

Instructional Design for Interactive Multimedia: A guide

Johann Fouché

Contents

1	IMM AS AN INSTRUCTIONAL DELIVERY SYSTEM	4
1.1	WHAT IS INTERACTIVE MULTIMEDIA	4
1.2	HOW DO I SELECT THE APPROPRIATE INSTRUCTIONAL DELIVERY SYSTEM?.....	5
1.3	WHEN NOT TO USE IMM	6
1.4	FORMATIVE EVALUATION AND INSTRUCTIONAL DESIGN	6
2	WHEN TO USE IMM	7
2.1	THE FEASIBILITY OF INTERACTIVE MULTIMEDIA.....	7
2.2	A DECISION AID FOR THE FEASIBILITY OF INTERACTIVE MULTIMEDIA.....	9
2.3	THE EXPORTABILITY OF INTERACTIVE MULTIMEDIA.....	9
2.4	IMM AUTHORIZING SOFTWARE.....	10
2.5	MANAGEMENT AND ORGANISATIONAL SUPPORT	14
2.5.1	<i>Management Support</i>	14
2.5.2	<i>Staff Support and the IMM Team</i>	15
2.5.3	<i>The IMM Implementation Team</i>	16
2.5.4	<i>How to change the Level of Support for IMM</i>	17
2.6	FACILITY REQUIREMENTS FOR THE IMPLEMENTATION OF IMM:.....	18
2.7	IMM COST CONSIDERATIONS	19
2.7.1	<i>IMM Development Costs</i>	19
2.7.2	<i>IMM Development Hours</i>	19
2.7.3	<i>More on Level of Presentation and Types of Training</i>	20
2.7.3.1	<i>The Best Case Scenario</i>	21
2.7.3.2	<i>Effect of Changes in the "Best Case" Scenario</i>	22
2.7.4	<i>Influence of Program Change on Costs</i>	24
2.7.5	<i>Labour Hours to Produce IMM</i>	25
3	HOW TO PLAN AN IN-HOUSE IMM EFFORT	26
3.1	OVERVIEW	26
3.2	OUTLINE THE IMM EFFORT	26
3.2.1	<i>Step 1: Establish a Development Process</i>	26
3.2.2	<i>Step 2: Prepare the Project Team</i>	28
3.2.3	<i>Step 3: Develop Quality Control Procedures</i>	28
4	HOW TO DESIGN IMM	30
4.1	DEVELOP THE IMM SPECIFICATION	30
4.2	DETERMINE INSTRUCTIONAL STRATEGIES.....	32
4.3	EVENTS OF INSTRUCTION FOR IMM	33
4.4	IMM CONTENT TYPES	34
4.4.1	<i>Level of Processing for Content Type</i>	35
4.5	INTERACTIVITY	36
4.5.1	<i>Guidelines for Increasing Interactivity</i>	37
4.5.2	<i>Learner Control</i>	38
4.5.3	<i>Feedback Design</i>	39
4.5.3.1	<i>Guidelines for Designing Feedback for IMM</i>	40
4.6	DETERMINE CMI AND TESTING STRATEGIES	41
4.6.1	<i>Computer Managed Instruction</i>	41
4.6.2	<i>IMM Tests</i>	41
5	FLOWCHARTING AND STORYBOARDS.....	43
5.1	FLOWCHARTING	43
5.2	STORYBOARDS	45
5.2.1	<i>The Steps Involved in Storyboard Development</i>	46
5.2.2	<i>Guidelines for Storyboarding IMM</i>	47
5.3	VISUAL ELEMENTS	49
5.3.1	<i>Guidelines for Visual Elements in a Storyboard</i>	49
5.3.2	<i>The Video Storyboard</i>	52

5.3.3	<i>Guidelines for Text Elements of a Storyboard</i>	54
5.3.4	<i>Guidelines for Graphics and Animation Elements of Storyboard</i>	55
5.3.5	<i>Guidelines for Audio</i>	56
5.3.6	<i>Programming Standards Considerations</i>	58
5.3.7	<i>Storybook Guidelines for Programming</i>	59
5.3.8	<i>A Checklist for Storyboarding</i>	59
6	HOW TO DEVELOP IMM	64
6.1	PROGRAM THE LESSONS.....	64
6.2	PRODUCE VISUAL DISPLAYS AND RECORD AUDIO	66
6.2.1	<i>Guidelines for Producing Full Motion Video</i>	66
6.2.2	<i>Guidelines for Recording Audio</i>	67
6.2.3	<i>Guidelines for Displays in an IMM Program</i>	67
6.3	DEVELOP SUPPORTING MATERIALS.....	68
7	BIBLIOGRAPHY	69

1 IMM as an Instructional Delivery System

1.1 What is Interactive Multimedia

What Is IMM?	IMM, from a technology viewpoint, is a computer-controlled computer program where the learning experience is based on the interaction between the learner and the computer system, using text, graphics, video, animation and sound. The student's decisions and inputs to the computer determine the level, order, and pace of instructional delivery, and types of visual and auditory outputs.
How IMM Works	With an interactive program, the student advances through the sequence of instructional events by making decisions and selections through an input device such as a keyboard, touch screen, mouse, trackball, light pen, or joystick. The instruction branches according to the student's inputs and responses.
IMM and Instructional Design	Because Interactive Multimedia is one of many instructional delivery tools, it is essential that a full instructional design model should be implemented in order to establish training requirements and translating them into appropriate instructional objectives. In the design phase, one of the first and most important tasks is that of selecting the instructional delivery system.
Examples of Instructional Delivery Systems	IMM, lectures, notes, platform instruction, formal on-the-job training, and training devices and simulators are all examples of instructional delivery systems. Time spent in properly matching training needs to the most appropriate delivery system will ensure that today's selected state-of-the-art technologies do not become tomorrow's dust collectors.
Advantages of IMM	IMM, with characteristics never before available at any price, may be a suitable instructional delivery system for many training objectives. Thanks to the rapid development of computer technology, it is now possible to create, at a reasonable price, new ways of designing and developing education and training materials. Today, computers can be used to deliver interactive, competency-based, individualised, multimedia instruction.

1.2 How do I select the appropriate Instructional Delivery System?

General Rules for Selecting IMM as an Instructional Delivery System

Brandt (1987) proposed certain rules for using interactive video as a instructional delivery system. Brandt's rules have been revised to apply to any form of IMM. The rules are shown in the following table:

General Rules for Using IMM as an Instructional Delivery System

Rule 1	Use IMM 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.	Rationale: When the volume of slides and the demand for reproduction reach a certain point, the use of interactive videodisc (IVD) or CD-ROM may prove to be the most cost-effective means of distribution. As for motion sequences, film and video reproduction is, in the long run, much more expensive than videodisc or CD-ROM reproduction. Also, film and video tapes tend to deteriorate over time, where IVD or CD-ROM will maintain the images at the same resolution for extensive periods.
Rule 2	IMM training should be considered when there are a large number of learners distributed over time and place.	Rationale: In this instance, a cost trade-off exists between self-paced, individualised training and lecture-based training. The break-point is achieved when the number of students is so large that it becomes more economical to use individualised training methods rather than lecture.
Rule 3	IMM may be applied when instructors with subject matter expertise are in short supply.	Rationale: Reductions in force, early retirements, instructors who are subject matter experts (SME) but not skilled educators are some of the reasons it is advantageous to capture subject matter expertise into an IMM program.
Rule 4	Consider using IMM 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.	Rationale: Use of real equipment or a simulator for training may present a number of needs that could be met with an IMM simulation. If designed correctly, an IMM 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 use.
Rule 5	IMM can provide a safe, yet realistic, simulation of dangerous activities and situations.	Rationale: 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. It is not possible to practice this task in an actual situation. Simulation would allow maintenance personnel to practice proper procedures without exposure to actual dangers. An IMM simulation can show the effects of improperly performed procedures without damaging equipment or injuring personnel.
Rule 6	IMM is a particularly suitable delivery system when training requires continuous practice and/or retraining.	Rationale: One of the most desirable features of IMM is the ease with which any portion of a course or lesson can be retrieved and reviewed. This characteristic of IMM is best illustrated by pilot training. Continuous practice is required in many types of training.
Rule 7	IMM can be a very useful delivery method in training problem-solving and decision-making skills.	Rationale: 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. IMM training could be substituted, thereby freeing skilled employees from the task of training others. In theory, this type of formal training has the potential to increase the productivity of all employees, and thus save the organisation considerable expense.
Rule 8	When a training situation is such that students vary in experience, learning style, and skill level, IMM instruction can provide different types and levels of instruction to different students.	Rationale: Specific features can be designed into an IMM program to allow users to advance from level to level based on their experience and skill levels. IMM programs can be designed to facilitate individual differences in students' learning styles.

1.3 When NOT to use IMM

Key to Using IMM Deciding when to use IMM requires a step-by-step examination process. IMM should not be selected simply for its technological appeal. IMM is not the best method for every training objective. This module will try to provide background information and decision aids to help you decide when IMM is an appropriate instructional method.

1.4 Formative evaluation and instructional design

Definition	Formative evaluation is the continuous, organised creation of beneficial change to the process of designing and developing IMM. The objective of this process is to ensure the continuous improvement of the IMM process and products.
Continuous Improvement	Continuous improvement of the quality of instructional programs is an ongoing concern. Each phase of the instructional design process is designed to force managers and designers to ask the right questions to help focus on the actual needs of the customer in terms of requirements, schedules, and budgets. Customer satisfaction is the number one goal, and customer satisfaction translates into meeting instructional requirements in the most effective and efficient manner possible.
Define Customer's Needs	The first and most important step in developing quality IMM is to define the customer's needs and requirements. It is impossible to design an adequate training program without knowing the lack of knowledge or the performance problems that need to be solved. The problems, needs, requirements and objectives of the instructional program must be fully defined and agreed upon before proceeding with the detailed instructional design.
Keep Customer Involved	Once the requirements for the program have been established and agreed upon, it is important to keep the customer involved in the process. There are several natural phase points in the development of an IMM program where the customer should be involved in the development and review of different products that make up the IMM material.
Get "Buy In"	It is essential that your customer "buy in" to your process and design. If your customer disagrees with your solutions or ideas, it is better to find out and make adjustments early in the process. If you keep your customer involved throughout the process, there should be no "surprises" when the final product is delivered.
Establish IMM Team	Many different people are involved in the IMM process. Each member of the IMM development team must know what is expected of them. Not only do they need to know what products are required and when, they need to know how IMM programs in your organisation look and function.
How To Use These Guidelines	The guidelines in this module should help you to design and develop quality IMM. The guidelines are drawn from the experience of many IMM development teams throughout the world. These guidelines are not meant to be binding on all IMM programs. They should be evaluated for use in your environment, and adjusted accordingly. The guidelines are a starting point to developing your own style guide and design criteria.

2 WHEN TO USE IMM

Introduction Careful planning is essential in any program that brings together a number of resources to accomplish a specific goal. Deciding whether to use IMM requires very careful planning and consideration. This chapter provides information and decision aids to help you decide when to use IMM.

2.1 The Feasibility of Interactive Multimedia

Introduction The general feasibility of IMM is evaluated by examining the following factors:

- Content factors
- Student factors
- Organisational factors

IMM Feasibility Summary

	A	B	C
Rule	Type of Factor	Data Examined	Impact on IMM Decision
CONTENT			
1	Content characteristics	Content and training effectiveness	Consider IMM if training effectiveness is dependent on or enhanced by graphic, sound, motion, or photographic presentation.
2	Content stability	Likelihood of major revisions	Consider IMM if major revisions are limited to one per year.
3	Training time	Projected number of IMM lessons	Consider IMM if the number of projected IMM lessons can offset development and maintenance costs within 2 years.
4	Course life cycle	Projected course life	Consider IMM if development and maintenance costs can be offset during the life of the course.
STUDENT			
5	Learning style	Former student records	Consider IMM if learning style is highly visual. (Resulting IMM should also be visually oriented with heavy use of video graphics.)
6	Reading ability	Former student records	Consider IMM only if reading ability supports projected reading level of anticipated lessons.

7	Motivation level	Former student records	Consider highly interactive IMM with frequent embedded questions/extensive feedback if low motivation is expected.
ORGANIZATIONAL			
8	Training equipment	Availability for hands-on training	Consider IMM with simulation capabilities if hands-on equipment is unavailable.
9	Staff availability	Resources and commitments	Consider IMM if staff is available for dedicated assignment to IMM project.
10	Staff experience	Resumes	Consider IMM regardless of staff experience. Plan for learning curve time if staff is inexperienced.
11	Attitude toward IMM	Staff meetings	Consider IMM if resistance is moderate or low. Plan for IMM awareness training if resistance is high.
12	Support for IMM	Management meetings	Consider IMM if support is evident. Plan for development of position paper if support is low.
13	Development schedule	Management meetings	Given a short schedule, consider IMM if staff experience is extensive, instructor resistance is low, and management support is high.

2.2 A Decision Aid for the Feasibility of Interactive Multimedia

How To Use This Decision Aid The IMM feasibility determination decision aid lists the factors that impact the IMM decision. The factors are in the form of yes/no questions.

Consider pursuing IMM if you obtain five or more "yes" responses from the factors on the decision aid.

The three factors with an asterisk (*) are especially critical because they influence IMM costs. A "no" response to any of these three questions provides evidence that IMM should not be pursued.

The factor with the double asterisk (**) is also critical. A "yes" response to this question strongly indicates a need for IMM.

