in instructional development and computer technologies, in accessing IETMs, and other forms of digital instructional materials.

6.5.2.3 CAI and instructor support. CAI may consist of only an instructor workstation that supports automated development and delivery, or may be a full suite of student workstations networked to the instructor station. The CAI provides the instructor with an efficient means for developing and displaying personal course annotations, including related graphics, videos, IETMs, and other multimedia. Instructional treatments for instructor-student interaction, presentation of the course materials, student study, and monitoring student activities are controlled from the instructor workstation. These instructional treatments can be accomplished with the following capabilities:

a. Automated instructor guides for directing instructor activities.
b. Automated trainee guides that provide students additional course information and exercises for practice and study.
c. IETMs that provide extensive course relevant technical information.
d. Interconnected student and instructor workstation.
e. Student response monitoring for summarizing student responses and assignments.
f. Instructor controlled multimedia presentations in a variety of media formats.

6.5.3 Learning Management System (LMS). LMS is software for course administration and management that provides information concerning performance trends, records individual and group performance data, schedules training, and provides support for other training management functions. The instructor has the responsibility to diagnose, to identify performance deficiencies, and to prescribe the next level of instruction.

6.5.4 Electronic job aids. Electronic job aids may be stand alone (e.g., EPSS) or embedded in other software applications (e.g., templates, macros, interactive tutorials, coaches).

## 7. INTERACTIVE MULTIMEDIA INSTRUCTION EVALUATION

7.1 IMI quality process. The quality process is an important part of IMI development. The quality process includes a combination of verification, validation, acceptance, and lessons learned to ensure training products meet training requirements. Evaluation is an inherent part of the IMI development process.

7.1.1 Verification. At this point in the IMI development process, LOs have been developed, test items written, instructional methods and media selected, and IMI is being developed. Yet, there is no assurance the IMI will be effective. Therefore, the IMI should undergo validation to prove that the instruction provides students with skills, knowledge, and attitudes to meet job performance requirements. If deficiencies are found in the IMI during validation, they are corrected before IMI implementation. Validation consists of technical accuracy review, individual tryouts, and small-group tryouts that are conducted as a part of formative evaluation and operational (field) tryouts that make up summative evaluation.

7.1.2 Validation. Validation evaluates the effectiveness of IMI while it is being developed with the intention of improving it. It is a repetitive process of development, tryouts, and revisions until evidence shows that the training accomplishes its intended purpose. When possible, validation is done as segments, units, or blocks of instruction are developed or revised. Validation is conducted to:

a. Verify the effectiveness of training products and support materials in meeting objectives and goals.
b. Determine beneficial improvements in the quality of training products and materials.
c. Identify training product deficiencies.
d. Improve efficiency and effectiveness of training objectives, sequence, products, and materials. In the testing context, it is the process of determining the degree of validity of a measuring instrument (e.g., skill qualification test, end of module test, and end of course comprehensive test).

7.1.3 Acceptance. Receiving verified and validated courseware/IMI, and acknowledging that the delivered product meets stated requirements.

7.1.4 Document lessons learned. Document only what is necessary to alert others to essential do's and don'ts, standards, conventions, and templates.

7.2 Develop a validation plan. For a training system to be effective, adequate planning should take place in the initial stages of IMI development. A part of that planning is the evaluation plan which often includes a plan of how the IMI is to be validated. These plans can be separate or can be subsets of other plans. Validation planning is essential for successful implementation of an IMI program.

7.2.1 Purpose. A validation plan provides IMI developers with a roadmap for validating the IMI. A validation plan provides organization and creditability to the validation process.

7.2.2 What is in a validation plan? Validation plans may contain the following:

a. A description of instruction to be validated (e.g., LOs, method, media).
b. The individual/organization that will be conducting the validation.
c. Validation procedures.
d. Validation schedules.
e. Program schedule constraints.
f. Number of tryouts to be conducted in each of the tryout activities.
g. Number and availability of students to be used in the tryouts.
h. A description of how the results should be documented.
i. Contingency plans.

7.2.3 Getting ready to validate. Prior to starting validation:

a. Understand each activity in the validation process.
b. Identify roles and responsibilities of the validation team members.
c. Know when the activities are to occur. Verify plans, events, and milestones.
d. Ensure that the IMI is ready for validation.
e. Ensure that students have been scheduled.
f. Know how to document any deficiencies.
g. Know procedures for revising the IMI, if applicable.

7.2.4 How to use a validation plan. Using the plan, those validating the IMI follow the predetermined guidelines and standards for evaluating the effectiveness of the IMI under

validation. Using the plan also provides organization to the process and adds credibility by providing a documented process.

