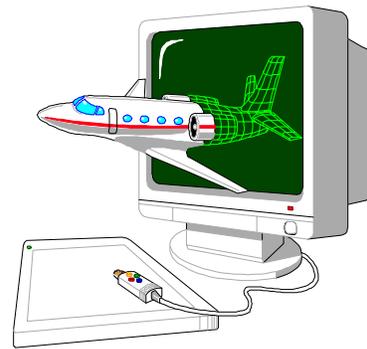

Understanding Aircraft Certification's Software Approval Process:

A Course for Managers

*IVT Course # 62830
Self-Study Video #25830*



**Developed and Presented by
Leanna Rierson
FAA, National Resource Specialist
For Aircraft Computer Software**

**Aircraft Certification Service
Federal Aviation Administration**

November 28, 2001

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Who Is the Target Audience?
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What Does the Lesson Cover?

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- B. RTCA/DO-178B Tables
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- J. Example Software Test Data
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- L. Course Evaluation Form

How Do I Use This IVT Guide?

This Interactive Video Teletraining (IVT) Guide provides you with an orientation to the IVT presentation, support materials for use during the broadcast, and the course evaluation.

Follow these steps to complete your study:

1. Review the *IVT Presentation Orientation* before the broadcast, if possible, or before you watch the self-study videotape. It provides the purpose of the presentation, the target audience, information about the instructor, what you will learn, and topics covered.
2. Turn to Appendix A, *IVT Presentation Visuals*, and refer to it during the broadcast/videotape. You can use these visuals to take notes and follow along when viewing the presentation/ self-study video.
3. Reference Appendices B-K throughout the broadcast/videotape.
4. Complete the *IVT Evaluation Form* in Appendix L and send it to your Directorate/Division Training Manager (ATM). Your comments are very important to us and will help to enhance the quality of the IVT lesson.

NOTE: The IVT broadcast will be videotaped so that it may be used as a self-study package for those who were unable to participate in the broadcast, or for those who wish to refresh their knowledge of the content presented. This IVT Guide may also be used with the self-study videotape.

What Is IVT?

Interactive Video Teletraining, or IVT, is instruction delivered using some form of live, interactive television. This course originates from the television studio at the FAA Academy in Oklahoma City. Through the IVT broadcast facility, the instructor is able to use a variety of visuals, objects, and media formats to support the instruction.

Participants are located at various receive sites around the country and can see the instructor and his/her materials on television sets in their classrooms. The participants can communicate with the instructor either through a microphone and/or the simple-to-use Viewer Response System keypads. During the live presentation, when a participant has a question or the instructor asks for specific participant responses to questions, the participant(s) can signal to the instructor using the keypad.

The collective participant responses, or the name of a specific participant signaling a question, are immediately visible to the instructor on the console at the broadcast site. The instructor can then respond as needed. When the instructor calls on a specific participant to speak from a site, participants at each of the other sites can simultaneously hear the participant who is speaking.

This guide provides you with a framework for this course as well as the following three appendices to be used during the course:

- Appendix A contains copies of the actual slides used by the instructor during the broadcast. You can use these visuals to follow along with the broadcast or when you watch the tape and to record notes directly on the pages.
- Appendices B-K contain the documents that will be discussed throughout the broadcast.
- Appendix L contains the IVT Course Evaluation Form. Please fill out this form after the IVT/self study course is finished and send the form to your Directorate/Division Training Manager (ATM).

Who Is the Target Audience?

Aircraft Certification managers (e.g., managers of offices, branches, and standards staff), project managers, and senior engineers.

Who Is the Instructor?



Leanna Rierson is the National Resource Specialist for Aircraft Computer Software. She has 13 years of experience in the computer/aviation industry. These positions include: national software program manager of the FAA Avionics Branch (AIR-130), avionics/electrical engineering specialist at the Wichita ACO, and software positions with industry at NCR and Cessna Aircraft Company. Leanna graduated summa cum laude from Wichita State University, has a Master's degree in Software Engineering, and is currently pursuing a PhD.

What Will You Learn?

At the end of the training, participants will be able to:

- Explain the importance of software in today's aviation market.
- Describe the software review and approval process.
- Explain keys for effectively managing projects involving software.
- Describe keys for managing resources for software approval.

Self-Assessment

Pre- & Post-Course Self-Assessment Questions

If you are taking this course via IVT and you are logged on to a keypad, you will be asked before and after the broadcast to complete this self assessment, using your keypads. If you are taking this via self-study video, please complete manually and return with your end of course evaluation to your directorate/division training manager (ATM).

Rate your confidence level for each of the following statements before and after completing the course.

1. I can explain the importance of software in today's aviation market.

	<u>Very Confident</u>	<u>Moderately Confident</u>	<u>Not Confident</u>
BEFORE THE COURSE:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
AFTER THE COURSE:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2. I can describe the software review and approval process.

	<u>Very Confident</u>	<u>Moderately Confident</u>	<u>Not Confident</u>
BEFORE THE COURSE:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
AFTER THE COURSE:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3. I can explain keys for effectively managing projects involving software.