Type of Factor		Feasibility Question	Yes	No
CONTENT	Content stability*	Are IMM major revisions limited to one per year?		
	Training time*	Can the number of projected IMM lessons offset development and maintenance costs within 2 years?		
	Course life cycle*	Is course life expectancy long enough to offset a reasonable portion of development or maintenance costs?		
STUDENT	Learning style	Is learning style highly visual?		
	Reading ability	Does reading ability support projected reading level of anticipated lessons?		
	Motivation level	Is low motivation expected?		
ORGANIZATIONAL	Training equipment**	Is hands-on equipment unavailable for training?		
	Availability	Is staff available for dedicated assignment to IMM?		
	Experience	Is staff experienced?		
	Attitude	Is acceptance to IMM high?		
	Support	Is support for IMM evident?		
	Development schedule	Is the schedule flexible?		

2.3 The Exportability of Interactive Multimedia

IMM Exportability Issue Exportable IMM is IMM which is developed and/or managed at a centralised location, but delivered at more than one remote user facility.

A Decision Aid: : If you plan to export IMM to remote locations, use this decision aid to determine if it is possible to do so.

How to use the Decision Aid on Exportable IMM Feasibility

SECTION	DESCRIPTION
I	If you obtain a "yes" response to all three questions in Section I, go directly to Section III. If you obtain a "no" response to any of the questions in Section I, you need to complete Section II.
II	A "no" response to either question in Section II indicates that exportable IMM cannot be supported by the budget and should not be attempted until funds are allocated. "Yes" responses to Section II indicate that exportable IMM is feasible, and you should complete Section III.
III	"Yes" responses to the questions in Section III indicate that IMM is feasible.

Exportability Questions	Yes	No
PART I		
Is there existing hardware that can support IMM training?		
Is the number of hardware stations sufficient to train the number of IMM students?		
Is the existing hardware available for IMM training?		
PART II		
Have you budgeted for hardware and software procurement?		
Is budget available for operating IMM?		
PART III		
Is IMM an appropriate media for presenting this content?		
Is the number of projected lessons large enough to justify IMM use?		
Is the number of projected students large enough to justify IMM use?		

2.4 IMM Authoring Software

Introduction This section describes authoring software and how the characteristics of authoring software affect selection of an authoring software package. Decision aids for selecting authoring software are presented.

Definition of Authoring Software Authoring software is a special set of computer instructions used to create the individual displays that make up IMM lessons. These instructions are used by the courseware developer to tell the computer how the lesson should look and operate.

Types of Authoring Software

There are three types of IMM authoring software:

- 1 • Authoring Languages
- 2 • Authoring Systems
- 3 • Ancillary Software

Description of Authoring Software

The following is a description of the three types of authoring software.

Type of Authoring Software	Description
Authoring Languages	An authoring language is a specialised, high-level, plain English, language-like computer program (often based on another computer language like BASIC or PASCAL). Authoring languages are flexible and can meet a full range of instructional needs but are frequently difficult to learn and use by anyone who does not have a computer programming background. An example of an IMM authoring language is TenCore Language Authoring System (LAS).
Authoring System	An authoring system (often referred to as an authoring package) is a pre-packaged, prompted authoring aid, courseware template, or menu- driven editor designed to help authors (without formal computer programming skills) create IMM without elaborate programming. Examples of IVD authoring systems are Quest, TenCore Producer, Mandarin, and WISE. Examples of authoring systems for digital formats are Toolbook, MediaScript, QuickTime, Authorware Professional, Authology, and Video for Windows.
Ancillary Software	Ancillary software refers to commercial, off-the-shelf software packages or tools used with authoring software. Examples of ancillary software are: <ul style="list-style-type: none">• Word processing software• Graphics software• Flowcharting software• Storyboarding tools• Computer-managed instruction (CMI) software

Restrictions for Using Ancillary Software

There are three restrictions for using ancillary software. The following is a description of the three restrictions.

Restriction	Description
1	The authoring and ancillary software must use the same operating system. Windows, MS-DOS, UNIX, Macintosh System 7, and OS/2 are major operating systems.
2	The authoring software must have the capability to import the code generated by the ancillary software.
3	The authoring software must be able to understand the imported code.

Authoring Software Capabilities

The following table shows authoring software capabilities of authoring languages and authoring systems.

	Authoring Languages	Authoring Systems
1	Extensive CMI capabilities	Limits on CMI
2	Programming language available (for developing utilities to increase efficiency)	Programming language may or may not be available
3	Sophisticated branching	Some systems limited on branching
4	Flexible screen design	Structured screen design
5	Programming required	Programming not required

Technology Advances with IMM Software

As technology advances, the distinction between authoring languages and authoring systems is becoming less defined. New versions of authoring languages incorporating selection menus are on the market today. Similarly, some authoring systems incorporate a programming language to enhance flexibility.

Authoring Software Decisions

Typically, you will not need to decide whether to use an authoring language or an authoring system. Because of the ease of implementation and the flexibility and power now available with most authoring systems, the decision you are more likely to be faced with is which authoring system you should use. The information presented below will help you make this decision.

Key Capabilities of Authoring Systems

For authoring systems to facilitate development of IMM, a variety of key capabilities are required. The capabilities for authoring systems can be divided into two major categories:

- Authoring and presentation capabilities
- CMI capabilities

The following is a description of Authoring, Presentation and CMI capabilities:

Type of Capability	Description
Authoring and Presentation	Authoring/ presentation capabilities assist in performing such authoring tasks as: Developing or editing text displays Creating or editing graphics Animating graphics Developing written questions and response analysis Creating performance questions Programming video sequences Sequencing lesson material Using utilities
CMI	CMI capabilities are available to manage instruction. Categories for CMI capabilities are: Administration Record keeping Schedule generation Answer judging Report generation

Authoring systems or packages vary with regard to the authoring and presentation capabilities and specific CMI capabilities listed above.

Factors Influencing Selection of Authoring Systems

Authoring systems should be analysed for the following selection factors:

- Capability to support instructional design
- Ease of implementation
- Hardware compatibility
- Use of existing software
- Cost
- Vendor support and reputation
- Licensing arrangements

2.5 Management and Organisational Support

Introduction Successful implementation of IMM depends on:

- Management support
- Staff support
- Proper facilities

2.5.1 Management Support

Management Support Three general types of management support are required:

- Commitment of funds
- Enthusiasm for project
- Ability to meet staff demands

Type of Support	Description
Commitment of Funds	Upper-level management support is needed for successful IMM implementation. Management controls the spending of funds. On IMM projects, funds will be needed for: <ul style="list-style-type: none">• Purchasing hardware and software• Training the IMM development staff• Training personnel on their changing roles related to IMM projects
Enthusiasm for Project	Enthusiastic managers can serve as project advocates and promote an atmosphere of co-operation throughout the training organisation. Managers can reduce negative attitudes by their enthusiasm for a project.
Meeting staffing demands	Management support is essential in meeting staffing demands. The selection, assignment, and training of personnel should be a major concern. 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 IMM project. Personnel rotation can slow the IMM process because of learning curves for new employees, and different perceptions of what is needed.

2.5.2 Staff Support and the IMM Team

Staff Support IMM development requires staff members with a variety of experience. The following table shows the basic IMM development team composition. It lists the IMM staff positions and describes the specific responsibilities assigned.

IMM Development Team

	Position Title	Responsibilities
1	Courseware developer (CD)	Authors lesson designs, flowcharts, and storyboards. Designs and/or creates static and animated graphics, performance exercise, simulations, and interactive sequences. Programs lessons with authoring systems.
2	Instructional designer (ID)	Develops standards and instructional strategies for IMM lessons. Assists with lesson authoring when required. Reviews completed lesson designs, flowcharts, and storyboards for instructional integrity and conformance with standards and strategies.
3	Subject matter expert (SME)	Provides information on IMM subject matter. Reviews lesson designs, flowcharts, storyboards, and programmed lessons for accuracy and currency. Authors lessons as required.
4	Courseware programmer (CP)	Programs lessons with authoring languages. Develops static and animated graphics with authoring languages. Assists in ASCII code conversion when automatic conversion is unavailable.
5	Graphic artist (GA)	Develops graphics on paper for inclusion as an interactive still-frame. May develop initial illustrations for complex computer-generated graphics.
6	Computer artist (CA)	Develops computer-generated graphics for inclusion as a still-frame.
7	Media specialist (MS)	Films motion and still-frame sequences. Co-ordinates audio narration. Assists in planning premaster tape layout.

2.5.3 The IMM Implementation Team

IMM Implementation Team After IMM is developed, a team of personnel with specific responsibilities is needed to implement the program. The following table shows the IMM implementation team composition and lists the position titles and responsibilities of the team members:

IMM Implementation Team

	Position Title	Responsibilities
1	Resource manager	Catalogues, 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.
2	Courseware administrator	Enrols students in IMM. Tracks student progress through CMI reports. Maintains records on student progression. Provides student progression records to instructors.
3	System administrator	Sets up and runs computer laboratories. Contacts vendor for unscheduled maintenance. Trains staff to use the hardware system.
4	Class monitor	Assists students using IMM. Responds to operational questions and monitors performance using CMI. Updates instructors on student performance.
5	Instructor	Provides individual remedial instruction and counselling. Tracks student performance through CMI. Schedules students for remediation. May also participate in IMM development as courseware developer, instructional design, or subject matter expert.

2.5.4 How to change the Level of Support for IMM

	Support Category	Results of Support Deficit	Action to Alter Deficit
1	Management support	May have funding problems. Lack of support may flow down through organisation.	Inform management of IMM advantages and benefits. Involve managers in the decision process or planning phase.
2	Staff support	Instructors may resist the change and be uncooperative during implementation.	Provide training on IMM to reduce resistance. Convince staff that changing roles does not mean less responsibility. Involve staff in decision process.
3	Staff availability	May not have the force to develop IMM.	Add staff to current force. Defer current commitments. Contract out IMM development.
4	Staff skills	Learning curve will be high. Development will proceed slowly.	Train staff to perform IMM development. Contract out development. Add experienced staff to current force.
5	Staff dedication	Lesson revisions increase with IMM staff changes.	Develop and enforce lesson standards to reduce potential for format changes.

2.6 Facility requirements for the implementation of IMM:

Facility Requirements

A number of facility requirements affect the implementation of IMM:

- Delivery system facility requirements
- Development system facility requirements
- Special facility requirements

Type of Requirement	Description
Delivery System Facility Requirements	You will need a room to house the delivery hardware systems. This room must be large enough to house a learning station for each student. Partitions are often used around the learning stations to provide privacy for the students. The learning station should also have storage space for supplemental materials (workbooks, laser discs, diskettes) and work space for the students. If systems are networked, space must also be available for the system used to monitor CMI. Space may also be needed if a printer is used.
Development System Facility Requirements	Each member of the development team will need work space and special resources. For example, the graphic artist may need a drafting table and a computer system. The medial specialist may need access to a video lab and audio recording studio.
Special Facility Requirements	The rooms housing the development and delivery systems should have adequate cooling and power. Rooms with networked systems must provide storage for cabling that links each system with the file server or host computer.

2.7 IMM Cost Considerations

2.7.1 IMM Development Costs

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

Cost Factors The final decision about using IMM cannot be made until direct and indirect costs are known. Here is a description of direct and indirect costs

Type of Cost	Description
Direct Cost	A direct cost is any cost that is specifically identifiable to the project. Examples of direct costs are hardware and software purchases, travel and per diem costs, and time charges to a specific project. Other direct costs include reproduction costs of IMM materials including discs, costs to copy discs, and video production costs.
Indirect Cost	An indirect cost is any 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 training a programmer on a particular authoring system if the costs are not charged directly to a specific project. Moneys associated with modifying or constructing the IMM facilities could be indirect costs.

2.7.2 IMM Development Hours

Estimating IMM Development Hours The following table provides a baseline estimate from which you can begin the process of determining the total number of hours it will take to design, develop, and evaluate one hour of IMM. The table shows a baseline estimate based on experience from actual IMM projects. The estimates are broken down into level of presentation and type of training. Program management time is included in the estimates.

Level of Presentation	Estimate	Type of Training		
		Knowledge	Skill	Attitude
I – Basic	30-200	30	75	200
II – Medium	75-250	75	125	250
III – High	200-600	200	400	600

2.7.3 More on Level of Presentation and Types of Training

Level of Presentation	Description
Level I	Basic Presentation. This is the lowest level of IMM development in that Level I lessons are linear (one idea after another), and are used primarily for introducing an idea or concept. There is little "interaction" other than the student touching the screen or using a keystroke or mouse click to continue. The media used are primarily text and graphics (not complex).
Level II	Medium Simulation Presentation. This presentation level involves the recall of more information than a basic Level I presentation and allows the student to have increased control over lesson presentation; that is, there is more interaction, for instance, students may be able to rotate a switch. CMI can be used in Level II lessons to track and analyse student performance. Level II normally combines audio, video, text, graphics and animation.
Level III	High Simulation Presentation. This level involves aspects of both Level I and Level II while using the full abilities of IMM. Level III may even present onscreen interaction similar to that used in an aircraft simulator. This level provides a high degree of interactivity, extensive branching capability, maximum remediation opportunity (supports multiple levels of errors), real-time event simulation with minor equipment limitations, capability to interface with other output devices, and thorough CMI capability.
Type of Training	Description
Knowledge	A knowledge objective involves the use of mental processes which enable a person to recall facts, identify concepts, and apply rules or principles. An example of a knowledge objective is knowing how the fuel flows through an aircraft system. A person manifests knowledge through performing associated overt activities. Although knowledge is not directly observable, it is measurable.
Skill	Skill objectives are commonly described in terms of hard skills and soft skills. Hard skills involve physical or manipulative activities, such as operating or maintaining a piece of equipment. Soft skills often require interpersonal activities such as conducting an interview. Hard and soft skills are directly observable and measurable.
Attitude	An attitude is a persisting state that influences or modifies an individual's choices or decisions to act under certain circumstances. An attitude objective represents a tendency on the part of the learner to respond in a particular way. An example of an attitude objective is choosing to wear a seat belt. Attitude objectives may be difficult to observe and measure.