7.2.5 Measure against a standard. Each component of the IMI is measured against a predetermined standard. If components of the IMI do not meet the criterion/standard, then an analysis of the component(s) should be conducted to determine why they do not meet the established standard. First, determine if the standard is realistic and valid. If so, then examine why the established standard is not being achieved. For example, a majority of the students are unable to accomplish a specific performance task in the time specified. A check of the technical data and with SMEs indicates that the standard is correct. A further analysis of the IMI lesson reveals that the task procedures are being taught incorrectly, thus causing additional time to be needed to complete the task. Validating each component of the IMI against standards established in the plan allows those components not meeting standards to be identified and corrected as necessary. This process ensures that the quality and effectiveness of the IMI will be maintained.

7.2.6 Follow the plan. Following the established guidelines in the validation plan ensures that the validation of the IMI is performed in an organized, timely manner with each component of the IMI being validated at the appropriate time in the process. For example, the plan identifies each component of the IMI, how each component will be validated, when each component will be validated, and the standard to be used in the validation process. The plan also serves as the basis for reporting results of the validation process.

7.3 Conduct technical accuracy reviews. The technical accuracy review, a formative evaluation activity, is the first step of the validation process. This review identifies inaccuracies and weaknesses in the IMI under review. IMI should be thoroughly reviewed, since this may be the last opportunity to revise draft materials before they are tried out on the students. If possible, and when applicable, conduct technical accuracy reviews each time IMI is developed, updated, or revised. Technical accuracy reviews may be conducted by:

a. SMEs.
b. Instructional developers.
c. Instructors.

7.3.1 What should be reviewed? Instructional materials to be reviewed include, but are not limited to:

a. LOs.
b. Test items.
c. IMI.
d. LMS features.

7.3.2 How to conduct a review. There are many ways to review IMI for accuracy, completeness, and quality. The bottom line is to cross-check the materials against the data sources such as technical orders, regulations, directives, and checklists. Use Table 49 to assist in conducting the internal review. This list is not all-inclusive and should be modified to fit each program.

TABLE 49. **Sample job aid for internal review.**

| ITEM | DESCRIPTION | YES | NO |
|---|---|---|---|
| 1 | Is the content of the material accurate? | | |
| 2 | Is the material current? | | |
| 3 | Is the material complete? | | |
| 4 | Does the sequence of the material build learning on learning? | | |
| 5 | Are the practice exercises adequate? | | |
| 6 | Are the review exercises adequate? | | |
| 7 | Does the material/lesson effectively teach the behavior specified in the LO? | | |
| 8 | Is the LO adequately evaluated? | | |
| 9 | Is the content of the material compatible? | | |
| 10 | Are there any "bad" parts in the material?<br>If so, where? | | |
| 11 | Can the materials be improved?<br>If so, how? | | |

a. When conducting a review, the reviewers should:

(1) Take careful notes while conducting the review.
(2) Make specific comments.
(3) Identify weaknesses in the materials.
(4) Recommend ways to improve the IMI.

b. After the review, the reviewers should:

(1) Discuss their findings.
(2) Determine what revisions or changes should be made to the IMI.
(3) Decide the best way to make the necessary corrections to the IMI.
(4) Make revisions and changes to the IMI, as applicable.

7.4 Conduct individual tryouts. Individual tryouts, a formative evaluation activity, are normally the next step in the validation process. During this step, as IMI is being developed, they are tried out on individual students. The IMI needs to be tried out on several students, if practical, in order to add validity and reliability to the data collected during the tryout.

7.4.1 Purpose. The purpose of an individual tryout is to determine the effectiveness of small segments or lessons as they are developed, updated, or revised.

7.4.2 Select students. A great deal of care should be used when selecting students to participate in the individual tryouts. During the selection process, consider the following factors:

a. If students do not fall within the predetermined range, tryout results can be skewed. Thus, student performance cannot be generalized to the target audience. Students selected for the tryouts should be from the target audience and fall within the predetermined range of:

   (1) Aptitude.
   (2) Skills.
   (3) Attitude.
   (4) Prior knowledge.
   (5) Background experience.

b. Students for the first tryouts should be selected from the upper percentage ranges in aptitude and background because:

   (1) Brighter students are often more likely to point out and analyze weaknesses in the instruction and materials.

   (2) If better students cannot learn the material, less capable students may not be able to learn the material.
   (3) If lower-level students are used in the individual tryouts and they do well, there is no way to tell if the IMI is designed at the proper level.
   (4) It is easier to work down from a known point of difficulty than to work up from an unknown point of difficulty.
   (5) It is simpler to add material to make a lesson easier than to delete material to make it more difficult.