	<u>Very Confident</u>	<u>Moderately Confident</u>	<u>Not Confident</u>
BEFORE THE COURSE:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
AFTER THE COURSE:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

4. I can describe keys for managing resources for software approval.

	<u>Very Confident</u>	<u>Moderately Confident</u>	<u>Not Confident</u>
BEFORE THE COURSE:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
AFTER THE COURSE:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Presentation Visuals

Appendix A

Software for Managers

Understanding Aircraft Certification's Software Approval Process:

A Course for Managers



Leanna Rierson

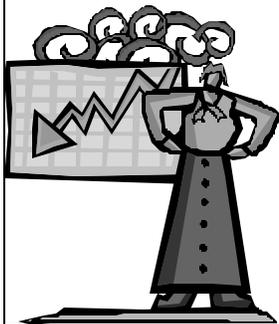
November 28, 2001

Software for Managers – Nov 2001

Slide 1

Course Objectives

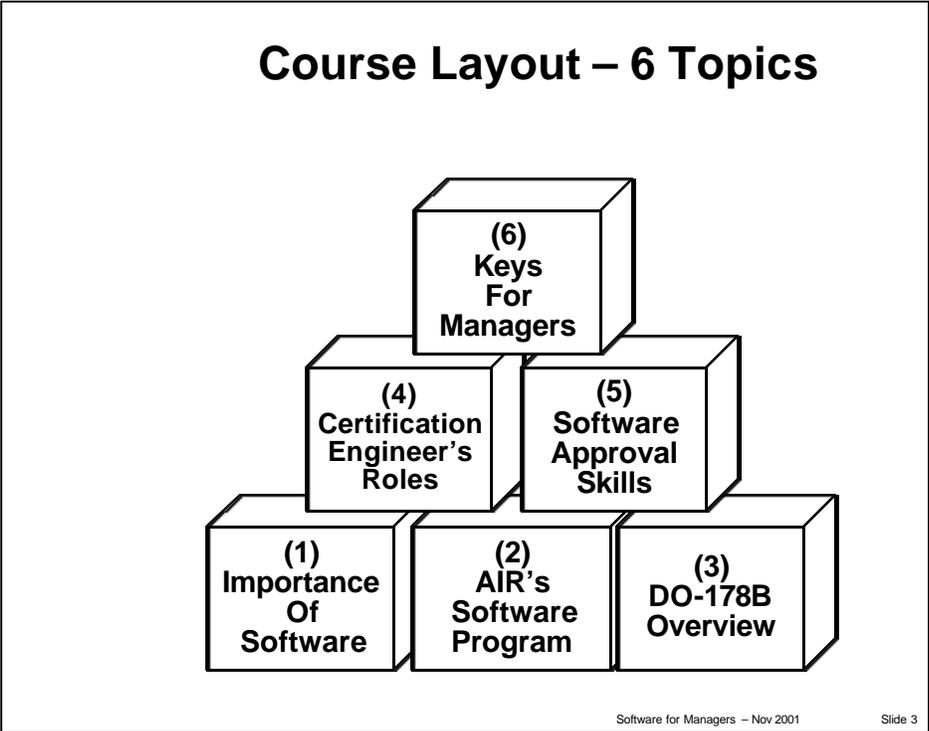
- ◆ Explain the importance of software in today's aviation market.
- ◆ Describe the software review and approval process.
- ◆ Explain keys for effectively managing projects involving software.
- ◆ Describe keys for managing resources for software approval.



Software for Managers – Nov 2001

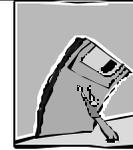
Slide 2

Software for Managers



Software for Managers

Role of Software in Aviation



- ◆ In 1999, ACO engineers performed approximately 1000 software approvals.
- ◆ ACO engineers estimate that the number of software projects in each office is growing at least 25-50% every year.
- ◆ There are over 250 DERs with software authority.
- ◆ There are many new software DERs and candidates.
- ◆ There is a growing dependence on software in aircraft and engines.
- ◆ Software technology is changing rapidly.

Software for Managers – Nov 2001

Slide 5

Software Problems That Can Lead to Safety Issues

- ◆ Operating System Problem
- ◆ Compiler Problem
- ◆ Software Requirements or Design Problem
- ◆ Coding Error
- ◆ Improper/Inadequate SW Testing
- ◆ Micro Processor Error



Software for Managers – Nov 2001

Slide 6

Software for Managers



**TOPIC 2:
AIR'S
SOFTWARE
PROGRAM**

- Past (1996-2001)
- Present (2002)
- Future (beyond 2002)

Software for Managers – Nov 2001 Slide 7

**Past
(1996-2001)**



Software for Managers – Nov 2001 Slide 8

Software for Managers

Past Accomplishments

- ◆ **Software Grand Design (96-99)**
- ◆ **Streamlining Software Aspects of Certification (97-98)**
 - <http://shemesh.larc.nasa.gov/ssac/>
- ◆ **Technical ReUsable Software Team (99-00)**
- ◆ **Established Annual Software Standardization Conference (99 & on)**
- ◆ **Established Software Training (97 & on)**
- ◆ **Performed Some Research Activities**