2.7.3.1 The Best Case Scenario

Assumptions for Estimating Development Hours

The hours provided in the previous table assume a "best case" situation. Here is a list of factors which define a "best case" situation.

- The IMM developer is familiar with the subject matter, and has in-house subject matter experts.
- The subject matter is not highly complex.
- 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 IMM training do not continually change.
- 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.
- The total IMM course length is 100 hours or more and the development process will be accomplished within one year.
- The IMM developer is familiar with the selected IMM authoring software.
- The IMM developer is familiar with the target audience.
- The best commercial practices are accepted for software development and video production.
- The IMM project team consists of individuals who are experienced with IMM management, design and development.
- The selected IMM authoring system is mature and stable. No beta versions are used.
- A lesson format and design strategy are agreed upon "up front", and the customer has "bought into" it. If possible, the customer has approved a prototype lesson. Also, the development process is standardised.
- The customer works closely with the design team on a regular basis. The customer uses an objective acceptance criteria and does not continually change the individual who is responsible for reviewing and approving the lessons.
- All required resources are in place.

2.7.3.2 Effect of Changes in the "Best Case" Scenario

Effect of
Changes in
Variables

The following table illustrates how the development hours will increase if the factors described above are not present. Estimates are also provided regarding the amount of risk associated with each variable.

Variables	Increase Hours By:	Risk (Scale 1-5)				
		None		High		
		1	2	3	4	5
1. No "in-house" SMEs; must rely solely on use of customer SMEs.	25:1		2			
2. Subject matter is highly complex.	100:1				4	
3. Instructional content is unstable. System for which IMM being developed is emerging. Tasks for IMM constantly changing.	100:1					5
4. Inadequate documentation. No training needs assessment was performed. No task analysis or learning analysis data. Technical manuals/orders non-existent or not helpful.	20:1				4	
5. Total IMM course length <100 hours. (less potential for use of templates, shells, etc.)	20:1	1				
6. IMM developer not familiar with IMM software/authoring package.	15:1		2			
7. IMM developer not familiar with target audience.	10:1		2			

Variables	Increase Hours By:	Risk (Scale 1-5)				
		None		High		
		1	2	3	4	5
8. Inexperienced project team:						
IMM designers inexperienced	80:1			3		
IMM manager inexperienced	100:1	1				
IMM programmer inexperienced	60:1				4	
9. Using a beta version of the IMM software.	80:1				4	
10. No prototype exists, no agreement "up front" on design strategy, no standardised development process followed.	50:1					5
11. Customer not using objective and consistent acceptance criteria. Customer unsure of what he wants and does not communicate with developer.	50:1					5
12. Required resources not in place at start of project.	20:1	1				

Estimating Labor Hours to Produce IMM

Use the information in the above tables to estimate the hours required to design, develop, evaluate and produce IMM.

Example of Using the Above Tables.

Assume that Level II IMM is being estimated to train a skill. The product to be developed is IVD, and the course length is estimated at 100 hours. You are familiar with the software and have experienced people. The programming and video production will be completed "in house." No training needs assessment has been performed and the subject matter is highly complex (add 100 hours). You do not have in-house subject matter experts (add 25 hours). The instructional content is stable but the documentation is poor (add 20 hours). You are not familiar with the target audience (add 10 hours). Beginning with the number 125 (the hours it would take to develop one hour given the "best case" situation), you should add a total of 155 hours to the estimate, bringing the total up to 280 hours.

2.7.4 Influence of Program Change on Costs

Estimating Costs for Course Configuration and Maintenance

The following table gives examples of the typical kinds of changes often encountered during IMM development. The table shows the number of hours commonly associated with minor, moderate, and major changes. The hour estimates can be used to help the IMM manager determine if the change will require additional funds to implement.

Type of Change	Level of Change		
	Minor	Moderate	Major
Technical	Example: switch position is wrong	Example: functioning of an entire component must be changed due to an equipment modification	Example: introduce entire set of new tasks
Instructional	Example: allow student two tries instead of one	Example: change one test from multiple choice to true/false	Example: introduce entire new strategy on how to test
Media	Example: change font	Example: add four full-motion video shots	Example: replace all graphics with video
Hours (to drive decision)	<40	Judgement call 40-160	>160

2.7.5 Labour Hours to Produce IMM

Estimating Labour Hours to Produce IMM

Here is a description of the type of changes you can expect during the IMM development process.

Type of Change	Description
Minor changes	Minor changes typically are those requiring less than 40 labour hours to complete. Minor changes rarely require additional funds.
Moderate changes	Moderate changes often require "judgement calls" to determine whether more funds are necessary. Often a moderate change can be made if some other aspect of the course design is reduced.
Major changes	Major changes are those requiring more than 60 labour hours to accomplish, and most likely will result in the requirement to add funds to the project.

3 HOW TO PLAN AN IN-HOUSE IMM EFFORT

3.1 Overview

Introduction The first step to deliver a quality IMM program to your customer is to develop a project plan. Without a well-developed project plan, neither you nor your 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 convenient tool to use to communicate with your customer. This chapter describes all of the activities performed during the planning phase of an IMM program.

3.2 Outline the IMM Effort

Introduction Procedures for outlining the IMM development effort are described in this section. There are four steps to outlining the IMM effort.

Step 1	Establish a development process.
Step 2	Determine project deliverables.
Step 3	Define staff positions and responsibilities.
Step 4	Develop a master schedule.

3.2.1 Step 1: Establish a Development Process

Establish a Development Process Think through the entire development process and prepare a list of steps required for each phase. Not all the steps shown in this table are needed for every project, and the last three steps apply only to projects in which IVD is the delivery system. Once you select the steps as listed, briefly write out the following information:

- Purpose of the step
- Products resulting from the step
- Documentation used in developing the products
- Personnel responsible for the step
- Review and approval process for the step

Determine Project Deliverables The project plan should clearly spell out what products you will deliver to your customer. The most common IMM products are:

- IMM treatment plan or course specification
- Storyboards and flowcharts
- IMM lessons
- Supporting materials

IMM Phases and Steps

	A	B	C
	Phase	Step	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 data bases.	Determine organisation of project data bases (graphics library, CMI, 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 data base.
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 for videodisc.	Shoot photographs and video of operational equipment, procedures, etc.; select best frames.
14		Record narration.	Record IVD narration using storyboard scripts.
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 videodisc layout.	Plan placement of frames on videodisc to reduce access time during lesson operation.
18		Review master tape or videodisc.	Perform quality control for final approval.
19		Update storyboards.	Enter final frame numbers onto storyboards.
20		Complete lesson programming.	Program video-dependent segments of lesson.

Define Staff Position and Responsibilities	The make-up of the development team depends on the characteristics of the proposed IMM and the authoring software selected for the project. As part of your project plan, you need to describe the positions and responsibilities of each IMM team member. Define their individual assignments and how they will work together as a team to produce interim products and final lessons.
Develop a Master Schedule	Develop a master schedule as part of your process outline. Define completion dates for each interim and final IMM product. The IMM development team will use this schedule to pace its efforts. The IMM management team will use this schedule to track progress on the effort.

3.2.2 Step 2: Prepare the Project Team

Introduction	Once you have developed the master schedule and you have defined the roles of all project team members, you need to prepare the project team to do the job. Do the following things: <ul style="list-style-type: none"> • Determine training requirements. • Provide documentation.
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 IMM experience, they are likely to need some training. If they do have IMM experience, they still may need formal training on the software package chosen if they lack experience with it.
Provide Documentation	The development team members will need copies of documents that explain how they are supposed to do their job. They should also receive documents that are required to develop IMM, such as: <ul style="list-style-type: none"> • Development process outline • Quality control procedures • IMM design specifications • IMM hardware and software user's manual

3.2.3 Step 3: Develop Quality Control Procedures

Introduction	The last activity performed during the planning phase is to develop the quality control (QC) procedures to give to 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. Include the following in the QC procedures: <ul style="list-style-type: none"> • Establish a review and approval process. • Develop QC job aids. • Establish a process to report discrepancies.
Review and Approval Process	The review and approval process should be established to make sure that all products meet quality standards.

A Review and Approval Form

The review and approval form should be filled out and attached to each product associated with a lesson. As the product is reviewed and approved, the document should be signed by the approving authority. The document 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.

QC Team Responsibilities

QC is the collected responsibility of the entire development team, and each member has specific review and approval duties.

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. Many items on the checklist could be taken directly from the design specification document. Your IMM job aids may use some of the same information.

QC Responsibilities of IMM Development Team

	Position Title	Quality Control Responsibility	Significance of Review and Approval Sign-Off
1	Courseware developer	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	Instructional designer	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. Develops clear, easy-to-read 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.	Online graphics have been reviewed and are judged to be correct, clear, and easy to read.
6	Media 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 HOW TO DESIGN IMM

Introduction This chapter addresses how to design an IMM course. When you design the IMM, you will use products from the ISD process, such as task analysis reports, lists of learning objectives, and target audience analysis reports.

4.1 Develop the IMM Specification

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

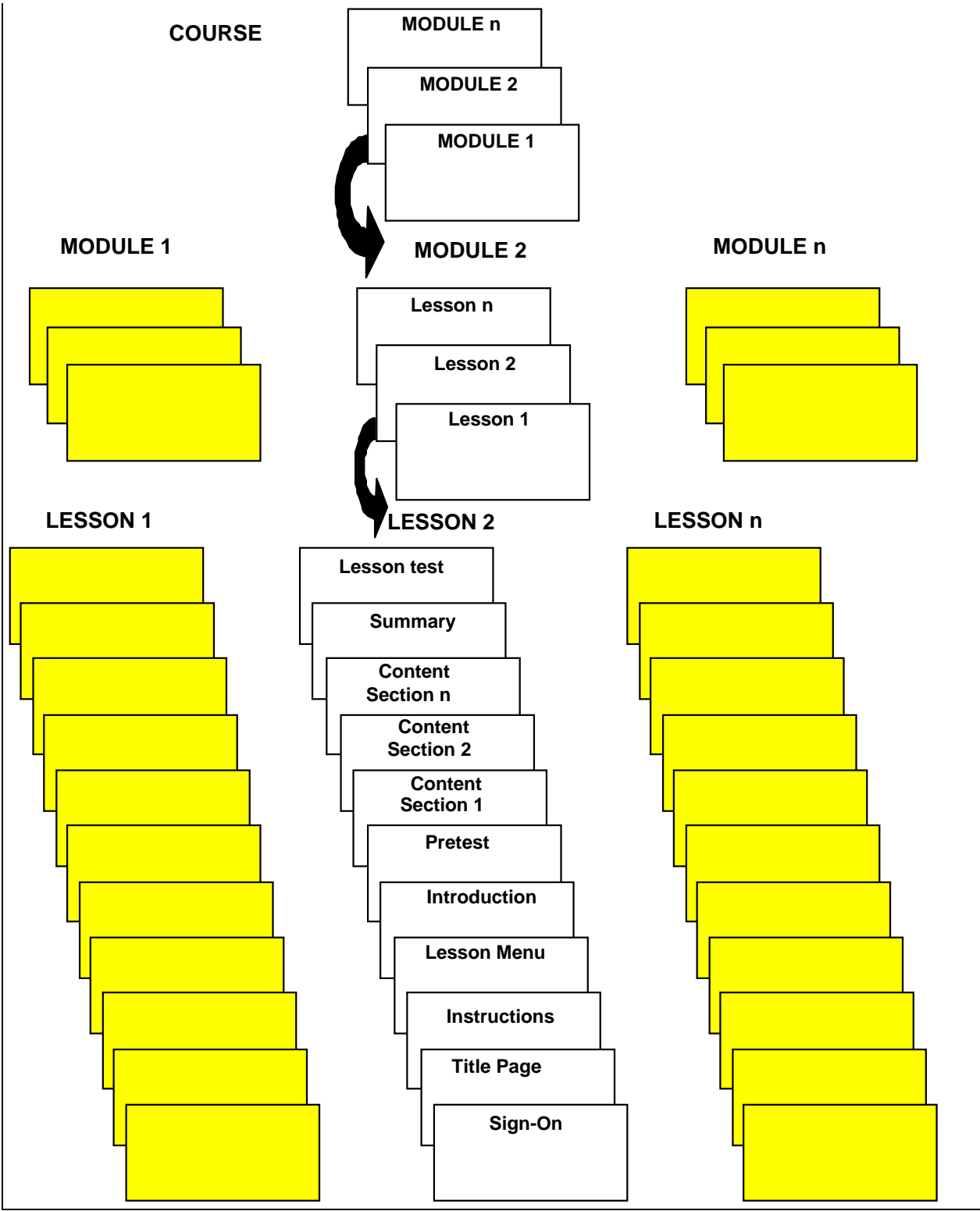
Purpose of Course/Lesson Specification There are many purposes for the course/lesson specification:

- The IMM design team uses it to guide their efforts in meeting the customer's needs.
- It serves as a vehicle to get your customer to "buy in" to your IMM efforts. If the customer does not agree with the approach as described in the design specification, you can make changes to the strategy that will not affect work already completed (like storyboards or programmed lessons).
- The design specification describes what you think is the "best approach" for presenting the IMM instruction.

Level of Detail in the IMM Course/Lesson 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, you have not thought things out thoroughly enough. The specification is like an executive summary of the IMM, not a detailed description. Jack Webb said it best: "Just the facts."

