

3-28-2018

Task 10: Research an Alternative Instructional Design Model

Steven Hampton

Embry-Riddle Aeronautical University, hamptons@erau.edu

Jan G. Neal

Embry-Riddle Aeronautical University, nealc62@erau.edu

Luis A. Ramirez

Federal Aviation Administration

Dustin R. Talkington

Federal Aviation Administration

JMA Solutions, Inc.

Follow this and additional works at: <https://commons.erau.edu/publication>



Part of the [Higher Education and Teaching Commons](#), [Multi-Vehicle Systems and Air Traffic Control Commons](#), and the [Scholarship of Teaching and Learning Commons](#)

Scholarly Commons Citation

Hampton, S., Neal, J. G., Ramirez, L. A., Talkington, D. R., & JMA Solutions, Inc. (2018). Task 10: Research an Alternative Instructional Design Model. *Center of Excellence for Technical Training and Human Performance (TTHP): Solutions for Operational Aviation Research*, (). Retrieved from <https://commons.erau.edu/publication/1027>

The views expressed in this document do not necessarily reflect the official views or policy of ERAU or the FAA, which make no warranty, either implied or express, for the information contained in this document. Neither does ERAU or the FAA assume any responsibility or legal liability for the completeness, accuracy, or utility of this information. Some of the materials in this technical report have been excerpted or adapted as cited from academic and trade journals, textbooks, websites, and various sources under the Fair Use Doctrine of the United States Copyright Statute 17, U.S. Code, Section 107. Under these conditions, photocopy or reproduction of materials in this document may not be used for any purpose other than private study, scholarship, or research. This redacted document is approved for public distribution.

This Report is brought to you for free and open access by Scholarly Commons. It has been accepted for inclusion in Publications by an authorized administrator of Scholarly Commons. For more information, please contact commons@erau.edu.

Center of Excellence for Technical Training and Human Performance (TTHP)



TASK 10: RESEARCH AN ALTERNATIVE INSTRUCTIONAL DESIGN MODEL

Steven Hampton, Principal Investigator
Jan G. Neal, Co-Principal Investigator

EMBRY-RIDDLE
Aeronautical University.
DAYTONA BEACH, FLORIDA

Luis A. Ramirez, Sponsor
Dustin R. Talkington, Technical Monitor



JMA Solutions, Inc., Industry Advisor



March 28, 2018

© Embry-Riddle Aeronautical University (ERAU)
600 South Clyde Morris Boulevard
Daytona Beach, FL 32117

© Federal Aviation Administration (FAA)
800 Independence Avenue, SW
Washington, DC 2059

The FAA has sponsored this project through the Center of Excellence for Technical Training and Human Performance. However, the agency neither endorses nor rejects the findings of this research. This information is provided in the interest of invoking technical community comment of the results and conclusions of the research.

Copyright Disclaimer

The views expressed in this document do not necessarily reflect the official views or policy of ERAU or the FAA, which make no warranty, either implied or express, for the information contained in this document. Neither does ERAU or the FAA assume any responsibility or legal liability for the completeness, accuracy, or utility of this information.

Some of the materials in this technical report have been excerpted or adapted as cited from academic and trade journals, textbooks, websites, and various sources under the Fair Use Doctrine of the United States Copyright Statute 17, U.S. Code, Section 107. Under these conditions, photocopy or reproduction of materials in this document may not be used for any purpose other than private study, scholarship, or research. This redacted document is approved for public distribution.



Direct correspondence to Steven Hampton, Ed.D.
Embry-Riddle Aeronautical University
600 South Clyde Morris Boulevard
Daytona Beach, FL 32117

1.0 EXECUTIVE SUMMARY

Under authority of the Federal Aviation Administration (FAA), the Center of Excellence (COE) Technical Training Human Performance (TTHP) Task 10 research team has prepared a comprehensive technical report and an executive summary for the Air Traffic Organization (ATO) concerning the instructional development (ID) of occupational education and training for Air Traffic (AT) controllers and Technical Operations (TO) technicians. Research included:

- **Front-end analysis** of available FAA courses and government furnished information (GFI), including course-development documentation and associated guidance, policies, and regulations.
- **Structured and semi-structured data-gathering techniques** in cooperation with Instructional Systems Specialists (ISS), ISS Managers, and Requirements personnel.
- **Informal observations** of validation events for Air Traffic training.
- **Analysis of the relevant literature** from academic, government, and industry domains.

The executive summary describes the findings and observations of issues directly related to the ID process and potential solutions based on findings from this comparative analysis. The comprehensive report that follows includes these and additional observations and recommendations as well as the project overview, an introduction to best practice research, the research methodology, presentation and analysis of the results, and discussion of the findings and conclusions.

2.0 FINDINGS

2.1 Front-End Analysis

Examination of instructor-led training (ILT) and web-based training (WBT) revealed high quality and engaging instructional materials and courseware. Although the researchers are not AT or TO subject matter experts (SMEs), training developed in accordance with the AJI-2 Safety and Technical Training Standard Operating Procedure (2016) appears to be rigorous based on observed alignment with the course design guides (CDGs) and validation documentation used to ensure instructional soundness, technical accuracy, and function. Similarly, observations of and communications with key AJI-2 stakeholders revealed them to be extremely professional, capable, and focused on developing and delivering occupational education and training in support of the FAA's safety-critical mission.

2.2 Structured and Semi-Structured Data Gathering Techniques

Findings from semi-structured interviews of two AJI-2 managers and structured surveys of 11 ISSs revealed high ISD experience in industry, means of 22.5 and 17.4 years, respectively. FAA experience was significantly lower. Both managers have worked for the FAA for 7 years, while the average tenure for the ISSs was approximately five years but ranged from 1 to 15 years. Both managers have a Master's degree; one ISS has a doctorate degree; nine ISSs have a Master's degree; one ISS has a Bachelor's degree. Both managers and 10 ISSs have from 1 to 10 occupation-related certifications and one ISS has from 11 to 20 certifications. The mean (M) satisfaction (1 = *low* and 7 = *high*) with ATO's systematic ID process was 7 and 5.18 for the managers and ISSs, respectively. On a scale where 1 is the most difficult or problematic (lowest satisfaction) and 7 is the least difficult or non-problematic (highest satisfaction), the managers reported the lowest difficulty with the Validation phase for ILT and WBT ($M = 5.00$) and the most difficulty with the Design phase for ILT ($M = 3.00$). They reported the next most difficult was the Design phase for WBT ($M = 3.75$) followed by the Development phases for both ILT and WBT ($M = 3.75$). The mean scores across all four phases for both ILT and WBT was 3.75 to 5.00 for the managers. The ISSs reported the least difficulty with the ILT Design phase ($M = 3.90$) followed by the WBT Design phase ($M = 3.81$). They reported the most difficulty with the Analysis phase for ILT ($M = 2.90$) and WBT ($M = 3.18$) followed by the Validation phase for WBT ($M = 3.36$). The mean scores across all four phases for ILT and WBT was 3.18 ($SD = 2.11$) to 3.90 ($SD = 2.11$) for the ISSs. Although model usage varied among all respondents, both managers and 10 ISSs reported the greatest amount of experience using the classical systems approach consisting of Analysis, Design, Development, Implementation, and Evaluation phases, known as the ADDIE model.

Findings on the responses to the items related to bottlenecks and suggestions for improvement revealed five themes. The themes for bottlenecks were issues with SMEs, roles, information, external (e.g., decisions, analyses, events beyond ISS control), and management. The themes for suggestions were ID model, roles, tools, validation, and management. The chief finding regarding bottlenecks in AJI-2's ID process was SME recruitment, scheduling, and reviews. The next two most frequently cited bottlenecks concerned training analysis and requirements followed by requirement leads' knowledge of the AJI-2 ID process. The two chief findings regarding improvement were suggestions for employing only one ISS on each project and instituting process uniformity across AJI projects and FAA Academy (AMA) projects. The roles and management themes occurred in both bottlenecks and suggestions. Follow-up observations, conversations, and examination of the government furnished information (GFI) corroborated these findings for the most part.

2.3 Informal Observations

Findings from the observations of the alpha test for WBT and a first course conduct (FCC) for a blended course (ILT and WBT components) include the following information.

When one SME or student wants significant changes late in the validation process and the vendor implements these changes, it begs these questions: Is AJI-2 developing training to satisfy one person's preferences? Shouldn't AJI-2 be developing training for the target student population? Even though the students receive an email before the training explaining what their role is in the FCC, they tend to assume a lot of authority beyond the scope of their defined role for these events. However, the ISS admitted to finding numerous issues with training and recording them on an errata form to share with the ISS Lead of record. Although all of the errata were not examined, one particular issue was rudimentary; namely, document titles not matching in the student and instructor materials. Currently, the ISS and Requirements leads confer on the FCC feedback and agree on which revision requests to present to the Vendor to implement.

Observations offered by the Requirements Lead bridged several topics. The first observation was that the same SMEs tend to serve as students across many AT course developments. This relates to the question by the ISS about developing training based on the views of one SME because the same SMEs appear to be informing the development of a disproportionate amount of AT training. The Requirements Lead provided another observation related to multiple ISSs on a project; each ISS would ask the Vendor to do things differently, and in some cases contradict feedback given by the other ISS. Other issues pertained to project timelines, specifically approvals and requests. The Requirements Lead said the Vendor prepares the project schedule and the Requirements Lead only has five days to determine if the milestones will work or not, even though the Requirements Lead has to coordinate with others to make such determinations. The ATO Technical Labor Office requires all requests for students to be at least 75 days before the FCC and AJT 45-day advance notice. Plus, the schedule has to be posted 27 days in advance. Because it is difficult to predict exactly when a project will be ready for validation, the 75-day lead time to schedule the developer SMEs and test students has been problematic for all concerned in AJI-2.

General observations from this FCC included a lack of guidance regarding student expectations and an insufficiently-detailed instructor guide. The student materials did appear to be appropriately organized and detailed and the instructor materials were as well for the most part. Although the course was designed to be run with as many as 20 students, having 16 students in the validation event seemed excessive given the significant cost to the FAA to fly each student in from around the U.S., especially considering only about half of the students consistently provided actionable feedback that could be used to validate and improve the training. The Vendor expressed frustration with so many changes, some which they reported conflicted with prior input, saying they said should have been noted and discussed prior to the FCC.

2.4 Analysis of the Relevant Literature

Findings from the systematic review of the relevant literature on instructional development were paltry. Only 51 papers (0.2%) of the pool of approximately 25,296 papers met the inclusion criteria by relating to the research questions and providing the ID approach,

training context, and target audience. Besides there being few papers, even fewer rose to the evidence level from which to draw best practices. Of them, only one paper demonstrated exemplary support, although the generalizability of its findings was limited by the inherent nature of experimental designs. Four papers demonstrated adequate support; one paper demonstrated some support; 11 papers demonstrated minimal support; 34 papers failed to demonstrate any support.

Keeping in mind that some papers addressed more than one model, the coded literature encompassed 44 different models. Fifteen papers addressed the ADDIE model; five addressed an Agile or Scrum model; four addressed the 4C/ID model and a Rapid Prototyping model; three addressed the Isman model; two addressed a Project Management model; the rest of the models were each addressed in single papers.

3.0 OBJECTIVES AND CONCLUSIONS

3.1 Objective 1: Report the best practices relating to the use of ID methodologies that could facilitate course development by the ATO of occupational education and technical training of air traffic controllers and technicians.

- **Objective 1 Conclusion:** Our analysis of the literature included examination of approximately 44 ID models. The five phases in the ADDIE model are common to most models to one degree or another. The analysis of the selected literature indicated the ADDIE, Agile, Systems Approach, 4C/ID, and Rapid Prototyping models routinely result in high-quality training and education. However, there was only weak support showing these models are generalizable to different settings and learners and are sustainable by different organizations. The key differences between the activities in these models rest in whether some or all of the activities occur in series, parallel, or in cycles.

3.2 Objective 2: Report a set of criteria that identify best practices for producing occupation education and technical training within the U.S. government.

- **Objective 2 Conclusion:** The following criteria are based on expert opinions and seminal works, not on reliability measures.
 - In accordance with the Layers of Necessity model (Wedman & Tessmer, 1991) and with the principles of allocation efficiency (Avkiran, 2001), adopt a systematic ID approach or activities that match or fit the training requirements and project resources. Vary the analysis, design, development, implementation, and evaluation activities to expedite production.

- When using an iterative/incremental model (e.g., Agile, Scrum, Rapid Prototyping), begin with the longest or most complex component first to validate the design, learning strategy, and ID process. This also serves to calibrate the workgroup's understandings and expectations.
- Seek and implement SME feedback early and often on smaller chunks of the training so there are fewer and less dramatic revisions later in the process after the product is developed.
- Have the developer SME/instructor teach or facilitate the first course, especially for training developed via Rapid Prototyping, and use that instructor's feedback to inform future improvements to the training.

4.0 RESEARCH QUESTIONS (RQ) AND CONCLUSIONS

4.1 RQ 1: How do other organizations with similar regulatory, safety and/or security requirements approach their training development?

- **RQ 1 Conclusion:** The ID literature from similar government sites was sparse and some of what was found was dated. Nonetheless, the literature reviewed from numerous government training organizations and TransAsia Airways show the use of prescriptive ID models (i.e., ADDIE or SAT) still prevails. However, some government agencies and the Defense Acquisition University (DAU) are using iterative processes (e.g., Agile and Rapid Prototyping).

4.2 RQ 2: How and where can ATO leverage training development efficiencies, such as Scrum, Agile, and Rapid development approaches?

- **RQ 2 Conclusion:** The ATO can leverage an Agile-type development approach for training with high requirements (e.g., 4 hours or more of instructional time; high web interactivity, simulations, part-task training). The ATO can leverage a Rapid Prototyping approach for developing non-critical and non-high-stakes training.

5.0 CHIEF OBSERVATIONS AND RECOMMENDATIONS

5.1 Observation 1

The mid ILT development hours per course hour for FAA projects is about [REDACTED] than that for industry and it is [REDACTED] or Level 1 WBT. Typically, the Development and Validation phases consume the most time [REDACTED]. The ISSs report experiencing the most difficulty during the Analysis and Validation phases, respectively, closely followed by the Development phase for ILT and WBT. The AJI-2 managers experience the most difficulty during the Design and Development phases for ILT and the Development and Analysis phases, respectively, for WBT. FAA Order 3000.22A does not provide detailed ISD processes for training development. Nor does it allow flexibility in

the current process or offer resolutions for hindrances. The ISSs suggested using the ADDIE model for short courses, an Agile model for long courses, and mandatory briefing items (MBI), informational handouts, and videos in lieu of Recurrent WBT, hereinafter referred to as WBRT.

5.1.2 Recommendation 1

- Recommendation 1.1: Adopt a flexible (Agile) approach** to training development based on the training requirements (course length, safety criticality, professional stakes, etc.) and resources (i.e., funding and personnel available). In addition to using the current ADDIE model, adopt an Agile-ADDIE model for courses with high requirements (e.g. long or complex courses), breaking the process up into short work sprints in which a feature (ILT/WBT learning unit/module or prototype) is designed, developed, and evaluated in each sprint cycle. The most complex component should be designed, developed, and evaluated first to demonstrate validity and quality of the product design and the effectiveness of the chosen instructional strategies. By informing the design and development of the remaining components, there should be fewer and less significant revisions later in the process. However, because Agile and rapid approaches depend on high SME involvement and feedback throughout the entire project, issues with SME availability and reviews would need to be addressed beforehand, as addressed in other recommendations. Likewise, the current ISSs lack of knowledge and experience using Agile and Rapid methodologies would also need to be addressed through professional development and creation of additional SOP guidance.
- Recommendation 1.2: Adopt a rapid development process** for briefings, workshops, and courses that are informational, non-safety critical, and short in instructional time. Per JO 3000.22A: 2-4 Training Development Workgroup, the workgroups for courses, workshops and briefings are to include a Project Manager, ISS, and SME, and ISSs may serve as PMs. Therefore, rapid developments could be largely handled by an ISS and in-house SME (or SMEs, if the briefing involves more than one functional unit). As PM, the ISS would need to participate in requirements planning.
- Recommendation 1.3: Change JO 3000.22A 2-4 b. and 3-2 k** to allow use of other instructional development models or state “systematic development processes appropriate for the training solution based on the specific requirements and available resources.”

5.2 Observation 2

Too many SME revision requests, especially late in the ID process, and casual disregard for roles and specific role boundaries by the SMEs were mentioned by personnel from AJI-2100,

AJI-2300/AJI-2400, and a vendor as continual and significant problems. A preponderance of evidence shows significant change requests by SMEs are occurring late in development, after the training materials were reviewed and revised based on feedback received on the CDG, instructional materials, and course walkthrough (CWT). The prevalence of this problem indicates a role deficiency. The SMEs might not understand the purpose and objectives of each review or comprehend and appreciate the impact late change requests have on project development and delivery as well as curriculum development overall. The SMEs do not undergo any training related to the ID process besides the orientation they get in a kickoff meeting. Frequent and major rework have been exacerbating product development and delivery time, and, ultimately, project cost.

5.2.1 Recommendation 2

- **Recommendation 2.1: Clarify the SME role** as content and policy expertise decision-makers.
- **Recommendation 2.2: Create a short SME orientation course** covering IPT roles and responsibilities, and include an IPT charter that provides behavior norms (expectations) that team members sign in the project kickoff.

5.3 Observation 3

An excessive number of change requests arise during the Validation events.

5.3.1 Recommendation 3

- **Recommendation 3.1: Limit approved changes arising during Validation** to those that would have a significant impact on teaching or learning. If the purpose of validation events is to “validate the effectiveness of the instruction and its learning application to the job tasks” (FAA, 2014a, p. 25), permitted change requests should be limited to those that would dramatically affect the teaching and learning outcomes related to the targeted job tasks.
- **Recommendation 3.2: Modify the ISS role to empower ISS Leads to accept, reject, or table revisions.** The project ISS should rule at the time of the request, identifying the criticality of the change based on impacts to teaching/learning or course function. If late change requests by the SMEs, instructors, and test students would not contribute to teaching and learning as determined by the ISS, they should be tabled until after the course has run several times and the data from the end-of-course feedback and Level 3 and 4 Kirkpatrick evaluations have been collected and analyzed to justify the revisions. Furthermore, the ISS lead should document the need to validate non-critical change requests after the course has run and student feedback has been analyzed. The criticality of the

course also needs to be considered at the time of the ISS's ruling on the change. High critical/high stakes training should weigh the decision toward implementing the change as opposed to postponing the change until after the course has been run in the field. These decisions should also factor in the Vendor's input on how easy or difficult the changes would be to make before the final deliverables are due or when the course is updated at a later date.

5.4 Observation 4

The CWT is resulting in significant editorial changes, sometimes as many as 200 change requests from each SME. If the purpose of the OTO/Alpha is to locate, analyze, and remedy issues, this begs the question: How do the CWT and OTO/Alpha differ if the development SMEs are the test participants? Most changes routinely come from the same SME. Moreover, the same set of SMEs are participating in a disproportionate number of Validation events. Although more reviews and reviewers generally results in a better designed product (Nielsen, 2011), it can lead to *hill climbing* where, in accordance with the law of diminishing returns, the level of benefit gained is less than the cost to obtain that gain, especially for WBRT that is neither safety critical nor high stakes.

5.4.1 Recommendation 4

- **Recommendation 4.1: Eliminate the CWT and begin validation with the OTO/Alpha**, as appropriate. The incremental product reviews during the Development phase should accomplish the same goals as a course walkthrough for WBRT, and could for ILT when the SME/instructor teaches the OTO. The majority of change requests should be made before the OTO/Alpha test.
- **Recommendation 4.2: Do not use the developer SMEs for the OTO/Alpha** that were instrumental in the training development, as appropriate.
- **Recommendation 4.3: Reduce the number of test students during the OTO/Alpha to one for each functional unit that the training addresses**, as appropriate, and give selection priority to SME/test students who are certified in multiple areas to reduce the number needed.

5.5 Observation 5

Required training that is not successful or is not beneficial is too expensive. In the absence of passing scores for WBRT, there is no sure way to know if the training was successful (solved the training need) or beneficial (was the right solution for the problem). Verifying student achievement of the learning outcomes and conducting Levels 3 and 4 Kirkpatrick evaluations are not being done. Consequently, training effectiveness and the organizational impact of training on the NAS as it relates to Air Traffic Safety Action Program (ATSAP) data is unknown.

5.5.1 Recommendation 5

- **Recommendation 5.1: Enforce the ATO's minimum 70% passing score requirement** for all courses and measure student achievement and student satisfaction with the training.
- **Recommendation 5.2: Measure post-training job performance and organizational impact** (quality, safety, and financial metrics). The Kirkpatrick (1994) evaluation model stresses individual learner reactions to training as opposed to improvements in organizational performance. Swanson and Holton's (1999) Results Assessment System (RAS) measures performance outcomes related to the organization's mission, learning results related to the knowledge and skills transferred to the workplace, and perceptions from learners and stakeholders. The RAS approach is recommended. Organizational impact can be assessed by field managers and supervisors observing training graduates at two different time intervals (e.g., immediately post training and 30-days post training) and using a standard form to assess learning transfer and document changes in job productivity against key performance indicators (e.g., percent time saved in reduced job support or mentoring, percent increase of throughput, number of safety-related incidents). Compare these data with ATSAP data to determine if the problem has been resolved as a result of the training.

5.6 Observation 6

The task orders for new and recurrent training do not necessarily arise from a thorough preliminary analysis identifying the desired behavioral changes (needs) and learning outcomes. Decision-making during the Analysis phase regarding the type of training solution, learning strategies, and the tasks analysis is not being informed by the ISSs, the people qualified by training and experience to make such determinations. This is important, because Branchoff (1997) found that out of the 11 design activities (stages) identified by Andrews and Goodson (1980), only the thoroughness of the needs assessment ($p = .008$) and selecting the delivery system ($p = .041$) were statistically significant with perceived project success by instructional designers. The ISSs do not have input into the Media Analysis, the training modality, although it is used to determine the learning methods, strategies, and activities as well as the delivery method, platforms, and settings. Their role is to ensure instructional soundness of the training; however, they are not included in the important initial decisions that affect the instructional design of the training. Although, the project ISS/ID can, with agreement by the work group, recommend and seek approval for changing the modality, this is rarely done once the requirements have been established. Furthermore, the Top 5 only releases the NAS issues/risks once a year. Because Recurrent AT training is automatically developed every six months, NAS needs do not always inform the need for the training (task

order) nor the learning outcomes and objectives of the training solution. Consequently, additional analysis is necessary during the project kickoff, but is often inadequate given scheduling and funding constraints.

5.6.1 Recommendation 6

- **Recommendation 6.1: Include the project ISS Lead in the planning and preliminary requirements analysis** to make decisions impacting instructional design and development that affect teaching and learning.
- **Recommendation 6.2: Redefine the Requirements Lead role to portfolio and project management.**
- **Recommendation 6.2: Develop an accessible online job-task database** and maintain its currency, so that project workgroups can access task analysis data when needed.

Table of Contents

	Page
Executive Summary	3
Chapter 1: Introduction	19
Project Overview	22
Description	22
Purpose	22
Goals	22
Goal 1	22
Goal 2	22
Objectives	23
Objective 1	23
Objective 2	23
Problem Statement	23
Research Questions	23
Research Question 1	23
Research Question 2	23
Assumption	23
Delimitations	23
Delimitation 1	23
Delimitation 2	23
Limitations	23
Limitation 1	23
Limitation 2	23
Limitation 3	24
Period of Performance	24
Milestones	24
Summary	24
Chapter 2: Methodology	27
Best Practice Research	27
Research Design	27
Sources of the Data	28
Interview and Survey Data Collection	29
Observational Data Collection	29
Literature Review	29
Case Success Method	30
Evidence-Based Best Practices (EBBP)	30

Best Practices (BP).....	31
Promising Practices (PP).....	31
Evaluation Strategy.....	31
Criterion 1.....	31
Attribute 1.....	31
Attribute 2.....	31
Criterion 2.....	31
Attribute 1.....	31
Attribute 2.....	31
Attribute 3.....	31
Criterion 3.....	32
Attribute 1.....	32
Attribute 2.....	32
Attribute 3.....	32
Hierarchy of Evidence.....	32
Summary.....	32
Chapter 3: Results	35
Project Phase 1: AJI-2100 ID Process Analysis	38
Analysis Phase	43
Design Phase.....	45
Development Phase.....	46
Instructor-Led Training (ILT).....	46
Web-Based Training (WBT).....	47
Validation Phase	47
ILT Validation	48
WBT Validation	48
On-Site Observations	50
Recurrent WBT Training.....	50
Blended Training.....	51
Course Examples.....	53
ILT Example	54
WBT Example	54
Blended Example.....	55
Survey Results.....	56
Project Phase 2: Literature Analysis	62
Site Context.....	62

Regulatory Constraints	62
Alternative ISD Models	62
Dick and Carey's Systems Approach	63
Successive Approximation Model (SAM)	63
Agile Learning Design (ALD)	64
A.G.I.L.E.	65
Scrum	66
Rapid Models	67
Literature Search Strategy.....	69
Selection Criteria.....	69
Summary.....	74
Chapter 4: Discussion and Conclusions.....	75
Discussion.....	75
Conclusions.....	80
Chapter 5: Recommendations.....	83
List of References	93
Appendixes	101
A: TTHP Task 10: Alternative ID Models Survey	102
B: List of Definitions	110
C: AJI-2000 SOP ISD Process	115
D: Flight Plan Data (60004723) ILT Project Schedule	116
E: SBS Fundamentals (68000398) WBT Project Schedule	117
F: JO 3000.22A Requirements Checklist for Technical Training	118
G: JMA ADDIE and SAM Development Hours / Course Hour.....	120
H: Proposed Agile AJI-2 Process	121
I: Researchers' Biographies	122

List of Tables

Table		Page
1	Project Milestones and Dates	24
2	Scale for Coding Best Practice Evidence	32
3	Types of Training Events	36
4	Development Guides, Deliverables, and Tools Used by AJI-2000	40
5	REDACTED.....	41
6	REDACTED.....	41
7	REDACTED.....	42
8	REDACTED.....	55
9	REDACTED.....	56
10	Highest Education Degree and Certifications.....	57
11	Instructional Systems Design Experience	57
12	Mean (SD) Expertise, Satisfaction, and Difficulty with the ATO Process	58
13	Instructional Systems Specialists Model Use	59
14	Themes for Bottlenecks and Improvements.....	61
16	Summary of Development Approaches.....	68
17	Literature Search.....	69
18	Source Title, Model/Approach, Average Code	70
19	Model Frequency	73
20	Site, Domain, Model, Delivery Methods	74
21	Unified Modeling Language (UML) Features and Applications	92

List of Figures

Figure		Page
1	Research Activity Flowchart	28
2	AJI Organizational Training-Development Task Flow	37
3	Systematic Development Process and Documentation Used by AJI-2100	39
4	Excerpt from a Preliminary Analysis Report.....	43
5	Excerpt from a Task Analysis	44
6	Media Selection Process	44
7	Course Priority Matrix	50
8	REDACTED.....	54
9	REDACTED.....	54
10	REDACTED.....	55
11	REDACTED.....	55
12	Bottlenecks Reported by the Instructional Systems Specialists	60
13	Suggestions Reported by the Instructional Systems Specialists	61
14	ADDIE Model	62
15	Dick and Carey's Systems Approach Model	63
16	Successive Approximation Model (SAM)	64
17	Agile Learning Design (ALD) Model	65
18	A.G.I.L.E. Instructional Design Model.....	66
19	Scrum Model and Sprint Cycle	67
20	Rapid Application Development (RAD) Model	68
21	Instructional Development Decision Tool	79
22	Example Analysis Object for a Performance Case Model.	91

PAGE INTENTIONALLY LEFT BLANK

Chapter 1: Introduction

Distinguishing between instructional theory and practice can be confusing, primarily because terms may lack common definitions and usage. Practitioners often swap the terms instructional design process, instructional development (ID) model, and instructional systems development (ISD) process (Reigeluth, 1999). Therefore, it is essential to begin by defining the terminology inherent to understanding the framework of this study. Instructional design theory embodies different theories, models, and strategies, and is a descriptive and systematic approach for understanding, originating, and improving education and training (Reigeluth, 1983). Its focus is on how to teach. It is not on what to teach (the domain of curriculum theory), nor on how students learn (the domain of learning theory), nor on how training is developed (the domain of instructional-design process), nor on how knowledge is applied to learning systems (the domain of instructional technology). While ID represents the entire process from planning to implementation, this study focuses on the practices of creating and validating education and training and how to optimize such practices.