Software for Managers – Nov 2001

Slide 9

Past Accomplishments (cont)



- ◆ **Completed 10 Software Notices (97-00)**
 - **Field Loadable Software**
 - **Legacy Software**
 - **Parts Manufacturers Approval of Field Loadable Software**
 - **Software Review Process**
 - **Previously Developed Software**
 - **Software Tool Qualification**
 - **User Modifiable Software**
 - **Software Change Impact Analysis**
 - **Software Conformity**
 - **Level of FAA Involvement**

Software for Managers – Nov 2001

Slide 10

Software for Managers

Past Accomplishments (cont)

Established The Software
Home Page (98 & on)

<http://av-info.faa.gov/software>



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Slide 11

Present
[2002]



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Slide 12

Software for Managers

FY 02 Software Activities



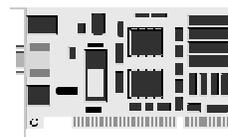
- ◆ **Integrated Modular Avionics (IMA)**
- ◆ **Object-Oriented (OO) Workshop**
- ◆ **Software Policy**
- ◆ **Software Training**
- ◆ **Certification Authorities Software Team (CAST)**
- ◆ **Software Conference**
- ◆ **Software & Digital Systems Safety (SDSS) Research**
- ◆ **Other**

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Slide 13

Integrated Modular Avionics (IMA) Team Purpose

- ◆ **Create a Technical Standard Order (TSO) for the IMA Hardware Element**
- ◆ **Create an Advisory Circular (AC) for integration, installation, certification, & continued airworthiness of IMA Systems that use IMA Hardware Elements**
- ◆ **Determine future IMA policy/guidance needs**

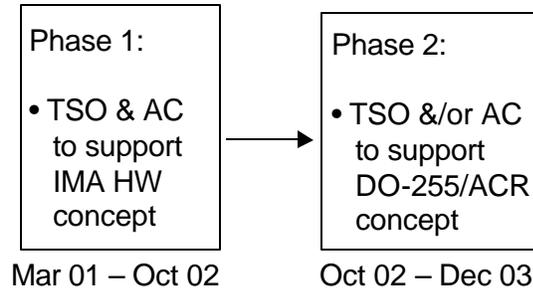


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Slide 14

Software for Managers

IMA Team Schedule



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Slide 15

IMA Team Schedule (cont)

- ✦ **TSO**
 - TSO to Federal Register – 12/01
 - Complete TSO – 6/02 (in Bus. Plan)

- ✦ **AC**
 - AC to FAA field – 11/01
 - AC to Federal Register – 6/02
 - Complete AC – 10/02

- ✦ **Start Phase 2 – 10/02**

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Slide 16

Software for Managers

OO Workshop & Guidance

- ◆ Object-Oriented (OO) technology is a “new” approach to software design
- ◆ Goal is to work with industry to draft guidance material
- ◆ OO Workshop – 4/02
- ◆ Draft Guidance Document – 9/02

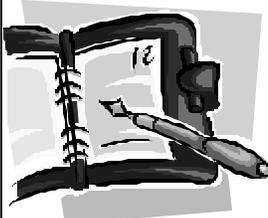


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Software Policy

- ◆ Notice 8110.reuse – 12/01
 - Reuse of software life cycle data
- ◆ Notice 8110.RSC – 2/02
 - Reuse of software components
- ◆ Mega Software Order (combines notices)
 - Route to field – 12/01
 - To Federal Register – 9/02 (in Bus Plan)
 - Complete Order – 3/03



Software for Managers – Nov 2001

Slide 18

Software for Managers

Software Training

- ◆ **Software Job Functions Course (DO-178B) – on-going**
- ◆ **Software for Managers IVT (11/01)**
- ◆ **Software Reuse IVT (4/02)**
- ◆ **Real-time Software Design (5/02 & 8/02)**



Software for Managers – Nov 2001

Slide 19

Certification Authorities Software Team (CAST)



- ◆ **International Team of Software/Certification Specialists**
- ◆ **Meet 2X per Year**
- ◆ **Support Industry Software Committees**
- ◆ **Harmonize Among Certification Authorities on Software Issues**
- ◆ **Develop Position Papers**

Software for Managers – Nov 2001

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Software for Managers

CAST (cont)

- ◆ **Example of Papers in Work:**
 - **Software Partitioning/Protection**
 - **Software ReUse in Certification Projects**
 - **Digital Databus Criteria**
 - **Transferring of Software Via Internet/E-mail**
 - **Autocode Generators**

Software for Managers – Nov 2001

Slide 21

Software Conference

- ◆ **Purpose is to provide standardization among FAA, DERs, and industry**
- ◆ **Annual event**
- ◆ **Average around 200 attendees each year**
- ◆ **Planned for 5/02 in Ft. Worth**