Content of the Course/Lesson Specification The course/lesson specification should include:

- An overview of the content of the course (lesson objectives).
- A brief description of the instructional strategy. This is a very important aspect of IMM design. Section B describes in detail how to determine the IMM instructional strategies.
- A high-level description of how the IMM will work from the student's perspective. Take the task data and objectives and determine the number of modules and lessons that will be required to support the objectives. 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 IMM design specification you do not need a lot of detail. You need to provide just enough information to give your developers and your customers a "feel" for the IMM.
- A top-level flowchart is a useful way to describe how the IMM will work from the student's point of view. Figure 1 provides a sample of the organisation of a typical IMM course.
- A description of the student measurement (testing) approach for the course.
- A list of supplemental materials to be developed to support the course.



4.2 Determine Instructional Strategies

Introduction Instructional strategies are the general instructional treatment given to lessons in an IMM course. In determining instructional strategies you will be concerned with ensuring that:

- The IMM design facilitates learning and processing of information.
- The IMM design accommodates the types of information or content of the program.
- Interactivity is increased.
- Degree of learner control is addressed.
- Feedback is appropriate for enhancing learning and transfer.

Each of these issues is addressed below.

Events of Instruction for IMM Particular activities or events can be designed into IMM programs to help ensure that learning occurs. The method chosen for inclusion is Gagné's "Events of Instruction."

Types of Content Content of training programs can be categorised as a particular type of information. The type of information affects the design of lessons in terms of processing required, the instructional treatment used, and requirements for practice within a lesson.

Instructional Implications of Content Type Depending on the type of content, different levels of information processing may be required.

Guidelines for Increasing Interactivity A key feature of IMM is that it provides the opportunity to involve the learner in a training program. It is important to design as much meaningful interaction as possible into an IMM program.

4.3 Events of Instruction for IMM

Events of Instruction		
Event	Purpose	Examples
1. Gain Attention	<ul style="list-style-type: none"> Focus student attention on key information Motivate 	<ul style="list-style-type: none"> Use humour Show consequences of certain actions
2. Inform Student of Objective(s)	<ul style="list-style-type: none"> Tell students what they are about to learn 	<ul style="list-style-type: none"> Tell Demonstrate Ask rhetorical questions
3. Stimulate Recall of Relevant Prior Knowledge	<ul style="list-style-type: none"> Help students retrieve background and prerequisite information 	<ul style="list-style-type: none"> Ask rhetorical questions Present a review Remind students
4. Present Information	<ul style="list-style-type: none"> Teach students the required knowledge/skills 	<ul style="list-style-type: none"> Use audio, text, video, and graphics Compare similarities and differences Point out critical and distinctive features
5. Provide Guidance	<ul style="list-style-type: none"> Enhance comprehension and retention 	<ul style="list-style-type: none"> Ask probing questions Give students hints or options for help Use mnemonics, job aids, checklists
6. Elicit Performance	<ul style="list-style-type: none"> Provide practice 	<ul style="list-style-type: none"> Ask questions Ask students to do something
7. Provide Feedback	<ul style="list-style-type: none"> Address student's misconceptions or lack of knowledge and skills 	<ul style="list-style-type: none"> Feedback can be: <ul style="list-style-type: none"> right or wrong explanation why remediation
8. Assess Performance	<ul style="list-style-type: none"> Determine if students have mastered the objectives 	<ul style="list-style-type: none"> Test on knowledge/ understanding Test on task performance
9. Enhance Retention and Transfer	<ul style="list-style-type: none"> Help students apply knowledge and skills learned 	<ul style="list-style-type: none"> Review questions missed in practice Provide a summary Practice across different situations Practice in real job environment

4.4 IMM Content Types

Content Type	Definition	Example
Fact	<ul style="list-style-type: none">• Unique, one-of-a-kind type of information	<ul style="list-style-type: none">• Parts of a car
Concept	<ul style="list-style-type: none">• Class of items that share critical common features	<ul style="list-style-type: none">• Cars• Horsepower• Torque
Principle	<ul style="list-style-type: none">• Cause-and-effect relationship that results in predictable outcomes	<ul style="list-style-type: none">• If the engine generates more horsepower, more torque is produced
Procedure	<ul style="list-style-type: none">• Series of clearly defined steps which result in achievement of a job task	<ul style="list-style-type: none">• How to change oil
Process	<ul style="list-style-type: none">• Description of how things work (i.e., what happens)	<ul style="list-style-type: none">• How a car engine works

4.4.1 Level of Processing for Content Type

Content Type	Level of Processing	Instructional Treatment	Practice Requirements
Fact	Remember	<ul style="list-style-type: none"> • Provide tutorial • Use lists, charts, or graphics (with labels) to present facts 	<ul style="list-style-type: none"> • Provide drill and practice to reinforce recall • Provide job aid if memorisation of the facts is not essential • Provide opportunities to practice facts in context (e.g., in processes or procedures)
Concept	Application	<ul style="list-style-type: none"> • Provide tutorial • Present definition, examples, non-examples, and analogies of a concept • When presenting examples and non-examples, start with clear-cut ones and then move to fuzzy ones 	<ul style="list-style-type: none"> • Provide drill and practice to reinforce classification • Use new examples and non-examples in practice • Provide opportunities to practice concepts in context (e.g., in principles)
Principle	Application	<ul style="list-style-type: none"> • Present guidelines and examples (and perhaps non-examples) to illustrate a principle • Use graphics, video, or animation • Analogies may help clarify the point 	<ul style="list-style-type: none"> • Provide drill and practice to facilitate automaticity • Provide problem-solving exercises and simulation to reinforce transfer
Procedure	Application	<ul style="list-style-type: none"> • Demonstrate steps and provide follow-along practice • Use flowcharts, action/decision tables, and checklists for mental procedures • Use video for demonstrating physical procedures 	<ul style="list-style-type: none"> • Provide drill and practice to facilitate automaticity • Provide problem-solving exercises and simulation followed by hands-on exercises in real job environment to ensure transfer
Procedure	Application	<ul style="list-style-type: none"> • Illustrate the flow of the process • Use graphics, animation, or video to portray a process if real objects are involved (e.g., blood flow in human bodies) • Use process tables or flow diagrams to present a process if it is abstract (e.g., management process) • Analogies may help clarify the point 	<ul style="list-style-type: none"> • Provide drill and practice to enhance retention • Provide problem-solving exercises and simulation to reinforce transfer

4.5 Interactivity

Definition of Interactivity	In any type of computer-based training, interactivity refers to the activities performed by both the learner and the computer. The quality of interaction depends on a number of variables, including the type of input required by the learner, how the response is analysed, and how the computer responds back to the learner.
Guidelines for Learner Control	In many instances learners can make appropriate decisions about the most effective way to proceed through a training program. Research suggests, however, that in many instances, learners do not choose the most effective route; therefore, careful consideration of learner control issues is important in the design of IMM.

4.5.1 Guidelines for Increasing Interactivity

	Guideline Description	Rationale
1	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.
2	Chunk the content into small segments and build in questions (with feedback), periodic reviews, and summaries for each segment.	Chunking 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.
3	Ask as many questions as possible without interrupting the continuity of the instructional flow.	<p>Questions:</p> <ul style="list-style-type: none"> • Produce immediate feedback to students regarding their own performance • Provide information for the system to evaluate student performance and take necessary actions • Sustain student attention by keeping them mentally active in the learning process
4	Ask a question after, but not immediately following, the related content.	A gap between a post-question and its related content forces learners to mentally search for and review necessary information, rather than repeating what they were just taught. This searching and reviewing enhances retention.
5	Sometimes a straightforward presentation of new content can be boring. Ask students a question related to the content that hasn't been taught but the answer can be figured out using previously learned knowledge.	This adds variety, challenges students, and maintains their interest.
6	Ask questions at the application rather than the memory level.	Application questions enhance attention and comprehension and facilitate transfer of learning.
7	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.
8	Consider designs where the learner 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.

4.5.2 Learner Control

Definition of Learner Control Learner control refers to the degree to which learners are allowed to take charge of the aspects of the instruction and their learning environment: what to learn and how to learn it. The table presents some guidelines for designing learner control of content, sequencing, and pace into IMM training programs.

Guidelines for Designing Learner Control into IMM

	Guideline Description	Rationale
Provide learner control over pace when:		
1	Students believe that spending more 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 more time on the topics that relate to their personal needs and goals.
2	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 learner control of sequence when:		
1	Lengthy instructional programs are introduced with no specific presentation order.	Control over sequence will help maintain learner motivation and interest.
2	Students are familiar with a topic and are able to make appropriate sequence choices.	Students can choose information which will be relevant to them.
3	The type of learning includes cognitive strategies or higher-order problem solving.	Sequence control will allow students to make selections that may facilitate flexible and novel thinking.
Note:	Do not provide sequence control to students in situations where the materials have a specific prerequisite order. Determine the amount of learner control based on your resource availability as well as these guidelines	Learning could be inhibited if the sequence is improperly chosen. The more control you allow the student over content, pacing, and sequence, the more development work and therefore the more resources will be required.
Provide full learner control of content if:		
1	Students have significant previous knowledge of the content.	Presentation of known materials could be irrelevant and uninteresting to students.

2	Students have higher ability (that is, they are "sophisticated" learners).	Sophisticated learners may be better able to make content choices based on their needs.
3	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.
4	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.
5	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.
Note: Do not provide full learner 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.

Influencing Factors

The following factors may influence your decisions regarding the amount of learner control you design into the IMM:

- Your knowledge of the target audience
- Learning skills of the target audience
- Motivation of the target audience
- Type of content
- Criticality of training
- Available resources

4.5.3 Feedback Design

Guidelines for Feedback Design

Another important aspect of good IMM design is the use of feedback to the learner.

Definition of Feedback

Feedback refers to the indication that tells the learner 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.

Content of Feedback

Feedback may consist of:

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

4.5.3.1 Guidelines for Designing Feedback for IMM

	Guideline Description	Rationale
1	Keep feedback on the same screen with the question and student response.	Reduce memory load.
2	Provide feedback immediately following a student response.	Information about test results is an important element in the learning process. Delayed feedback can confuse students.
3	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.
4	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 question.
5	Tailor the feedback to each learner's response.	Feedback should address the misconception a student may have by selecting a particular incorrect response.
6	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.
7	In simulation, feedback is embedded in how the simulated world responds to a particular learner action. 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. Later it can be phased out to facilitate transfer.
8	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.

4.6 Determine CMI and Testing Strategies

Introduction An important aspect of IMM development is test and test items design and the design of computer-managed instruction (CMI) functions and records.

4.6.1 Computer Managed Instruction

Definition of CMI CMI is the function of the IMM authoring software related to student data collection. CMI generally includes:

- Registration of the student in an IMM course.
- 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.
- Collection of data regarding the student's performance on tests and practice exercises.
- Determination of student mastery of objectives.
- Reporting of information to an instructor.
- Disenrollment of student from the course.

CMI Capabilities Prior to designing the CMI for your IMM course, you need to review the authoring software selected to determine the kind of data collection and analysis that is possible.

4.6.2 IMM Tests

Design of IMM Tests Tests are developed to measure a student's knowledge, skill, or attitude on a particular subject.

Types of IMM Tests The types of tests usually developed in IMM courses are pre-tests and criterion tests.

Pre-test	The pre-test is used to measure the student's ability to attain each objective and is used after the IMM is operational to determine what instruction the student needs.
Criterion Test	The criterion test is used to measure the student's attainment of the objectives and to measure the effectiveness of the IMM.

Tips for IMM Test Design The following table provides guidelines for designing IMM tests:

Guidelines for Designing IMM Tests

	Guideline Description	Rationale
1	Use a student's pre-test score to branch the student to "need to know" information.	This reduces student boredom by forcing them to learn things they already know.
2	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").
3	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.
4	Introduce the test by telling students how many questions they will see and how long it should take them to complete the test.	This will help students gauge how extensive the test is.
5	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 don't know the content can introduce unnecessary stress into a learning situation.
6	Provide good instructions for taking the test, including how to change answers.	This reduces the possibility of students making errors when they actually have mastered the objective.
7	Provide a method for students to review their completed test.	If students responded with a wrong answer and subsequently realise it, they should be able to correct the answer, just as they can in a paper-and-pencil testing situation.
8	Provide feedback to students' answers in the same order that they answered the questions.	This reduces confusion.
9	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 go on from there.
10	If questions are drawn from a "pool of questions," remove correctly answered questions from the pool.	The learning criterion has been achieved and students should not be required to answer these questions again.

5 Flowcharting and Storyboards

5.1 Flowcharting

Introduction	This section presents guidelines for flowcharts and storyboard development.
IMM Flowcharts	Prior to the development of the IMM 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.
Definition of an IMM Flowchart	IMM flowcharts are developed to show the layout of the entire IMM course. To save time and effort it is recommended that you use a flowcharting software tool, such as the PC-based tool called "Flowcharting 3, Version 1.1" (product of Patton and Patton Software Corporation). 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. However, some authoring software packages include a flowchart tool in the package.
IMM Flowchart Guidelines	<p>An IMM 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 IMM flowchart.</p> <ul style="list-style-type: none">• Keep it simple. It should communicate to a person without IMM experience.• Don't show individual screens on the flowchart.• Represent entire segments of the lesson by a single entry.• Show just enough detail on lesson branching to depict the overall flow.• Don't indicate specific menus, feedback, remediation, or help screens.• Show the suggested sequence of the modules and lessons.

Example of IMM Flowchart Figure 2 provides an example of an IMM flowchart.