The goal of every ISD project is to produce quality instruction that serves an education or training need (Romiszowski, 1982, 1984). The desired outcomes of the ISD process, as well as instructional development-, implementation-, and management models, are instructional effectiveness, efficiency, and appeal (Reigeluth, 1983, 1999). Measures of outcome effectiveness rely on various kinds of student achievement; typical measures of outcome efficiency divide instructional effectiveness by the instructional time or by the costs of developing and delivering the instruction; measures of outcome appeal use student satisfaction or motivation to continue with learning (Reigeluth, 1983, p. 20). Effectiveness and efficiency are of special interest in this study because they determine productivity, which informs what ID process might be a better return on investment for an organization (McGee, 2006). Yet, determining which process is best, or preferable, is more complex than simply measuring productivity; model preferability is “the extent to which a method is better than other known methods for attaining the desired outcome” (Reigeluth & Frick, 1999, p. 634). The considerable length of time that it can take to develop a course, to say nothing of the development costs, speaks to the importance of choosing the best ID process or processes to use under a set of given circumstances.

Although instructional design models are prolific, many are derivations of the Systems Approach to Instructional Design (SAID) (Baba, 2016). The most widely used is the ADDIE model (Morrison, Ross, Kalman, & Kemp, 2012), a systematic approach that originated with the U.S. military (Gibbons, 2015). With its Analysis (A), Design (D), Development (D), Implementation (I), and Evaluation phases and 19 standardized and repeatable steps, it and similar systematic approaches are highly prescriptive processes (Branson, Rayner, Cox, Furman, King, & Hannum, 1975; Watson, 1981). However, rarely, if ever, is the exact model followed in real life (Leigh & Tracy, 2010; Neal & Hampton, 2016; Visscher-Voerman & Gustafson, 2004; Wedman & Tessmer, 1991, 1993;), the implication being that an ideal model does not exist (Parnas & Clements, 1986). The reasons vary, but poor communication by and between stakeholders and changes in requirements often lead to project creep. Scope changes can range from rework to extensive project reboots, either of which can be both costly and time consuming.

The purpose of an ID model is to provide systematic procedures for developing training both consistently and reliably (Branch & Merrill as cited in Reiser & Dempsey, 2012, p. 8). However, following a process precisely without regard for the type of solution needed is also inefficient and costly. An extreme example is following the ADDIE model to develop a job aid.

Not only would this consume more resources than is necessary, protracting development would also delay delivery of the support to workers needing the information. This would incur additional costs in terms of reduced work productivity, not to mention the possibility of unwanted consequences of delays that could compromise operational safety or security. Although the ADDIE model and other waterfall-type approaches have a long history of extensive use, chief complaints are that they take too long and are too prescriptive, costly, and not responsive to emergent needs of students, instructors, and organizations alike (Irlbeck, et al., 2006; Kruse, 2009; Sims & Jones, 2003; Wedman & Tessmer, 1991, 1993). Good ID models and practices embody characteristics of general systems theory described by Branch and Merrill as “systematic, systemic, responsive, interdependent, redundant, dynamic, cybernetic, synergistic, and creative (as cited in Reiser & Dempsey, 2012, p. 8). However, frequent changes in regulatory policies, modernizations in equipment, and innovations in educational technologies necessitate the use of ID models that emphasize rapid, responsive, versatile, and cost-effective development, delivery, and maintenance of training solutions (Neal & Hampton, 2016; Rico, 2008, 2007a, 2007b).

In discussing fundamental and transformative changes needed in the instructional design field, Reigeluth (1996) argued that the standard process of completing all of the analysis activities first and completing all of the evaluation activities last is a senseless way to produce learner-focused instruction, especially training and education addressing occupational performance problems. Although he did not call for rejection of the ADDIE model, he has advocated for a “user-designer approach to the ISD process, which conceives of the ISD process as series design decisions, each which requires a cycle of analysis, synthesis, evaluation, and change (ASEC)” (Reigeluth, p. 19). The “just-in-time analysis decisions. . . . [and] . . . zero-delay evaluation” (p. 15) is what set his ASEC approach apart from classical linear or rectilinear models. Today, numerous ID models are employing this sort of iterative and incremental, or curvilinear, production process.

Instructional development models vary considerably, and while some are validated, many are not, and some have very limited use (Gustafson & Branch, 1997; 2002). Key differences include origin—whether the model is founded in theory or practice; function—whether its purpose is conceptual or procedural; and scheme—whether its activities are sequenced by interdependent tasks or by separate processes (Lee, & Jang, 2014). For example, out of the 40 models analyzed by Andrews and Goodson (1980), only three included the 14 common development tasks: outcomes, tests, analysis, learner attributes, strategy, media, development, tryout/revision, need, alternatives, constraints, and costs (p. 15). Nonetheless, just because a model includes all essential ID tasks does not mean it would be the best approach for every type of training solution.

Multiple ID approaches can enable more cost effective and rapid development and delivery of training. For example, with the Layers of Necessity model, later revised as the Contextual Layered ID model (Wedman & Tessmer, 1991, 1993; see also Gustafson & Branch, 2002), the ID process becomes more complex or systematic with increases in available project development resources (i.e., time, people, technology, funding) and in training quality needs and regulatory requirements. Thus, a simple ID process would be suitable where project resources and educational/regulatory requirements were low while a complex process would be best where they were high (Deberry, 2015). Advantages of project-based ID flexibility include (a) rapid development and delivery, (b) cost-effective production, and (c) responsiveness to emergent needs of users and organizations (Irlbeck, et al., 2006; Sims & Jones, 2003). Also, a model that permits quick reactions to performance needs and problems is desirable. For an organization whose mission is safety, the ideal approach is one that is also proactive by

anticipating a problem and quickly developing and implementing the most cost-effective training solution. Therefore, the obligation of every training organization is determining which ID model and decision sequences to use based on each project's current and future resources and requirements.

The Federal Aviation Administration's (FAA) occupational training is the responsibility of the Air Traffic Organization (ATO) Office of Safety and Technical Training (AJI), as specified in FAA Order 3120.4 (FAA, 2015b). The goal of ATO's technical training program is to "prepare employees to perform the tasks specific to their job using applicable tools, equipment, and processes within the air traffic controller and technical operations technician workforces" (FAA, 2014a, p. 1). AJI-2000 develops four types of training:

- Qualification for new hires,
- Proficiency encompassing Recurrent, Refresher, Supplemental, and Skill Enhancement Training (SET),
- Remedial for correcting documented deficiencies in performance, and
- Recertification for demonstrating currency requirements (FAA, 2014a).

The ATO requires a holistic approach to identifying, planning, designing, developing, evaluating, maintaining, and delivering national education and training for air traffic controllers (ATC) and Technical Operations (TO) technicians (FAA, 2014a). The design and development of ATO technical training must comply with the standards and requirements identified in the "Air Traffic Organization Outcomes-Based Technical Training National Policy" (JO 3000.22A) (FAA, 2014a). This order prescribes workforce training requirements and "applies to all personnel involved in the design development, validation, revision, and evaluation of ATO technical training" (FAA, 2014a, p. 1). "Air Traffic Technical Training" (JO 3120.4P) requires AJI-2000 to solicit air traffic "facility training best practices" (FAA, 2015b, p. 2-1). In a report by an Independent Review Panel (IRP) convened by the FAA to examine the processes for hiring, training, screening, and assigning ATC specialists, the IRP identify several areas for improving the development of new controllers (Barr, Brady, Koleszar, New, & Pounds, 2011). One particular recommendation focuses on the necessity to deliver quality training using "effective practices and well-integrated processes" (Barr, et al., 2011, p. 3). Additional suggestions by the panel include the development of a "national database of best practices, lessons learned and current training techniques that are easily available to OJTIs [on-the-job-training instructors]" (Barr, et al., p. 33). In a different FAA-sponsored study on ATC training at the FAA Academy, observations about ATC training include "limited visibility into the whole process" "undocumented processes or altered processes" [and] "limitations on feedback loops" (FAA, 2013b, p. 9). Three of the key recommendations deal with sharing best practices (FAA, 2013b, p. 14) and developing and delivering training more efficiently and effectively (FAA, 2013b, p. 15). Both "A Plan for the Future: 10 Year Strategy for the Air Traffic Control Workforce" (FAA, 2015a) and "AJI Technical Training Strategy & Roadmap" (AJI-2000, 2017b) include calls to action for the ATO to improve technical occupational training and update its training processes.

These orders, studies, and reports reflect the importance of best ID practices in both developing and delivering quality training as efficiently as possible. However, based on findings from Kirkpatrick four-level evaluations of a small sample of courses in their curriculum, the AJI reports developments and updates are expensive (Haley-Seikel, 2016). Consequently, the training development solution that the ATO seeks for the future is a systematic but agile ISD process, "to more efficiently and effectively develop and deliver the right training, at the right

time, to the right person, through the right method” (AJI-2000, 2017b, p. 2). The objective is to become better at developing, validating, and maintaining a curriculum program that proactively responds to workforce needs.

It is probably safe to say that every ID model and process has advocates claiming their procedure is best (Reiser, & Dempsey, 2016). Unfortunately, strong data backing up such claims are scant. Indeed, quantitative evidence in the research literature is sparse (Richey & Klein 2007; Richey, Klein, & Dempsey, 2007). As a case in point, in the “Educational Technology Research & Development” literature published from 1999 to 2003, approximately 20% of the studies addressed occupational learning and performance but only five studies provided empirical evidence (Conn & Gitonga, 2004). Bernard et al. (2004) had similar issues with their meta-analysis. Out of 1,000 cases of face-to-face and e-learning studies identified in the literature from 1985 to 2002, most failed to meet their inclusion criteria necessary for empirical comparison. While this indicates a gap in the literature quantifying best practices, the implication is that archival research of best practices for developing occupational education and training is likely to be largely limited to qualitative data. This notwithstanding, by presenting the findings from examinations of the relevant ID literature and ID practices by industry, government, and the ATO, this research study addresses a gap in the best-practice literature.

Project Overview

The FAA funded this study under a grant from the FAA’s Center of Excellence (COE) for Technical Training and Human Performance (TTHP). The Embry-Riddle Aeronautical University (ERAU) research team, with advisory support from JMA Solutions, Inc., sought to find one or more alternative ID models that AJI-2000 could use to streamline production of technical occupational training without sacrificing the quality of instruction, which could ultimately jeopardize safety or security of the National Airspace System (NAS).

Description. This is a report on the exploratory qualitative study of best practices within U.S. aviation industry and government for the development of occupation education and technical training.

Purpose. The intent of this study is to present observations from the review of the process AJI-2 uses for developing technical education and training and to present recommendations for improving that process based on industry and government best practices found through a systematic review of the relevant literature.

Goals. In support of the FAA’s call to action to improve occupational training and to update its ID processes, the focus of the research goals is on identifying best practices for developing technical training for Air Traffic (AT) controllers and Technical Operations (TO) technicians.

Goal 1. Identify, critically appraise, and synthesize best, current practices within the aviation/aerospace industry and U.S. government relating to the use of instructional systems design (ISD) methodologies for development of both instructor-led- and self-directed e-learning occupational education and technical training.

Goal 2. Develop a set of criteria that define the best practices for the development of occupational education and technical training conducted by Federal agencies within the U.S. government that align with the regulatory mission of the FAA and safety and security objectives of the ATO.

Objectives. The study objectives are to (a) identify and define specific ID-related inefficiencies within the ATO, and (b) generate practical solutions based on organizational impact by comparing metrics provided by the ATO with the best-practice benchmarks identified in the literature. These recommendations would support ISD decision-making at the ATO.

Objective 1. Report the best practices relating to the use of ID methodologies that could facilitate course development by the ATO of occupational education and technical training of air traffic controllers and technicians.

Objective 2. Report a set of criteria that identify best practices for producing occupation education and technical training within the U.S. government.

Problem statement. The ATO's technical training has fundamentally one development process with one set of validation criteria applied across the board. This one-size-fits-all approach is not agile, nor is it flexible, and it is not conducive to ATO's mission.

Research questions. The AJI-2100 provided two succinct research questions that encapsulate the project objectives and scope.

Research question 1. How do other organizations with similar regulatory, safety and/or security requirements approach their training development?

Research question 2. How and where can ATO leverage training development efficiencies, such as Scrum, Agile, and rapid development approaches?

Assumption. There is one study assumption. The participants in this study will provide honest responses to the interview and survey questions.

Delimitations. There are two study delimitations. They relate to the scope of the study.

Delimitation 1. The multitudinous, multifaceted, and diverse AJI-2000 training development projects require delimiting the focus of this study to the standard operating procedure (SOP) current at the time of this writing and in which an external vendor creates the training solution under AJI-2000 oversight. This study does not examine internally developed projects. This study only examines courses meeting these stipulations and that the FAA both released for study inclusion and provided development documents.

Delimitation 2. The countless number of instructional development models and voluminous education literature necessitate delimiting this study to a search of literature (a) addressing the practices of developing occupational education and training, (b) spanning 1997 to 2017, and (c) retrieved from full-text electronic sources.

Limitations. There are three study limitations. They relate to the research approach.

Limitation 1. Best practice research lacks a unified best practice theory (Overman & Boyd, 1994; Bardach, 2003; Myers, Smith, & Martin, 2004; Vesely, 2011).

Limitation 2. Case-based analysis lacks generalizability due to a low level of external control (not using a control design; not sampling all best practice cases; not measuring all

process inputs/outputs) (Overman & Boyd 1994; Bretschneider, Marc-Aurele, & Wu, 2001; Veselý, 2011).

Limitation 3. Limiting case study search parameters and limited availability of data (i.e., print and non-print communications about ID practices, project tasks time/costs, & curriculum effectiveness), and limited number of participants prevent rigorous quantitative analysis.

Period of performance. The project start date was January 3, 2017. The project end date was December 31, 2017, but was extended to March 29, 2018.

Milestones. There are eight project milestones: three in Phase 1 and five in Phase 2. Table 1 provides their corresponding dates and descriptions.

Table 1

Project Milestones and Dates

Phase 1 Milestones		Date
Define Protocol	Formulate the purpose and develop qualitative review protocol (list of databases and citation indexes, definitions of coding categories and selection criteria, etc.).	17 Jan 17
Collect Data	Data Collection & Review: Collect and review government furnished information and collected data, including questionnaire data.	19 Mar 17
Deliver Report	Categorize, collate, and decipher FAA documentation to understand and summarize the instructional development processes for developing new education/training for Air Traffic controllers and Technical Operations technicians.	20 Apr 17
Phase 2 Milestones		Date
Review Literature	Conduct a systematic review of the relevant literature using coding categories and download citations to bibliographic software/tool.	21 May 17
Screen Studies	Apply inclusion and exclusion (screening) criteria to cases to screen for relevance, citing reasons for exclusion.	23 Jun 17
Synthesize & Summarize	Generate a report of full-text articles, abstract data, and synthesize studies using a contrast/compare strategy.	23 Aug 17
Analyze Findings	Analyze and synthesize findings from the ATO documentation and literature review.	24 Oct 17
Deliver Report	Interpret findings, and prepare and deliver a summary report on the findings.	14 Feb 18*

* The end date of the no-cost extension is March 29, 2018.

Summary

This chapter provided a brief introduction distinguishing instructional systems design and instructional development, a discussion on some of the chief issues related to developing occupational training, and an overview of this research project, including the goals, objectives,

problem statement, research questions, assumption, delimitations, limitations, and performance milestones.

The chapters that follow cover the research methodology, results, discussion and conclusions, and recommendations. Chapter 2 provides background into best practice research and describes the research design and procedures followed in this study. Chapter 3 provides the results from the analysis of the instructional development processes of AJI-2100 that occurred during Phase 1, as well as the results from the analysis of the case literature performed during Phase 2. Chapter 4 includes a discussion of the findings and conclusions in context of the ATO's practices. Chapter 5 presents the recommendations based on the findings from this study. The Appendixes include the online survey, a list of key terms and definitions, a flowchart depicting the proposed AJI-2000 Standard Operating Procedure (SOP) for developing training, sample project schedules, and brief biographies of the researchers.

PAGE INTENTIONALLY LEFT BLANK

Chapter 2: Methodology

Best Practice Research

Best practice research (BPR) examines the relationship between productivity and efficiency. Productivity refers to “efficiency of production” (Sherman as cited in Avkiran, 2001, p. 59). Efficiency is the “ability to produce the outputs or services with a minimum resource level required” (Avkiran, 2001, p. 59). Technical efficiency (TE) assumes it is impossible to increase process outputs without first increasing process inputs, but efficiency successfulness varies. With constant returns to scale (CRS) efficiency, increases in input levels result in proportional increases in output levels. This assumes no relationship exists between the scale and efficiency of the operations (Avkiran). For example, a large university would be just as efficient as a small university at producing courses. Conversely, with variable returns to scale (VRS), small increases in input levels produce disproportionate increases in output levels. For example, adding a few instructors would result in teaching significantly more students at a university. Allocation efficiency seeks to minimize production expenses by choosing inputs based on their cost.

Overman and Boyd (1994) offer this definition of BPR: “The selective observation of a set of exemplars across different contexts in order to derive more generalizable principles and theories of management” (p. 69). They categorize this type of practice-to-principles inquiry as “pragmatic, practice driven, positive, prescriptive, commercial, user-friendly, and innovative” (p. 75). However, in their critique of BPR, they point out that BPR tends to focus on relatively recent experiences, not on the “longer term consequences of reform efforts identified as best practices” (p. 76), and go on to say “best practices are not transferable” (p. 78). This is primarily because BPR designs rely on retrospective case studies that lack intervention and experimental control, thus, internal validity. Efficiency measurements are relative to the other measurements within the sample or reference set. Unless the complete population of comparable inputs/outputs of a process is measured, the study lacks internal validity and the findings are not generalizable. Furthermore, the concept of just what defines an industry, thus comparable populations, can be subjective. For example, definitions may focus on what a company produces, what core technologies it uses, what values it creates, or where it operates instead of the Standard Industrial Classification (SIC) codes (Sharp, Bergh, & Li, 2013). Data interpretation is difficult at best when the data are lacking integrity due to selection bias, measurement error, or imprecise analysis of the resource-outcome linkages or causal chain (Avkiran, 2001; Bretschneider, Marc-Aurele, & Wu, 2001). Nonetheless, BPR can provide useful comparability information that an organization could use to inform and improve strategic decision making regarding its process models.

Research Design

The purpose of this qualitative exploratory study (Babbie, 2013) was to obtain insights into the best practices associated with implementing ID models and processes for different types of occupational education and training. The approach involved content analysis, semi-structured interviews, and surveys (Bendixsen & de Guchteneire, 2003; Davies, 2000; Weber, 1990). The research design had two phases based on the particular focus of the researchers. Figure 1 illustrates the researchers’ efforts delineated by stages of assessment activity.

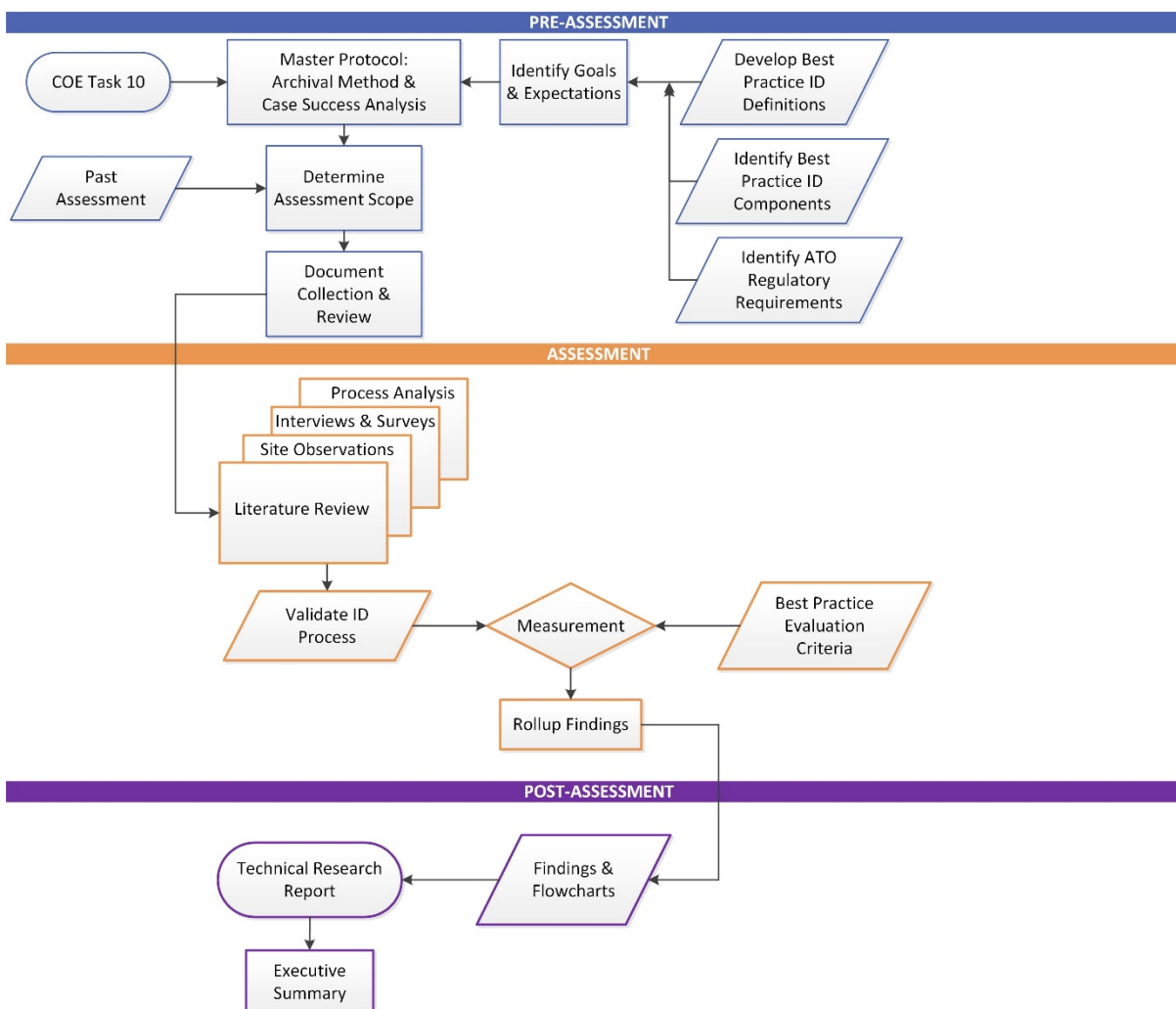


Figure 1. Research activity flowchart. ATO = Air Traffic Organization. COE = Center of Excellence. ID = Instructional Development.

Sources of the data. The data collected and reviewed during Phase 1 consisted of government furnished information (GFI) from AJI-2000, relevant FAA orders/standards, observational data from validation testing, and interview and survey response data from FAA AJI-2 managers and ISS leads. The GFI documents included current guides, templates, checklists, evaluation forms, and worksheets used during the design and development of occupational training for AT controllers and TO technicians. They also included completed documentation and deliverables for instructor-led training (ILT), web-based training (WBT), and blended courses developed using the current ID process, and FAA evaluations of a small number of courses developed using prior and current ID processes. Opinion data were collected from a joint interview of AJI-2 ISS managers and online surveys of ISSs/ID leads working for AJI-2000 and at the FAA Academy. Observational data were collected during on-site visits of two separate validation events. The first was an alpha test of four recurrent courses (WBT) and the second was a first course conduct (FCC) of a blended course (WBT and ILT components). Examining document data, interview data, survey data, and observational data provided different perspectives, each a counterbalance to the other. This allowed alternative interpretations and greater insight into the ID practices of interest.

Interview and survey data collection. The ISSs from AJI 2100, FAA Academy (AMA) 400, and AMA 20 were purposely selected to complete a survey because their occupational expertise is instructional systems design and they use the AJI-2000 ISD process routinely in their jobs. They were asked to complete an online survey administered through Survey Monkey® seeking their knowledge, experience, and opinions about ID models and processes used for developing technical occupational training for the ATO.

The survey tool, as shown in Appendix A, included both quantitative and qualitative items. Although a pilot study was not conducted to validate the instrument, SME feedback (and approval) was sought on the initial instrument (Babbie, 2013). The draft version was emailed as a Microsoft Word® file to the Technical Monitor (TM) to review and to distribute to his AJI-2 managers and the Professional Association of Aeronautical Center Employees (PAACE) union representatives for their input. Their recommendations included (a) clarifying instructions and vocabulary on a couple of items, (b) including item rationale and response relevance (i.e., why each question was being asked and how the information would be used in this study), (c) and instrument availability and completion time. All of the feedback was incorporated and the final instrument was again sent out for review and approval before the survey was created in the Survey Monkey® account of the School of Graduate Studies at ERAU.

The TM emailed the web link and password for accessing the online survey to the population of ISSs and ID leads, 16 people in all. The hyperlink was active for approximately two weeks. The solicitation and reminder emails included the survey instructions and the deadline for completing the survey. Although the survey asked for the participants' contact information in case any response clarification was needed, no follow-up contact was made with the survey participants, excluding regular contact with the TM who had participated.

Two AJI-2 ISS managers were interviewed in person together by both researchers. The interview session was semi-structured—they were asked the same questions as the items in the online survey—but they were free to elaborate as desired and respond to follow-on questions.

Only the researchers had access to the raw data. The response data were stored in the researchers' password-protected computers and a private folder in Microsoft SharePoint®, the University's cloud-based document management and storage system that requires authentication to access. The researchers maintained the confidentiality of each participant's name and contact information, including not disclosing this information in this report. The researchers deleted the raw data and the personal information of the participants from all storage devices after delivering this final report to the FAA.

Observational data collection. The researchers observed the alpha test for web-based training (WBT), equivalent to a course walkthrough (CWT) for instructor-led training (ILT), as well as a first course conduct (FCC) for a blended course (ILT and WBT components). These on-site observations occurred in November 2017 and January 2018, respectively.

Literature review. The data collected during Phase 2 came from primary and secondary literature retrieved from online databases. This systematic literature review involved searches of education-related databases using multiple search strings to identify relevant sources (Beecham, Baddoo, Hall, Robinson, & Sharp, 2006). Results were filtered to only include full-text articles written in English language and published anytime from 1997 through 2017 or 1999 through 2017, depending on the limitations of the database. The titles, abstracts, and key words of the search results were reviewed for relevance to the research questions. After this initial

search, papers were selected for further screening if they provided the ID model, context (education/training setting or site), and audience (targeted learners/trainees). The model and site could be provided explicitly or implicitly, but the preference for the model was an operational definition in accordance with this perspective: “An ID model should contain enough detail about the process to establish guidelines for managing the people, places and things that will interact with each other and to estimate the resources required to complete the project” (Gustafson & Branch, 2002, p. 4). Both researchers independently reviewed each article to confirm its qualification for inclusion. An article was selected if it provided the ID model, setting, and audience. The inter-rater reliability was approximately 90 percent agreement. For each discrepancy, the researchers discussed their rationale and came to a consensus to either include or exclude the paper. Next, each researcher independently coded the selected articles and manually recorded the results in a Microsoft Excel® spreadsheet. Then both researchers conferred on the coding results until consensus was reached.