Software for Managers – Nov 2001

Slide 22

Software for Managers

Software & Digital Systems Safety (SDSS) Research Purpose

◆ To address safety, performance, and technology issues in the areas of:

- Software
- Complex electronic hardware
- Digital systems

◆ SDSS research supports the policy and guidance initiatives of the FAA



Software for Managers – Nov 2001

Slide 23

SDSS Research Priorities



- 1- COTS software and components
- 2- Object oriented technology
- 3- Complex electronic hardware case study
- 4- Software development tools assessment
- 5- Software verification tools assessment
- 6- New paradigm for aircraft fly-by-wire control
- 7- Databus evaluation criteria
- 8- Semiconductor wearout effects
- 9- Tool qual of complex electronic hardware
- 10- Real-time scheduling analysis

Software for Managers – Nov 2001

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Software for Managers

SDSS Research Priorities (cont)

- 11- Ethernet as an aviation databus
- 12- Avionics computer resource issues
- 13- Microprocessor evaluations
- 14- Safety engineering in software
- 15- Software service history and reliability models
- 16- Transfer of aviation data on the internet
- 17- COTS ground systems verification
- 18- Software service history case study



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Other FY02 SW Activities

- ◆ AIA/GAMA - Software Considerations in Manufacturing
- ◆ AIA/GAMA - Digital Data Storage
- ◆ Modification of Software Review Job Aid
- ◆ Supporting Numerous Aircraft and Avionics Projects



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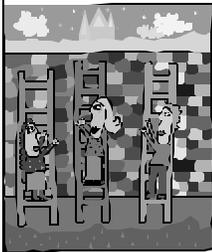
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Software for Managers



Continuing Activities

- ◆ Develop Object-Oriented (OO) Guidance
- ◆ Address Integrated Modular Avionics (IMA) Technology Long-Term Issues
 - Guidance and Training
- ◆ Software Training Efforts for FAA and Industry
- ◆ Proactive Research Initiatives
- ◆ Keep Pace with Industry and Addressing Software Needs



Software for Managers

Develop Visions to Address Software Safety Needs

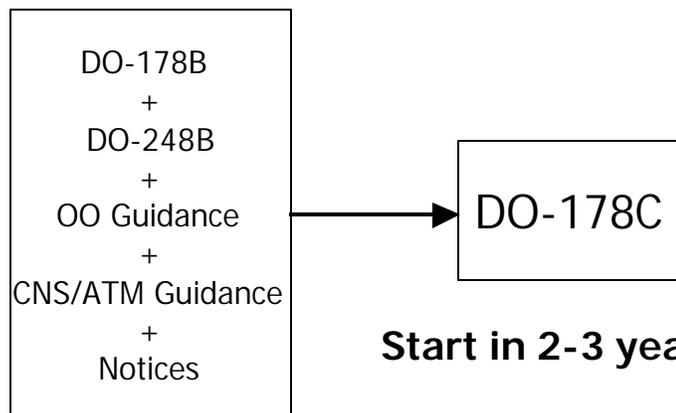
- ◆ CNS/ATM Software Vision
- ◆ Software Tools Vision
- ◆ Work with Flight Standards to Address Software Needs
- ◆ Monitor Needs of Military in Software Safety Discipline
- ◆ Addressing International Software Training Needs



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DO-178C



Start in 2-3 years

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Software for Managers

TOPIC 3: RTCA/DO-178B OVERVIEW



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Importance of DO-178B

- ◆ An internationally recognized means of compliance to the regulations
- ◆ Provides an objective approach for software developers
- ◆ Accommodates an objective approach for FAA oversight

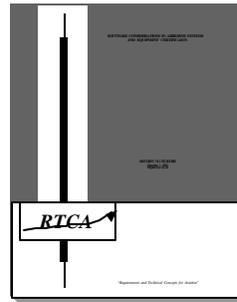
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Software for Managers

DO-178B Objectives

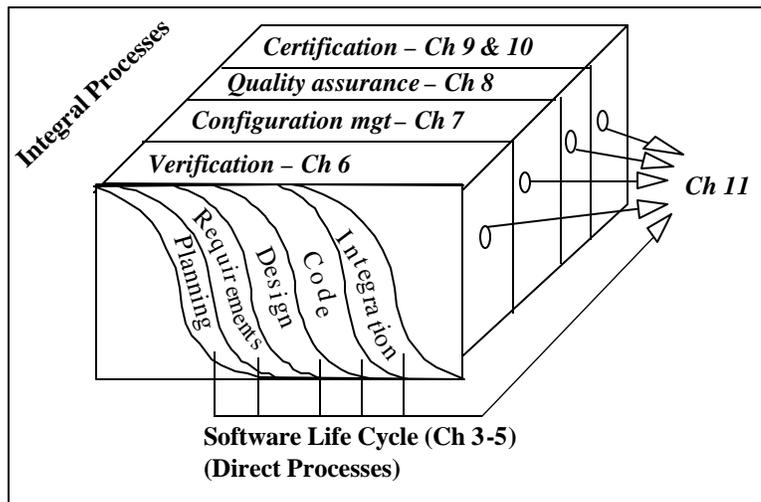
- ◆ Level A: 66 (Catastrophic)
- ◆ Level B: 65 (Hazardous)
- ◆ Level C: 58 (Major)
- ◆ Level D: 28 (Minor)
- ◆ Level E: 0 (No Effect)