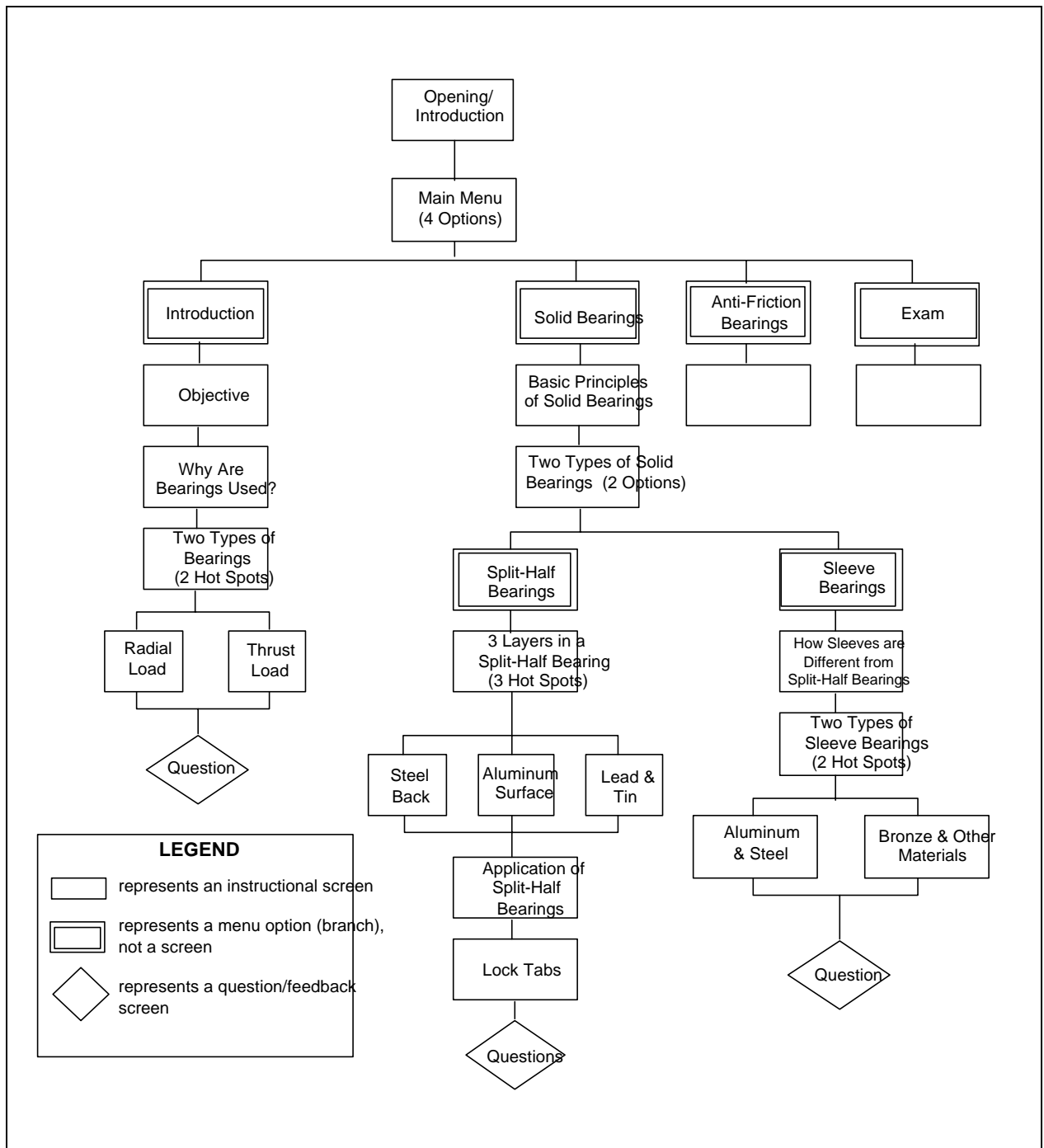


Figure 2. Example of IMM Flowchart (Subject: Bearing Identification). 1

5.2 Storyboards

Definition of Storyboard	Storyboards provide explicit information on how the IMM lessons will look and function. Consideration is given to general principles and visual, audio, and programming elements.
Purpose of Storyboards	Storyboards are used to develop the actual screen presentations for IMM.
Storyboarding Techniques	Storyboards can be developed in print format or automatically using a special purpose storyboarding tool.
General IMM Storyboard Design Principles	<p>There are a number of general IMM design principles which you should consider when developing the IMM storyboards. Examples are:</p> <ul style="list-style-type: none">• User-friendliness• Menu-driven design• Browsing alternatives• Help functions• Record tracking• Navigation• Impact of type of input devices• User messages• Cues• Capabilities of selected authoring software

5.2.1 The Steps Involved in Storyboard Development

	Action
1	Define the scope of the program and collect content. <ul style="list-style-type: none">• Know your audience.• List objectives.• Identify types of content.• Obtain content.• Verify content.• 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: <ul style="list-style-type: none">• Menu structure• List of lessons, subjects, and topics included• Navigation options• Available help functions• Program flowchart
4	Determine a high-level instructional treatment for the program.
5	Chunk information into smaller segments.
6	Determine a detailed instructional treatment for each segment (text, video, graphics, animation).
7	Document your designs in a storyboard following the guidelines provided in this reference. <ul style="list-style-type: none">• Design instruction for each segment.• Design inserted questions, reviews, and summaries for each segment.• Design practice exercises and/or test items (criterion referenced) for larger unit of instruction.
8	Constantly communicate with the production crew to fine-tune your design and to make sure it is implementable.
9	Involve subject matter experts at major milestones in validating the program: <ul style="list-style-type: none">• Completion of storyboards for one topic• Completion of video segment, graphics, etc.• Completion of a prototype lesson

5.2.2 Guidelines for Storyboarding IMM

	Guideline Description	Rationale
1	<p>Develop a user-friendly system. A user-friendly system should:</p> <ul style="list-style-type: none"> • Be self-explanatory • Make the system functions evident to students • Give students a sense of control • Acknowledge student input (audio or visual) • Be interruptible at any point (e.g., pause and continue, exit program, etc.) • Permit easy reversal of actions 	<p>A user-friendly system prevents students from becoming frustrated with the system and allows them to concentrate on learning the content of the program.</p>
2	<p>Provide a menu-driven system using the following guidelines:</p> <ul style="list-style-type: none"> • Menus should be distinguishable from the rest of the display. • Menus should be consistent in design and display. • Use meaningful labels for menu items. 	<p>Menus display available functions so students do not have to know or remember what's available at any point. They simply select from the range of possibilities offered to them.</p>
3	<p>Provide a browsing alternative.</p>	<p>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.</p>
4	<p>If possible, present information on Windows rather than on a separate screen.</p>	<p>Many computer operating systems and software applications use a windows-style user interface to display information. Since windows are portions of the computer screen that have distinct functions from the rest of the screen, they give users a unique view of information and make lessons easier to use.</p>
5	<p>Allow the student to request and receive information so that the action to request help does not affect the student's course of action.</p>	<p>Help functions should provide the student with supplemental information, explanations, or assistance without affecting the student's ongoing performance.</p>
6	<p>Clearly identify screen objects.</p>	<p>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.</p>
7	<p>Provide instructions which describe screen functions.</p>	<p>Learners need appropriate and clear navigational tools and instructions for using the tools to investigate even the most effectively designed programs.</p>

	Guideline Description	Rationale
8	Provide student record tracking.	This feature allows student performance records (scores on tests, time spent on a particular task, etc.) in a training program to be collected and analysed.
9	Provide an optional navigation lesson for new students including: <ul style="list-style-type: none"> •Overview of the content •Special features of the program •Menu structure •How to use a mouse •How to get around in the program 	Students can concentrate on learning the content rather than the navigation mechanism.
10	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: <ul style="list-style-type: none"> • Selecting an object for manipulation • Positioning an object on a display • Making a choice from a menu
11	When a mouse is used, make the acceptance area larger than the actual button for faster and easier selection, especially when the button is small. Do not overlap the acceptance area of different targets.	<ul style="list-style-type: none"> • Students may click a little off the target and nothing will happen. • Overlapping acceptance areas may cause incorrect actions to occur.
12	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.
13	Provide error messages that are informative and low-key. Error messages should: <ul style="list-style-type: none"> •Be specific about the nature and the cause of an error •Be given immediately after an error occurs •Inform students of the correct course of action to take •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.
14	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 fulfilment, and keep students oriented.
15	Know the capabilities and limitations of your authoring language. Don't design some features that cannot be implemented. Always talk to your programmers.	You don't want to waste time designing IMM which cannot be developed due to limitations of authoring language.

5.3 Visual elements

Guidelines for Visual Elements	Visual information in an IMM course serves to enhance the effectiveness of the training program. Visual elements include video, text, graphics and animation.
Guidelines for Video	Video is often a major element of IMM. 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
Guidelines for Text	Text may be the primary method for presenting content to the learner or it may serve to highlight certain information.
Guidelines for Graphics and Animation	Graphics and animation can be included in an IMM program to enhance learning.
Guidelines for Audio	Audio is often a major element of an IMM program. The audio part of a storyboard is used by a narrator during audio production..
General Guidelines for Programming	The actual programming or authoring of an IMM program typically occurs in the development phase. However, consideration needs to be given to a number of programming issues during storyboard design.
Programming Standards	It is wise to establish programming standards before you begin 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 IMM program.

5.3.1 Guidelines for Visual Elements in a Storyboard

	Guideline Description	Rationale
1	Do not jam 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).
2	When presenting a large amount of relevant information, display small chunks of information one at a time through: •Screen build-up •Window overlay •Icon buttons	<ul style="list-style-type: none"> • To reduce memory load. • To facilitate recall and comprehension. • To avoid overwhelming or intimidating students with a large amount of information.
3	Use windows to group or separate certain information from the rest of the display.	<ul style="list-style-type: none"> • To draw students' attention to a particular set of data. • To reduce the density of display on the screen by superimposing one display on top of another. • To establish student expectancy that certain data will always appear in a certain format and location.

	Guideline Description	Rationale
4	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.
5	Consider presenting information graphically and spatially (e.g., in a diagram or a flowchart).	<ul style="list-style-type: none"> Relationships among content or the overall program structure can be more easily visualised and remembered. A student's path through the program can be easily displayed and remembered.
6	<p>Techniques to keep students oriented:</p> <ul style="list-style-type: none"> Place certain information in constant locations. Provide consistent layout for same types of screens. Maintain a constant perspective in a series of visuals. If a change of perspective is necessary, cue students to the change. Use letter sizes, colours and shapes as cues. 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. Provide a bird's-eye view or long shot before zooming into details. 	<p>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.</p> <p>Establishes a frame of reference.</p>
7	<p>To position information on a screen:</p> <ul style="list-style-type: none"> Present key information in prominent areas (e.g., away from the border). Present information that changes from display to display (the body of the instruction) in the center of the screen. Present recurrent information (e.g., menu bars) in constant locations. Present navigation buttons near the borders of the screen. <p>To differentiate key information and attract/direct attention, these cueing techniques are available:</p> <ul style="list-style-type: none"> Arrows, labels, narration Display density, white space Separation of information into distinct objects Windows Colour, shape Highlighting, bordering, underlining Mixed type sizes and fonts Blinking 	Position information on a screen to establish expectancy and reduce memory load.

	Guideline Description	Rationale
8	<p>Guidelines for using the cueing techniques:</p> <ul style="list-style-type: none"> • Reserve blinking for critical situations requiring immediate student attention or action. • Borders should be distinct from the object enclosed. • Highlighting can be achieved by either brightening the area of interest or dimming the background. • Limit highlighting to 10% of the display for effectiveness. • Avoid using too many cues at one time. <p>Note: Over-saturation reduces the effectiveness of these techniques.</p>	Helps the student focus on critical elements of the instructional content.
9	<p>Guidelines for using colours:</p> <ul style="list-style-type: none"> • Too many colours on a display reduce effectiveness and aesthetic quality. • Use yellow, green, or white for text. Blue is an excellent background colour. But don't use blue for text, edges, narrow lines, or small objects. • Ensure enough contrast between the text colour and background colour. • Avoid distinctions based on the colour cue only. When using colours, always use a second cue (e.g., label, shape, texture) for colour-blind students. 	Proper use of colours helps to focus the student's attention to relevant instructional content.