Case success method. Adapting Brinkerhoff's (2003, 2005; Toister, 2016) case success method, we used the following steps to identify, critically appraise, and synthesize the best current practices for developing occupation education and technical training:

1. Formulate the review questions based on what is relevant to the desired ATO goals and outcomes. Develop a qualitative review protocol describing the analytical processes, including defining the purpose, target site, source sites, databases, citation indexes, bibliographic software, coding (screening) categories, a priori decision criteria (for rater reliability), and best-practice components and subcomponents.
2. Conduct a literature search and download the citations to the bibliographic data-collection tool.
3. Apply inclusion and exclusion criteria to the studies to screen for relevance; cite reasons for exclusion.
4. Generate a report of the full-text articles, abstract the data, and synthesize the studies.
5. Interpret the findings using a contrast and compare strategy, and prepare final (written) report.

Categorization of best practices relies on the type of evidence used to support them. Such evidence can rely on either human judgment in the forms of authoritative opinions of SMEs or on statistical procedures measuring efficiency and productivity. There are many definitions for best practices, but the one provided in the seminal work by Overman and Boyd (1994) is often cited (Vesely, 2011).

Evidence-based best practice (EBBP). This term refers to best-practice exemplars supported primarily with empirical evidence (Bretschneider, Marc-Aurele, & Wu, 2001). Nonparametric data envelopment analysis (DEA), quantile regression analysis, and ratio analysis are the common statistical methods for measuring process inputs/outputs. While DEA is the preferred method of measuring relative technical efficiency and is more rigorous than regression or ratio analysis, it does have limitations that are important to acknowledge.

Best practices (BP). This term refers to high-impact exemplars supported with qualitative evidence based upon a preponderance of expert opinions (Bardach, 2003). This category includes best practices that have withstood the test of time.

Promising practices (PP). This term refers to creative or innovative practices supported with qualitative evidence that are not BP exemplars (Bardach, 2003). This category includes emerging practices that are either not in wide use or have not yet been studied sufficiently and reported on in the case literature.

Evaluation strategy. The evaluation strategy relied on case success analysis (Brinkerhoff, 2003, 2005; Toister, 2016) to identify best practices in the literature. The objective was to identify the (a) process components and elements that contribute to the desired education or training outcomes; (b) aspects of the context (setting) that facilitate transfer to different contexts; and (c) factors that are necessary for sustainability of the instructional development process. This required developing (*a priori*) best practice criteria, attributes, and indicators based on ISO 9000 Quality Management (QM) principles (International Organization for Standardization, 2015).

Criterion 1. Process continuously results in high-quality training or education.

Attribute 1. Effectiveness: Process results in the desired education/training outcomes.

- Indicator: Users state training is relevant and accurate (QM principle 1 Customer focus, ISO, 2015).

Attribute 2. Decision Making: Process supports efficient and effective ID decisions.

- Indicator: Decisions are fact-based, targeted, and correct (QM 2 Leadership & QM 7 Relationship Management, ISO, 2015).

Criterion 2. Process is transferable or generalizable.

Attribute 1. Scalable: Process can meet different sized needs of an enterprise.

- Indicator: Leverages resources to fulfill development requirements (QM 3 Engagement of People, ISO, 2015).

Attribute 2. Flexible: Process accommodates users.

- Indicator: Responsive to emergent needs of users and continual improvement (QM 6 Evidence-based Decision Making & QM 5 Improvement, ISO, 2015).

Attribute 3. Visible: Process stages and steps are accessible by all stakeholders.

- Indicator: Project status is visible (QM 3, ISO, 2015).
- Indicator: Management process is described (QM 4 Process Approach & QM 5, ISO, 2015).

Criterion 3. Process is sustainable.

Attribute 1. Simple: Process is easy to implement.

- Indicator: Time to learn is relatively short (QM 3, ISO, 2015).

Attribute 2. Rapid: Process is not constrained arbitrarily.

- Indicator: Minimizes production, speed to market (QM 4 & QM 5, ISO, 2015).
- Indicator: Optimizes size of the operations team (QM 4 & QM 5, ISO, 2015).

Attribute 3. Efficient: Process optimizes technical resources.

- Indicator: Adaptable resource utilization.
- Indicator: No redundant or unnecessary approvals (QM 4 & QM 5, ISO, 2015).

Hierarchy of evidence. Informed by Bretschneider, et al. (2001), Bardach (2003), and Veselý (2011), Table 2 identifies the scale used for ranking practices from the literature.

Table 2

Scale for Coding Best Practice Evidence

Exemplary Evidence	Adequate Evidence	Some Evidence	Minimal Evidence	No Evidence
5	4	3	2	1

Summary

The purpose of the content analysis was to identify ID models, processes, and practices used by comparable organizations to the ATO, entities within industry and government adhering to stringent safety, security, and regulatory policies for the design and development of their occupational education and training. Data mining key databases and online repositories for case literature, and coding and analyzing the selected literature attempted to capture quantitative support for identifying EBBPs and qualitative support for identifying BPs and PPs. Given the large volume of education literature, the search timeframe was from 1997, which began the rise of the Internet and its widespread use in distance and online education, through 2017. Delimiting the domain of cases defined a complete set, approximating “completeness” (Bretschneider, et al., 2001, p. 312), a condition of comparability. Additional study delimitations included the education databases and other primary and secondary sources that offer relevant full-text content. This comparative analysis only included cases that pertained to the systematic planning and procedures for “designing, developing, implementing, and evaluating instruction” (Seels & Richey, 1994, p. 31).

Surveys of ISSs and ID leads from AJI-2100 and the FAA Academy and interviews of AJI-2100 managers provided additional insights. Items on current ID processes and historical practices provided context for findings in the relevant literature. Training and experience

demographics provided insights into the acceptance and future implementation of transformative changes related to the AJI-2100 ID process. This qualitative approach permitted a systematic assessment of the strengths and weaknesses of ID processes (Brinkerhoff, 2003, 2005), thereby providing a pragmatic lens to evaluate current practices at the ATO. Observations of validation events provided insight into the efficiency and effectiveness of the collaborations among stakeholders and the inputs and outputs of AJI's ID process. Contrasting and comparing ID practices, including associated decision-making, and identifying relevant exemplars provided a framework for identifying efficiencies and inefficiencies between ID approaches.

PAGE INTENTIONALLY LEFT BLANK

Chapter 3: Results

This chapter presents the results from our formal analyses of the government-furnished information (GFI), interview and survey data, personal discussions with AJI managers and ISSs, and the literature synthesis. It has two main sections that correspond with the two phases of the study. The first section provides a general description of each phase of the AJI-2000 ID process, including the stakeholders and development documents and vendor deliverables. These descriptions provide the site context for contrasting and comparing best practices screened from industry and government sources in the literature that are presented in the second section.

In Phase 1, the focus was on the ID process used by ATO, seeking to understand the organizational structure, purpose, mission, regulatory requirements, and ID process. This entailed a thorough examination of the related data, including the relevant GFI, such as orders, standards, procedures, guides, templates, and project schedules created or provided by the FAA. The next research activities included surveys and follow-up interviews of the ISSs under the FAA Technical Training Development & Curriculum Group (AJI-2100) and at the FAA Academy. These data furthered understanding of the ID process by revealing perceptions and practices not discernable in the GFI.

The FAA's Technical Training Directorate (AJI-2000), as illustrated in Figure 2, is responsible for creation and maintenance of all national education and training policies for ATO safety and technical training (FAA, 2015b). The Development & Curriculum Group (AJI-2100) under the authority of AJI-2000 designs, develops, and maintains the following four types of training:

- Qualification for new hires,
- Proficiency encompassing Recurrent, Refresher, Supplemental, and Skill Enhancement Training (SET),
- Remedial for correcting documented deficiencies in performance, and
- Recertification for demonstrating currency requirements (FAA, 2015b).

The ATO offers three types of training events: courses, workshops, and informational briefings. Table 3 provides descriptions for each type.

Table 3

Types of Training Events

	Course	Workshop	Briefing
Description	A training event structured by measurable objectives that is designed for a particular target audience.	A training event structured by measurable objectives that is designed for a particular target audience.	An organized body of information delivered to learners.
Purpose	Performance improvement/change.	Provide practice and/or hands-on activities for skill improvement or acquisition.	Disseminate information.
Type	Instructional.	Experiential.	Informational.
Instructional Objectives	Required.	Required.	Recommended.
Structure	Objective driven.	Objective or activity driven.	Objective or activity driven.
Evaluation of Training Materials	Required for technical content and instructional design.	Required for technical content and instructional design.	Required for technical content and instructional design.
Interactivity	Includes interaction via exercises, case studies, scenarios, etc.	Includes interaction such as hands-on activities, opportunities to collaborate.	Little or no interaction.
Assessment	Written and/or performance tests for all designated objectives.	Assessment of objectives is recommended; there may be subjective feedback.	No testing or feedback.
Validation	Required.	Recommended.	Not Applicable.

Note. Adapted from “Air Traffic Organization Outcomes-Based Technical Training National Policy” (JO 3000.22A), 2014, p. 11. Copyright 2014 by the Federal Aviation Administration.

There are different delivery modalities for courses and workshops. The following list provides definitions for the five modes of learning (FAA, 2000).

- Instructor-Led training (ILT): This is the term for foundational instruction delivered in a physical classroom.
- Web-Based Training (WBT): This is the term for instruction delivered online in the FAA’s electronic learning management system (eLMS).
- Part Task Training (PTT): This is the term for equipment training provided through the physical mock-up of specific elements of the real equipment.
- Structured On-the-Job-Training (SOJT): This refers to structured training providing direct experience delivered by a qualified individual in the work environment.
- Simulation (SIM): This is the term for training consisting of familiarization, instructional, and evaluation exercises designed to allow the developmental/CPC-IT to apply the basic skills and knowledge gained during instructor-led/situational training.

A blended or hybrid course may include any combination of ILT, WBT, PTT, and simulation instructional elements or events. Although WBT can be instructor-facilitated or self-directed, the FAA does not list any instructor-led WBT in its technical training curriculum for AT controllers or TO technicians at this time. Conversely, ILT may include web-based elements, simulation training, or both to enhance learning (AJI-2000, 2016b).

The FAA Development & Curriculum Group Manager (AJI-2100) can receive course development requests from several areas within the ATO (see Figure 2). During the Planning phase, the Curriculum Architecture (CA) Team (AJI-2130) completes the Preliminary Analysis Report (PAR) to determine if training already exists or if similar pre-existing training is available for identifying job specifications and job task data. This joint review involves a key-word search and obtaining consensus on the alignment of the knowledge, skills, and abilities (KSAs) to the job tasks that are the target for the training (D. Talkington, personal communication, February 15, 2017). Once the PAR is completed, the AT/TO Requirements Teams (AJI-2300/AJI-2400) determines the specific training requirements with the requestor (customer) and the other stakeholders. Then the Requirements' team sends the training proposal, requirements, and PAR to the Development Team (AJI-2120). The AJI-2120 Manager reviews the documents and provides comments. Upon FAA approval of the documentation and allocation of funding for either an internal task order or external contract, the actual ID process begins.

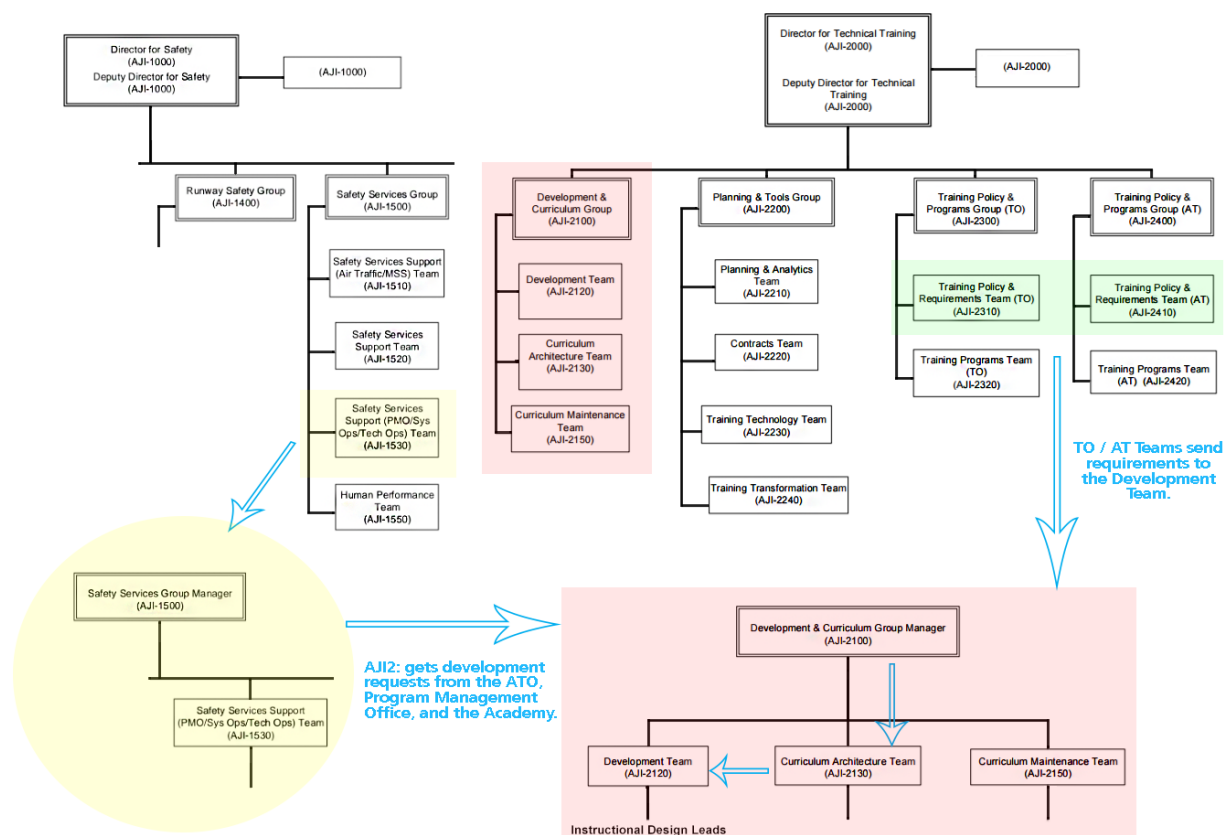


Figure 2. AJI organizational training-development task flow. Adapted from “AJI-2 Organizational Chart.” Copyright 2017 by the Federal Aviation Administration.

The AJI-2000 ID projects are highly prescriptive because they must comply with the requirements in “Air Traffic Organization Outcomes-Based Technical Training” (JO 3000.22A) (FAA, 2014a) and other FAA orders and policies specified by AJI. Each project has an Integrated Project Team (IPT) comprised of a FAA Project Lead or Project Manager (PM), an AJI-2100 Instructional Design (ID) Lead (or more ISSs depending on the scope of the project), an AJI-2220 Project Manager (PM), an AJI-2300/AJI-2400 Requirements Lead, one or more Subject Matter Experts (SMEs), and the external Vendor contacted to create the training solution. Per JO 3000.22A, the IPT adheres to the prescribed steps within each phase shown in the AJI-2000 ISD Process flowchart (see Appendix C). Activities within these steps include the use of specific developmental guides, templates, and checklists to ensure the technical quality and instructional soundness of the training products. For example, the IPT uses JO 3000.22A Requirements Checklist for Technical Training (Ballentine, n.d.) to ensure each new course development is in compliance. In addition, the FAA Requirements and Project Leads must track and enter the milestones, deliverables, and other key information in the Project Status Reporting Tool (PSRT), which provides continuous project status visibility to the Safety and Technical Training Groups’ team managers within AJI-2120, AJI-O, AJI-2320, and AJI-2330 (AJI-2000, 2016a).

Project Phase 1: AJI-2100 ID Process Analysis

The “AJI-2 Safety and Technical Training Standard Operating Draft Procedure” (SOP) (AJI-2000, 2016b) provides specific requirements and guidelines for ordering, contracting, planning, developing, and maintaining outcomes-based technical training for controllers, technicians, and engineers. To ensure this technical training complies with FAA policies, standards, and recommended practices, AJI-2000 adheres to a close approximation of the ADDIE model, called the P-ADDIE-M model, for developing training. Figure 3 is a depiction of the process from the AJI-2 Training Guidance Background (2016a) and Figure 4 depicts the ID process as described in the SOP (AJI-2000, 2016b). The AJI-2000 adheres to four systematic processes or phases for developing training: Analysis, Design, Development, and Validation. While this ID process approximates the ADDIE model, AJI-2000’s current ID model diverges from the traditional model in several important aspects. First, the Validation phase includes a Course Walk-Through (CWT), Operational Try-Out (OTO), and First Course Conduct (FCC) (see Figure 4). Second, the Maintenance (M) phase (course updates) follows the Project Initiation phase (see Figure 3 & Appendix C). However, these activities occur in the Implementation and Evaluation phases, respectively, of the ADDIE model.

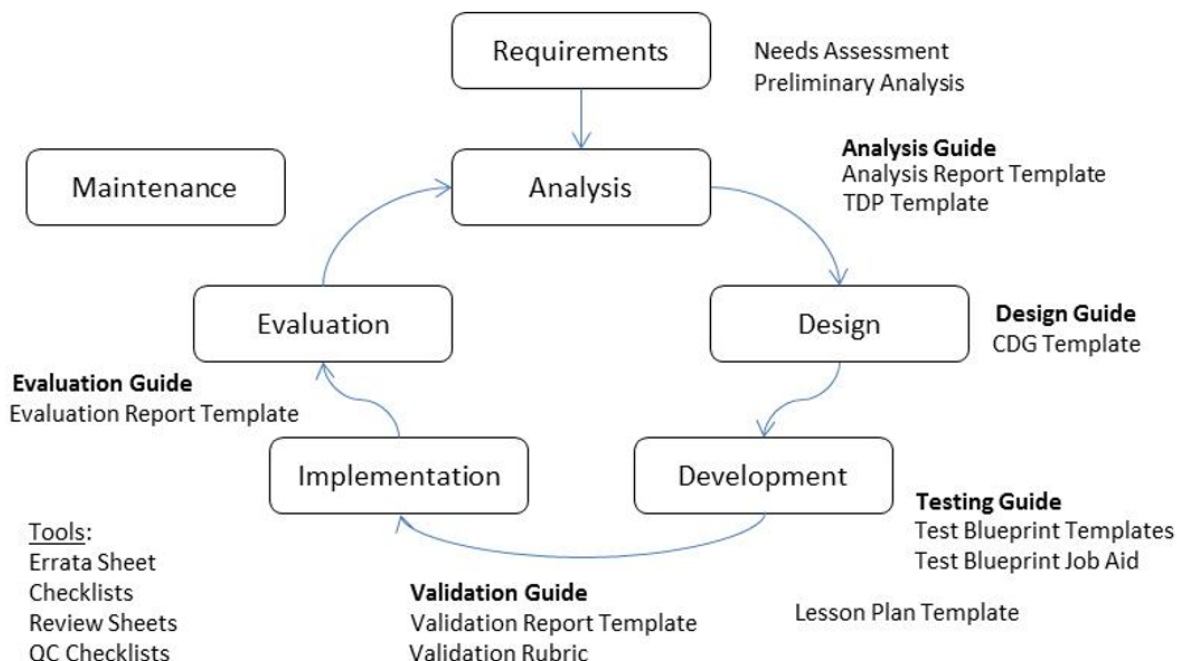


Figure 3. Systematic development process and documentation used by AJI-2100. TDP = Training Development Plan. CDG = Course Design Guide. QC = Quality Control. From “AJI-2 Training Guidance Background,” 2016, p. iii. Copyright 2016 by the Federal Aviation Administration.

There are additional differences between the phases described in the AJI-2000 guidance. Figure 3 uses ‘Requirements’ and Figure 4 uses ‘Planning’ to identify the Contract Action phase. The titles of some of the documents and deliverables differ as well. Figure 3 includes use of the Evaluation Report Template but Figure 4 includes use of the Errata Workbook. The Evaluation Report Template is probably a typo and should be titled Validation Report Template (D. Talkington, personal communication, April 28, 2017). In addition, the JTA and Media Analysis are not in Figure 3 while they are in Figure 4. Because they inform the training content, instructional strategies, and delivery mode, including them in Figure 3 should be helpful. The main observation is lack of consistency within and between ID documentation.

Table 4

Development Guides, Deliverables, and Tools Used by AJI-2000

	Guides	Deliverables	Tools
ADDIE Process	Analysis <ul style="list-style-type: none"> • Job Task Analysis • Media Analysis • Other Analyses 	Analysis Report <ul style="list-style-type: none"> • Job Task Analysis • Media Analysis • Audience Analysis • Content Gap Analysis TDP	Preliminary Analysis Analysis Report Template TDP Template
	Design <ul style="list-style-type: none"> • OB Training • Objectives • Assessment Strategy • Instructional Strategy 	CDG <ul style="list-style-type: none"> • Outcomes/Objectives • Assessment Strategy • Instructional Strategy • Course Design Table 	CDG Template ILT Course Templates WBT GUI Templates Errata Workbook
	Testing <ul style="list-style-type: none"> • Testing Standards 	Written Tests Performance Tests	Blueprint Job Aid Written Test Templates Performance Test Templates
	Development	ILT Lesson Plans ILT Presentations ILT Student Guides ILT Handouts/Refs WBT Storyboards WBT Programming WBT Source Files/Codes Videos Exercises	Quality Control Checklist (eLMS Content Integration Tools) ILT Instructor Lesson Plan Template Errata Workbook Template
	Validation <ul style="list-style-type: none"> • Validation Process • Validation Criteria Validation Guide	Validation Report <ul style="list-style-type: none"> • Validation Activities • Validation Criteria • Recommendations CWT Materials OTO Materials	Validation Rubric Validation Report Template Errata Worksheet Technical Accuracy Review Sheet (SME) Instructional Review Sheet (ISS) Observation Design Review Sheet Training Alignment Checklist Formatting Checklist First Course Conduct Materials CDG Alignment Checklist
Evaluation Process	Evaluation <ul style="list-style-type: none"> • Evaluation Activities • Evaluation Criteria 	Evaluation Report <ul style="list-style-type: none"> • Evaluation Activities • Evaluation Criteria • Recommendations 	Evaluation Report Template Validation Rubric Validation Report Template Errata Worksheet Technical Accuracy Review Sheet (SME) Instructional Review Sheet (ISS) Observation Design Review Sheet Training Alignment Checklist Formatting Checklist First Course Conduct Materials CDG Alignment Checklist

Note. ILT = Instructor-Led Training. WBT = Web-Based Training. TDP = Training Development Plan. eLMS = eLearning Management System. SME = Subject Matter Expert. ISS = Instructional Systems Specialist. OB = Outcomes-Based. CWT = Course Walkthrough. OTO = Operational Try Out. Adapted from "AJI-2 Training Guidance Background," 2016, p. iv. Copyright 2016 by the Federal Aviation Administration.

Production effort (time) varies depending on the type of training, its complexity (requirements), delivery method, and the amount and quality of vendor and FAA resources. Tables 5, 6 and 7 provide the activity estimates and the mid development hours typical of both industry and the FAA.

Table 5

REDACTED

Note. REDACTED

Table 6

REDACTED

Note. REDACTED

Table 7

*REDACTED**Note.* REDACTED

Typically, a field manager in AT or in TO recognizes an opportunity, problem, or need and makes a diagnosis that some sort of training is an appropriate solution. The request then goes to the Training Policy & Programs group under AJI-2000. When the Technical Policy & Requirements Team receives the training request, they perform a needs assessment that begins with answering the following basic questions:

- Who (e.g., developmentals, Certified Professional Controllers, technicians, supervisors) and where (e.g., facilities, Academy, Academy/Tech Center) are the workers that need this instruction?
- What tasks in terms of knowledge and skills do the learners need to learn?
- How does the learner perform those tasks?
- What training delivery methods are best (e.g., ILT, WBT, or blended)?

The Requirements Team answers these questions for courses and workshops based on the Significant Safety Issue Identification (FAA, 2014a; 2016). As described in the Analysis Guide (AJI-2000, 2016c), the PAR provides information about training, including a job task listing, a DIF Analysis (the acronym for Difficulty, Importance, and Frequency of the tasks to be learned or performed), and performance proficiency (novice, intermediate, advanced, or expert level) requirement for each job task. It also includes a list of other courses that address the specified topic. Four types of information are provided in a PAR:

- Review of the Training Proposal (TP),
- Next Generation Air Transportation System (NextGen) Strategic Training Needs Analysis (STNA), if applicable,
- training data about the job tasks from the Curriculum Architecture (CA) based on the TDP, and
- data from existing courses covering the same job tasks.

Once this initial planning is complete, project control transitions to the IPT in the Analysis phase.

Analysis phase. The ID process begins after the Contract Action phase, also called the Planning phase. It is the first phase of the ID production model. Its purpose is to identify the “tasks, skills, and knowledge to be trained, the outcome and objectives needed to achieve it, and a clear description of the learners who will receive the training (FAA, 2014a, p. 24). This includes determining an appropriate ISD approach or delivery modality. [REDACTED]

The IPT holds a kickoff meeting, which usually runs three days. During the first two days, the FAA’s Project Lead (PL), Requirements Lead, ISS Lead, and SMEs review the JTA for the specific development project. Figure 4 shows an excerpt of PAR data for a weather information course. Education is knowledge oriented and training is task oriented, but technical training develops both knowledge and skills. The JTA includes the following, at a minimum:

- Starting with the high-level job tasks presented in the PAR and drilling down to the level needed to develop the training,
- Aligning the appropriate knowledge and skills from the preliminary analysis with the identified job tasks, and
- Aligning delivery methods with the job tasks (AJI-2000, 2016b).

Activity Sub-Activity Task	Unique ID	Task Statement	DL	DP	I	F	Proficiency	Recommended Delivery Method (SME)
Sub-Activity	SA39	Process Tower weather information	2	2	4	4	3	PTT
Task	T142	Receive Tower weather condition updates	2	2	4	4	3	PTT
Task	T143	Disseminate Tower weather condition updates	2	2	4	5	3	PTT
Task	T144	Process significant Tower weather information	3	3	4	4	2	PTT
		Average DIF-P	3	2	4	4	3	

Figure 4. Excerpt from a preliminary analysis report. SA = Sub Activity. T = Task. DL = Difficulty to Learn. DP = Difficulty to Perform. I = Importance. F = Frequency. PTT = Part Task Training. From “Analysis Report Guide,” 2016, p. 7. Copyright 2016 by the Federal Aviation Administration.

The IPT performs a media analysis to determine the appropriate delivery method for the instruction (e.g., audio, video, simulation, classroom, blended). The eLearning Media Guide (AJI-2000, 2014) provides suggestions for the delivery approach based on the instructional needs, including explanations of engaging versus interactive learning approaches (see Figure 7). Although the PAR includes a preliminary decision about the delivery method and media, the workgroup reviews the suggestions to ensure they are appropriate based on the available technology platforms and various multi-media tools. Then the workgroup agrees on the delivery of the instruction; ILT, WBT, or a blend of ILT and WBT (see Appendix C). The excerpt from a Final Analysis Report (AJI-2000, 2016d) in Figure 6 shows more detail with the suggested delivery method now included.

Task Information		DIF Analysis					Analysis Data			
Task ID	Task Statement	Learn	Perform	Importance	Frequency	Proficiency	KnowledgeID	Skill ID	Learning Objective	Delivery Method
SA39	Process Tower weather information	2	2	4	4	3	K8.1 K8.3 K8.4	Sk47		WBT Video Demo
T142	Receive Tower weather condition updates	2	2	4	4	3	K8.2	Sk48		WBT
	Log in to weather reporting system									
	Generate weather report									

Figure 5. Excerpt from a task analysis. T = Task. K = Knowledge. Sk = Skill. WBT = Web-Based Training. PTT = Part Task Training. From “Analysis Report Guide,” 2016, p. 7. Copyright 2016 by the Federal Aviation Administration.