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DO-178B Layout



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Software for Managers

Annex A – 10 Tables

- **Table A-1: Software Planning Process**
- **Table A-2: Software Development Processes**
- **Table A-3 to A-7: Verification Processes**
- **Table A-8: Software Configuration Management Process**
- **Table A-9: Software Quality Assurance Process**
- **Table A-10: Certification Liaison Process**

Example of Table A-4, Objective 1

	Objective		Applicability by SW Level				Output		Control Category by SW level			
	Description	Ref.	A	B	C	D	Description	Ref.	A	B	C	D
1	Low-level requirements comply with high-level requirements.	6.3.2a	●	●	○		Software Verification Results	11.14	2	2	2	

Software for Managers

TOPIC 4: Major Roles of Certification Engineers in Software Approvals

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Two Major Roles

- ◆ Determining Level of FAA Involvement in Software Projects
- ◆ Conducting Software Reviews



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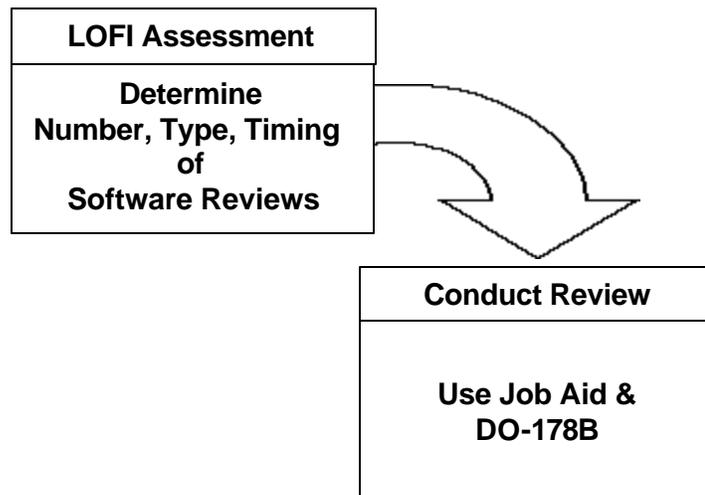
Software for Managers

Determining Level of FAA Involvement (LOFI) In Software Projects

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Tie Between LOFI and Review Process



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Software for Managers

Level of FAA Involvement (LOFI)

- ◆ Outlined in Notice 8110.87, “Guidelines for Determining the Level of Federal Aviation Administration (FAA) Involvement in Software Projects”
- ◆ Identifies how much the FAA is involved in a software project:
 - Number & type of reviews
 - Amount of data submittals
 - Amount of delegation



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LOFI (cont)

- ◆ LOFI assessment considers
 - Software Level
 - Developer’s Software Experience
 - Developer’s Software Process Capability
 - Developer’s Software Service History
 - Specifics of the Proposed Software Application
 - Designee Support
- ◆ Results in High, Medium, or Low Involvement
- ◆ Reference Appendix D

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Software for Managers

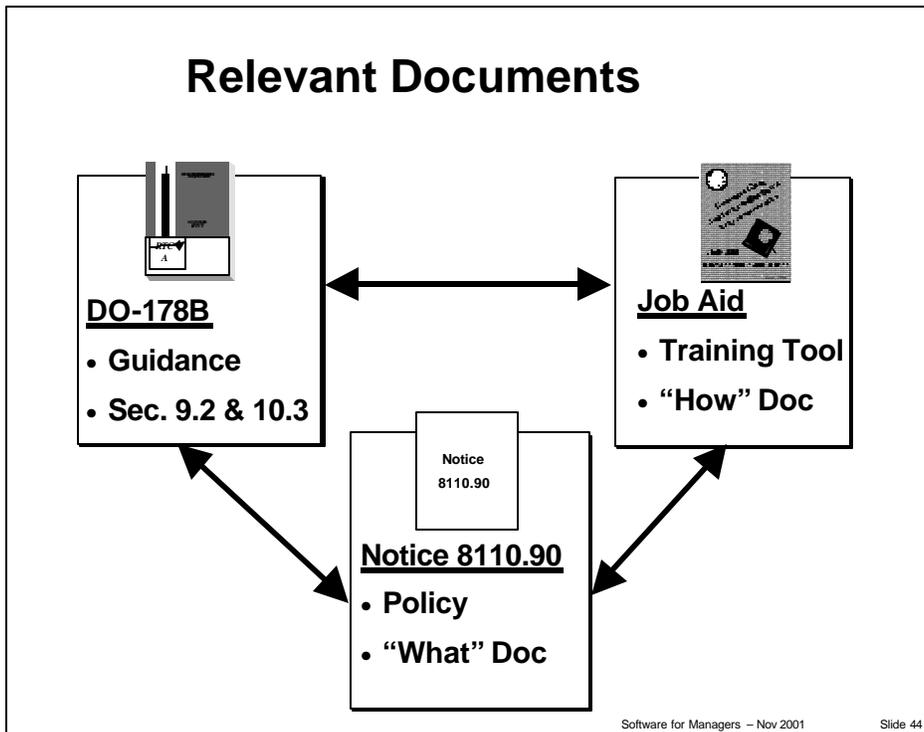


Conducting Software Reviews
From the Certification
Job Aid
AIRCRAFT CERTIFICATION SERVICE
June 1998