7.4.3 Before an individual tryout. If instructors are involved with the individual tryouts, they should be aware of their role and the role of the student. Before conducting the individual

tryouts, instructional developers should prepare the students for the tryouts. Students need to know:

a. The purpose of the tryout.
b. Their role in the tryout.
c. That they are not being evaluated; the training and material are.
d. That their active participation is essential if the individual tryout is to be successful.
e. That their feedback is necessary in determining adequacy of the IMI.

7.4.4 During an individual tryout. Sources of individual tryout information are provided in Table 50. During the individual tryouts, instructional developers should:

a. Closely observe students as they use the material.
b. Make careful note of where students seem to have problems or uncertainties.
c. Give assistance to students only when it is essential to student progress.
d. Administer the relevant test item at the appropriate time.
e. Get the student's view about the difficulties encountered during the tryout.

TABLE 50. **Sources of individual tryout information.**

| SOURCE | ACTIVITY/INFORMATION |
|---|---|
| Diagnostic Tests | • Administer pre-test to identify entry behavior.<br>• Administer post-test to assess learning as a result of the tryout. |
| Student Performance During Learning | • Observe and record student's performance.<br>• Determine which exercises or tasks result in errors; types of errors; how many students are making the same error(s). |
| Student Comments | • Get student reaction to the instruction and materials, especially their difficulties.<br>• Ask students for suggestions on how the IMI can be improved. |

7.4.5 Typical problems. Often, when conducting individual tryouts, problems are identified that are typically found during the first tryouts. Some examples are:

a. Improper sequencing of the training.
b. Instruction not clear and concise.
c. Lack of supporting training materials.
d. Confusing test items.
e. Test items that do not measure LOs.
f. Insufficient practice time.

7.4.6 After an individual tryout. When the individual tryouts have been completed, analyze the resulting data to determine if error patterns or problems have occurred on successive tryouts. If so, changes or revisions to the IMI may be appropriate. For example, if each student participating in the individual tryouts fails to meet the performance standard for a particular LO. Review the LO, IMI, and test items, and revise as necessary. In most cases, several tryouts should be conducted before making any significant revisions or changes to the IMI. When significant revisions or changes are required in the IMI, it is recommended that additional individual tryouts be conducted again in order to determine if the problem was solved.

7.5 Conduct small-group tryouts. After the individual tryouts have been completed and all necessary revisions have been made to the training, it is time to conduct the next stage of validation, which is the small-group tryouts. In this stage, which is the last activity in formative evaluation, the IMI is tried out on small groups of students. Up to this point, the success of the instruction has been based on a limited sampling of students with higher aptitudes. It should be pointed out that the IMI is developed for average students; thus, small-group tryouts are focused on the average group.

7.5.1 Purpose. The purpose of conducting small-group tryouts is to determine if the IMI works under conditions approximating the actual teaching-learner activity.

7.5.2 Select students. Student selection for the small-group tryout is again very important in terms of validating the effectiveness of the IMI. Students selected to participate in the tryout should be representative of the target audience. If possible, students selected should have:

a. Even distribution between low and high aptitudes. Even distribution of students helps determine if the IMI will be effective under operational conditions.
b. Varying skill levels.
c. Different backgrounds.

7.5.3 Number of students. The number of students included in the small groups should be determined based on factors such as:

a. Need for teams of students within the small group (e.g., some tasks may require students to work in teams of two; if so, the small-group size should be based on multiples of two).
b. Planned normal group size of the operational system.
c. Availability of equipment.
d. Availability of facilities.

7.5.4 Time is a critical factor. To this point in the validation process, time required to perform a task has not been of major concern. However, time becomes a critical factor in the

small-group tryouts. Learning the material or performing a task is not sufficient; students should be able to learn the information or perform the task within a reasonable time period. Therefore, effort should be made to develop training that can be accomplished within a realistic time period based on training requirements and the capability of average students.

7.5.5 Before a small-group tryout. The following should be completed before trying out training on small groups:

a. Determine number of students to be included in the small group.
b. Determine the number of groups to be used in the tryouts.
c. Select representative students from the target audience.
d. Ensure that the IMI have been revised to include the applicable information resulting from individual tryouts.
e. Ensure that student materials are available in adequate quantities.
f. Ensure that resources such as equipment, personnel, and facilities to be used during the tryout approximate the operational conditions.
g. Ensure that the instructional information management system is operating for data collecting, analysis, and reporting.

7.5.6 During a small-group tryout. Do not supplement the instruction. Supplementing the instruction may skew the results of the tryout. When conducting small-group tryouts:

a. Ensure that the time required for each student to complete the material is accurately recorded. This information is used to determine unit times, course length, and course content.
b. Record accuracy of student responses. This information should help determine deficiencies in the IMI.
c. Establish the number of trials a student should be permitted to meet performance requirements.