5.3.2 The Video Storyboard

Video Storyboard Guidelines A video storyboard usually includes sketches of the shots and camera lenses, angles, and movements. Sample standard shot abbreviations are:

CU = Close-up
MS = Medium Shot

LS = Long Shot
OS = Over-the-shoulder Shot

	Guideline Description	Rationale
1	<p>Tips for preparing video storyboards:</p> <ul style="list-style-type: none"> •Present all information in three-shot sequences (long, medium, and close-up) to establish visual orientation. •Close-up shots grab attention and imply that something is important; long shots establish frames of reference. •A zoom-in focuses attention on a particular object while maintaining visual orientation, providing a similar effect to a three-shot sequence. •A low camera angle looking up at a person implies that the person is strong, powerful, and authoritative. •A high camera angle looking down on a person makes the person appear weak and inferior. •Try to avoid static shots when shooting motion video. •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, you don't have to focus on it as long the next time we show it. •Keep the main subject well lit and watch for possible background distractions. 	<p>Professional conventions for video production.</p> <p>The eye focuses on lighted instead of dark areas and movement instead of static images.</p>
2	<p>Consider the following motion video formats:</p> <ul style="list-style-type: none"> •Facility/event walk-through (with an off-screen narrator) •Lecture (talking head) •Demonstration (show and tell) •Interview •Talk show •Panel discussion •Dramatisation •Simulation •Hybrid format 	<p>Use appropriate format for the content presented and to maintain interest.</p>

	Guideline Description	Rationale
3	<p>Two types of simulation:</p> <ul style="list-style-type: none"> • "First-person" simulation - the program creates as closely as possible an actual situation (e.g., operating a piece of equipment or trouble-shooting). • "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. 	<p>The "third-person" simulation may be more appropriate when you want the students to explore the consequences of both right and wrong behaviours in a high-risk situation.</p>
4	<ul style="list-style-type: none"> • Use audio and video to reinforce each other. Never present two unrelated or clashing pieces of information in the two channels. • Design a visual message appropriate to the content. Make sure that each visual ties in directly to the accompanying audio. 	<p>Presenting unrelated or clashing information or a visual which is inappropriate can confuse the student.</p>
5	<p>Present a series of visuals quickly prior to or at the end of instruction.</p>	<ul style="list-style-type: none"> • Quick visual inserts presented before instruction stimulate recall of prerequisites, serve as an advance organiser, direct attention to key information, and heighten interest. • Quick visual inserts presented after instruction remind the audience of the key information (what's repeated is more important) and enhance retention (what's repeated is remembered better).
6	<p>Provide a quick showing of future events or consequences of unacceptable performance (e.g., disaster caused by human errors) prior to instruction.</p>	<ul style="list-style-type: none"> • To impress the audience with the serious outcomes associated with unacceptable performance. • To motivate the audience to adopt acceptable behaviours or practice.
7	<p>Show the same program content repeatedly in either an identical format or a different perspective to draw attention heighten interest, and enhance retention.</p>	<ul style="list-style-type: none"> • What's repeated is remembered better. • The mere fact that something is repeated implies that it is important.
8	<p>Criteria to determine the use of motion video versus still frame:</p> <ul style="list-style-type: none"> • Use motion video if the content requires motion to clearly depict the point. • Motion video adds motivational value to training. • Use still frames if production resources are limited without compromising instructional effectiveness. • Be aware of the storage limitation of your hardware: motion video takes up more storage space than still frames. 	<p>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 objectives and simulations.</p>

5.3.3 Guidelines for Text Elements of a Storyboard

	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.
2	<ul style="list-style-type: none"> • Regular text should be left-justified only. Centre headings and titles. • Use paging (not scrolling) when presenting large amounts of text. • Upper case should be reserved for emphasis and titles only. • 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	<ul style="list-style-type: none"> • Provide generous white space to separate blocks of information. • Use headings as content summarisers and navigation aids. • Convert sentences containing serial items to lists. • Organise complex information into tables to help learners integrate program content. 	Makes information more legible.
4	<p>Use attention-getting techniques:</p> <ul style="list-style-type: none"> • Limit highlighting or boldface to 10% of the display. • Underlining is best for titles or headings. • Use reverse video or blinking with extreme discretion. • Use mixed type sizes or fonts to differentiate screen components. • Use no more than three attention-getting techniques on a single screen. <p>Note: Over-saturation reduces the effectiveness of these techniques.</p>	Helps to focus the student's attention on key information.
5	Verify the appropriateness of the colours used for text under simulated presentation conditions.	The clarity of colours used for text will vary depending on such factors as lighting of the room where the IMM stations are and degree of proximity of the students to the machine.

5.3.4 Guidelines for Graphics and Animation Elements of Storyboard

	Guideline Description	Rationale
1	Use graphics or animation when: <ul style="list-style-type: none">• A realistic presentation (i.e., video) may overwhelm the audience with too much detail.• 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 (gender, ethnic groups, etc.).	Students could find it insulting.
4	Use exaggeration and humour appropriately to heighten student interest and to facilitate recall.	Increases motivation. People often remember exaggerated or humorous information better.

5.3.5 Guidelines for Audio

	Guideline Description	Rationale
1	<p>Guidelines to determine the use of text or audio for primary presentation of the program content:</p> <ul style="list-style-type: none"> • Use text when the message is long, complex, or uses technical or unfamiliar terms. • Use audio when the message is short, simple, requires immediate student response, or when the visual channel is overloaded. • 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. 	<p>Research data indicates that these guidelines make it easier for students to comprehend and process information.</p>
2	<p>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, don't let the audio compete for attention.</p>	<p>Research data indicates that these guidelines make it easier for students to comprehend and process information.</p>
3	<p>Guidelines for scripting narration:</p> <ul style="list-style-type: none"> • Think visually. • Consider students' language ability, subject matter knowledge, and vocabulary. • Use appropriate style and tone. • Write the script for the ear, not the eye. • Keep the language simple, active, and direct. • Use short sentences. • Watch out for acronyms, technical jargons, and unfamiliar terms. Define them if you have to use them. • Make the transitions from one concept to another clear. • Every piece of narration must have a corresponding visual. • Avoid long pauses in visuals waiting for extended narration to finish. • Select appropriate narrators. • Consider alternating male and female voices to provide variety and to maintain audience attention. • Read the script out loud to yourself and listen to how it sounds. 	<p>These guidelines will make it easier for the narrator or professional talent to record or read the IMM audio.</p>

	Guideline Description	Rationale
4	<p>Script format for professional talent/narrators:</p> <ul style="list-style-type: none"> • Always have your script typed. • Number all pages in the upper right-hand corner. • Use all caps. • Specify how acronyms should be read. • Spell out all numbers. • Spell difficult words and names phonetically. • Separate each letter in an abbreviation with a hyphen (e.g., I-C-W). • Describe non-verbal cues in parentheses. • Indicate pauses by the word "PAUSE" in parentheses. • Indicate emphases in parentheses if inflection is not obvious. • Double or triple space between lines. • The script should not exceed three inches in length and should use a legible type size. 	<p>These guidelines will make it easier for the narrator or professional talent to record or read the IMM audio.</p>
5	<p>Stick to the message. Tell the students only what is relevant.</p>	<p>Production of irrelevant information is a waste of money and time.</p>
6	<p>Keep the script short and simple. If the message is too long, break it into chunks separated by instructional activities (e.g., quizzes, reviews, hands-on exercises).</p>	<ul style="list-style-type: none"> • Students may get bored if they receive information passively from the program for an extended period of time. • Short audio segments are easier to program.
7	<p>Use sound effects as cues:</p> <ul style="list-style-type: none"> • A beep or "oh-oh" to clue students that they've done something incorrectly on the screen (e.g., response formatted incorrectly). • A tune associated with a certain event in the program (e.g., quizzes inserted in the instruction, feedback for incorrect responses). 	<p>Once the link between a sound effect and a specific event is established, the sound effect serves as an efficient navigation aid.</p>
8	<p>Keep production limits in mind (i.e., budget, time, technical capabilities). Allow time for audio rework, which could happen as the development effort proceeds.</p>	<p>Avoid reaching a point in the development effort where you have run out of funds and "aren't quite finished" with the program.</p>
9	<p>Provide students with headphones.</p>	<p>Students in lab environment will not be distracted by the audio from other student stations.</p>

5.3.6 Programming Standards Considerations

Consider Standards for:	
Screen Type	<ul style="list-style-type: none"> • Course/lesson/subject title screen • Introduction/overview screen • Instructional screen • Inserted question and feedback screen • Review screen • Summary screen • Practice/exercise screen • Test screen • Help screen
Screen Layout	<ul style="list-style-type: none"> • Amount of text • Text placement • Headings • Margins • Text font and size • Captions • Colour (text, background, emphasis, borders) • Attention-getting cues • paragraph indentation • Buttons (what - navigation/help/content; format - icon/text) • Menus (structure, labels) • Windows
Questions and Feedback	<ul style="list-style-type: none"> • Presentation of questions (text, audio, graphical, or combination) • Type of student responses required (pointing, selecting, or text entry) • Number of tries allowed • Hint • Type of feedback for each try (knowledge of result, explanation, remediation) • Presentation of feedback (text, audio, graphical, or combination)
Presentation Sequence in Each Segment	<ul style="list-style-type: none"> • Title screen • Opening (motivational video segment) • List of objectives • Main body of instruction with inserted questions and periodic reviews • Summary • Exercise, practice, and test
Miscellaneous	<ul style="list-style-type: none"> • Naming conventions for video segments and files • Transition • Sign-on procedures • Cursor placement on each new screen • Voice - e.g., referring to students as "YOU" and the program as "I" or a third person • Movement instruction (given via audio channel or buttons on the screen)

5.3.7 Storybook Guidelines for Programming

	Guideline Description	Rationale
1	Prepare a flowchart for the overall flow of the program.	<ul style="list-style-type: none"> • It provides a top-level organiser to guide the development of storyboards. • 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 assures that everybody uses the same abbreviations that are understood by everybody else.
3	Follow the program standards, unless you can offer a convincing argument as to why the standards are not applicable to your design.	<ul style="list-style-type: none"> • Standards save time; they eliminate the need for reinvention and modification. • Standards promote clarity and consistency. • Standards should be periodically reviewed, evaluated, and changed if necessary.

5.3.8 A Checklist for Storyboarding

Directions: Place a check in the middle column if the corresponding guideline is included in your 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. Objectives provide complete coverage of content to be taught.		
5. Instruction and test items correlate with objectives.		
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 chunked into small segments; and questions (with feedback), periodic reviews, and summaries are built in.		
3. Numerous questions are included, but do not interrupt the continuity of the instructional flow.		
4. Questions 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.		
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 learner may discover information through active exploration.		
IV. INSTRUCTIONAL DESIGN GUIDELINES: Learner Control		Comments:
1. Students are given the appropriate amount of learner control.		
2. Learner control designed can be implemented within available resources.		
3. Students are always given control over the following elements: pacing, support information, navigation, termination.		
V. INSTRUCTIONAL DESIGN GUIDELINES: Feedback Design		Comments:
1. Feedback is on the same screen with the question 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.		
VI 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.		
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.		
VII PROGRAMMING		Comments:
1. Programming acronyms are defined.		
2. Program standards are followed (e.g., screen type, screen layout, questions and feedback, sequence of presentation within subjects).		
VIII 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 chunked appropriately.		
15. Only relevant information is included in the script.		
16. Audio designed can be implemented within production limits.		
IX. 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 chunks of information are presented one at a time through use of windows, icon buttons, and screen build-up.		
6. Cueing techniques are used to attract/direct student attention (e.g., arrows, labels, colour, highlight).		
7. Attention-directing cues are gradually faded to facilitate learning transfer.		
8. Colour is used appropriately.		
9. Information is positioned appropriately on the screen (location of key information and menu bar).		
X. 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.		

XI VISUAL: TEXT DISPLAY		Comments:
1. Text is left-justified (no right justification). Headings and titles are centred.		
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 summarisers 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, colour).		
10. Spelling, grammar, and punctuation are correct.		
XII 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 humour are used appropriately to heighten student interest and to facilitate recall.		

6 HOW TO DEVELOP IMM

Introduction This chapter addresses how to develop and produce an IMM course as specified in the IMM storyboards. When you develop IMM you will be concerned with all production requirements, such as programming, producing video and recording audio, developing graphics and animation sequences, pressing laser discs or digitising video, and preparing support materials such as student workbooks.

6.1 Program the Lessons

Introduction This section presents guidelines on IMM programming. Quality programming is a key element to maintaining the courseware. The guidelines presented here are designed to improve the supportability of IMM lessons and help decrease the amount of time required to program the lessons.

Programming Guidelines The following table lists various programming guidelines, what the guidelines mean, and the rationale for implementing the guidelines.

Programming Guidelines During Development Phase of IMM

Guideline	Rationale
1. Develop templates for recurring routines.	Many IMM 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.
2. Develop object libraries.	Group recurring screen elements (such as graphics which will appear in many lessons) into object libraries for easy reuse and modification to save time.
3. Use "built-in" CMI functions if possible.	Some IMM authoring systems have "built-in" computer-managed instruction (CMI) functions and routines to track data. Use these features to save time.
4. Avoid excess use of CMI capabilities.	If your authoring system does not have built-in CMI 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 CMI 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, percent score, and whether the student passed or failed according to the training standards.
5. Standardise the file names for all CMI data.	This allows easy data consolidation and analysis across students and classes.
6. Keep track of the size and storage requirements for CMI files.	This is especially important for floppy-disk-based lessons. If you don't keep track of file sizes, you may run out of room and either lock up the lesson or lose some of the data you need.
7. Keep good software documentation.	One of the most important and costly aspects of IMM is maintenance. Detailed and accurate program documentation is critical to lesson maintenance. Keep lists of all program variables used and indicate where they are and what they are used for. 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 co-ordination. Assign a single person to function as librarian. Configuration management is critical to success.

Guideline	Rationale
8. Maintain master copies of all program data.	Keep in one package a set of master lesson disks and all lesson specifications.
9. If programming in an authoring systems internal language, try to program within a screen.	Some authoring systems provide an internal programming language to supplement the basic functions of the authoring tool. If you can program within a screen, you will significantly reduce access times while running the lesson.
10. 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 IMM software programs.
11. Formatively evaluate the IMM software before implementing the program.	Even though most IMM programmers will take painstaking efforts to ensure the program's flawless execution, bugs can still exist. Programming flaws which cause unintentional directional flows or unanticipated characters to appear can cause a student to think the entire program is poorly designed.

6.2 Produce Visual Displays and Record Audio

Introduction This section presents guidelines for producing all IMM visual displays and recording audio.

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

6.2.1 Guidelines for Producing Full Motion Video

Guidelines for Producing Full-Motion Video Using full-motion video in IMM 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.