Conducting Software Reviews



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Software for Managers

Definition of "Review"

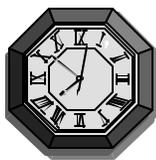


- ◆ Process of Examining Software Life Cycle Data, Project Records, and Other Evidence to Determine if DO-178B Objectives are Satisfied

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Slide 45

Purpose of Software Review



- ◆ **Address Technical Issues In A Timely Manner**
- ◆ **Examine Compliance Data -- Visibility**
- ◆ **Verify Adherence to Plans and Procedures**
- ◆ **Monitor Designees**

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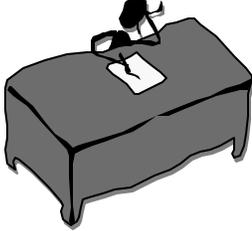
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Software for Managers

Types of Reviews



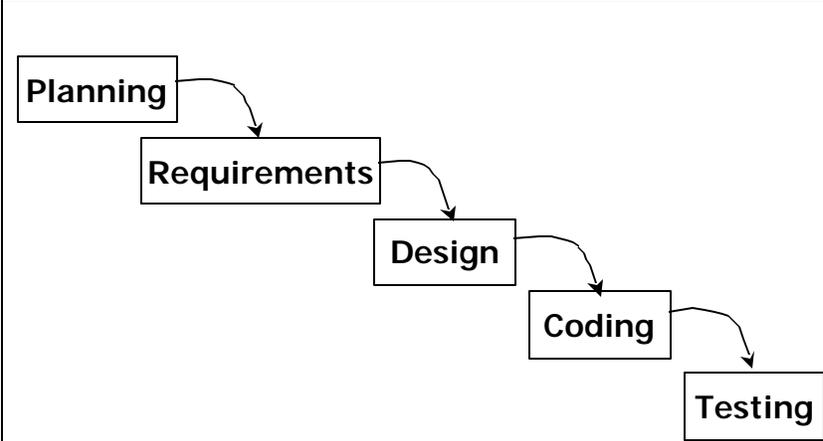
On-site



Desk-top

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Typical Development Process



```
graph TD; Planning[Planning] --> Requirements[Requirements]; Requirements --> Design[Design]; Design --> Coding[Coding]; Coding --> Testing[Testing];
```

SQA, SCM, Verification, Cert Liaison

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Software for Managers

Lots of Software DATA

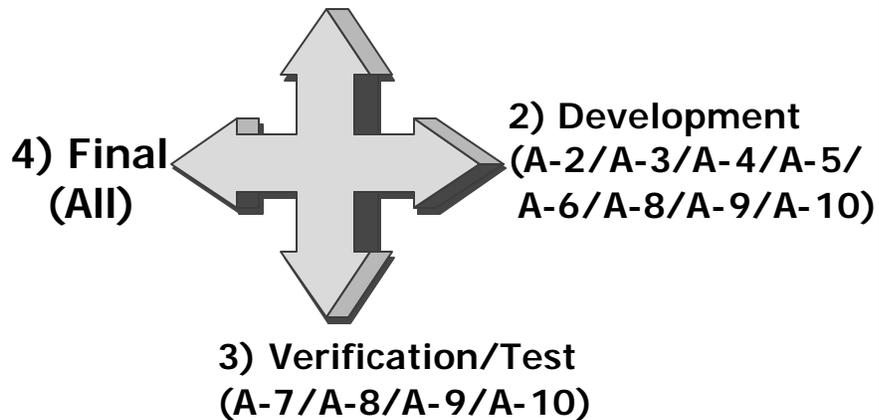


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Four Stages of Involvement (SOI) & Relationship to DO-178B