7.5.7 After a small-group tryout. As with the individual tryout, if the IMI requires significant revisions or changes, it is recommended that additional small-group tryouts be conducted again to determine if the revisions were effective. Conduct a sufficient number of small-group tryouts to ensure that the data collected is both valid and reliable. Once the data has been collected, it should be analyzed to determine:

a. Median time required to complete each segment or unit of training (this information is used to set the approximate times for lessons, segments, units, or modules of instruction).
b. Need to revise equipment requirements, make changes to facilities, and adjust personnel authorizations.

c. IMI requiring revisions or changes.
d. Priority for accomplishing revisions or changes and plan of accomplishment.

7.6 Finalize the IMI program. After validating the training, finalize the IMI. During this step, make sure that all necessary changes are made to the IMI and it is ready for implementation.

7.6.1 Purpose. The purpose of finalizing the IMI is to ensure that it:

a. Has been revised to include the most current and accurate information.
b. Is complete.
c. Is ready to use in the teaching-learner activity.

7.6.2 What needs to be updated? When finalizing training materials, update:

a. Plans that have been developed.
b. Course control documents.
c. Training materials.

7.6.3 Final quality check. Prior to final release and implementation of the IMI, check to ensure that the following steps have been accomplished:

a. The program has been updated.
b. The programming is complete.
c. The IMI has been successfully completed and operationally tested.

## 8. NOTES

8.1 Intended use. This handbook is intended to be used in conjunction with MIL-PRF-29612, MIL-HDBK-29612-1, MIL-HDBK-29612-2, MIL-HDBK-29612-4, and MIL-HDBK-29612-5 to aid in the application of IMI for training programs.

8.2 CD-ROM destruction. Currently there is no standard for the destruction of classified and classified-sensitive Compact Disks-Read Only Memory (CD-ROM). Special care is required for the incineration of CD-ROMs as fumes in high concentration can be toxic. MIL-HDBK-9660, DoD-Produced CD-ROM Products, provides information for the destruction of CD-ROMs including addresses and shipping instructions for central destruction sites.

8.3 Subject term (key word) listing.

Advanced Distributed Learning (ADL)

Animations
Computer-Aided Instruction (CAI)
Electronic guides
Electronic Performance Support Systems (EPSS)
Electronic publications
Electronic testing
Instructional media delivery system
Interactive Courseware (ICW)
Interactive Multimedia Instruction (IMI)
Learning Management System (LMS)
Levels of interactivity
Multimedia
Simulations
Training

**CONCLUDING MATERIAL**

Custodians:
Army - AV
Navy - AS
Air Force - 94
Marine Corps - MC
DLA - DH

Review Activities:
Army - TM
Navy - SH, EC, TD
Air Force - 11
DLA - CS, GS, IS, DP
NSA - NS

Preparing Activity:
Navy - AS
(Project SESS-0017)

## STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

## INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.

2. The submitter of this form must complete blocks 4, 5, 6, and 7, and send to preparing activity.

3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

| **I RECOMMEND A CHANGE:** | **1. DOCUMENT NUMBER** | **2. DOCUMENT DATE** (*YYYYMMDD*) |
|---|---|---|

**3. DOCUMENT TITLE**

**4. NATURE OF CHANGE** (*Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.*)

**5. REASON FOR RECOMMENDATION**

**6. SUBMITTER**

| a. NAME (*Last, First, Middle Initial*) | b. ORGANIZATION | |
|---|---|---|
| c. ADDRESS (*Include ZIP Code*) | d. TELEPHONE (*Include Area Code*)<br>(1) Commercial<br>(2) DSN<br>(*If applicable*) | **7. DATE SUBMITTED**<br>(*YYYYMMDD*) |

**8. PREPARING ACTIVITY**

| a. NAME<br>COMMANDER<br>NAVAL AIR WARFARE CENTER<br>AIRCRAFT DIVISION | b. TELEPHONE (*Include Area Code*)<br>(1) Commercial<br>(732) 323-2947<br>(2) DSN<br>624-2947 |
|---|---|
| c. ADDRESS (*Include ZIP Code*)<br>CODE 414100B120-3<br>HIGHWAY 547<br>LAKEHURST, NJ 08733-5100 | **IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:**<br>Defense Standardization Program Office (DLSC-LM)<br>8725 John J. Kingman Road, Suite 2533<br>Fort Belvoir, Virginia 22060-6221<br>Telephone (703) 767-6888 DSN 427-6888 |