The SOP (AJI-2000, 2016b, p. 22) states that the Vendor submits a Project Management Plan, Project Schedule, and Errata Sheet(s) in the Contract Action Phase. The Project Task Order or Contract identifies these items as project deliverables with specific timelines for delivery, so the FAA cannot require a Vendor to deliver them until the Task Order or Contract has been initiated (G. Sanders, personal communication, April 23, 2017).

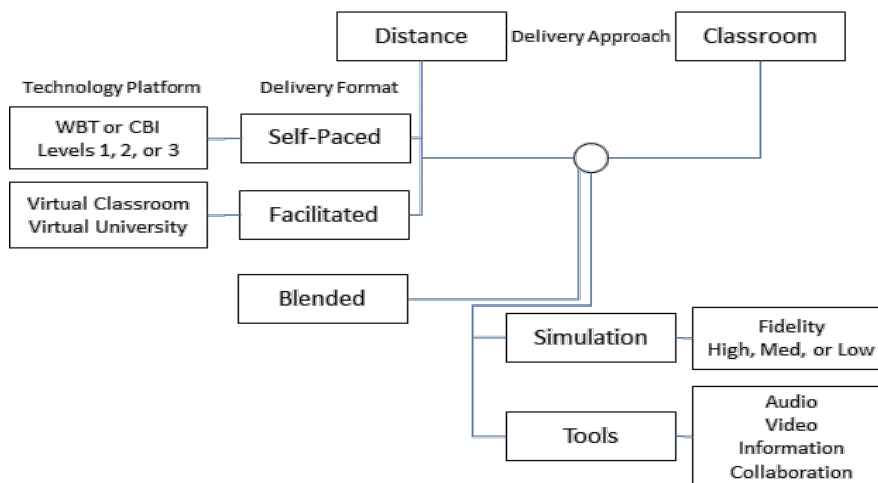


Figure 6. Media selection process. From “Analysis Report Guide,” 2016, p. 10. Copyright 2016 by the Federal Aviation Administration.

According to the Analysis process described in the draft AJI-2 SOP (AJI-2000, 2016b), the analysis includes tasks and skills analysis, content analysis, front-end and GAP analysis using the job task analyses for controllers or technicians, as appropriate. After collecting the data, the Vendor synthesizes the results in the Draft Analysis Report.

The AJI-2100 ISS Lead is responsible for providing ID oversight and recommendations. Upon completion of the analysis, the Vendor uses the Analysis Report Template to complete a Draft Analysis Report (AJI-2000, 2016d). The Vendor then submits it to the FAA for review by the IPT, SME's, and others as needed. Time allotted for these reviews is typically between 5 to 10 business days, but varies depending on the extent of the reports and number of FAA

personnel involved in the project and the size of the final product. The AJI-2100 ID and Requirements Leads consolidate the comments (feedback) from the reviews in the Errata Workbook (AJI-2000, n.d.c), and then returns this worksheet to the Vendor.

If the Analysis Report indicates the need for a change in the project scope, AJI-2100 initiates the Scope Change Process described in the SOP (AJI-2000, 2016b), as illustrated in Appendix C. If no scope change is required, the Vendor responds to the FAA's feedback by making appropriate changes in the Analysis Report and then documenting the changes made and revisions not made and why in the Errata Workbook. Next, the Vendor conducts a Quality Assurance/Quality Control (QA/QC) review of the Analysis Report prior to submitting the Final Analysis Report to the PL. The ISS Lead and the Requirements Lead ensure that the errata comments were completed and then recommend approval to the Team Managers.

There is considerable inconsistency between the Analysis Design Guide and the Draft SOP. The Design Guide has more detail. Consequently, either the Draft SOP (AJI-2000, 2016b) or the Design Guide (AJI-2000, 2016g) needs revision for consistency in both the sections and their nomenclature.

Design phase. The Design phase is the second ID process. Its purpose is to produce a roadmap or "blueprint for instruction" (FAA, 2014a, p. 25). Activities in this phase are dependent on the results from the Analysis process, specifically, information about the targeted job tasks, knowledge, and skills from the JTA (FAA, 2014b) and from the Analysis Report (AJI-2000, 2016d). Execution of this phase is to adhere to the Project Management Plan (PMP) and the work breakdown schedule in the Project Plan or schedule developed by the Vendor during the preceding Contact Action phase (FAA, 2016a). The Design activities formally begin after the Team Managers approve the Analysis Report.

All of the design and development guides fall under JO 3000.22A (FAA, 2014a). A Course Design Guide (CDG) is required for courses and workshops, but is not required for briefings. The deliverables from the Vendor include the completed CDG (AJI-2000, 2016f) and sample user interface/templates for WBT or course templates (sample instructor-, student-, presentation templates), and additional supporting course templates as appropriate for ILT. Deliverables for blended training—instruction that incorporates both self-directed/paced and instructor-facilitated delivery modalities—includes all of these documents as appropriate. The Design Guide (AJI-2000, 2016g) explains strategies for writing the (a) course outcome and objectives based on Bloom's taxonomy; (b) knowledge and performance assessments; and (c) learning approaches and tactics for the particular audience (participants), application (job performance), and proficiency level. To ensure consistency and completeness of the design plan, the project workgroup uses the CDG Template (AJI-2000, 2016f) to inform the development of the course templates, specifically the Lesson Template Instructions (AJI-2000, n.d.f) for both ILT and WBT. The workgroup also uses the eLearning Media Guide (AJI-2000, 2014) when developing WBT.

[REDACTED]

The FAA Development Team (AJI-2120), Requirements Team (AJI-2320/2420), and Vendor develop the CDG—master plan for the training development—in cooperation with the SMEs. It provides the structure and flow of the training and includes the following information:

- all learning outcomes and knowledge and performance objectives,

- the length of the training units (in hours),
- an outline of the technical content,
- the chosen delivery method,
- types of media, assessments, and learning types,
- ID notes, and the
- references used in and for the lessons in the curricular unit (AJI-2000, 2016b).

The project workgroup revises the CDG template throughout the entire ID process so that it always matches the current state of the instructional product (course or workshop).

The SMEs and IPT review all of the course templates and provide feedback in the Errata Workbook (AJI-2000, n.d.a) for the Vendor to implement. Once all of these templates and documents are ready for approval, the IPT reviews them. If not acceptable, the IPT provides additional feedback for revision on the Errata Worksheet. After making the necessary changes in the documents, the Vendor seeks IPT acceptance again and then the Managers' approvals.

A scope change may become necessary when the change requests affect the project timeline or delivery schedule and cost. The Scope Change Process, as described in the AJI-2 SOP (AJI-2000, 2016b), is validated by the PL and/or the IPT. Once the revisions (or scope change) are accepted, revisions are made by the Vendor, and the final versions of the CDG and course templates are accepted by the IPT and approved by the Managers, the development process can begin.

Development phase. The Development phase is the third ID process. Its purpose is to create "learning materials to execute the strategy described in the design plan" (FAA, 2014a, p. 25). In this phase, the Vendor, in cooperation with the SMEs, develops the instructor guides, lesson plans, presentation documents, tests, handouts, and participant materials in accordance with the CDG (AJI-2000, 2016g). Vendor deliverables include the Lesson Template Instructions (AJI-2000, n.d.f), and the testing templates; namely, the Test Blueprint – Written Test (AJI-2000, n.d.i) for ILT and/or the Test Blueprint - Performance Test (AJI-2000, n.d.h), as explained in the Test Blueprint Job Aid (AJI-2000, n.d.g). The Requirements Lead ensures technical accuracy and completeness, including inclusion of GFI where applicable and the ISS Lead ensures instructional soundness of the deliverables. These leads consolidate their feedback on the Errata Worksheet and give it to the Vendor to inform revisions to the training documentation and deliverables.

Instructor-led training (ILT). The Vendor develops the draft instructor guides and presentation materials with SME support using the Lesson Template Instructions (AJI-2000, n.d.g) and the Test Blueprint: Written Test Blueprint Instructions (AJI-2000, n.d.i) for knowledge-based assessments and Test Blueprint: Performance Test (AJI-2000, n.d.k) for performance-based assessments. The lesson plans outline the content, interactivity, instructional graphics and any supplemental resources/references for the instructor or participants.

The Vendor develops the training in accordance with the CDG approved in the previous phase. The AJI-2100 ISS Lead ensures the training is instructional sound. The AJI-2300 Requirements Lead ensures the content is technically correct. The IPT, including the SMEs and stakeholders, review the guides and ensure that GFI is included, as needed. Minimum review time is usually not less than five (5) business days but can vary depending on the scope of the project, size of the lesson plan, course length, and number of SMEs and FAA personnel

involved in the review. The AJI-2100 ISS Lead and AJI-2300 Requirements Lead consolidate similar feedback and submit the feedback to the Vendor.

Once approved, the Vendor finalizes the instructor guides and presentations, and then submits these materials to the IPT for final review. Once the IPT accepts them and the Managers approve them, the Vendor develops draft Student Guide Materials (SGM) to include Testing and/or Performance Blueprints using the Test Blueprint Job Aid (AJI-2000, n.d.j). The Vendor submits these files to the IPT for review. The AJI-2100 ISS Lead and AJI-2300 Requirements Lead consolidate similar feedback and follow up on inconsistent / contradictory feedback to ensure alignment and then submit the comments to the Vendor. The Vendor incorporates that feedback, finalizes the SGM and Testing and/or Performance Blueprint(s), and conducts a QA/QC in preparation for the Validation phase. The Vendor provides the following deliverables during this phase:

- Instructor Lesson Plans and Presentation Materials
- Student Guides and Handouts/References
- Test Blueprint and/or Performance Blueprint (if applicable)
- Videos (if applicable)
- Exercises
- Errata Sheet(s) (AJI-2000, 2016b, p. 34)

Web-based training (WBT). For WBT, the Requirements Lead must complete and submit the ATO eLMS New Item Form (AJI-2000, 2016a, 2016e) to the FAA's eLMS representative. The Vendor, with SME support, develops drafts of the storyboards, including screen captures of samples of the graphical user interface (GUI) and supporting course templates, as appropriate. These drafts undergo review by the IP. According to AJI-2000, n.d.a, each reviewer records feedback in the errata workbook and then that information is consolidated by the ISS in a single Errata workbook. The Validation Rubric (AJI-2000, 2016m) may be used by the ISS, SME, and others during evaluation to determine if the training matches the related analyses and the CDG; thus, meeting the validity requirements as specified in JO 3000.11A. After the Vendor revises the drafts based on the feedback received, the IPT reviews the final storyboards. Once the IPT accepts and the FAA Managers approve them for the Course Walk-Through (CWT), the Vendor develops a draft version of the programmed WBT in the FAA's staging eLMS, which includes video content and the Test Blueprint or Performance Blueprint (instructional materials), as appropriate. This programmatic version of the training undergoes quality review by the ID and Requirements Leads. Then the Vendor implements the change requests, documenting what changes were and were not made and why in the Errata Worksheet. This finalizes the Development activities, which means the WBT is ready for the Validation phase. At this point the Project Manager, ISS Lead, and Requirements Lead verify the logistics for the Alpha and Beta testing with the IPT, additional AJI-2 personnel as needed, students, and other stakeholders.

Validation phase. The Validation phase is the fourth ID process. Its purpose is to "validate the effectiveness of the instruction and its learning application to the job tasks" (FAA, 2014a, p. 25). Validation incorporates formative and summative evaluations. The former refers to "methods undertaken during training development (forming) that determine the technical

accuracy and completeness of a product and whether the design, instructional strategy, and materials are likely to result in learners being able to achieve objectives and outcomes” (p. 27). The latter refers to “methods of judging the value/effectiveness of training at the end of training activities” (p. 27). The Validation Guide (AJI-2000, 2016k) provides instructions for carrying out the validation activities. Order 3000.22A provides the list of minimum criteria that all courses must and workshops may meet (see Appendix F). The ISS Lead uses the CDG Alignment Checklist (AJI-2000, n.d.b), Formatting Checklist (AJI-2000, n.d.d), and the Instructional Design Review Sheet (AJI-2000, n.d.e) to validate the Vendor-supplied training materials. The SMEs use the Technical Accuracy Review Sheet (AJI-2000, n.d.i) to verify technical accuracy of the content. The ISS Lead and Requirements Lead record needed revisions on the Errata Workbook (AJI-2000, n.d.a). The ISS, SME, and other IPT members may use the Validation Rubric (AJI-2000, 2016m) during validation to determine if the training matches the related analyses and the CDG, and thus, meeting the validity requirements as specified in JO 3000.11A. The Course reports summarize the results from the first presentation of the course materials to the last course conduct with students.

ILT validation. During this phase, the Vendor conducts a CWT with the IPT and other stakeholders. There are several objectives for the stakeholders. The first is to ensure that the Vendor made the previous corrections and revisions from the instructional materials review. The second is to verify the sequencing, timing, and duration are correct; at this point the content should be instructionally sound and technically accurate because of the prior reviews. The Vendor notes issues and corrections on the Errata Workbook during this walkthrough and corrects them prior to the Operational Try-Out (OTO), the next step in the validation process. The IPT may choose to conduct a final review of the course prior to proceeding to the OTO.

The purpose of the OTO is to locate, analyze, and eliminate any remaining problems prior to implementing the course with students. Following the OTO, the Vendor finalizes the course materials in preparation for the First Course Conduct (FCC).

The FCC participants include the students, the customer, the vendor, AJI-2100 ISS Lead, AJI-2300 Requirements Lead, and Union representative(s). The IPT and other observers fill out the Training Observation Review Sheet (AJI-2000, n.d.m) and the Validation Rubric (AJI-2000, n.d.n).

Following the FCC, AJI-2100 prepares a draft Validation Report (AJI-2000, 2016l) in accordance with the Validation Guide (AJI-2000, 2016k), providing recommendations for changes and whether the course is ready for approval or not. If changes are necessary, the IPT meets with the Vendor to discuss and implement recommendations. The Vendor finalizes the materials and conducts a quality assurance/quality check (QA/QC) prior to final delivery. If significant changes are compulsory, the IPT can require a second validation, termed a Second Course Conduct (SCC). It would follow the same process as the FCC. The IPT may decide to conduct a final review following the FCC or the SCC sequence to determine if the course is ready for final approval. The finalized Validation Report goes to the AJI-2120 Training Development Manager for approval, followed by release and implementation.

WBT validation. In the Validation phase, the Vendor—if the Vendor receives such privileges—or an FAA eLMS Administrator loads the draft WBT into the FAA’s staging environment for a CWT by the IPT and other stakeholders, as appropriate. Its purpose is to ensure the revisions to the storyboards are programmatically correct and the instructional sequencing, timing, duration, and programming are functionality accurate (AJI-2000, 2016b). The reviewers provide formative feedback, which the PL and ISS Lead consolidate in the Errata

Workbook, and then give to the Vendor. Using the same worksheet, the Vendor documents all programmatic revisions and includes the rationale for not implementing any feedback in the programming.

Alpha testing follows the CWT and it is equivalent to the ILT OTO, a user acceptance test conducted with real students in the eLMS. Once the Requirements Lead approves the participants, he or she requests the eLMS Admin to enroll them and the other stakeholders (ISS leads, SMEs, customer, etc.) in the course. After the Alpha, the FAA's ID and Requirements leads consolidate the feedback on the Errata Workbook for the Vendor, who then makes the revisions and documents what was and was not revised and why. Once the IPT accepts the WBT, the FAA Manager approves the course for Beta testing.

The purpose of the Beta testing is to gather feedback from the target audience on both instruction and functionality; consequentially, it is equivalent to a FCC performed in an ILT project. As with the Alpha, once the Requirements Lead approves the participants, he or she requests the eLMS Admin to enroll them and the other stakeholders (ISS leads, SMEs, customer, etc.) in the course. Once the IPT signs off on the draft of the Beta, the Contracting Officer (CO) notifies the Vendor of the FAA's approval to integrate the FCC materials into the FAA's eLMS staging environment. From this point forward, the Vendor must complete the programming in the eLMS within 15 days. Once the WBT is ready, the Vendor conducts the Beta testing with the target students and with the Customer, ISS Lead, Requirements Lead, and Union representative(s) enrolled to observe. The Vendor receives feedback from the students from the End-of-Course Evaluation forms and from the observers on the Training Observation Review Sheets. The Vendor makes necessary revisions to the WBT based on this summative feedback and documents those changes and responses in the Errata Workbook. If the ISS Lead does not recommend a second Beta, equivalent to a Second Course Conduct (SCC) for ILT, in the draft Validation Report, the Vendor performs the final QA/QC review of the materials prior to delivering the final course materials and the WBT coding to the FAA. If the ISS Lead does recommend a SCC because evaluation feedback revealed significant changes are necessary, the decision to require it or not falls to the Director of AJI-2000. If required, the second Beta/SCC follows the same procedures for scheduling, running, and evaluating the first Beta/FCC. After the Vendor finalizes the WBT and documents the changes and responses to feedback, the IPT may conduct a final review of the course materials. Once the IPT signs off on the course, signaling its acceptance to the CO/COR, and the Managers approve, the Vendor submits the final versions of the deliverables: programmed course, course assessment, test blueprints and/or performance blueprints (if applicable), videos (if applicable), exercises, end-of-course survey, and the course source files. Within 30 to 60 days from the end of the last course conduct, the ISS Lead completes and submits the final Validation Report to the AJI-2120 Team Manager, and the CO/COR notifies the Vendor of FAA's approval (AJI-2000, 2016b).

[REDACTED]

E-learning courses are published in the eLMS environment based on a queue. Position in this queue is based on the course readiness or its completeness, the planned course launch date, and the level of safety impact and requirements (FAA, 2014c). The higher the level on the Course Priority Matrix (Figure 7), the higher up in the launch queue.

Requirement Source	Impact on Safety			
		Direct	Indirect	Marginal or None
	Flight Plan, Regulatory, High Governmental Authority (Generally Mandatory)	High	High	Medium
	LOB Plan (Generally Position Essential)	High	Medium	Low
	Unplanned	Medium	Low	Low

Figure 7. Course priority matrix. From “FAA eLMS Content Integration Guide” 2014, Appendix D. Copyright 2014 by the Federal Aviation Administration.

On-site observations. We observed an alpha test of four simultaneously-developed recurrent WBT courses and the FCC for a blended course with WBT and ILT components. The three-day alpha validation event was held in at the Micaplex at the Research Park located in Daytona Beach, Florida in November 2017. The three-day FCC event was held at NATCA headquarters in Washington, DC in January 2018.

Recurrent WBT training. The alpha test was attended by seven SMEs (AT controllers, each from different locations and with different expertise), the Requirements lead, the ISS, and two Vendor personnel. FAA57201801 Parachute Operations (Briefing), FAA57201802 Visual Approaches, FAA57201803 Terminal Teamwork (Briefing), and FAA57201804 Basic Radar Services to VFR Aircraft were all Level 1 WBT (videos and interactive quizzes but no branching scenarios). They had been loaded into the FAA’s eLMS staging and the Vendor lead was logged into the FAA’s secure network on his laptop computer and mirrored his laptop’s display on the large overhead monitor so that everyone could see the screen. The other Vendor representative and a few of the SMEs also had laptops; however, only one SME was running the course through an external link. Although seven SMEs were present, the majority of the revision requests came from the one SME who was logged into the course. One other SME had several revision requests and comments, but the others were relatively silent throughout the review process. Types of errata recorded by the Vendor leading the review included content, sequencing, and presentation revisions; for example, deleting, moving, and wordsmithing videos and changing and moving buttons (interaction triggers). According to the Vendor lead, the number and type of the change requests by the SMEs were typical of alpha testing, even though these same SMEs had reviewed the storyboards and participated in the prior course walkthroughs that were also conducted in staging. According to the ISS Lead, the CWT for recurrent training is resulting significant editorial changes, sometimes as many as 200 change requests from each reviewer (D. Talkington, personal communication, April 28, 2017).

According to the Vendor, there was only two weeks between the end date of the alpha testing and the due date when the final deliverables had to be submitted to the FAA, requiring significant reallocation of their resources to meet the deadline.

There are also some discrepancies between the AJI-2000 SOP process flow and project schedules in the courses reviewed. In the SOP flowchart (AJI-2000, 2016b), implementation is part of the Validation phase, and begins with implementation of the CWT for both WBT and ILT. The CWT is followed by the WBT Alpha test/ ILT OTO, WBT Beta test/ILT FCC, a WBT/ILT SCC (if required), and then the final WBT/ILT approval (see flowchart in Appendix C).

Currently, the logistics—location and selection of the participants—for the Beta for recurrent training are determined in the kickoff meeting, as opposed to just after the CWT for the Alpha test and just after the Alpha test for the Beta test for new WBT (D. Talkington, personal communication, February 15, 2017).

The Top Five Team in AJI determines what refresher and recurrent training is necessary but does not rely on a JTA to inform such decisions. In addition, a minimum passing score is not required as it is for other courses. It is unknown if the scheduling and process differences between new and recurrent course developments are deviations arising from the SOP still being in flux at the time of this research or because of management differences between IPT leads. Refresher and recurrent training should be categorized as a briefing, because they do not require assessments, an Analysis Report, CDG, nor any validation activities per JO 3000.22A.

Blended training. The second validation event was the FCC for a blended course held at NATCA headquarters in Washington, DC. The course, “Training Review Board Class (TRB),” which will replace a current NATCA course, is Self Enhancement Training (SET) designed to prepare AT personnel to conduct TRBs in accordance with JO 3120.4P (FAA, 2015b) and the Collective Bargaining Agreement (CBA). If the FCC is successful and the students pass the performance assessment, the students receive credit for taking the course and may become cadre instructors.

Attendees in this FCC included the Requirements Lead, an ISS substituting for the recently retasked ISS Lead, two vendor representatives, a NATCA representative, and 15 students on day 1 and 16 students on day 2 (one student was unable to attend the first day because of weather-related flight delays). The student population was a fairly balanced mix of male and female controllers. Two NATCA instructor-facilitators co-taught the classroom training in accordance with JO 3000.22A (FAA, 2014a). This order states that the purpose of the FCC is to:

- Conduct the delivery of training to target audience.
- Be observed by the technical content lead and the training development lead to determine if training meets validation criteria and the instructional materials and associated documentation are complete, accurate, and ready for delivery.
- Determine whether the training is effective, adequate, and acceptable to the learners during the first delivery.

Satisfactory completion of the FCC required completion of the self-paced 1-hr WBT and the subsequent 3-day ILT. The students indicated they had completed the WBT, but it was not made available for our observation during the validation event. The classroom training consisted of five lessons completed across the first two days and a mock TRB meeting completed on the third day. Each lesson ended with the students completing an anonymous Student Assessment form, identifying the readiness of that portion of the training for release (implementation either in the field or at the FAA Academy). Specifically, they considered 11 areas, including the learning objectives, instructor’s presentation, instructional materials, and the sequencing and pacing of the training.

The ILT began with an instructor-led review of the WBT followed by assessment of the WBT by the students. Only 12 students submitted this assessment form. Eight of those forms included qualitative feedback. Comments included “too slow,” “basic,” “had some errors in Chapter 4 in notes portion,” “two questions regarding team responsibilities that seemingly exclude the FLM/OS,” and “feedback form would have been helpful while taking the course.” Two students noted issues on where to click. One student stated, “Only the test would open.” One other student checked the box for needs improvement (NI).

Examination of the 15 student assessments of Lesson 1 of the ILT revealed six students marked “yes, basically there were no problems in this area” on all 11 items, and eight students provided qualitative feedback. Four students had questions about responsibilities of the training team; three students commented on the class discussion; one student had concerns about the clarity of the learning objectives and lack of references on a slide; one student commented on the lack of examples of skills.

Examination of the 15 student assessments of Lesson 2 revealed only eight included qualitative feedback. Statements from one student included “answers were in the student manual – intentional?”, “continue to explain, don’t have full package”, and “set up scenarios when passing out material.” Another student said, “I really like the way the TRB package was broke down to let us digest it piece by piece.” Another student said, “It could have been a bit more clear, the point that the 3120-25 forms may be out of order in the TRB package.” One student said, “It might be easier to do group work with different table / desk configuration.” No one selected “NI” and nor did anyone provide the page numbers in the Lesson Plan associated with their comments.

A prearranged meeting with the FAA sponsor on day three at FAA Headquarters meant we could only observe the first two days of this FCC. Lesson 3 was still ongoing on at the end of day 2; consequently, we did not collect data on Lessons 3 – 5 or the mock TRB meeting. Nevertheless, observations of the first two days’ activities and assessments and informal discussions with the Requirements Lead and ISS provided additional insights into the ID process.

Some observations offered by the ISS focused on the roles and responsibilities of the SMEs and students during validation (S. Fowler, personal communication January 10, 2018). If one SME or student wants significant changes late in the validation process and the vendor implements these changes, it begs these questions: Is AJI-2 developing training to satisfy one person’s preferences? Shouldn’t AJI-2 be developing training for the target student population? Even though the students receive an email before the training explaining what their role is in the FCC, they tend to assume a lot of authority beyond the scope of their defined role for these events. However, the ISS admitted to finding numerous issues with training and recording them on an errata form to share with the ISS Lead of record (S. Fowler, personal communication, January 9, 2018). Although all of the errata were not examined, one particular issue was rudimentary; namely, document titles not matching in the student and instructor materials. It is the responsibility of the ISS and Requirements leads to confer on the FCC feedback and to agree on which revision requests to present to the Vendor to implement.

Observations offered by the AJI 2410 Requirements Lead bridged several topics (B. Kahklen, personal communication January 10, 2018). The course underwent two OTOs. The 5-member workgroup performed the first OTO, but none of the participants had the prerequisite TRB experience, so it failed. The second OTO held with six SME/students with the prerequisite

knowledge was passed. The fact that there are five functional areas in TO and three in AT makes it problematic for the Requirements Leads to function as SMEs. The Requirements Lead also explained that the same SMEs tend to serve as students across many AT course developments. This relates to the question by the ISS about developing training based on the views of one SME because the same SMEs appear to be informing the development of a disproportionate amount of AT training. The Requirements Lead provided another observation related to multiple ISSs on a project; each ISS would ask the Vendor to do things differently, and in some cases contradict feedback given by the other ISS. Another issue discussed pertained to project timelines, specifically approvals and requests. The Requirements Lead said the Vendor prepares the project schedule and the Requirements Lead only has five days to determine if the milestones will work or not, even though the Requirements Lead has to coordinate with others to make such determinations. The ATO Technical Labor Office requires all requests for students to be at least 75 days before the FCC and AJT wants 45 days of advance notice. Plus, the schedule has to be posted 27 days in advance. Because it is difficult to predict exactly when a project will be ready for validation, the 75-day lead time to get students and SMEs has been problematic for all concerned in AJI-2, as reported by AJI-2 Management, ISS, and Requirements' personnel.

General observations included a lack of guidance regarding student expectations and an insufficiently-detailed instructor guide. The student materials appeared to be appropriately organized and detailed, and the instructor materials were as well for the most part. Although the course was designed to be run with as many as 20 students, having 16 students in the validation event seemed excessive given the significant cost to the FAA to fly each student in from around the U.S., especially considering about half of the students were consistently providing actionable feedback that could be used to validate and improve the training. The Vendor expressed frustration with so many changes, some which they reported conflicted with prior input, some which they said should have been noted and discussed prior to the FCC.

Presently, the ATO is not getting evaluation feedback after a course has run in the field (D. Talkington, personal communication, February 15, 2017). Although the FAA's eLMS records students' grades (scores) for courses with assessments, AJI-2000 is not collecting nor analyzing these data; the back-end piece of evaluation is missing for virtually every course (D. Talkington, personal communication, April 28, 2017). Because AJI-2000 is not regularly performing the Kirkpatrick evaluation model, student-, workplace-, and organizational data are scant to nonexistent. Level 1 evaluation determines student satisfaction with the training; Level 2 evaluation determines achievement of the course outcomes; Level 3 evaluation determines skill implementation in the workplace; Level 4 evaluation determines organizational impact; Level 5 evaluation determines ROI (Ho, 2016a, 2016b). Although Levels 3 and 4 evaluations normally occur in the Evaluation phase of the ADDIE model, the FAA's current SOP does not incorporate them. Nor does it appear that the AJI 2150 Curriculum Maintenance Team is collecting such data on a routine basis.