Guidelines	Rationale
1. Ensure that sets are appropriate to actual work environment.	Enhances realism of IMM.
2. Use consistent camera angles, lighting, and distance to emphasise similarities between objects. For analog 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.
3. 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.
4. 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.
5. 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.
6. Use video or graphic window overlays to show extreme close-ups of small objects such as knobs and switches in the context of the wider- angle view.	Allows the student to see things in detail.
7. If the storyboard is automated, use a laptop computer with the storyboard during video production to immediately enter SMPTE codes for selected shots onto storyboard.	Provides an automated edit-decision list and greatly reduces amount of time needed in post-video production.

6.2.2 Guidelines for Recording Audio

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 IMM and reduces costs during production. While there are costs associated with using professional talent, money is often saved because it doesn't take them as long to learn and deliver their lines.

6.2.3 Guidelines for Displays in an IMM Program

Type of Display	Guidelines	Rationale
Text	Follow specifications in storyboard for colour and font.	Product will be produced to match specification.
Graphics	<ol style="list-style-type: none"> Follow sketches or drawings shown in storyboard. Use computer to generate graphics when possible. Identify graphics library code. Program graphics to appear on the screen before text or captions. Program large or complex graphics to appear on the screen in logical sections. Each section should finish drawing before the next begins. 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. Use an arrow instead of a box or circle to highlight graphic objects. 	<p>Product will be consistent with specification.</p> <p>Can get better detail and more sophisticated- looking graphic.</p> <p>Other developers can access the graphic for their lessons.</p> <p>Easier for the student to comprehend presentation information.</p> <p>Makes it easier for the student to view and understand what is being presented.</p> <p>Makes it easier for the student to view and understand what is being presented.</p> <p>Will help to avoid alignment problems between hardware systems.</p>
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.	Helps to focus the student's attention on key elements.
	2. If the result of motion is the focus, draw the object and then begin the animation. After the animation occurs, add labels, captions, text on the screen.	Supports learner control guidelines.

6.3 Develop Supporting Materials

Introduction	Instructor and user guides are often developed to support an IMM program. This section explains the purpose of supporting materials.
Purpose of Supporting Materials	Supporting materials should outline and describe all manual procedures required to load, start and complete the IMM program. The guides should also spell out procedures for managing the IMM program.

7 Bibliography

1. Allen, B. S. (1986). A Theoretical Framework for Interactivating Linear Video. *Journal of Computer-Based Instruction*, 13, 107-112.
2. Alessi, S. M. and Trollip, S. R. (1985). *Computer-based Instruction Methods and Development*. Englewood Cliffs, New Jersey: Prentice-Hall, Inc.
3. Anglin, G. J. and Kwak, E. (1991). Research on Pictures: Knowledge Acquisition, Visual Thinking, and Cognitive Skill Acquisition: A Guide to the Literature, 1986-1990. Paper presented at the Annual Convention of the Association for Educational Communications and Technology, Orlando, Florida, February
4. Apple Computer, Inc. (1987). *Human Interface Guidelines: The Apple Desktop Interface*. Reading, Massachusetts: Addison-Wesley Publishing Company.
5. Arnone, M. P. and Grabowski, B. L. (1991). Effect of Variations in Learner Control on Children's Curiosity and Learning from Interactive Video. In M. R. Simonson and C. Hargrave (Eds.), *Proceedings of the 1991 Convention of the Association for Educational Communications and Technology (45-67)*. Orlando, Florida: Association for Educational Communications and Technology.
6. Arwady, J. and Gayeski, D. M. (1989). *Using Video: Interactive and Linear Designs*. Englewood Cliffs, New Jersey: Educational Technology Publications.
7. Aspillaga, M. (1991a). Implications of Screen Design Upon Learning. *Journal of Educational Technology Systems*, 20(1), 53-58.
8. Aspillaga, M. (1991b). Screen Design: Location of Information and its Effects on Learning. *Journal of Computer-Based Instruction*, 18(3), 89-92.
9. Barker, P. G. (1984a). MUMEDALA3/4An Approach to Multi-media Authoring. *British Journal of Educational Technology*, 15(1), 4-13.
10. Barker, P. G. (1984b). MUMEDALA: An Approach to Multi-media Authoring. *Computers and Education*, 8(4), 463-469.
11. Berry, L. (1991). Visual Complexity and Pictorial Memory: A Fifteen Year Research Perspective. In M. R. Simonson and M. Treimer (Eds.), *Proceedings of Selected Research Paper Presentations at the 1985 Annual Convention of the Association for Educational Communications and Technology (92-102)*. Ames, Iowa: Iowa State University Press.
12. Bork, A. (1990). Practical Techniques Useful in Authoring Technology-based Learning Material. *Journal of Computer-Based Instruction*, 17(2), 53-60.
13. Borsook, T. (1991). Harnessing the Power of Interactivity for Instruction. In M. R. Simonson and C. Hargrave (Eds.), *Proceedings of the 1991 Convention of the Association for Educational Communications and Technology (103-117)*. Orlando, Florida: Association for Educational Communications and Technology.
14. Braden, R. (1986). Visuals for Interactive Video: Images for a New Technology. *Educational Technology*, 26(5), 18-23.
15. Brandt, R. H. (1987). *Videodisc Training: A Cost Analysis*. Falls Church, Virginia: Future Systems Inc.

16. Brozo, W. G., Schmelzer, R. V. and Spires, H. A. (1983). The Beneficial Effect of Chunking on Good Readers' Comprehension of Expository Prose. *Journal of Reading*, 26, 442-445.
17. Bunzel, M. J. and Morns, S. K. (1992). *Multimedia Applications Development Using DVI(r) Technology*. New York, New York: McGraw-Hill, Inc.
18. Buxton, W. (1989). Introduction to This Special Issue on Nonspeech Audio. *Human-Computer Interaction*, 4, 1-9.
19. Card, S. K., Pavel, M. and Farell, J. E. (1984). Window-based Computer Dialogues. In B. Shackel (Ed.), *Human-Computer Interaction 3/4 INTERACT '84*. Amsterdam: Elsevier.
20. Carrier, C. A. and Jonassen, D. H. (1988). Adapting Courseware to Accommodate Individual Differences. In D. H. Jonassen (Ed.), *Instructional Designs for Microcomputer Courseware*. Hillsdale, New Jersey: Lawrence Erlbaum Associates.
21. Carver, R. P. (1970). Effect of "Chunked" Typography on Reading Rate and Comprehension. *Journal of Applied Psychology*, 54, 288-296.
22. Chung, J. and Reigeluth, C. M. (1992). Instructional Prescriptions for Learner Control. *Educational Technology*. October, 14-19.
23. Clark, R. C. (1989). *Developing Technical Training (A Structured Approach for the Development of Classroom and Computer-Based Instructional Materials)*. Reading, Massachusetts: Addison-Wesley Publishing.
24. Cook, E. K. (1990). The Use of Macintosh Authoring Languages in Effective Computer-Assisted Instruction. *Journal of Educational Technology Systems*, 18(2), 109-122.
25. Copeland, P. (1988). Interactive Video: What the Research Says. *Media in Education and Development*, 2(2), 60-63.
26. Dalton, D. W. and Hannafin, M. J. (1987). Examining the Effects of Varied Computer-Based Reinforcement on Self-Esteem and Achievement: An Exploratory Study. *Association for Educational Data Systems Journal*, 18(3), 172-182.
27. Dean, C. T. (1988). Storyboarding for Computer-Based Training: A Technique in Transition. *Performance and Instruction*, 27(5), 8-14.
28. DeBloois, M. L. (1982). *Videodisc/Microcomputer Courseware Design*. Englewood Cliffs, New Jersey: Educational Technology Publications.
29. DODI 1322.20, Development and Management of Interactive Multimedia for Military Training, 14 March 1991.
30. Duchastel, P. C. (1986). Intelligent Computer-Assisted Instruction Systems: The Nature of Learner Control. *Journal of Educational Computing Research*, 2(3), 379-393.
31. Duchastel, P. C. (1988). Display and Interaction Features of Instructional Texts and Computers. *British Journal of Educational Technology*, 19(1), 58-65.
32. Duchnicky, R. L. and Kolers, P. A. (1983). Readability of Text Scrolled on Visual Display Terminals as a Function of Window Size. *Human Factors*, 25(6), 683-692.
33. Dwyer, F. M. (1978). *Strategies for Improving Visual Learning*. State College, Pennsylvania: Learning Services.

34. Fleming, M. and Levie, W. H. (1978). *Instructional Message Design*. Englewood Cliffs, New Jersey: Educational Technology Publications.
35. Frase, L. T. and Schwartz, B. J. (1979). Typographical Cues That Facilitate Comprehension. *Journal of Educational Psychology*, 71, 197-206.
36. Frick, T. W. (1989). Bayesian Adaptation During Computer-Based Tests and Computer-Guided Practice Exercises. *Journal of Educational Computing Research*, 5(1), 89-114.
37. Frick, T. W. (1990). A Comparison of Three Decision Models for Adapting the Length of Computer-Based Mastery Tests. *Journal of Educational Computing Research*, 6(4), 479-513.
38. Gagné, R. M. (1985). *The Conditions of Learning and the Theory of Instruction* (4th ed.). New York: Holt, Rinehart and Winston.
39. Garner, K. H. (1991). 20 Rules for Arranging Text on a Screen. In R. B. Frantzreb (Ed.), *Training and Development Yearbook*, 1991 Edition (4.16-4.18). Englewood Cliffs, New Jersey: Prentice-Hall.
40. Gaver, W. W. (1989). The SonicFinder: An Interface That Uses Auditory Icons. *Human-Computer Interaction*, 4, 67-94.
41. Gay, G. (1986). Interaction of Learner Control and Prior Understanding in Computer-Assisted Video Instruction. *Journal of Educational Psychology*, 78, 225-227.
42. Gayeski, D. (1983). *Corporate and Instructional Video Design and Production*. Englewood Cliffs, New Jersey: Prentice-Hall.
43. Gillingham, M. G. (1988). Text in Computer-Based Instruction: What the Research Says. *Journal of Computer-Based Instruction*, 15(1), 1-6.
44. Glynn, S. M., Britton, B. K. and Tillman, M. H. (1985). Typographical Cues in Text: Management of the Reader's Attention. In D. H. Jonassen (Ed.). *The Technology of Text (Volume Two): Principles for Structuring, Designing and Displaying Text* (192-209). Englewood Cliffs, New Jersey: Educational Technology Publications.
45. Grabinger, R. S. (1984). CRT Text Design: Psychological Attributes Underlying the Evaluation of Models of CRT Text Displays. *Journal of Visual Verbal Linguaging*, 4(1), 17-39.
46. Grabinger, R. S. (1985). Relationships Among Text Format Variables in Computer-Generated Text. Paper presented at the Annual Conference of the Association for Educational Communications and Technology, Research and Theory Division, Las Vegas, Nevada, January.
47. Grabinger, R. S. (1989). Screen Layout Design: Research into the Overall Appearance of the Screen. *Computers in Human Behavior*, 5, 175-183.
48. Grabinger, R. S. and Amedeo, D. (1985). CRT Text Layout: Prominent Layout Variables. In M. R. Simonson and M. Treimer (Eds.), *Proceedings of Selected Research Paper Presentations at the 1985 Annual Convention of the Association for Educational Communications and Technology*. Ames, Iowa: Iowa State University Press.
49. Griffin, R. E. (1992). *A Visual Primer: The Manager's Guide to Preparing a Visual Presentation*. Manuscript submitted for publication.

50. Griffin, R. E., Miller, S. K., Whiteside, J. A. and Whiteside, M. F. (1985). Business People, Personal Computers and Graphics Programs Come Together; Visual Literacy Cruising into the Future. Bloomington, Indiana: Western Sun Printing Co., Inc.
51. Grimes, T. (1990). Audio-Video Correspondence and Its Role in Attention and Memory. Educational Technology Research and Development, 38(3), 15-26.
52. Hannafin, M. J. (1984). Guidelines for Determining Locus of Instructional Control in the Design of Computer-Assisted Instruction. Journal of Instructional Development, 7(3), 6-10.
53. Hannafin, M. J. (1989). Interaction Strategies and Emerging Instructional Technologies: Psychological Perspectives. Canadian Journal of Educational Communications, 18(3), 167-179.
54. Hannafin, M. J. and Colamaio, M. E. (1987). The Effects of Variations in Lesson Control and Practice on Learning from Interactive Video. Educational Communications and Technology Journal, 35(4), 203-212.
55. Hannafin, M. J. and Hooper, S. (1989). An Integrated Framework for CBI Screen Design and Layout. Computers in Human Behavior, 5, 155-165.
56. Hannafin, M. J. and Peck, K. L. (1988). The Design, Development, and Evaluation of Instructional Software. New York: Macmillan.
57. Hannafin, M. J. and Rieber, L. P. (1989). Psychological Foundations of Instructional Design for Emerging Computer-Based Instructional Technologies: Part I. Educational Technology Research and Development, 37(2), 91-101.
58. Hartley, J. (1987). Designing Electronic Text: The Role of Print-Based Research. Educational Communications and Technology Journal, 35(1), 3-17.
59. Hathaway, M. D. (1984). Variables of Computer Screen Design and How They Affect Learning. Educational Technology, 24(1), 7-11.
60. Heines, J. M. (1984). Screen Design Strategies for Computer-Assisted Instruction. Bedford, Massachusetts: Digital Press.
61. Higginbotham-Wheat, N. (1988). Perspectives on Implementation of Learner Control in CBI. Paper presented at the Annual Meeting of the Mid-South Educational Research Association, Lexington, Kentucky, November (ERIC Document Reproduction Service No. ED 305 898).
62. Higginbotham-Wheat, N. (1990). Learner Control: When Does it Work? In M. R. Simonson and C. Hargrave (Eds.), Proceedings of the 1990 Convention of the Association for Educational Communications and Technology. Anaheim, California: Association for Educational Communications and Technology (ERIC Document Reproduction Service No. ED 323 930).
63. Hooper, S. and Hannafin, M. J. (1986). Variables Affecting the Legibility of Computer-Generated Text. Journal of Instructional Development, 9(4), 22-28.
64. Huber, D. M. and Runstein, R. E. (1989). Modern Recording Techniques (3rd Ed.). Carmel, Indiana: Howard W. Sams and Company.
65. Hunka, S. (1989). Design Guidelines for CAI Authoring Systems. Educational Technology, 29(11), 12-17.