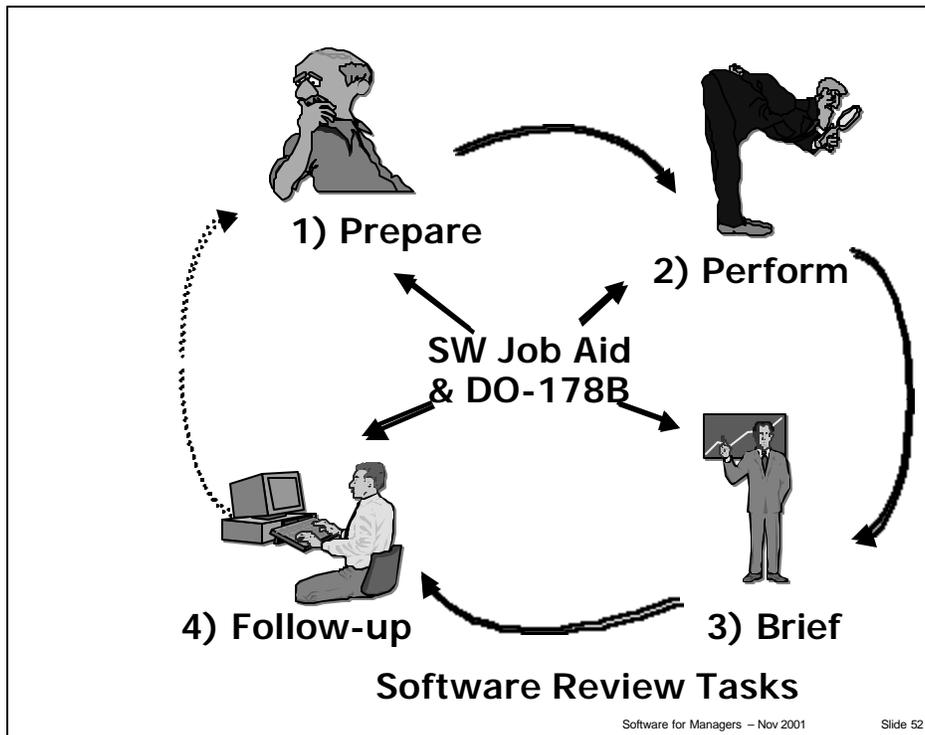
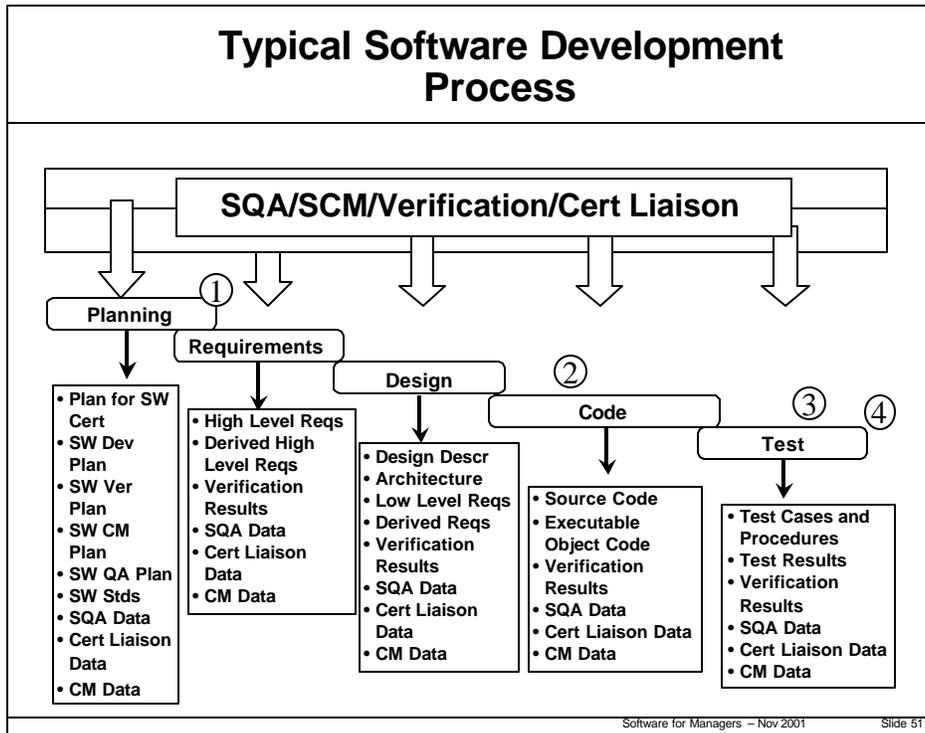
1) Planning (A-1/A-8/A-9/A-10)



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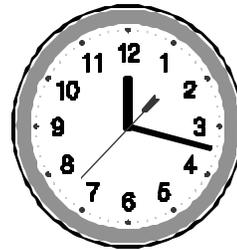
Software for Managers



Software for Managers

Typical Time Requirements for a Review

- ◆ Preparing: 1-2 days
- ◆ Performing/Documenting: 2-3 days
- ◆ Follow-Up: 1-2 days



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Topic 5: Skills Needed to Approve Software



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Software for Managers

Education/Experience Needed to Identify Safety Issues

- ◆ C or Ada Programming
- ◆ Algorithms and Data Structures
- ◆ Real-time, embedded software design
- ◆ Software testing
- ◆ Operating systems
- ◆ Fundamentals of computer hardware
- ◆ FAA Software curriculum



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Additional Recommended Education/Experience

- ◆ Assembly language
- ◆ Other programming languages (C++, Java)
- ◆ Compiler Theory