Course examples. Descriptions of ILT and WBT courses allow for a clearer understanding of the differences between the workload efforts required for the two primary types of training events. It is important to point out, however, that vendors produce the project schedules or project plans, not the FAA. Consequently, documenting project work differs both between vendors and between projects. Work effort, measured in task days, varies between projects based on several factors such as the length and complexity of the course, the number of concurrent course developments tasked under the FAA contract, and the amount of FAA and Vendor resources deployed on a project. Nevertheless, illustrating production effort by ID

phases and by FAA effort and Vendor effort make it possible to see what activities consume the most time. This also permits broad comparisons between ILT and WBT developments.

ILT example. The Flight Plan Data course (20160452) is 17-hour instructor-led training delivered in four knowledge-based lessons, with 65% direct instruction and 35% indirect instruction. By the end of the course, the learners' level of understanding should be at the intermediate level. Instructional techniques include structured overview, concept mapping, and didactic questions.

The course includes several assessments. According to the CDG, administration of the formative assessments may be at the completion of each lesson or anytime during the course when combined. These lesson tests consist of one question for each enabling learning objective. These tests are scored, but the scores are not recorded. Administration of the summative assessment is at the end of the course. This test is scored and the score is recorded, because 70% or better is required to pass the course.

According to the vendor's project schedule, it took [REDACTED] days to develop this course. Figure 8 shows the work breakdown structure by ADDIE phases and Figure 9 shows the breakdown for the FAA and Vendor's efforts. [REDACTED]

Figure 8. REDACTED.

Figure 9. REDACTED.

WBT example. The Surveillance & Broadcast Services (SBS) Fundamentals course (68000398) provides learners with novice-level proficiency of theoretical and conceptual knowledge of SBS. This training is required for learners in En Route, Terminal, and Oceanic Technical Operations and is a prerequisite for nine courses. A total composite score of 70% is required to pass the course. The CDG describes it as 2-hour self-paced WBT with 1.5 hours for instruction and 30 minutes for all assessments. Its four modules include knowledge checks, a pre-test, and there is an end-of-course test. The content incorporates text-based slides, graphics, illustrations, and charts. [REDACTED]

According to the SBS Fundamentals Project Plan (2016), the product duration was [REDACTED] days; however, manually calculating the production schedule results in [REDACTED] production days. (Total Days shown in the chart in Appendix D are the total task days for the chief activities in each phase.) Figure 10 shows the overall production time for each phase of the project for the combined efforts of the FAA and vendor based on the [REDACTED] production schedule. Figure 11 shows the production effort by the FAA and the vendor for the same total duration. Notice that the vendor's effort during the Planning phase was less than that of the FAA's but greater in the other phases, and that validation activities consumed the major portion of the production time.

Figure 10. REDACTED.

Figure 11. REDACTED.

This schedule for this WBT course reveals discrepancies with the SOP (AJI-2000, 2016b). According to the SOP, the Alpha test for WBT is equivalent to the CWT for ILT; however, this project schedule (see Appendix D) identifies the Alpha testing as the OTO in eLMS staging. It also shows separate Alpha/OTO testing of the test blueprints in staging. The Validation phase for this 2-hr course was █████ of the project effort, considerably more than all other effort combined, and six times greater than the percentages used by industry and the FAA to estimate development time for Level 1 WBT (see Table 6). Conversely, the █████ Development effort was lower than the █████ used by the FAA to estimate course productions.

Blended example. The FAA Academy administers the Initial En Route Qualification Training (50148001) course for developmental ATC Specialists (ATCS) seeking Certified Professional Controller (CPC) assignments at en route facilities. The CDG (Sanders, 2016) describes the course as a blend of ILT and WBT comprised of 21 e-learning activities, with about 25% of the instruction direct, 5% indirect, 20% interactive, and 50% experiential. Direct instruction consists of instructor-led academic lectures, presentations, discussions, demonstrations, and question-answer sessions. About 80% of the course consists of technology-enhanced instruction involving part-task training and low-, medium-, and full-fidelity simulation training in different laboratories (i.e., non-radar, ERAM, & SIGNAL). There are 48 lessons delivered over 59 days. A total composite score of 70% is required to pass the course.

Access to course production materials was limited to a small sample of the curriculum. Furthermore, the GFI was not consistent between the courses; many courses lacked project schedules and other pertinent documentation. Nonetheless, we reviewed the GFI for AT and TO courses developed using the new SOP and courses using an older, unidentified process. Table 8 shows the work days for each phase and for the entire project for the sample of ILT and WBT courses provided by the ATO that were developed using the 2016 SOP.

Table 8

REDACTED

Note. REDACTED.

While there are not many course developments using the 2016 SOP, five FAA ISSs documented their effort (time) for each phase of the ADDIE process for five ILT and four WBT courses. They worked about █████ per ILT course hour and about █████ per WBT course hour, including travel time (D. Talkington, personal communication September 6, 2017).

Table 9 compares the ISSs' efforts with the FAA estimates for the project activities for both ILT and WBT developments. The FAA estimates represent the combined effort of all resources on a project, but the ISS Lead effort is estimated to be approximated [REDACTED] while the ISS effort is estimated to be approximately [REDACTED] of the project effort. Validation time consumes the largest part of ISS effort, on average approximately [REDACTED]

Table 9

REDACTED

Note. REDACTED

Survey results. An online version of the survey (see Appendix A) was available to all FAA ISSs. The overall response rate was 68.75% for the population of 16 ISSs: There were six participants from AJI, seven from AMA 400, and two from AMA 20. Two AJI managers completed the survey during an interview. Table 10 provides the frequencies for highest education achieved and range of certifications obtained for ISSs and managers. Table 11 provides the central tendencies across ISD experience. Table 12 provides the mean scores and standard deviations for expertise, satisfaction, and difficulty with the four phases of the ID process for both ILT and WBT: Analysis, Design, Development, and Validation.

Table 10

Highest Education and Certifications

	Instructional Systems Specialists (N = 11)	AJI 2100 Team Managers (N = 2)
Bachelor's Degree	1	0
Master's Degree	9	2
Doctorate Degree	1	0
1 – 10 Certifications	10	2
11 – 20 Certifications	1	0
21 – 30 Certifications	0	0
+ 30 Certifications	0	0

Table 11

Instructional Systems Design Experience

	Instructional Systems Specialists (N = 11)				AJI 2100 Team Managers (N = 2)		
	<i>M</i>	<i>Mdn</i>	<i>Max</i>	<i>Min</i>	<i>M</i>	<i>Max</i>	<i>Min</i>
Years in Industry	17.04	16.00	34.0	1.5	22.50	29.0	16.0
Years with FAA	5.68	3.00	15.0	1.0	7.00	7.0	7.0
Number of Projects ^a	6.12	5.00	16.0	1.0	20.00	20.0	20.0
Years with AJI ^b	4.00	3.75	7.0	1.0	7.00	7.0	7.0
Years with AMA 400 ^c	5.71	1.00	15.0	1.0	0.00	0.0	0.0
Years with AMA 20 ^d	3.75	3.75	6.0	1.5	0.00	0.0	0.0

^aIncludes projects completed and in progress using the current AJI-2 instructional systems development SOP. It does not include any non-activated projects.

^b*n* = 6.

^c*n* = 7.

^d*n* = 2.

Table 12

Mean (SD) Expertise, Satisfaction, and Difficulty with the ATO ISD Process

	Instructional Systems Specialists (N = 11)	AJI 2100 Team Managers (N = 2)
Expertise with the ATO ISD Process	5.18 (1.66)	7.00
Satisfaction with the ATO ISD Process	4.18 (2.08)	5.00
Difficulty with the ILT Analysis Phase	2.90 (2.02)	4.00
Difficulty with the WBT Analysis Phase	3.18 (2.40)	4.00
Difficulty with the ILT Design Phase	3.90 (2.11)	3.00
Difficulty with the WBT Design Phase	3.81 (2.22)	3.75
Difficulty with the ILT Development Phase	3.72 (2.00)	3.75
Difficulty with the WBT Development Phase ^a	3.40 (2.27)	3.75
Difficulty with the ILT Validation Phase	3.45 (1.96)	5.00
Difficulty with the WBT Validation Phase	3.36 (1.96)	5.00

Note. Expertise and Satisfaction scales: 1 – 7 (1 = low, 7 = high). Difficulty scale: 1 – 7 (1 = very difficult; 7 = very easy or non-problematic). ATO = Air Traffic Organization. ISD = Instructional Systems Design. ILT = Instructor-Led Training. WBT = Web-Based Training.

^a1 missing response.

Table 13 shows the ISD models identified by the survey participants in Item 4 and their frequency of use from most used (1st) to least used (4th). As expected, the ADDIE model has the highest usage with 10 participants placing it first. The second most used model was fairly evenly distributed across nine models. Two participants identified Successive Approximation (SAM) and two identified Bloom as the 2nd most used model, although the latter is typically classified as a learning taxonomy (see Reigeluth & Moore in Reigeluth, 1999). All of the participants identified the most used model. However, responses were progressively fewer for the less frequently used models. This might represent a lack of designer experience with different models or may be missing responses.

Table 13

Instructional Systems Specialists Model Use

Model	1st	2nd	3rd	4th
Analysis, Design, Development, Implementation, Evaluation (ADDIE)	10	1		
Gagne's Conditions of Learning model (Nine Events of Instructional Design)	1	1		
Bloom's Taxonomies		2	1	
Successive Approximation Model (SAM)		2	1	
Dick and Carey's Systems Approach		1		1
Agile		1		
Systematic Approach to Training (SAT)		1		
Mager's Criterion Referenced Instruction (CRI)			1	
Guaranteed Learning (Esseff's Instructional Development Learning System)			1	
Virtual Classroom (OnLine Training, Inc. iterative eLearning approach)				1

Figure 12 shows the bottlenecks reported in survey item 22 clustered by major themes, with the themes shown above the bars. The first theme relates to the SMEs. The second relates to the roles of team members. The third relates to information access, sharing, and storage. The fourth relates to external factors outside of the control or purview of the ISSs. The fifth relates to upper-level management decisions. The two managers echoed the ISSs' sentiments about SME change requests, role clarity, and requirements/analysis.

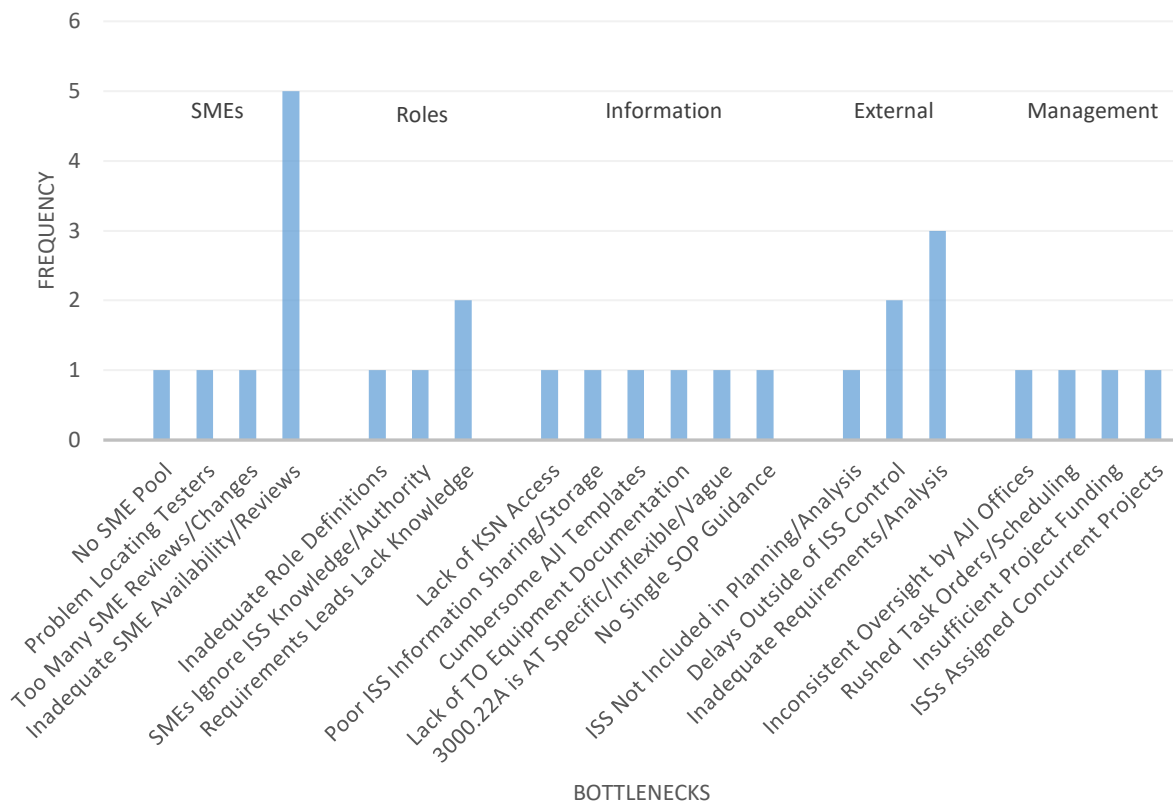


Figure 12. Bottlenecks reported by the Instructional Systems Specialists. SME = subject matter expert. KSN = Knowledge Sharing Network. ISS = Instructional Systems Specialist. AT = Air Traffic. TO = Technical Operations. SOP = standard operating procedure.

Figure 13 shows the suggestions reported in survey item 23 clustered by major themes, with the themes above the bars. The first theme relates to the ID model. The second relates to the team roles and guidance. The third relates to tools. The fourth relates to project validation. The fifth relates to management. The two managers' suggestions were similar to themes one, two, and four.

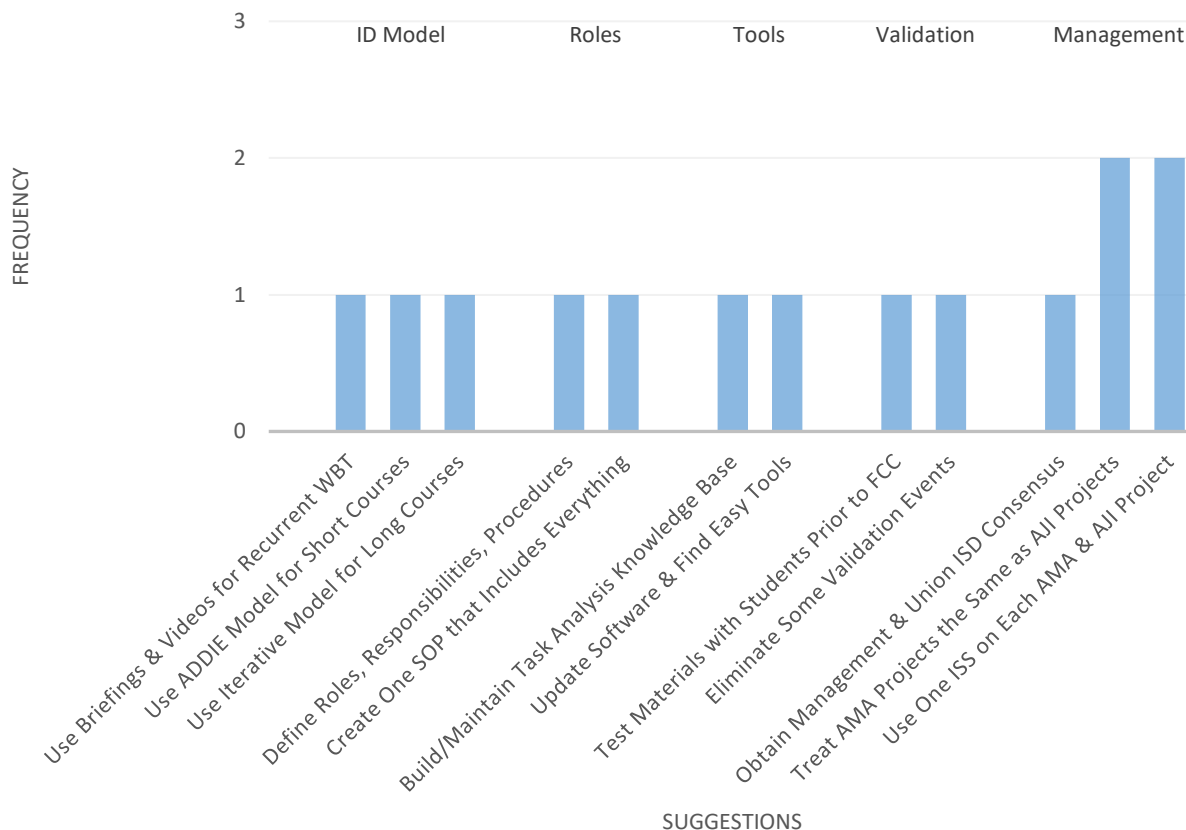


Figure 13. Suggestions reported by the Instructional Systems Specialists. WBT = Web-Based Training. SOP = standard operating procedure. FCC= first course conduct. ISD = Instructional Systems Design.

Table 14 lists the themes for the process bottlenecks and for the improvements suggested by the survey participants. Roles and management themes appear in both bottlenecks and suggestions and the information and tools themes have some similarities.

Table 14

Themes for Bottlenecks and Improvements

Bottlenecks	Improvements
SMEs	ID Model
Roles	Roles
Information	Tools
External	Validation
Management	Management

Project Phase 2: Literature Analysis

Site context. When comparing ID practices to explore performance differences, it is necessary to define the site context or setting into which best practices will transfer. Understanding the conditions under which AJI-2000 develops occupational training is essential to identifying ID practices that are transferable to AJI. There are both endogenous and exogenous factors affecting ISD. Endogenous factors are under internal control of AJI-2000. They include the organizational, managerial, technical, and individual resources (inputs) used to produce units of training (outputs). Exogenous or external factors have very little if any direct control by AJI-2000. They include economic, safety, legal, and physical constraints under which AJI-2000 must operate.

Regulatory constraints. Order 3120.4P “prescribes the instructions, standards, and guidance for the administration technical training for air traffic controllers” (FAA, 2015b, p. 2). The AJI-2000 receives its authorization from JO 3000.22A, and is “responsible for program guidance, effectiveness, technical accuracy, evaluation of air traffic technical training, coursework/curriculum development and review, maintenance, and oversight of national and FAA Academy-delivered courses” (FAA, 2014a, 2-1). In addition to having to work within organizational regulatory constraints, there are also legal constraints stemming from other government laws (e.g., Section 508 law, labor laws, etc.). For example, NATCA is the bargaining unit representing various employees in ATO Technical Operations (AJW) at regional divisions and operational control centers and at various divisions of Aviation System Standards (AJW-3). The Professional Association of Aeronautical Center Employees (PAACE) is the bargaining unit for contracted AMA Instructors/Non Instructors, AMA 900 of the FAA Academy at the Mike Moroney Aeronautical Center. Legal and federal regulatory constraints affect job performance, thus operational effectiveness, at both individual and organizational levels.

Alternative ISD models. There are numerous alternatives to the ADDIE model, but virtually all are close approximations to the traditional five-phase process described in Chapter 1. Therefore, the following section begins with an illustration of the ADDIE model used by the U.S. Army and descriptions and illustrations of other models. This information provides context for the results presented from the literature review that follow this section.

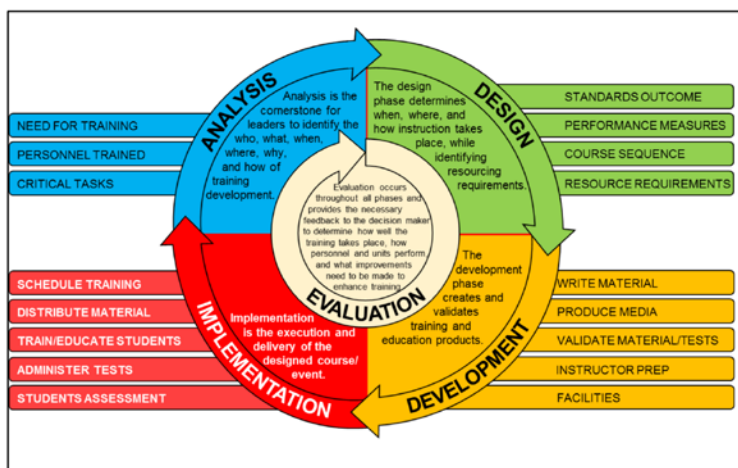


Figure 14. ADDIE model. From Figure 2-2 in “The U.S. Army Learning Concept for Training and Education 20120-2040 (TRADOC PAM 528-8-2),” 2017, p. 14. Copyright 2017 by the U.S. Department of the Army.

Dick and Carey's systems approach. This instructional design model, created by Dick, Carey, and Carey, is a descriptive approach based on systems and software engineering (Dick, Carey, & Carey, 2009). It is similar to ADDIE, but has 10 steps, and includes parallel and repetitive functions, so is sometimes described as an iterative process. Step 1 focuses on identifying the instructional goals and performing a needs analysis. Step 2 involves performing an instructional analysis, or learning-task analysis. Step 3 involves identifying the behaviors and characteristics of the target audience or learners. Step 4 involves writing the performance objectives. Step 5 involves developing criterion-referenced test items or the assessment instruments. Step 6 is where the instructional strategy, or how the training will be delivered, is determined. Step 7 involves developing the instructional materials. Step 8 includes designing and conducting formative evaluation of the training. Step 9 involves designing and conducting the summative evaluation to measure instructional effectiveness. Step 10 focuses on revising and improving the training based on feedback and data from the evaluations. Figure 15 illustrates the major activities in the Dick, et al. systems process.

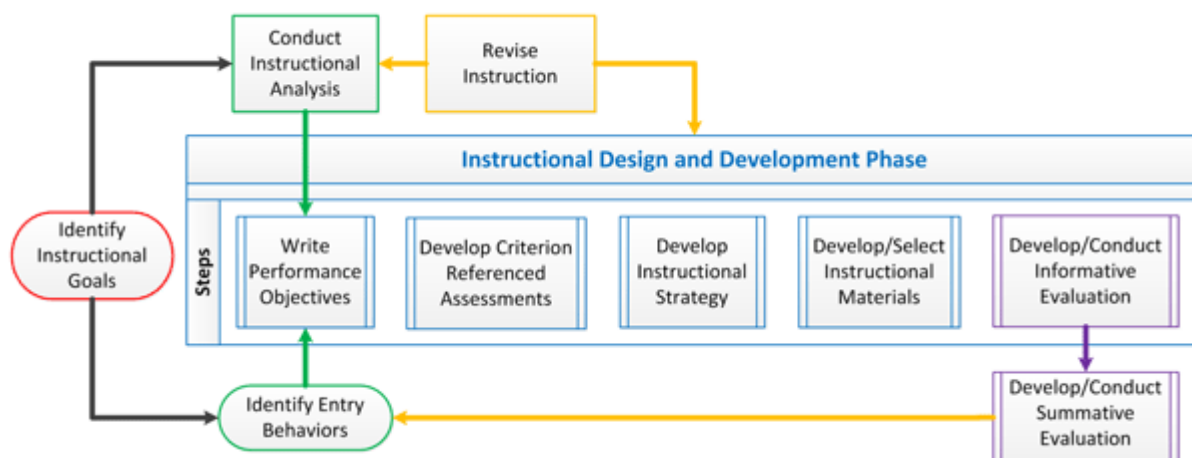


Figure 15. Dick and Carey's systems approach model.

Successive Approximation Model (SAM). This model, created by Allen Interactions as an alternative to the ADDIE model for developing e-learning (Allen Interactions, 2017), is an Agile-type model characterized by three phases. As illustrated in Figure 16, the phases are Preparation, Iterative Design, and Iterative Development. There are three design iterations and three development iterations, emphasizing collaboration, efficiency, and repetition (Training Industry Taxonomy, n.d.). The initial Preparation phase is notably short, because the objective is to gather background information in lieu of conducting a detailed needs analysis. The Iterative Design phase begins with brainstorming how best to address the student performance goals. The production team designs a prototype of the first feature and then releases it for review (evaluation) and revision. This cycle repeats until all of the features are prototyped and tested, and the product design proof is developed and ready for implementation and evaluation, first in Alpha testing and then Beta testing, after which the Gold Master is ready for release in the field. As with all Agile methodologies, incremental design and development is a learning process, in that improvements on earlier features inform the design and development of subsequent features. Rapid approaches such as this are rather useful when the client or SME is unclear about what the training solution should be or when the desired training solution is quite complex (Gustafson & Branch, 2002). This type of approach avoids cascading problems that pile up or

that remain undiscovered until end of the project when the complete product undergoes evaluation and validation. Catching issues earlier reduces review, revision, acceptance, and approval times.

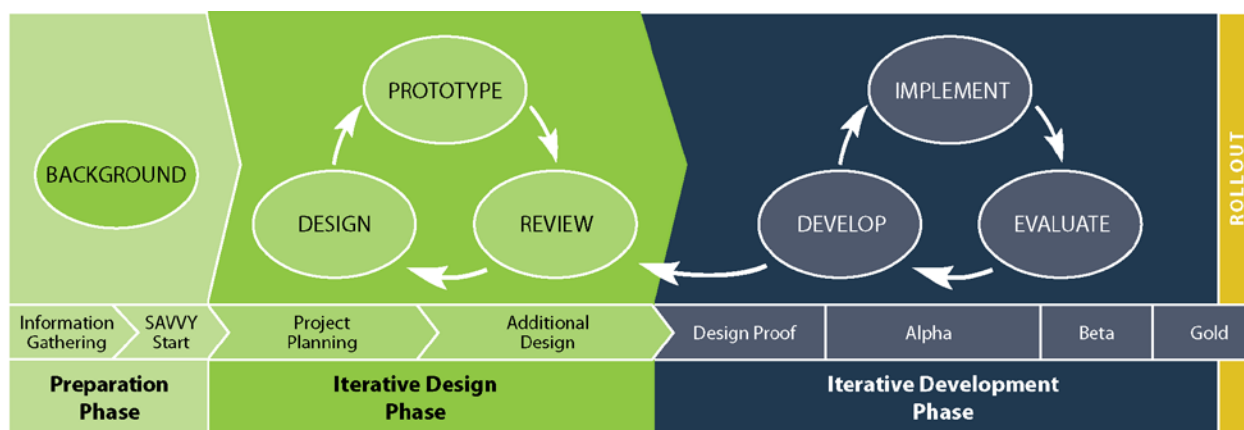


Figure 16. Successive approximation model (SAM). From Successive Approximation Model (SAM) Poster. Copyright 2017 by Allen Interactions. Used with permission.

Industry advisor, JMA Solutions, LLC, develops training for both industry and government entities, including the FAA. The types of training include facilitated workshops for feedback and process improvement, self-directed/paced online courses, job aids, and refresher training. The company uses both ADDIE and SAM, and reports that SAM results in about a 25% reduction in the development hours because the focus is primarily on the client's or major stakeholder's requirements, reducing the analysis and feedback times (A. Selnick, personal communication, April 3, 2017). However, JMS uses the ADDIE model for most developments and all developments that require a rigorous, systematic process. See Appendix H for the ratios used by JMA Solutions to estimate development time based on one hour of instructional training.