66. Isaacs, G. (1987). Text Screen Design for Computer-Assisted Learning. *British Journal of Educational Technology*, 1(18), 41-51.
67. Iuppa, N. V. (1984). *A Practical Guide to Interactive Video Design*. White Plains, New York: Knowledge Industry Publications, Inc.
68. Jonassen, D. H. (Ed.) (1982). *The Technology of Text: Principles for Structuring, Designing, and Displaying Text*. Englewood Cliffs, New Jersey: Educational Technology Publications.
69. Jonassen, D. H. (1985a). Interactive Lesson Designs: A Taxonomy. *Educational Technology*, 25(6), 7-17.
70. Jonassen, D. H. (1985b). Interactive Lesson Designs: A Taxonomy. *Educational Technology*, 25(7), 7-17.
71. Jonassen, D. H. (Ed.) (1985c). *The Technology of Text (Volume Two): Principles for Structuring, Designing, and Displaying Text*. Englewood Cliffs, New Jersey: Educational Technology Publications.
72. Jonassen, D. H. (1988). *Instructional Designs for Microcomputer Courseware*. Hillsdale, New Jersey: Lawrence Erlbaum Associates.
73. Jonassen, D. H. (1989). Functions, Applications, and Design Guidelines for Multiple Window Environments. *Computers in Human Behavior*, 26, 185-194.
74. Jonassen, D. and Hannum, W. H. (1987). Research-based Principles for Designing Computer Software. *Educational Technology*, 27(12), 56-62.
75. Jones, M. K. (1989). *Human-Computer Interaction: A Design Guide*. Englewood Cliffs, New Jersey: Technology Publications.
76. Kang, T. J. and Muter, P. (1989). Reading Dynamically Displayed Text. *Behavior and Information Technology*, 8(1), 33-42.
77. Keller, J. and Kopp, T. (1987). An Application of the ARCS Model of Motivational Design. In C. M. Reigeluth (Ed.), *Instructional Theories in Action*. Hillsdale, New Jersey: Lawrence Erlbaum Associates.
78. Kinzie, M. B., Sullivan, H. J. and Berdel, R. L. (1988). Learner Control and Achievement in Science Computer-Assisted Instruction. *Journal of Educational Psychology*, 80(3), 299-303.
79. Kolers, P. A., Duchnicky, R. L. and Ferguson, D. C. (1981). Eye Movement Measurement of Readability of C.R.T. Displays. *Human Factors*, 23(5), 517-527.
80. Kruk, R. S. and Muter, P. (1984). Reading of Continuous Text on Video Screen. *Human Factors*, 26(3), 339-345.
81. Kulhavy, R. W. (1977). Feedback in Written Instruction. *Review of Educational Research*, 47(1), 211-232.
82. Laurillard, M. (1984). Interactive Video and the Control of Learning. *Educational Technology*, 24(6), 7-15.
83. Lehrman, P. D. and Tully, T. (1991). Catch a Wave: Digital Audio. *MacUser*, October, 94-103.

84. Litchfield, B. C. (1990). Criteria for Evaluating Videodisc Interactivity. *Performance and Instruction*, 29(6), 23-26.
85. Lucas, L. (1991). Visually Designing the Computer-Learner Interface. *Educational Technology*, July, 56-58
86. Lucas, L. (1992). Interactivity: What Is It and How Do You Use It? *Journal of Educational Multimedia and Hypermedia*, 1(1), 7-10.
87. Mager, R. (1961). On Sequencing of Instructional Content. *Psychological Reports*, 9, 405-413.
88. Marchionini, G. (1988). Hypermedia and Learning: Freedom and Chaos. *Educational Technology*, 28(11). 8-12.
89. Mason, J. M. and Kendall, J. R. (1979). Facilitating Reading Comprehension Through Text Structure Manipulation. *The Alberta Journal of Educational Research*, 25, 68-76. Cited in O'Shea, L. J., and Sindelar, P. T. (1983). The Effects of Segmenting Written Discourse on the Reading Comprehension of Low- and High-Performance Readers. *Reading Research Quarterly*, 18, 458-465.
90. Mattoon, J. S., Klein, J. D. and Thurman, R. A. (1991). Learner Control Versus Computer Control in Instructional Simulation. In M. R. Simonson and C. Hargrave (Eds.), *Proceedings of the 1991 Convention of the Association for Educational Communications and Technology* (481-498). Orlando, Florida: Association for Educational Communications and Technology.
91. Merrill, M. D. (1983). Component Display Theory. In C. M. Reigeluth (Ed.), *Instructional-Design Theories and Models: An Overview of Their Current Status*. Hillsdale, New Jersey: Lawrence Erlbaum Associates. 279-333.
92. Merrill, M. D. (1984). What is Learner Control? In R. K. Bass and C. D. Dills (Eds.), *Instructional Development: The State of the Art II*. Dubuque, Iowa: Kendall/Hunt.
93. Merrill, M. D. (1985). Where is the Authoring in Authoring Systems? *Journal of Computer-Based Instruction*, 12(4), 90-96.
94. Merrill, P. F. and Bunderson, C. V. (1981). Preliminary Guidelines for Employing Graphics in Instruction. *Journal of Instructional Development*, 4(4), 2-9.
95. MIL-HDBK-284, *Interactive Multimedia for Military Training*, Parts 1-3, 22 July 1992.
96. Milheim, W. D. (1990). The Effects of Pacing and Sequence Control in an Interactive Video Lesson. *Educational and Training Technology International*, 27(1), 7-19.
97. Milheim, W. D. and Azbell, J. W. (1988). How Past Research on Learner Control Can Aid in the Design of Interactive Video Materials. In M. R. Simonson and J. K. Frederick (Eds.), *Proceedings of the 1988 Convention of the Association for Educational Communications and Technology* (459-472). New Orleans, Louisiana: Association for Educational Communications and Technology (ERIC Document Reproduction Service No. ED 295 652).
98. Miller, R. L. (1990). Ten Good Reasons: Learning Benefits of Interactive Technologies. *The Videodisc Monitor*, February, 15-17.
99. MIL-STD-1379D, *Military Training Programs*, 5 December 1990.

100. Misanchuk, E. R. (1989a). Learner Preferences for Screen Text Attributes in a Macintosh Microcomputer Learning Environment. In *Transitions: Proceedings of the AMTEC '89 Conference*. Edmonton, AB: Association for Media and Technology in Education in Canada.
101. Misanchuk, E. R. (1989b). Learner/User Preferences for Fonts in Microcomputer Screen Displays. *Canadian Journal of Educational Communication*, 18(3), 193-205.
102. Misanchuk, E. R. (1990). Learner/User Preferences for Leading (Vertical Spacing) in Microcomputer Screen Displays. Unpublished manuscript, University of Saskatchewan, Extension Division, Saskatoon, Saskatchewan.
103. Morariu, J. (1988). Hypermedia in Instruction and Training: The Power and the Promise. *Educational Technology*, 28(11), 17-19.
104. Morrison, G. R., Ross, S. M. and O'Dell, J. K. (1988). Text Density Level as a Design Variable in Instructional Displays. *Educational Communications and Technology Journal*, 36(1), 103-115.
105. Morrison, G. R., Ross, S. M., Schultz, C. W. and O'Dell, J. K. (1989). Learner Preferences for Varying Screen Densities Using Realistic Stimulus Materials with Single and Multiple Designs. *Educational Technology Research and Development*, 37(3), 53-60.
106. Muter, P., Kruk, R. S., Buttigieg, M. A. and Kang, T. J. (1988). Reader-Controlled Computerized Presentation of Text. *Human Factors*, 30(4), 473-486.
107. Novick, M. R. and Lewis, C. (1974). Prescribing Test Length for Criterion-Referenced Measurement (Tech Bull. No 18). Iowa City, Iowa: American College Testing Program.
108. Olsen, S. L. and Huckin, T. H. (1983). *Principles of Communication for Science and Technology*. New York: McGraw-Hill Book Company. 129-130.
109. Pettersson, R. (1989). *Visuals for Information: Research and Practice*. Englewood Cliffs, New Jersey: Educational Technology Publications.
110. Pioneer Video. (1984). *Post-Production and Formatting Information*. Montvale, Jew Jersey: Pioneer Video, Inc.
111. Rattanapian, V. (1992). The Effects of Learner Characteristics and an Evaluation Override Option on Achievement, Attitude, and Pattern of Program Use in Computerized Drill and Practice. Ph.D. dissertation, The Pennsylvania State University.
112. Reigeluth, C. M. (1979). TICCIT to the Future: Advances in Instructional Theory for CAI. *Journal of Computer-Based Instruction*, 6(2), 40-46.
113. Reigeluth, C. M. (Ed.) (1983). *Instructional-Design Theories and Models: An Overview of Their Current Status*. Hillsdale, New Jersey: Lawrence Erlbaum Associates.
114. Ross, S. M., Morrison, G. R. and O'Dell, J. K. (1988). Obtaining More Out of Less Text in CBI: Effects of Varied Text Density Levels as a Function of Learner Characteristics and Control Strategy. *Educational Communications and Technology Journal*, 36(3), 131-142.
115. Ross, S., Morrison, G. and O'Dell, J. (1990). Uses and Effects of Learner Control of Context and Instructional Support in Computer-Based Instruction. Paper presented at the Annual Meeting of the Association of Educational Communications and Technology, Anaheim, California, February.

116. Salisbury, D. F., Richards, B. F. and Klein, J. D. (1985). Designing Practice: A Review of Prescriptions and Recommendations from Instructional Design Theories. *Journal of Instructional Development*, 8(4), 9-19.
117. Santiago, R. S. and Okey, J. R. (1990). Sorting Out Learner Control Research: Implications for Instructional Design and Development. Paper presented at the Annual Conference of the Association for Educational Communications and Technology, Anaheim, California, February.
118. Schaffer, L. C. and Hannafin, M. J. (1986). The Effects of Progressive Interactivity on Learning from Interactive Video. *Educational Communications and Technology Journal*, 34, 89-96.
119. Schloss, P. J., Wisniewski, L. A. and Cartwright, G. O. (1988). The Differential Effect of Learner Control and Feedback in College Students' Performance on CAI Modules. *Journal of Educational Computing Research*, 4(2), 141-149.
120. Schneiderman, B. (1987). *Designing the User Interface: Strategies for Effective Human-Computer Interaction*. Reading, Massachusetts: Addison-Wesley Publishing.
121. Schwier, R. A. and Misanchuk, E. R. (1988). The Effect of Interaction and Perceived Need for Training on Learning from Computer-Based Instruction. *Canadian Journal of Educational Communication*, 17(3), 147-158.
122. Schwier, R. A. and Misanchuk, E. R. (1993). *Interactive Multimedia Instruction*. Englewood Cliffs, New Jersey: Educational Technology Publications.
123. Seidel, R., Wagner, H., Rosenblaff, R., Hillelsohn, M. and Stelzer, J. (1978). Learner Control of Instructional Sequencing Within an Adaptive Tutorial CAI Environment. *Instructional Science*, 7, 37-80.
124. Shapiro, A. F. and Gibbs, W. J. (1993). Design Considerations When Building Multimedia Instructional Systems. *Multimedia and Videodisc Monitor*, March, 17-21.
125. Smith, S. L. and Mosler, J. N. (1984). *Design Guidelines for the User Interface for Computer-Based Information Systems*. The MITRE Corporation, Bedford, Massachusetts, 01730, Electronic Systems Division. (Available from the National Technical Information Service, Springfield, Virginia.) Cited in Schneiderman, B. (1987). *Designing the User Interface: Strategies for Effective Human-Computer Interaction*. Reading, Massachusetts: Addison-Wesley Publishing.
126. Steinberg, E. R. (1977). Review of Student Control in Computer-Assisted Instruction. *Journal of Computer-Based Instruction*, 3(3), 84-90.
127. Tennyson, R. D. (1980). Instructional Control Strategies and Content-Structure as Design Variables in Concept Acquisition Using Computer-Based Instruction. *Journal of Educational Psychology*, 72(4), 525-532.
128. Tennyson, R. D., Park, O. and Christensen, D. (1985). Adaptive Control of Learning Time and Content Sequence in Concept Learning Using Computer-Based Instruction. *Journal of Educational Psychology*, 77(4), 481-491.
129. Thompson, J. G. and Jorgensen, S. (1989). How Interactive is Instructional Technology? Alternative Models for Looking at Interactions Between Learners and Media. *Educational Technology*, 29(2), 24-26.

130. Wager, W. and Wager, S. (1985). Presenting Questions, Processing Responses, and Providing Feedback in CAI. *Journal of Instructional Development*, 8(4), 2-8.
131. Walklin, L. (1982). *Instructional Techniques and Practice*. ST(P) Handbooks for Further Education. Cheltenham, England: Stanley Thornes Ltd.
132. Watkinson, J. (1988). *The Art of Digital Audio*. London: Focal Press.
133. White, J. V. (1983). *Mastering Graphics*. New York: Bowker.