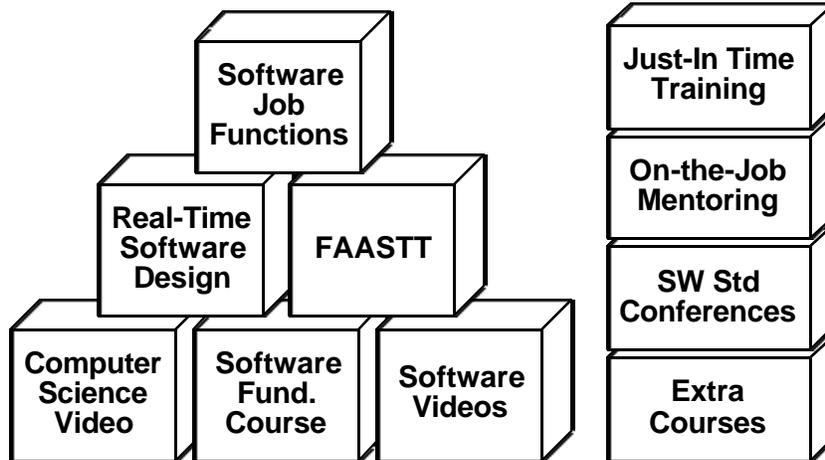


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Software for Managers

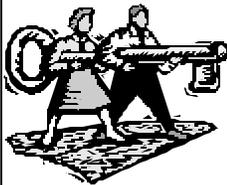
Overview Of Software Curriculum



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Slide 57

Topic 6: Keys for Managers



- Managing Projects with Software
- Managing Software Personnel

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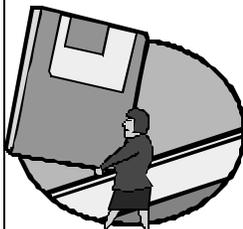
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Software for Managers



1. Identify the existence of software in your project

- ◆ Many TSO, TC, and STC projects involve software.
- ◆ Many projects have multiple software developers and suppliers, multiple software levels, and different software processes.



Software for Managers

2. Plan up-front

- ◆ Identify the SW point of contact (POC) for the project.
- ◆ Encourage LOFI assessments by the software POC.
- ◆ Request a project-level software plan, when multiple software projects exist.
 - The plan should list systems or sub-systems, suppliers, software levels, designee plan, review plan, unique issues, etc.



Software for Managers – Nov 2001

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2. Plan up-front (cont)

- ◆ Encourage early submittal and approval of PSACs.
- ◆ Identify software issues as early as possible.



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Software for Managers

3. Carry out the plan

- ◆ Support SW POC's activities.
- ◆ Review software review report summaries to keep abreast of issues.
- ◆ Communicate frequently with the SW POC.
- ◆ Keep abreast of major issues.
- ◆ Involve specialists, as needed.

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**Keys for Managing
Software Personnel**



Software for Managers – Nov 2001

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Software for Managers

1. Develop training plan for each person who approves software

- ◆ Work with the personnel to identify and address educational needs.
- ◆ Use the needs assessment, as appropriate.
- ◆ Encourage attendance of software courses and conferences.

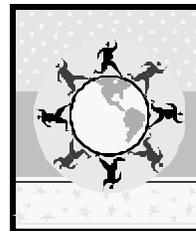


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2. Support personnel involvement in national efforts

- ◆ Encourage coordination with the national software team, as unique issues arise.
- ◆ Encourage involvement in reviewing draft policy and guidance.



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3. Support engineer's review activity

- ◆ Support use of LOFI to identify software resource needs.
- ◆ Keep abreast of major software issues and efforts.
- ◆ Participate in brief-outs of software reviews.
- ◆ Help keep the focus on safety.
- ◆ Review reports.



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4. Encourage standardization

- ◆ Identify areas where inconsistencies exist.
- ◆ Keep DERs informed.
- ◆ Identify areas where research is needed.
- ◆ Inform upper level managers of issues and needs in the software area.
- ◆ Identify software POCs/focals in each office.

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5. Keep abreast of national activities

- ◆ Review the monthly software NRS newsletter.
- ◆ Monitor the software web-site.
 - <http://av-info.faa.gov/software>
- ◆ Support the annual software conference.

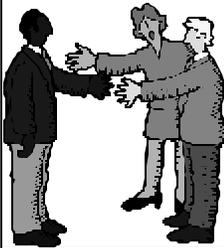


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6. Hire the right people

- ◆ Use standardized Knowledge/Skills/Abilities (KSAs) as a starting point.
- ◆ Involve software specialists in the interviewing process.
- ◆ Get new hires into training as soon as possible.



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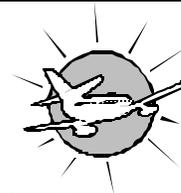
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Summary

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Summary



- ◆ **Software Is Playing An Increasingly Important Role in Aviation Safety**
- ◆ **Monitoring the Software Development Activities of Applicants is Essential to Ensure Safety**
- ◆ **Certification Engineers Need the Appropriate Training, Skills, and Support to Perform Software Reviews**
- ◆ **Your Support of the Software Specialty is Essential for Safety**

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