Agile Learning Design (ALD). This model is an Agile approach to the ADDIE model. The Agile methodology from which ALD is derived originated in the manufacturing industry and became popular in the software industry before its adoption in the instructional design field (Training Industry Taxonomy, n.d.). As illustrated in Figure 17, the ALD methodology is an iterative and incremental process model (Beck, et. al., 1981). The process “actively seeks to identify and resolve risks and use these to influence the evolution of a solution from requirements through to operations” (Moran, 2014, p. 34). As opposed to a waterfall approach that segregates development by system components or sub-components, an Agile approach breaks the process up by product features. Unlike the ADDIE model that relies on perfect execution of large phases, Agile relies on small adaptable and iterated steps. Production is a series of repeating work sprints, each with pre-specified time increments determined by the (a) number of tasks to develop a product feature, (b) complexity of each task/feature, (c) number of human resources on the project, and (d) velocity (productivity) of each worker. Once product feature is fully developed and tested in a work sprint before developing another feature in the next sprint. This, coupled with the fact that the client is involved throughout the entire production, purportedly avoids late diagnosis of problems and significant rework that can lead to costly delays in terms of time and resources. This type feature-driven approach is also transparent, making it easy to know if a project is meeting its targets or if project milestones are

slipping. For example, everyone from the client to management knows the project is 80% complete if 8 out of the 10 features of the product are complete.

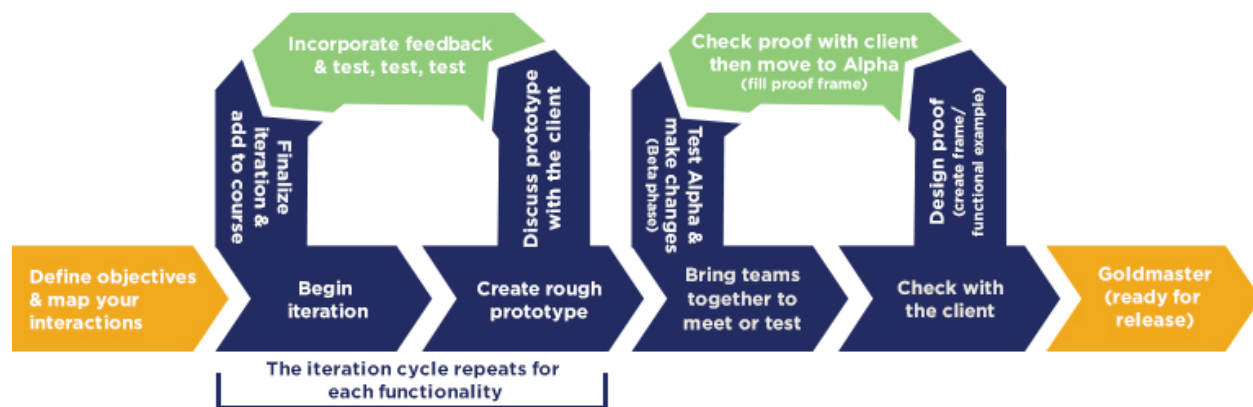


Figure 17. Agile learning design (ALD) model.. From “What is Agile learning design?” by J. Huhn, 2013. Copyright 2013 by Bottom-Line Performance.

ADDX Corporation uses an AGILE methodology for developing e-learning. The Analysis phase in which the requirements are determined remains unchanged, but they incrementally design, develop, test, and deliver each course feature and the associated instructor content. They tracked the number of hours required to design, develop, and publish all of the training assets for instructor-led training delivered in a classroom. Utilizing IDs, SMEs, and a copy editor, the total number of hours expended was 2,788 (A. Little, personal communication, January 3, 2017). This total production time translates to 34.85 hours of development time per hour of instructional time of the course. As noted in Tables 5 and 6, product developers within the training industry typically use 43 to 184 hours of development time per hour of instructional seat time depending on the complexity of the training content and level of training interactivity (Chapman, 2010, Kapp & Defelice, 2009). Compared to the industry norms for developing ILT courses, this example of the Agile ISD process would translate to worst-case time savings of 16.6% and a best-case time savings of 81% compared to the traditional ADDIE process.

A.G.I.L.E. Another variation of both ADDIE and AGILE is A.G.I.L.E. instructional design, a project-based model developed by Gottfredson (2013). The acronym stands for Align, Get set, Iterate & Implement, Leverage, and Evaluate. This approach is similar to ADDIE in that its core methodologies remain largely unchanged from those of ADDIE and is similar to Agile because of its cyclic incremental and iterative design and development process. Figure 18 shows the A.G.I.L.E. components and its curvilinear process flow. The Align step entails defining the business needs and estimating resources: determining the requirements. The first cycle, Get Set, includes preparing for the task analysis, performing a critical skills analysis, prioritizing the impact of the training, and conducting a LEaP analysis: designing the desired Learning Experience and Performance. The second cycle, Iterate & Implement, involves the iterative development and incremental implementation of the product features. The third cycle, Leverage, addresses continuous improvement of the performance support through efficient and effective utilization of people and technology. The last cycle, Evaluate, entails routine measurement and reporting strategies. Of course, like the conventional Agile model, A.G.I.L.E. instructional design also relies on close communication and collaboration with the customer and focuses on the learners' needs or interaction with the training.

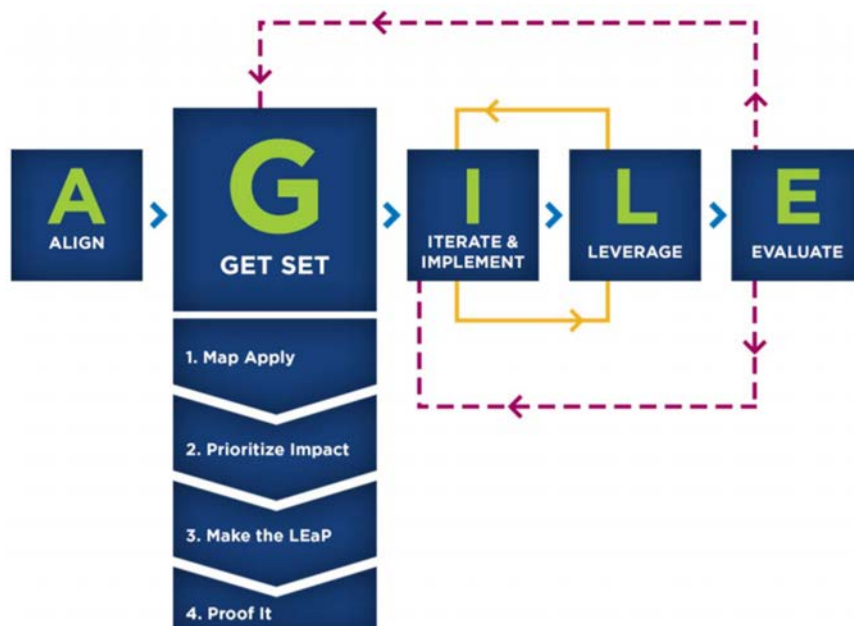


Figure 18. A.G.I.L.E. instructional design model. From “AGILE Instructional Design: Faster, Leaner, and More Effective @ the Speed of Change” by C. Gottfredson, 2013, p. 1. Copyright 2013 by The ELearning Guild Academy.

Scrum. This approach is a closely related to Agile models, sharing some attributes such as high communication and collaboration, fixed-length iterative sprints, and speed (Stair & Reynolds, 2014). Receiving feedback earlier in the process is what sets Scrum and all of the other curvilinear agile methodologies apart from the linear plan-driven approaches. Each sprint cycle begins with a planning meeting where the team identifies the tasks, collectively referred to as the feature backlog or simply the backlog. Feature development includes requirements identification, design and analysis, implementation and validation tests, and then deployment, as illustrated in Figure 19. The scrum master serves a leadership role, ensuring the team both understands and follows the process, and removing impediments with the goals of satisfying the product owner (client) and obtaining a ROI, and doing this all without exercising management authority over anyone. The process includes short daily team meetings to discuss what tasks were completed, what tasks are next, and what process impediments need elimination.

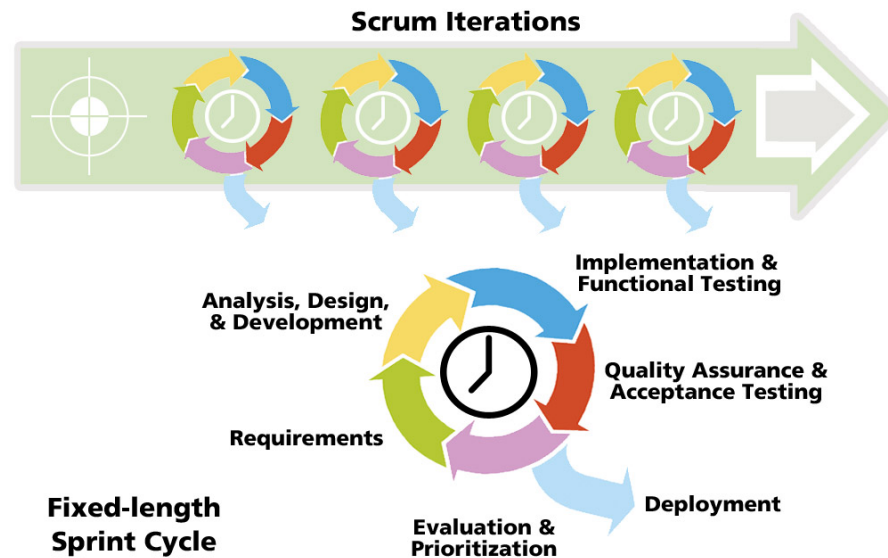
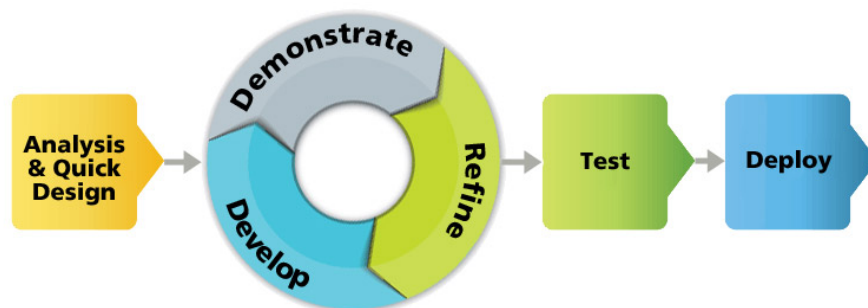


Figure 19. Scrum model and sprint cycle. Adapted from “Scrum Reference Card” by M. James and L. Walker. Copyright 2017. Retrieved from <http://scrumreferencecard.com/scrum-reference-card/>

Rapid models. Rapid Application Development (RAD) and Rapid Prototyping (RP) are development models predating the use of Agile in the software and manufacturing industries. In their textbook on information systems, Stair and Reynolds (2014) define RAD as “a system development approach that employs tools, techniques, and methodologies designed to speed application development” (p. 399). As illustrated in Figure 20, this model shares the functions of ADDIE as well as the incremental and iterative approaches of both Agile and SAM. However, RAD differs by using parallel incremental development of training features or components within time-boxed production for producing, testing, and delivering prototypes (Tutorials Point, n.d.). In an iterative process, the design team creates one version and then improves on it with each successive revision before the final design undergoes usability testing. In a parallel process, multiple alternative designs are created quickly and cheaply at the same time (e.g., storyboards) and then each undergoes user testing to determine the best solution. Research has shown that usability improves with each design iteration, but improvements in usability are significantly greater with a parallel process (Nielsen, 2011). Rapid Prototyping is similar to RAD, but after completing a quick analysis, the next step is designing and evaluating an actual prototype of the product. Getting client feedback on the prototype (or design) early in the ID process serves to validate the choice of instructional design model, more closely aligns SME and Vendor expectations, and more accurately scopes the project, all of which helps to avert both making poor learning-design decisions and developing training based on ill-defined requirements or inaccurate analysis. Ultimately, all of this helps save time and money; thus, improving the organization’s ROI for the training.



Prototype Cycles

Figure 20. Rapid application development (RAD) model. Adapted from “WaveMaker, Inc.” Copyright 2013 – 2017. Retrieved from <https://www.wavemaker.com/visual-modeling-rapid-application-delivery/>

Table 16 summarizes several approaches by their process phases; type of development; and timing of user involvement, identification of training requirements, and project deliverables.

Table 16

Summary of Development Approaches

Approach	Development Phases	Type	Client/SME Involvement	Needs Analysis	Product Delivery
ADDIE (SAT, Systematic)	Analysis, Design, Development, Implementation, Evaluation	Linear	Intermittent	Specify all requirements at project start	All at once at end of project
Agile (also A.G.I.L.E., ALD, Scrum, SAM, Iterative & Incremental)	Requirements; Analysis, Design, & Development, Testing; Deployment; Evaluation	Curvilinear	Continuous	Specify requirements at project start and prioritize feature requirements at start of each sprint cycle	Incremental throughout project
Dick, Carey & Carey	Identify, Conduct, Analyze, Write Performance, Develop, Design, Revise, Design	Parallel	Intermittent	Specify all requirements at project start	All at once at end of project
Rapid Prototyping	Analysis & Quick Design; Develop, Demonstrate, & Refine; Test; Deploy	Incremental & parallel	Continuous	Specify requirements at project start and refine throughout the project	Incremental throughout project

Note. ADDIE = Analysis, Design, Development, Implementation, Evaluation. A.G.I.L.E. = Align, Get set, Iterate, Implement, Evaluate. ALD = Agile Learning Design. SAM = Successive Approximation Model. SAT = Systematic Approach to Training.

Literature search strategy. The literature search followed common guidelines for conducting a systematic review (Beecham, Baddoo, Hall, Robinson, & Sharp, 2006), but with a few differences. Although the bodies of education literature and instructional design literature are quite extensive, there was relatively little focus on the instructional development process per se. Consequently, the scope was expanded to include *project management*, *training development*, and *occupation* search strings in hopes of capturing works with greater relevance to the research questions. Search parameters were limited (filtered) to full-text articles, English language text, and published anytime from 1997 through 2017 or from 1999 through 2017, depending on the constraints of the database. The search strings were applied to titles, abstracts, and keywords. Experts in the ISD field were not consulted for information on works in review or in press when the search was conducted at the end of December, 2017. Neither were the references of papers examined for additional literature to review.

Selection criteria. Initial selection of the literature consisted of querying full-text electronic databases using the following search strings under the given parameters:

- “Instructional Design”
- “Instructional Model”
- “Instructional Design Process”
- “Instructional Design” AND “Project Management”
- “Instructional Model” AND “Project Management” AND “Occupation”
- “Instructional Model” AND “Process”
- “Training Development” AND “Instructional Design”
- “Training Development” AND “Instructional Model” AND “Process”

Table 17 identifies the online source; total number of retrieved documents screened ($N = 25,296$); total number of papers selected for full review based on relevance to the research questions; and total number of papers included based on the ID process, context, and target audience being provided or discernable (see Chapter 2 Literature Review). Screening of the titles, abstracts, and key words resulted in 130 selections, 0.51% of the total. (This number includes 29 selections from Google® searches for government works.) After excluding duplicates and including works based on consensus by both researchers, 0.2% ($n = 51$) papers qualified for in-depth analysis and coding.

Table 17

Literature Search

Bibliographic Repositories	<i>N</i>	Selected	Included
Education Resources Information Center (ERIC) ^a	3,902	71	17
National Aeronautics and Space Administration (NASA) ^b	1,007	7	1
ProQuest Central ^b	15,305	21	8
Taylor & Francis ^b	5,053	2	1
Others including selective Google searches		29	24

^aFiltered by 1999 – 2017, full text only, English.

^bFiltered by 1997 – 2017, full text only, English.

Table 18 identifies the source, ID approach or model provided or described, and the average evidence score from coding the three criteria. The average codes for the papers that addressed multiple models represent the evidence presented, and does not necessarily represent the quality or strength of the evidence for any one or all of the models discussed. This should be considered when interpreting the findings.

Table 18

Source Title, Model/Approach, Average Code

No.	Source Title	Model/Approach	Code
1	AM-OER: An Agile Method for the Development of Open Educational Resources	AM-OER (Agile)	5
2	An Analysis of Instructional Design and Teaching Methods of Law Enforcement Ethics Education at Community Colleges [Dissertation, ProQuest]	Clark	4
3	Designing and Developing a Case-based MOOC to Impact Students' Abilities to Address Ethical Dilemmas	ADDIE	4
4	How Expert Designers Design	4C/ID	4
5	Effectiveness of Instructional Design Model (Isman - 2011) in Developing the Planning Teaching Skills of Teachers College Students' at King Saud University	Isman	4
6	Rapid Prototyping Instructional Design: Revisiting the ISD Model	Rapid Prototyping	3
7	Creating and Evaluating an Online and Work-Based Instructional Model	COECAP	2
8	Simulated Voyages: Using Simulation Technology to Train and License Mariners (1996) Chapter: 3 Effective Training with Simulation: The Instructional Design Process; and Appendix F: Uses of Simulators Illustrative Case Studies	Described as systematic, iterative, and incremental design and development (Agile-like)	2
9	Group-Work in the Design of Complex Adaptive Learning Strategies	4C/ID	2
10	Evaluating the Design and Development of an Adaptive E-Tutorial Module: A Rasch-Measurement Approach	ADDIE	2
11	Instructional Design Models--Framework for Innovative Teaching and Learning Methodologies [ProQuest]	Morrison, Ross, & Kemp	2
12	Snap-Courses: An Instructional Design Strategy for Aviation Mobile Learning [ProQuest]	CBE - Kearns	2
13	Learning Objects, Learning Objectives and Learning Design [ProQuest]	OOF	2
14	Paradigms in the Theory and Practice of Education and Training Design	Instrumental (ADDIE), Communication (Collaborative), Pragmatic (Agile, Rapid Prototyping), & Artistic (Non-Structured)	2
15	Designing Simulator-based Training: An Approach Integrating Cognitive Task Analysis and Four-Component Instructional Design	CTA; 4C/ID	2
16	A Distributed Online Curriculum and Courseware Development Model	CDT; ISDP	2

Table 18 Continued

Source Title, Model/Approach, Average Code

No.	Source Title	Model/Approach	Code
17	Re-Visiting the Instructional Strategy Diagnostic Profile: A Comparative Analysis	DONC	2
18	Instructional Design in Education: New Model	Isman	1
19	Individual, Group, and Organizational Instructional Systems Development Models [Wiley]	ILD Group Learning	1
20	U.S. Army Learning Policy and Systems (TP 350-70-14)	ADDIE	1
21	Rapid E-learning Development Strategies and a Multimedia Project Design Model	VPODDDA	1
22	DAU Curriculum Development Guide	ADDIE/SAT	1
23	Rapid Prototyping in the Instructional Design Process	Rapid (Rapid Prototyping)	1
24	Blueprints for Complex Learning: The 4C/ID-Model	4C/ID	1
25	The US Army Learning Concept for Training and Education	ADDIE	1
26	Unconventional Instructional Design for Special Operations Training	Joint Event Life Cycle-Lite (JELC-Lite) (Agile-like)	1
27	Are you Ready for AGILE Learning Design	Agile	1
28	The Implementation Results of New Instructional Design Model: Isman Model [Dissertation, ProQuest]	Isman	1
29	Best Practices for the Development, Delivery, and Evaluation of Susan Harwood Training Grants	ADDIE; ANSI Z490.1	1
30	Resource for Development and Delivery of Training to Workers	ADDIE; ANSI/ASSE Z490.1	1
31	Current Practice in Designing Training for Complex Skills Implications for Design and Evaluation	ADAPT[IT]	1
32	The ABC's of Online Course Design According to ADDIE Model	ADDIE	1
33	A Symbiosis between Instructional System Design and Project Management	ADDIE; Project Management	1
34	Department of Defense Instructional Systems Design for the Acquisition / Contracting Work Force: A View from the Inside [ProQuest]	Performance, systematic (ADDIE) & education models (Briggs)	1
35	LATiST: A Performance Support Tool for Integrating Technologies into Defense Acquisition University Learning Assets	LATIST; ILDF	1
36	Analog Design for Digital Deployment of a Serious Leadership Game (NASA)	Analog-Digital Prototyping	1
37	An Instructional Model for Preparing Teachers for Fieldwork	Instructional Model for Fieldwork (Adapted CAM)	1
38	Designing for Engagement: Using the ADDIE Model to Integrate High-Impact Practices into an Online Information Literacy Course	ADDIE	1
39	Elearning Asset Development Guide – DAU Blackboard	ADDIE	1
40	Using Project Management to Develop Training Programs	ADDIE; Project Management	1
41	Integrating Technology into Classroom: The Learner-Centered Instructional Design	ASSURE	1

Table 18 Continued

Source Title, Model/Approach, Average Code

No.	Source Title	Model/Approach	Code
42	A Model for Developing High-Quality Online Courses: Integrating a Systems Approach with Learning Theory	Puzziferro & Shelton	1
43	A Task-Centered Instructional Strategy	Pebble-in-the-Pond	1
44	Responsive Instructional Design: Scaffolding the Adoption and Change Process	Responsive Instructional Design	1
45	Engineering Instructional Development: Programs, Best Practices, and Recommendations	HPL	1
46	Advanced Distributed Learning (ADL) Past, Present, and Future in the Regional Department of Defense Resources Management Studies Educational Endeavor	ADL	1
47	The NTeQ ISD Model: A Tech-Driven Model for Digital Natives (DNs)	NTeQ	1
48	Instructional Design and Project Management: Complementary or Divergent?	Survey of models; Project Management; ADDIE	1
49	Maximize Your Training Development Efforts by Following a Systematic Instructional Design Process [ProQuest]	Systematic	1
50	Position Classification Flysheet for Instructional Systems Series, GS-1750	Systematic	1
51	Using The Waterfall Model In Instructional Design: A guide for eLearning Professionals	Waterfall	1

Table 19 shows the model data sorted by frequency and includes definitions for acronyms and authors where appropriate. Models included parenthetically signify reanalysis and fit with the other model. Some papers include multiple models, so this should be considered when interpreting the findings.

Table 19

Model Frequency

Model	Frequency
ADDIE (also SAT; Systematic; Clark; Waterfall; Instrumental) (Branson, et al.)	15
AGILE (also Iterative & Incremental; Scrum; AM-OER – AGILE; Responsive)	5
4C/ID – 4 Component Instructional Design (van Merriënboer et al.)	4
Rapid Prototyping (Tripp & Bichelmeyer) (also Analog-Digital Prototyping)	4
Isman	3
ANSI/ASSE Z490.1 – American Society of Safety Engineers	2
Project Management (PEMBOK®)	2
ASSURE – Analyze, State, Select, Utilize, Require, Evaluate (Smaldino et al.)	1
Kemp, Morrison, & Ross (also MRK)	1
ADAPT[IT]: Advanced Design Approach for Personalized Training-Interactive Tools	1
Advanced Distributed Learning (ADL)	1
Artistic paradigm (non-structured)	1
Briggs Education model (Briggs et el.)	1
CBE: Competency-Based Education (Kerns)	1
CDT: Component Display Theory (Merrill)	1
COECAP: Context, Online, Extras, Construct, Assess, Practical (Mardini)	1
Communication Paradigm (Collaborative)	1
CTA: Cognitive Task Analysis	1
DONC: Distributed Online Curriculum and Courseware Development Model	1
HPL: High Performance Learning (Eyre)	1
ILD Group Learning: Individual Learning Design	1
ILDF: Integrative Learning Design Framework	1
Instructional Model for Fieldwork: Adapted Concept Attainment Model (Hughes)	1
ISDP: Instructional Strategy Diagnostic Profile (Merrill, et al.)	1
JELC-Lite: Joint Event Life Cycle-Lite (NASA)	1
LATIST / ILDF: Learning Asset Technology Integration Support Tool (DAU)	1
Managing Interactive Video/Multimedia Projects (Bergman & Moore)	1
NTeQ: iNtegrating Technology for inQuiry (Morrison & Lowther)	1
OOF: Object Oriented Fundaments	1
Pebble-in-the-Pond (Merrill)	1
Pragmatic paradigm (Similar to Rapid Prototyping)	1
Prescriptive ID	1
Puzziferro & Shelton eLearning (Planning, Development, Testing/Revision, Approval)	1
Responsive Instruct. Design (Ertmer) (Reveal, Propose, Implement, Reflect, Refine)	1
VPODDDA: Vision, Profile, Objective, Design, Development, Delivery, Assessment	1

Table 20 shows the data from the literature for the ID models used in government and aviation industry organizations, which have similar safety and security missions and regulatory governance as the ATO. The dates for the sources are provided to show that some of the

literature was dated. Anecdotal data indicates DAU and a few others may be now using Agile and Rapid Prototyping processes, but this information could not be verified.

Table 20

Site, Domain, Model, Delivery Methods

Site	Date	Domain	Model	Delivery
CIA	2018	Government	Rapid Prototyping, Iterative Design	Online/All
DAU	2007	Government	ADDIE	All
DoD	2016	Government	ADDIE; JELC-Lite	Online/All
DoE	1996	Government	ADDIE/SAT	All
DHS	2009	Government	ADDIE	All
FLETC	2018	Government	ADDIE/System Approach	All
USAF	2002	Government	ADDIE	All
U.S. Army	2017	Government	ADDIE/SAT	All
USCG	1995	Government	ADDIE	All
USMC	2016	Government	ADDIE/SAT	All
USN	2010	Government	ADDIE	All
TransAsia Airways	2008	Industry	ADDIE	Online

Note. ADDIE = Analysis, Design, Development, Implementation, Evaluation. CIA = Central Intelligence Agency. DAU = Defense Acquisition University. DoE = Department of Energy. DoD = Department of Defense. DoE = Department of Energy. DHS = Department of Homeland Security. FLETC = Federal Law Enforcement Training Centers. SAT = Systems Approach to Training. USAF = United States Air Force. USCG = U.S. Coast Guard. USMC = U.S. Marine Corps. USN = U.S. Navy.

Summary

This chapter began with a detailed description of ATO orders and AJI-2 ID processes and documents, including examples of ILT, WBT, and blended projects, and observations of validation events for new and recurrent training. That was followed by the results from the semi-structured interviews and structured surveys of ISS managers and leads. Illustrations and descriptions of the classical waterfall or linear model, systems approach, various agile (curvilinear) models, and a rapid prototyping model were presented to provide context for the results of the systematic review of the literature. This chapter concluded with the literature analysis, a list of the selected papers and codes, and a list of ID models used in government and industry which have a similar context as the ATO.

Chapter 4: Discussion and Conclusions

This chapter begins with a short overview the findings from the front-end analysis of AJI-2's organizational strategy and ID process. This is followed by a discussion of specific findings from the analysis of the literature. The chapter ends with the conclusions related to the research questions and objectives.

Discussion

The significant differences between the ratios for development hour per instructional hour for both ILT (see Table 5) and Level 1 WBT (see Table 6) using the ADDIE model indicates higher productivity for industry. One possible reason might be that FAA training must satisfy a greater number of requirements and must adhere to more rigorous quality standards than industry because it is high safety or high stakes training. Yet, refresher or recurrent training that is neither appears to also take longer than equivalent industry training. An alternative explanation could be that AJI's development process is more demanding and prescriptive because of the necessity to comply with stringent regulatory and policy requirements. Either reason would certainly justify the inflated FAA production ratios compared to industry. Such variances in scale efficiency between bureaucracies with similar requirements can be only assumed. Although efforts were made to obtain such information, due to its proprietary nature, nothing was acquired.

[REDACTED]

[REDACTED]

Decision-making during the Analysis phase regarding the type of training solution, learning strategies, and gap analysis is not being informed by the ISSs, the only people who are qualified by training and experience to make such determinations. Requirements Leads are not thoroughly familiar with the ISD process and do not have the requisite SME training and experience in all AT and TO functional areas of expertise.

There are issues with both the availability and participation of SMEs. The inadequate availability of SMEs and excessive revision requests by the SMEs poses the two most significant bottlenecks in the current ID process according to ISS Leads, Requirements Leads, and AJI-2 managers. (See Figure 12 and also Chapter 3, Recurrent WBT Training, ¶1 and Blended Training, ¶9 & ¶10.) This issue stems from several areas. Problems begin with the

difficulty in scheduling test students so far in advance (see Chapter 3, Blended Training, ¶9) and extends to the scheduled SMEs being unable to contribute because of high work demands in the field. Plus, scheduling difficulties appear to be worse for recurrent training. Currently, the logistics—location and selection of the participants—for the Beta for recurrent training are determined in the kickoff meeting, as opposed to just after the CWT for the Alpha test and just after the Alpha test for the Beta test for new WBT (D. Talkington, personal communication, February 15, 2017). Scheduling issues are causing undesirable delays, not just in postponing project kickoffs, but also in the Design and Development phases that depend on high SME involvement and the Validation phase where student involvement is vital. Because the IPT must be available for a review event, when an SME can't attend, the event has to be rescheduled. It also contributes to rushed work, as demonstrated in the document titles not matching across instructor and student materials in the FCC. (See Chapter 3, Blended Training, ¶9.) Granted, when revision requests related to teaching and learning are not made, the result is the release of poor training in the field, which could negatively impact safety and security of the NAS. However, the ISSs and AJI-2 managers alike state it is not unusual for an SME to request a change in a course, and then after the change is made by the Vendor, the SME will request the course be changed back to its original state during the CWT or OTO. (See Chapter 3, Recurrent WBT Training, ¶1.) Two of the bottleneck themes that emerged from the survey of the ISSs relates to SMEs and Roles (see Figure 12). Complaints about SMEs include problems locating testers, too many SME reviews and change requests, and inadequate SME availability and reviews. Complaints about roles include SMEs ignore ISS knowledge and authority and inadequate role definitions.

The main differences between linear and curvilinear approaches pertain to how a project is managed, how a product is created, and when a product is delivered. The ADDIE model and other similar approaches is cyclical in that evaluation occurs in each stage, resulting in continuous improvement of the end product. However, it is characterized as linear because the completion of one stage becomes the start of the next. Although evaluation occurs throughout the process, the needs analysis and product design, development, validation, and delivery occur sequentially. Furthermore, linear projects are usually managed from the top down, have well-defined requirements, and rely on intermittent client involvement and feedback. Curvilinear projects tend to be collaboratively managed by self-directed cross-functional teams, begin with loosely-defined requirements, and rely on continuous client involvement and requirements refinement. Product components are designed, developed, and evaluated iteratively and functional components are delivered incrementally until the product is completed.

We came to the same conclusions that Gustafson and Branch (1997) found: “While there may be hundreds of ID models, there are few major distinctions among them”. . . [and] . . . “there is also a disturbingly small volume of literature describing any testing.” (p. 77). Although we conducted an extensive literature search, findings from the systematic review of the relevant literature on instructional development were paltry. Only 51 papers (0.2%) of the pool of approximately 25,296 papers met the inclusion criteria by relating to the research questions and providing or describing the ID approach, training context, and target audience. Besides there being few papers, even fewer rose to the evidence level from which to draw best practices. Of them, only one paper demonstrated exemplary support, although the generalizability of its findings was limited by the inherent nature of experimental designs. Four papers demonstrated adequate support; one paper demonstrated some support; 11 papers demonstrated minimal support; 34 papers failed to demonstrate any evidence.

Keeping in mind that some papers addressed more than one model, the coded literature encompassed approximately 44 different models. Fifteen papers addressed the ADDIE model;

five addressed an Agile or Scrum model; four addressed the 4C/ID model and a Rapid Prototyping model; three addressed the Isman model; two addressed a Project Management model. The rest of the models were each addressed in single papers. We have selected a few of the highest coded papers to describe. The results indicate rectilinear ID models still dominate instructional design work in government and industry. However, curvilinear models, characterized by iterative product design and development and incremental product delivery, are becoming more popular.

The only paper we coded as a 5 was a study by Arimoto, Barroca, and Barbosa (2016). They conducted a one factor-two treatment experiment involving the development of a software testing course to validate AM-OER, an Agile Method for the development of Open Educational Resources—freely provided digital teaching and learning materials, which can be anything from lectures to complete courses, textbooks, and videos. The AM-OER model imbeds practices from Agile and Scrum methodologies, such as design storming, sprint planning, architecture envisioning, iterative modeling and design, small releases, early and continuous evaluation, continuous integration, collaborative development, sprint reviews, and sprint retrospectives. It also employs elements of Learning Design, artifacts used during the course development. The independent variables were an Ad-Hoc (informal) method and the AM-OER method. The dependent variables were applicability, effectiveness, efficiency, and quality results. The non-probability sample consisted of 10 Ph.D. students, educators, and researchers from the University of Sao Paulo divided into two homogenous groups. Each group had 5 hours to create a 3.5 hour blended OER course for a target audience of undergraduate Computer Science and Computer Engineering students. The course components were evaluated by the instructor and the students at the end of the project. The AM-OER method was significantly more effective ($p = .000882$), more efficient ($p = .3556$), and had higher quality results ($p = .0006052$) than the Ad-Hoc method. The results for the applicability, defined as the method's appropriateness, ease of use, and user satisfaction, showed a tendency for the AM-OER method over the Ad-Hoc method. However, the users reported the needs assessment activity within the AM-OER method could be improved and they reported difficulty finding open resources to reuse, which has implications for generalizability.

In a quantitative study we coded as a 4, Carter (2015) examined the extent that directors of development of law enforcement training at community colleges in the U.S. used Clark's instructional design model and their perceived effectiveness of that model. The findings revealed that 96% of the directors frequently or always follow the Implementation phase, 94% frequently or always follow the Design phase, 87% frequently or always follow the Evaluation phase, and 86% frequently or always follow the Analysis phase of Clark's model. To the extent that the directors perceive the components of Clark's model to be effective, approximately 97 percent of the directors reported the Design component to be frequently effective or very frequently effective; 90% indicated the needs analysis was effective, and 91% reported that the Development phase was effective in producing law enforcement training.

In an empirical study we coded as a 4, Kirschner, Carr, and Merriënboer (2002) examined design priorities and practices of expert instructional designers, found differences between designers in higher professional education in a university setting ($N = 9$) and designers in a business setting ($N = 6$). Using Visscher-Voerman's (1999) 16 design principles, first each participant determined the top three principles that were most important to project success and the top three principles that needed the most improvement. Both groups rated principle 13 (starting with the needs of the learners rather than the learning content) as both most important and needs improvement. The university group also identified principles 3 (creating client ownership) and 4 (base their work in scientific knowledge and principles) as both most important

and needs improvement. The business group also selected principle 7 (show clients, partners, and other stakeholders products from prior projects to help them choose a training solution and formulate product specifications) as the most important and needs improvement. Next, the groups were broken into small teams: three university teams and two business teams. Each team was given an Action-Object Worksheet to use and asked to develop a preliminary design for a post-graduate course for a business firm. While all of the teams began with a task analysis, the university designers focused on creating a project plan and an instructional blueprint while the business designers focused on gaining client buy-in early in the production process by sharing prototypes. According to the authors, the designers in the university context find it exceedingly important to weigh the possible alternative solutions, but the designers in the business setting do not; although the authors stated this could be due to cultural differences (p. 102). The authors described the 4C/ID model developed by Merriënboer and stated they planned on using the empirical data from their study and other design models to develop a “full-fledged prescriptive ID model for the design of competency-based learning environments” (p. 93).

These results indicate rectilinear ID models still dominate instructional design work in government and industry. However, curvilinear models, characterized by iterative product design and development and incremental product delivery, are becoming more popular. Issue detection and remedies that occur during the first iteration of an Agile method serves to reduce the number and severity of subsequent changes and to validate the choices of learning strategies and the ID model. An industry partner and others have found Agile methodologies to be approximately 25 percent more efficient and just as effective as classical approaches.

Getting client feedback too late in the product development, or early feedback changing late in the process, usually results in not only more change requests but also more extreme, thus costly, changes to the product. Getting client feedback early and often validates the choice of instructional design and informs the future design and development of the product components. Usually this translates to significantly fewer change requests, minor and major, by the client during product validation.

Using one ID model for all education and training developments, regardless of the type or length of the training, is inefficient. Gustafson and Branch (2002) contend an “ID model should be selected (and probably modified) based on the specific context of the project” (p. 8). We propose a flexible approach based on necessity (Wedman & Tessmer, 1993; 1991): the requirements and resource information used by AJI to determine the type of training and delivery modality. Figure 21 shows an objective decision tool for choosing the ID model according to a safety-based (NextGen) strategic training needs analysis (STNA) and a preliminary analysis (PA) of the training requirements. In the first STNA, the average of the scores for the difficulty to perform, difficulty to know, importance of the training, frequency of the training, and the general training requirements would be used to determine the type of training solution (i.e., briefing, workshop, course). A low score indicating a briefing solution is appropriate would call for a rapid development process. The next higher score would indicate a workshop solution and the highest score would indicate a course solution. In the PA, the average of the scores for the training priority, audience, resources, cost benefit analysis, and logistics would be used to determine the delivery solution (i.e., self-paced ILT or WBT, instructor-facilitated WBT or ILT, blended). The length of the course would determine the production solution (e.g., Rapid Development, ADDIE, Agile-ADDIE); less than 4 hours long calling for the ADDIE process and more than 4 hours long calling for the Agile-ADDIE process. The rationale for using course length as the deciding factor is that scope and complexity usually

increase with the former. This translates to an increased number of features or components, making it advantageous to use a feature- or component-driven process such as Agile.

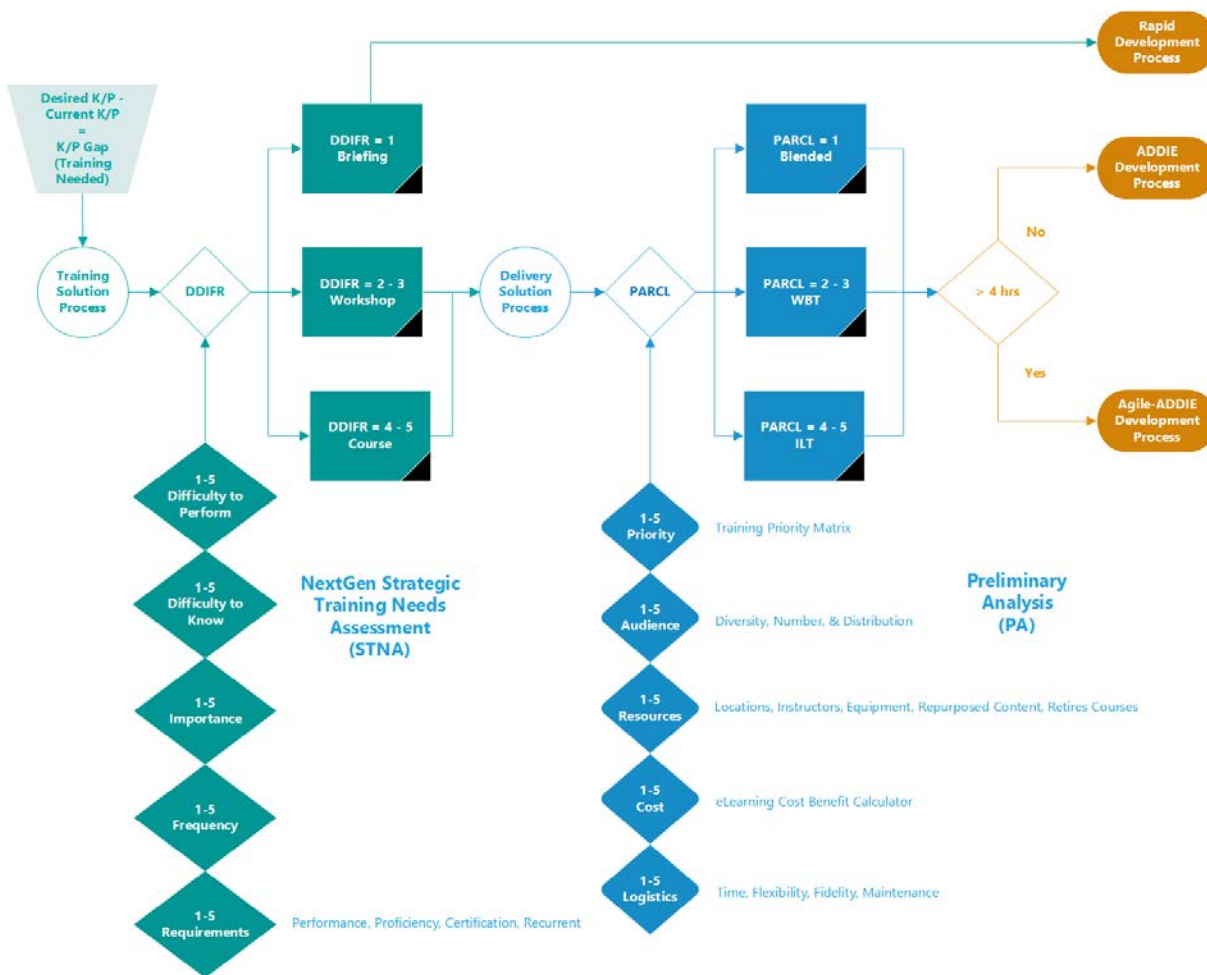


Figure 21. Instructional development decision tool.

Using the SBS 101 Fundamentals training as an example, an STNA score can be calculated by averaging proposed DDIFR scores based on data from the Analysis Report. The DDIF scores on the 5-point scales for Difficulty to Perform (DP) and Difficulty to Know (DK) were both 4. The DDIF Importance score would be 5 based on the training having a direct impact on safety and a direct relationship to NextGen milestones. The DDIF Frequency (F) score would be 5 based on a high number of personnel needing the training, the large geographic diversity of the learners, and content reuse with other courses, and the training serving as a prerequisite for nine courses. The Requirements score would be a 5 because the training is required for TO personnel in En Route, Terminal, and Oceanic, and optional for anyone in the FAA. The average DDIFR score would be 4.6, indicating the training solution should be a course. Indeed, that was the determination of the working group in the Planning phase.

The next step is to determine how the training should be delivered. We propose calculation of a PARCL score during the Preliminary Analysis; determined by averaging the

Priority (P), Audience (A), Resources (R), Cost (C), and the Logistics (L) scores. For our example, the P score would be a 5; here again based on safety and using something akin to the Course Priority Matrix. The A score would be a 5 based on high diversity, number, and distribution of potential learners. The R score would be a 2. This is based on a relatively high number of locations in which the training is required and desired but low availability/need for instructors, equipment, and repurposing content, and this new WBT course retiring an ILT course. While a cost-benefit analysis should not be performed for required training, one can be performed to inform decisions about delivery modalities of required training. Using a cost benefit calculator, such as the one at <http://aadm.com/ROI Calc.htm>, or using data from the FAA's IGCE, the relative cost benefit could be derived and reduced to a 5-point scale. Without access to the actual cost data for this example course and because the training is knowledge-based and introductory level, we assume a middle C score of 3. The L score would be a 2 because training time, fidelity, and maintenance are all low while training flexibility needs are high. This results in an average PARCL score of 3.4. Using Figure 19, this score would result in a delivery solution of WBT. Indeed, this is how SBS 101 is delivered.

The next step in the decision process is to determine which ID process to use. We know from the Analysis Report that SBS 101 was designed to be 2 hours long, and not over 4 hours. Given this information, the best method for producing this course would be an Agile-ADDIE. This approach seeks to shorten production by reducing the Validation activities. As noted in the results from the surveys of the ISSs and in personal conversations with ISSs and management, the OTO and CWT for WBT are redundant because they serve the same purpose; so the CWT should be eliminated from the Validation phase in the Agile-ADDIE process, but the OTO kept for user acceptance testing and locating and analyzing functionality issues. As shown in Table 9, it appears that validation often takes the most time with both ILT and WBT course developments; therefore, employing an Agile-ADDIE model is likely to produce time savings. This type of ID model would probably have been well-suited for this short WBT because Validation had consumed 66% of the total production time.

Conclusions

The ATO's technical training has fundamentally one development process with one set of validation criteria applied across all types of training and delivery methods. A one-size-fits-all approach is not agile, nor is it flexible, which is not suitable to meet the training demands of high-performance organizations like the ATO. The overarching purpose of this study was to present observations from our review of the process AJI-2 uses for developing technical education and training and to present recommendations for improving that process based on industry and government best practices found through a systematic review of the relevant literature. The first objective was to report the best practices relating to ID methodologies that could facilitate course development by the ATO and the second objective was to report a set of criteria that identify best practices for developing occupational technical training within the U.S. government.

Research question 1. How do other organizations with similar regulatory, safety and/or security requirements approach their training development?

The ID literature from similar government sites was sparse and some of what was found was dated. Nonetheless, the literature reviewed from government training organizations and TransAsia Airways show the use of prescriptive ID models (i.e., ADDIE, SAT) prevails.

Research question 2. How and where can ATO leverage training development efficiencies, such as Scrum, Agile, and Rapid development approaches?

The ATO can leverage an Agile-type approach for developing training with high requirements (e.g., 4 hours of instructional time; 2-4 web interactivity, simulations, or part-task training). The ATO can leverage Rapid Prototyping for developing briefing items and short training.

Our analysis of the literature and more than 44 ID models revealed that the five phases in the ADDIE model are common to most models to one degree or another. Our coding and frequency of the selected literature indicates that the ADDIE, Agile, Systems Approach, 4C/ID, and Rapid Prototyping models result in high-quality training and education, but there was only weak support showing they are generalizable to different settings for various learner populations and are sustainable by organizations. The key differences between the activities in these models rest in whether some or all of the activities occur in series, parallel, or in cycles.

The following criteria are based on expert opinions and seminal works, not on reliability measures.

- In accordance with the Layers of Necessity model (Wedman & Tessmer, 1991) and with the principles of allocation efficiency (Avkiran, 2001), adopt a systematic ID approach or activities that match or fit the training requirements and project resources. Vary the analysis, design, development, implementation, and evaluation activities to expedite production.
- When using an iterative/incremental model (e.g., Agile, Scrum, Rapid Prototyping), begin with the longest or most complex component first to validate the design, learning strategy, and ID process. This also serves to calibrate the stakeholders' understandings and expectations.
- Seek and implement SME feedback early and often on smaller chunks of the training so there are fewer and less dramatic revisions later in the process after the product is developed.
- Have the developer SME/instructor teach or facilitate the first course, especially for training developed via Rapid Prototyping, and use that instructor's feedback to make improvements to the training.

PAGE INTENTIONALLY LEFT BLANK

Chapter 5: Recommendations

In keeping with the study objectives, we have described various ID models, processes, and actions, and have identified gaps and inefficiencies within the AJI-2000 ISD process. Because participant data were limited and relied on self-reports, its validity should be regarded with a measure of skepticism. Furthermore, direct observations were limited to AT validation events; opportunities did not exist for TO during this study's period of performance. Based on our observations, survey and interview data, and results from analysis of the literature, we propose the following recommendations for improving the ISD processes that the ATO employs to design and develop technical education and training for air traffic controllers and technicians.

Observation 1

The mid ILT development hours per course hour for FAA projects is about [REDACTED] than that for industry (see Table 5) and it is [REDACTED] for Level 1 WBT (see Table 6). Typically, the Development and Validation phases consume the most time (see Figures 8 – 11). [REDACTED]

[REDACTED] The ISSs report experiencing the most difficulty during the Analysis and Validation phases, respectively, closely followed by the Development phase for ILT and WBT (see Table 12). The AJI-2 managers experience the most difficulty during the Design and Development phases for ILT and the Development and Analysis phases, respectively, for WBT (see Table 12). FAA Order 3000.22A does not provide detailed ISD processes for training development. Nor does it allow flexibility in the current process or offer resolutions for hindrances. The ISSs suggest using the ADDIE model for short courses, an Agile model for long courses, and informational briefings and videos for Recurrent WBT.

Recommendation 1

- **1.1 Adopt a more flexible (Agile) approach** to training development based on the training requirements (course length, safety criticality, professional stakes, etc.) and resources (i.e., funding and personnel available). In addition to using the current ADDIE model, adopt an Agile-ADDIE model for courses with high requirements (e.g. long or complex courses), breaking the process up into short work sprints in which a feature (ILT/WBT learning unit/module or prototype) is designed, developed, and evaluated in each sprint cycle. The most complex component should be designed, developed, and evaluated first to demonstrate validity and quality of the product design and the effectiveness of the chosen instructional strategies. By informing the design and development of the remaining components, there should be fewer and less significant revisions later in the process. However, because Agile and rapid approaches depend on high SME involvement and feedback throughout the entire project, issues with SME availability and reviews would need to be addressed beforehand, as addressed in other recommendations. Likewise, the current ISSs lack of knowledge and experience using Agile and Rapid methodologies would also need to be addressed through professional development and creation of additional SOP guidance.
- **1.2 Adopt a rapid development process** for briefings, workshops, and courses that are informational, non-safety critical, and short in instructional time. Per JO 3000.22A: 2-4 Training Development Workgroup, the workgroups for courses, workshops and briefings are to include a Project Manager, ISS, and SME, and ISSs may serve as PMs. Therefore, rapid developments could be largely handled by an

ISS and in-house SME (or SMEs, if the briefing involves more than one functional unit). As PM, the ISS would need to participate in requirements planning.

- **1.3 Change JO 3000.22A 2-4 b. and 3-2 k** to allow use of other instructional development models or state “systematic development processes appropriate for the training solution based on the specific requirements and available resources.”

Observation 2

Too many SME revision requests, especially late in the ID process, and casual disregard for roles and specific role boundaries by the SMEs were mentioned by personnel from AJI-2100, AJI-2300/AJI-2400, and a vendor as continual and significant problems. A preponderance of evidence shows significant change requests by SMEs are occurring late in development, after the training materials were reviewed and revised based on feedback received on the CDG, instructional materials, and course walkthrough (CWT). The prevalence of this problem indicates a role deficiency. The SMEs might not understand the purpose and objectives of each review or comprehend and appreciate the impact late change requests have on project development and delivery as well as curriculum development overall. The SMEs do not undergo any training related to the ID process besides the orientation they get in a kickoff meeting. Frequent and major rework have been exacerbating product development and delivery time, and, ultimately, project cost.

Recommendation 2

- **2.1 Clarify the SME role** as content and policy expertise decision-makers.
- **2.2 Create a short SME orientation course** covering IPT roles and responsibilities, and include an IPT charter that provides behavior norms (expectations) that team members sign in the project kickoff.

Observation 3

An excessive number of change requests arise during the Validation events.

Recommendation 3

- **3.1 Limit approved changes arising during Validation** to those that would have a significant impact on teaching or learning. If the purpose of validation events is to “validate the effectiveness of the instruction and its learning application to the job tasks” (FAA, 2014a, p. 25), permitted change requests should be limited to those that would dramatically affect the teaching and learning outcomes related to the targeted job tasks.
- **3.2 Modify the ISS role to empower ISS Leads to accept, reject, or table revisions.** The project ISS should rule at the time of the request, identifying the criticality of the change based on impacts to teaching/learning or course function. If late change requests by the SMEs, instructors, and test students would not contribute to teaching and learning as determined by the ISS, they should be tabled until after the course has run several times and the data from the end-of-course feedback and Level 3 and 4 Kirkpatrick evaluations have been collected and analyzed to justify the revisions. Furthermore, the ISS lead should document the need to validate non-critical change requests after the course has run and student feedback has been analyzed. The criticality of the course also needs to be

considered at the time of the ISS's ruling on the change. High critical/high stakes training should weigh the decision toward implementing the change as opposed to postponing the change until after the course has been run in the field. These decisions should also factor in the Vendor's input on how easy or difficult the changes would be to make before the final deliverables are due or when the course is updated at a later date.

Observation 4

The CWT is resulting in significant editorial changes, sometimes as many as 200 change requests from each SME. If the purpose of the OTO/Alpha is to locate, analyze, and remedy issues, this begs the question: How do the CWT and OTO/Alpha differ if the development SMEs are the test participants? Most changes routinely come from the same SME. Moreover, the same set of SMEs are participating in a disproportionate number of Validation events. Although more reviews and reviewers generally results in a better designed product (Nielsen, 2011), it can lead to *hill climbing* where, in accordance with the law of diminishing returns, the level of benefit gained is less than the cost to obtain that gain, especially for WBRT that is neither safety critical nor high stakes

Recommendation 4

- **4.1 Eliminate the CWT and begin validation with the OTO/Alpha, as appropriate.** The incremental product reviews during the Development phase should accomplish the same goals as a course walkthrough for WBT, and could for ILT when the SME/instructor teaches the OTO. The majority of change requests should be made before the OTO/Alpha test.
- **4.2: Do not use the developer SMEs for the OTO/Alpha** who were instrumental in the training development, as appropriate.
- **4.3: Reduce the number of test students during the OTO/Alpha to one for each functional unit that the training addresses,** as appropriate, and give selection priority to test students who are certified in multiple areas to reduce the number needed.

Observation 5

Required training that is not successful or is not beneficial is too expensive. In the absence of passing scores for WBRT, there is no sure way to know if the training was successful (solved the training need) or beneficial (was the right solution for the problem). Verifying student achievement of the learning outcomes and conducting Levels 3 and 4 Kirkpatrick evaluations are not being done. Consequently, training effectiveness and the organizational impact of training on the NAS as it relates to Air Traffic Safety Action Program (ATSAP) data is unknown.

Recommendation 5

- **5.1 Enforce the ATO's minimum passing score requirement of 70%** for all courses and measure student achievement and student satisfaction with the training.
- **5.2 Measure post-training job performance and organizational impact** (quality, safety, and financial metrics). The Kirkpatrick (1994) evaluation model stresses

individual learner reactions to training as opposed to improvements in organizational performance. Swanson and Holton's (1999) Results Assessment System (RAS) measures performance outcomes related to the organization's mission, learning results related to the knowledge and skills transferred to the workplace, and perceptions from learners and stakeholders. The RAS approach is recommended. Organizational impact can be assessed by field managers and supervisors observing training graduates at two different time intervals (e.g., immediately post training and 30-days post training) and using a standard form to assess learning transfer and document changes in job productivity against key performance indicators (e.g., percent time saved in reduced job support or mentoring, percent increase of throughput, number of safety-related incidents). Compare these data with ATSAP data to determine if the problem has been resolved as a result of the training.

Observation 6

The task orders for new and recurrent training do not necessarily arise from a thorough preliminary analysis identifying the desired behavioral changes (needs) and learning outcomes. Decision-making during the Analysis phase regarding the type of training solution, learning strategies, and the tasks analysis is not being informed by the ISSs, the only people who are qualified by training and experience to make such determinations. This is important, because Branchoff (1997) found that out of the 11 design activities (stages) identified by Andrews and Goodson (1980), only the thoroughness of the needs assessment ($p = .008$) and selecting the delivery system ($p = .041$) were statistically significant with perceived project success by instructional designers. The ISSs do not have input into the Media Analysis, the training modality, although it is used to determine the learning methods, strategies, and activities as well as the delivery method, platforms, and settings. Their role is to ensure instructional soundness of the training; however, they are not included in the important initial decisions that affect the instructional design of the training. Although, the project ISS/ID can, with agreement by the work group, recommend and seek approval for changing the modality, this is rarely done once the requirements have been established. Furthermore, the Top 5 only releases the NAS issues/risks once a year. Because Recurrent AT training is automatically developed every six months, NAS needs do not always inform the need for the training (task order) nor the learning outcomes and objectives of the training solution. Consequently, additional analysis is necessary during the project kickoff, but is often inadequate given scheduling and funding constraints.

Recommendation 6

- **6.1 Include the project ISS Lead in planning and requirement analysis** to make decisions impacting instructional design and development that affect teaching and learning.
- **6.2 Redefine the Requirements Lead role to portfolio and project management.**
- **6.2 Develop an accessible online job-task database** and maintain its currency, so that project workgroups can access task analysis data when needed.

Observation 7

The ATO Technical Labor Office requires all requests for students to be at least 75 days before the FCC; AJT requires 45 days of advance notice; the project schedule has to be posted 27 days in advance. The 75-day lead time to schedule SMEs and test students is problematic because the project cannot launch without the SME(s) and it is difficult to forecast accurately when the test students will be needed because project schedules are soft beyond about 60

days. Furthermore, sometimes the SMEs and test students are unable to contribute to the project as scheduled and initially agreed to by their managers because of high work demands in the field. This causes delays, which may contribute to rushed work and the high number of revision requests during validation. Furthermore, the Requirements Leads do not possess the requisite SME training and experience in all AT and TO functional areas of expertise to adequately inform related decision-making during the Planning and Analysis phases.

Recommendation 7

- **7.1 Change the advance SME request notice to 60 days**, and require a 60-day project schedule to be posted and submitted to the need-to-know entities and personnel, and for the schedule to be updated as needed, but at least with each sprint cycle. Milestones after the 60-day schedule should be included along the dates or a note that the dates will be entered or updated once they are firm.
- **7.2 Establish positions in AJI-2 for in-house SMEs** in the three functional areas of AT and the five functional areas of TO, drawing from the pool of SMEs who are on limited work duty or are near retirement or recently retired. Some or all of the positions could be temporary duties, rotating SMEs in and out based on their availability. These SMEs would stay current on policies, equipment, and duties by frequent communications with field managers and periodic visits in the field. An in-house SME's participation would begin with the Planning and Analysis phases and continue throughout the project as needed. Their participation during the front-end analysis means that projects could launch when the task order is signed, and not be hindered by delays bringing an SME in from the field. This would require revision to JO 3000.22A 2-4 c. This would also allow shifting the role and responsibilities of the Requirements Leads to portfolio and project management, dropping their SME functions.

Observation 8

The actions of the project team members are not consistently uniform between AJI-2, AMA 400, and AMA 20 projects. For example, the CDG is not always followed as initially written; some team members tend to view it as a rough draft of the course instead of a blueprint for the course. The reasons could be related to external or internal factors (e.g., time pressure, lack of project resources, lack of control or accountability in decision making, perceptions of individual tasks, and the employee's underlying philosophical beliefs and particular competencies, and differences in management oversight/direction between locations). Strategies for communication and coordination between the personnel in the various AJI, AMA 400, and AMA 20 branches and sections are not well defined. According to the results from the interviews and surveys, ID projects are not managed uniformly. Irregular processes and ineffectual communication and coordination can pose bottlenecks, slowing down project progress and jeopardizing risk-based decision-making. Variances between projects and communications could be due to resource limitations, different branch/office oversight policies, misunderstood or ill-defined stakeholder roles and responsibilities, or a combination of factors or something else altogether. However, it appears there are no normative guidelines for practice. Indeed, the current AJI-2 SOP (at the time of this writing) does not clearly describe each project member's role and responsibilities, including what actions must be performed and what actions permit flexibility. Nor does it provide solutions for issues that arise. Nor are there any automatic trigger points to facilitate risk-based decision-making. Similarly, FAA Order 3000.22A fails to address many of these same things. While it is unrealistic and undesirable to expect no

variation in ID practice, reducing variation within job roles should be sought to the extent that it results more efficient and effective ID processes and products.

There is no single source of truth—standards, documentation, guidance, templates, forms—for the ID process and procedures used by AJI and AMA. Similar to no centralized ID intelligence tool/guide, there is no single centralized repository for the documentation used and created during project developments.

Recommendation 8

- **8.1 Develop a comprehensive, yet simplified, AJI-2 SOP** that incorporates all required standards, guidance, templates, and tools applicable to both ILT and WBT developments. This guidance should be accessible from the cloud (accessible by all users via a secure Internet connection). Define the stakeholder roles and responsibilities so they are clear from the perspective of someone new in those roles.
- **8.2 Develop a AJI-2 SOP workshop addressing IPT knowledge and performance.** This will help calibrate the job knowledge and performance of all workgroup members, but particularly the ISS Leads and Requirements Leads.

Observation 9

Flying all the stakeholders in to meet face-to-face for reviews and validation events is costly and time consuming. Furthermore, the logistics of arranging dates where everyone is available to meet is difficult for ISSs and others who work on multiple concurrent projects. Furthermore, the ISS and Requirements leads have high workload demands. Routinely, the ISSs work on more than one project at the same time, as noted as a bottleneck by some of the ISSs. This has led to process shortcuts, omissions, and deficiencies, such as not requesting field SMEs for reviewing course materials with the lead time stipulated in the SOP. Rushed work may be a factor in the high number of errata recorded during Validation events.

Recommendation 9

- **9.1 Leverage an online project management website** with a calendar, collaboration, communication, conferencing, file sharing capabilities, and a dashboard with workflow progress, status indicators, approval trigger points, task assignments, and so forth.
- **9.2 Reduce the number of face-to-face meetings.** Permit stakeholders to review the course, materials, and related documentation separately, recording change requests on an online errata worksheet. Leverage online collaboration in the design, development, and revision processes. This would shorten the team meetings, whether held virtually or in person, depending on what is most expedient.

Observation 10

There is no post-project review involving informal or formal presentation of the lessons learned to the project team and AJI leadership to both improve current processes and ensure future compliance with the SOP.

Recommendation 10

- **10.1 Require an after action report (AAR)** to be completed by the IPT members, providing feedback on what went well and what did not go well, and then submit it to the AJI-2120 Team Manager. The Team Manager should collate the information and then forward a summary to the AJI-2100 Development & Curriculum Group Manager to help inform future practices, improving efficiency of the ID process.

Observation 11

The FAA's Independent Government Cost Estimate (IGCE) does not appear to capture or reflect the actual training projects' resources, requirements, and scope.

Recommendation 11

- **11.1 Update the IGCE** (AJI-2000, n.d.f) so it better aligns to the project plans (schedules). Presently the cost breakdown structure does not map to the work breakdown structure. If it did, it would be easier to track what specific processes and tasks are under or overestimated in either time, cost, or resources.

Observation 12

The ID process requires the use of numerous guides, templates, checklists, worksheets, review sheets, and rubrics, some which appear to use inconsistent or conflicting terminology, at a minimum, and others that appear to duplicate prior efforts. Consistency is important for clarity, especially when onboarding new AJI-2 employees and vendors to the ID process. Some discrepancies are noticeable in the CDG. For example, the CDG uses both "Design Process" and the "Design Phase" to refer to this stage, and "phases" is used in the SOP process flowchart (see Appendix B). The CDG does not have a clear linkage with the other guides and checklists, nor does it describe where the stakeholders use each of them. For example, the eLearning Media Guide (AJI-2000, 2014), referred to as the "Technology-based Training Delivery and Media Selection Guide" (p. iv), is used by the project workgroup to decide the delivery method and its format, platform, and types of media or tools. The workgroup documents those decisions in the Analysis Report, in the Training Development Plan (TDP) template (AJI-2000, 2016I) for complex projects, in the CDG template, and in the Lesson Template Instructions (AJI-2000, n.d.f). Yet, there is no direct mention of these documents in the CDG. This terminology issue extends to file naming conventions. For example, all files used as templates do not include "template" in the file name (e.g., Course Design Guide), and many files do not include dates for versioning, as observed with eight required AJI-2 documents.

Another issue is the volume of paperwork is time consuming, especially during validation activities, and it is an issue for the students, instructors, and ISSs alike. For example, the students in the FCC we observed completed a "Student Assessment of Classroom Lessons" form at the end of each of the five lessons, but most of the forced-response items (i.e., yes, no, needs improvement) pertain to instructional soundness, which should have been confirmed before validation. Plus, the form lacked any easy way to quantify the data. The course was attended by 16 students, so, at a minimum, the ISS would have to process the information on 80 forms, not including the end-of-course evaluation forms and the information on the Errata form. Furthermore, the instructional component was running quite long. Yet, the instructors and vendor mistakenly believed the time could be made up during the several hours set aside at the end of the course for the debriefing; the ISS explained that it was not possible and why.

Recommendation 12

- **12.1 Simplify, reduce, and consolidate production documents** used in designing, developing, evaluating, and validating training. For example, use one *master guide*, one evaluation/validation checklist, and the Errata Checklist. As suggested in Recommendation 8, having one comprehensive master guide that addresses all types of training and includes the documents used in the ID process would be more efficient, not just in using it but also in maintaining (updating) it.
- **12.2 Use a validated review form** at the end of the evaluation/validation to provide a quantitative measure of instructional effectiveness. For example, the Instructional Strategy Diagnostic Profile (ISDP) developed by Merrill, Olsen, and Coldeway (as cited in Moore & Lockee, 2009), which has a basis in the Instructional Transaction Theory (ITT), provides criteria to evaluate the efficiency and effectiveness (form and sequence) of the instructional content. The ISDP criteria could be incorporated into the Validation Rubric to address this gap. Furthermore, the Validation Rubric could be improved with more concise verbiage and addition of scoring of each criterion so that the total score would provide a quantitative measure of the instructional soundness (including effectiveness and efficiency) and technical accuracy.

Observation 13

Conflicting terminology, especially with the names of the same ID activities, events, and functions across the different training modalities can be confusing.

Recommendation 13

- **13.1 Employ uniform ID nomenclature** across all training documentation. For example, use OTO for the first validation event and FCC for the second.

Observation 14

Identifying and understanding the performance gap is a noted problem area stemming from either inadequate or inaccurate needs/task analyses. Part of the problem appears to be related to not having either sufficient time, tools, or access to the information to conduct the analysis. However, as the AJI shifts toward an Agile ID process to streamline training development and deployment, it will become essential to conduct the needs analysis faster and to do so without sacrificing quality.

Recommendation 14

- **14.1 Adopt Rapid Evaluation and Assessment Methods (REAM).** The goal of REAM is to determine the best solution to a performance problem, so relies on having tightly-focused questions about the problem, gap, or need (see McNall & Foster-Fishman, 2007). Also, incorporate performance case modeling in the form of educational use case (dynamic activity & static structure) diagrams; two of the nine unified modeling language (UML) diagramming techniques used to graphically represent performance needs and goals (see Douglas, 2011). Potential benefits include improving stakeholder communications in defining, documenting, and sharing learning designs and in reducing the complexity of course design (see Derntl &

Motschnig-Pitrik, 2011). Figure 22 is an example textual representation of a performance case model for a blended course design. Table 21 provides the properties of coUML.

Data Element	Data
Primary Role	Fire Support Officer
Performance Goal	Verify risk estimate distances & attack criteria (i.e. the risks of landing on your own forces when using long range weapons)
Secondary Role	Mission Commander
Optimal Performance	Correctly identify risks for each weapon system used Develop a comprehensive knowledge of mission plans No errors in processing
Gap Statement	Only 60% of plans after execution meet satisfaction of mission commander
Indicators	Errors identified during peer review of plan No friendly fire incidents during execution of plan Mission commander satisfied with the plan
Cause	FSOs have difficulty finding and retaining knowledge about varying risks involved in the many different weapon systems they have to deal with Calculations difficult to accomplish in available time frame
Recommended Solution	Create job aid for quick look-up of risk data Integrate job-aid into training Create software application to assist in calculation
Solution Links	Fires integration: http://www.globalsecurity.org/military/library/policy/army/fm/3-90-2/appg.htm
Metadata (derived from Dublin Core)	Title: Verify Risk Estimate Distances & Attack criteria Analysis Object Creator: Ian Douglas Subject: Military, Mission Planning Description: Contains information on the analysis of fire support planning. Identifies the roles involved, problem causes, performance indicators, and recommended solutions for achieving an optimal level of performance. Publisher: Learning Systems Institute Date: 2006-08-06 Resource Type: Analysis Object Format: XML file Identifier: 02993109 Relation: Fire Support Analysis Report, Archive of threaded discussion on this object, Performance Case Diagram for the FSO Language: eng

Figure 22. Example analysis object for a performance case model. Adapted from “Performance Case Modeling,” by I. Douglas, 2011, *Instructional Design: Concepts, Methodologies, Tools and Applications*, p. 1547. Copyright 2011 by Information Resources Management Association/IGI Global.

Table 21

Cooperative Unified Modeling Language (coUML) Features and Applications

Classification of Features	
Stratification	Layered , as it allows modeling entities of different types and at different levels of detail.
Formalization	Semi-formal , it inherits formal elements and semantics of UML, yet it allows the modeler to be creative in providing additional visual and textual information.
Elaboration	The primary intent of coUML is mostly conceptual , but it is also possible to model at the levels of specification and implementation.
Perspective	Multiple , as it is possible to model structural (i.e., goals, roles, and documents) and dynamic (i.e., activities) concepts from different perspectives and at different levels of abstraction.
Notation System	Visual , based on UML, with extensions and additional textual descriptions.
Classification of Application	
Communication	Can be used as a reflective and communicative tool, depending on involved stakeholders' skills and preferences.
Creativity	Can be used for both generative (design-in-progress) and finalist (documentation) purposes. However, Its [<i>sic</i>] origin lines in finalist use.

Note. Adapted from “coUML: A Visual Language for Modeling Cooperative Environments,” by M. Derntl and R. Motschnig-Pitrik, 2011, *Instructional Design: Concepts, Methodologies, Tools and Applications*, p 786. Copyright 2011 by Information Resources Management Association/IGI Global.

List of References

- Allen, I. E., & Seaman, J. (2013, January). *Changing course: Ten years of tracking online education in the United States*. Babson Survey Research Group and Quahog Research Group. Retrieved from http://onlinelearningconsortium.org/survey_report/changing-course-ten-years-tracking-online-education-united-states/
- Allen Interactions. (2017). *The Agile advantage: SAM process*. Retrieved from <http://www.alleninteractions.com/sam-process>
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (2014). *eLearning media guide*. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (2016a). *AJI-2 training guidance background*. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (2016b). *AJI-2 safety and technical training standard operating procedure (sop)* [Draft]. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (2016c). *Analysis guide*. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (2016d). *Analysis report template* [Microsoft Word® template]. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (2016e). *ATO elms new item form* [Microsoft Word® template]. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (2016f). *Course design guide* [Microsoft Word® template]. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (2016g). *Design guide*. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (2016h). *Evaluation report template*. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (2016i). *Testing guide*. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (2016j). *Training development plan* [Microsoft Word® template]. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (2016k). *Validation guide*. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (2016l). *Validation report*. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (2016m). *Validation rubric*. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (2017a). *AJI organization chart*. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (2017b). *AJI technical training strategy & roadmap (version 1)*. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (n.d.a). *Errata workbook* [Microsoft Excel® file]. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (n.d.b). *CDG alignment checklist*. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (n.d.c). *Course priority matrix*. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (n.d.d). *Formatting checklist*. Washington, DC: Federal Aviation Administration.

- Air Traffic Organization Technical Training Directorate. (AJI-2000). (n.d.e). *Instructional design review sheet*. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (n.d.f). *Independent government cost estimate (igce): V6 master* [Microsoft Excel® file]. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (n.d.g). *Lesson template instructions* [Microsoft Word® template]. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (n.d.h). Order 3000.22 requirements checklist for technical training. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (n.d.i). *Technical accuracy review sheet (sme)*. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (n.d.j). *Test blueprint job aid*. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (n.d.k). *Test blueprint: Performance test*. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (n.d.l). *Test blueprint: Written test blueprint instructions*. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (n.d.m). *Training observation review sheet*. Washington, DC: Federal Aviation Administration.
- Air Traffic Organization Technical Training Directorate. (AJI-2000). (n.d.n). *Validation rubric*. Washington, DC: Federal Aviation Administration.
- Andrews, D. H., & Goodson, L. A. (1980). A comparative analysis of models of instructional design models. *Journal of Instructional Development*, 3(4), 2-16.
doi:10.1007/BF02904348
- Arimoto, M. M., Barroca, L., & Barbosa, E. F. (2016). AM-OER: An agile method for the development of open educational resources. *Informatics in Education*, 15(2), 205-233.
<https://doi.org/10.11606/t.55.2016.tde-31102016-103914>
- Avkiran, N. K. (2001). Investigating technical and scale efficiencies of Australian universities through data envelopment analysis. *Socio-Economic Planning Sciences*, 35(2001), 57-80.
- Baba, N. M. (2016). Systems Approach to Instructional Design. In S. L. Danver (Ed.), *The SAGE encyclopedia of online education* (Vol. 3, pp. 1085-1089). Los Angeles: SAGE Reference. Retrieved from the Gale Virtual Reference Library.
- Babbie, E. R. (2013). *The practice of social research* (13th ed.). Belmont, CA: Cengage Learning.
- Ballentine, G. K. (n.d.). *Order 3000.22A requirements checklist for technical training*. Washington, DC: Federal Aviation Administration.
- Banchoff, E. R. (1997). *The effects of instructional design activities, situational factors, and designer profiles on project success* [Dissertation]. Wayne State University. ProQuest UMI Number: 9815270
- Bardach, E. (2003). 'Smart (best) practices' research: *Understanding and making use of what look like good ideas from somewhere else* (Monograph). Retrieved from http://www.archive.epinet.org/real_media/010111/materials/bardach.pdf
- Barr, M., Brady, T., Koleszar, G., New, M. & Pounds, J. (2011). *FAA independent review panel on the selection, assignment and training of Air Traffic Control Specialists* [Final Report]. Retrieved from https://www.faa.gov/news/press_releases/news_story.cfm?newsId=13132
- Battou, A., Baz, O., & Mammass, D. (2016). Learning design approaches for designing learning environments: A comparative study. Paper presented at the *2016 5th International*

- Conference on Multimedia Computing and Systems (ICMCS), 206-211. doi: 10.1109/ICMCS.2016.7905666
- Beck, K., Beedle, M., van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, . . . Thomas, D. (1981). *Manifesto for Agile software development*. Retrieved from <http://agilemanifesto.org/>
- Beecham, S., Baddoo, N., Hall, T., Robinson, H., & Sharp, H. (2006). *Protocol for a systematic literature review of motivation in software engineering* (Technical Report No: 453). University of Hertfordshire. doi:10.1.1.104.3675&rep=rep1&type=pdf
- Bendixsen, S., & de Guchteneire, P. (2003). Best practices in immigration services. *Journal of Policy Analysis and Management*, 22(4), 677-682.
- Bernard, R. M., Abrami, P. C., Lou, Y., Borokhovski, E., Wade, A., Wozney, L., Walseth, P. A., Fiset, M., & Huang, B. (2004). How does distance education compare to classroom instruction? A meta-analysis of the empirical literature. *Review of Educational Research*, 74(3), 379-439.
- Branson, R. K., Rayner, G. T., Cox, J. L., Furman, J. P., King, F. J., & Hannum, W. H. (1975). *Interservice procedures for instructional systems development: Executive summary and model* (5 vols.) (National Technical Information Service No. ADA 019 486 through ADA 019 490). Tallahassee: Center for Educational Technology, Florida State University.
- Bretschneider, S. Marc-Aurele, F., & Wu, J. (2001). Best practices research: A methodological guide for the perplexed. *Journal of Public Administration Research and Theory* 15(2), 307-323.
- Brinkerhoff, R. O. (2003). *The Success case method: Find out quickly what's working and what's not*. San Francisco, CA: Berrett-Koehler.
- Brinkerhoff, R. O. (2005). The Success case method: A strategic evaluation approach to increasing the value and effect of training. *Advances in Developing Human Resources*, 7(1), 86-101. Retrieved from <http://aetcnec.ucsf.edu/evaluation/Brinkerhoff.impactassess1.pdf>
- Chapman, B. (2010). *How long does it take to create learning?* [Research Study]. Published by Chapman Alliance LLC. Retrieved from www.chapmanalliance.com
- Clark, Sr., D. (2015). *An analysis of instructional design and teaching methods of law enforcement ethics education at community colleges* [Dissertation]. Morgan State University. ProQuest UMI Number: 3707591
- Conn, C. A., & Gitonga, J. (2004). The status of training and performance research in the AECT journals. *TechTrends*, 48(2), 16-21.
- Davies, P. (2000). The relevance of systematic reviews to educational policy and practice. *Oxford Review of Education* 26(3-4): 365-378. Retrieved from <http://dx.doi.org.ezproxy.libproxy.db.erau.edu/10.1080/713688543>
- Deberry, K. (2015, October). *Delivery of training to pilots and aviation safety inspectors in the Flight Standards environment* [Presentation]. Symposium conducted at the meeting of the Center of Excellence on Technical Training & Human Performance, Arlington, VA.
- Derntl, M. & Motschnig-Pitrik, R. (2011). coUML: A visual language for modeling cooperative environments. In M. Khosrow-Pour (Ed.), *Instructional Design: Concepts, Methodologies, Tools and Applications*, pp. 758-788. Information Resources Management Association/IGI Global. Retrieved from <https://ebookcentral.proquest.com>
- Dick, W., Carey, L., & Carey, J. O. (2009). *The systematic design of instruction* (7th ed.). Upper Saddle River, NJ: Merrill/Pearson.
- Douglas, I. (2011). Performance case modeling. In M. Khosrow-Pour (Ed.), *Instructional Design: Concepts, Methodologies, Tools and Applications*, pp. 1537-1552. Information Resources Management Association/IGI Global. Retrieved from <https://ebookcentral.proquest.com>

- Federal Aviation Administration (FAA). (2000). *Standard contract training programs* (FAA-STD028C). Washington, DC: Author.
- Federal Aviation Administration (FAA). (2013a). *FAA air traffic control job task analysis* (Vol. 1.4A). Washington, DC: Author.
- Federal Aviation Administration. (FAA). (2013b). *Review and evaluation of ATC training at the FAA Academy*. Washington, DC: Author.
- Federal Aviation Administration (FAA). (2014a). *Air Traffic Organization outcomes-based technical training* (Order 3000.22A). Washington, DC: Author. Retrieved from http://www.faa.gov/documentLibrary/media/Order/JO_3000_22A_09-15-14.pdf
- Federal Aviation Administration (FAA). (2014b). *Job task analysis* [Microsoft Excel® file]. Washington, DC: Author.
- Federal Aviation Administration (FAA). (2014c). *FAA eLMS content integration guide*. Washington, DC: Author.
- Federal Aviation Administration (FAA). (2015a). *A plan for the future: 10 year strategy for the air traffic control workforce*. Retrieved from https://www.faa.gov/air_traffic/publications/controller_staffing/media/CWP_2015.pdf
- Federal Aviation Administration (FAA). (2015b). *Air traffic technical training* (Order 3120.4P). Retrieved from https://www.faa.gov/regulations_policies/orders_notices/index.cfm/go/do
- Federal Aviation Administration (FAA). (2016). *Significant safety issue identification (ssi) process*. Washington, DC: Author.
- Gibbons, A. S. (2015). Instructional design models. In J. M. Spector (Ed.), *The SAGE Encyclopedia of Educational Technology*. Retrieved from <http://dx.doi.org.ezproxy.libproxy.db.erau.edu/10.4135/9781483346397.n164>
- Gottfredson, C. (2013). *AGILE instructional design: Faster, leaner, and more effective @ the speed of change*. The ELearning Guild Academy. Retrieved from <https://www.elearningguild.com/showfile.cfm?id=5084>
- Gustafson, K. L., & Branch, R. M. (1997; 2002). *Survey of instructional development models* (4th ed.). Syracuse, NY: ERIC Clearinghouse on Information & Technology. Retrieved from <http://eric.ed.gov/>
- Haley-Seikel, C. (2015, October). *Developing and maintaining technical training curriculum* [Presentation]. Symposium conducted at the meeting of the Center of Excellence for Technical Training & Human Performance, Arlington, VA.
- Ho, M. (Ed.). (2016a). *2016 state of the industry*. Alexandria, VA: Association for Talent Development. Retrieved from www.td.org/research
- Ho, M. (Ed.). (2016b). *Evaluating learning: Getting to measurements that matter*. Alexandria, VA: Association for Talent Development. Retrieved from www.td.org/research
- Huhn, J. (2013, May 7). *What is Agile learning design?* [Web log post]. Bottom-Line Performance. Retrieved from <http://www.bottomlineperformance.com/what-is-agile-learning-design/>
- International Organization for Standardization (ISO). (2015). *Quality management principles*. Geneva, Switzerland. Retrieved from <https://www.iso.org/files/live/sites/isoorg/files/archive/pdf/en/pub100080.pdf>
- Irlbeck, S., Kays, E., Jones, D., & Sims, R. (2006). The phoenix rising: Emergent models of instructional design. *Distance Education*, 27(2), 171-185. <http://dx.doi.org/10.1080/01587910600789514>
- Kapp, K. M., & Defelice, R. A. (2009, August 31). *Time to develop one hour of training*. Retrieved from the Association for Talent website at <https://www.td.org/Publications/Newsletters/Learning-Circuits/Learning-Circuits-Archives/2009/08/Time-to-Develop-One-Hour-of-Training>

- Kearns, S. K. (2010). *E-learning in aviation*. Burlington, VT: Ashgate. Retrieved from <http://site.ebrary.com.ezproxy.libproxy.db.erau.edu/lib/erau/detail.action?docID=10421635&p00=e-learning+aviation>
- Kennedy, M. R., & Ward, D. (2012, July). Inserting agility in system development. *Defense ARJ*, 19(3), 249–264. Retrieved from http://dau.dodlive.mil/files/2014/11/Kennedy_Ward_ARJ63.pdf
- Kirschner, P., Carr, C., & van Merriënboer, J. (2002). How expert designers design. *Performance Improvement Quarterly*, 15(4) pp. 86-104. <https://doi.org/10.1111/j.1937-8327.2002.tb00267.x>
- Kirkpatrick, D. L. (1994). *Evaluating training programs*. San Francisco, CA: Berrett-Koehler.
- Kruse, K. (2009). *Introduction to instructional design and the ADDIE model*. Retrieved from http://www.transformativedesigns.com/id_systems.html
- Lee, J., & Jang, S. (2014). A methodological framework for instructional design model development: Critical dimensions and synthesized procedures. *Education Communications and Technology*, 62(6), 743-765. <https://dx.doi.org/10.1007/s11423-014-9352-7>
- Leigh, H. N., & Tracey, M. W. (2010). A review and new framework for instructional design practice variation research. *Performance Improvement Quarterly*, 23(2), pp. 33-46. <https://doi.org/10.1002/piq.20080>
- McGee, P. (2006). Determining the productivity of instructional systems. *The Journal of Human Resource and Adult Learning*. 2(2), 1-7.
- Moore, D. R., & Lockee, B. B. (2009, Spring). Re-visiting the instructional strategy diagnostic profile: A comparative analysis. *International Journal of Instructional Media*, 36(2), 187+. Retrieved from <http://link.galegroup.com.ezproxy.libproxy.db.erau.edu/apps/doc/A273359053/AONE?u=embry&sid=AONE&xid=b405bc50>
- Moran, A. (2014). *Agile risk management*. New York, NY: Springer.
- Morrison, G. R., Ross, S. M., Kalman, H. K., & Kemp, J. E. (2012). *Designing Effective instruction* (7th ed.). Hoboken, NJ: John Wiley & Sons.
- Myers, S. Smith, H. P. & Martin, L. L. (2004). *Conducting best practices research in public affairs*, Vol. 3, Working Paper: Center for Community Partnerships, College of Health & Public Affairs, University of Central Florida.
- Naval Education and Training Command (2016, June). *Training requirement submission, and course development, delivery, and maintenance end-to-end process* (NETCINST 1500.19). Pensacola, FL: Department of the Navy. Retrieved from <http://aim.aimereon.com/AIMWikiDocuments/NAVEDTRA/NETCINST%201500.19.pdf>
- Neal, J. G., & Hampton, S. (2016). Developing a challenging online doctoral course using backward and three-phase design models. *Journal of Aviation/Aerospace Education & Research*, 25(2). <http://dx.doi.org/10.15394/jaaer.2016.1686>
- Nielsen, J. (2011, January). *Parallel & iterative design + competitive testing = high usability*. Retrieved from the NN/g Nielsen Norman Group website at <https://www.nngroup.com/articles/parallel-and-iterative-design/>
- Overman, E. S., & Boyd, K. J. (1994). Best practice research and post bureaucratic reform. *Journal of Public Administration Research and Theory* 4(1), 67–84.
- Oyen, E. (2002). *Best practices in poverty reduction: An analytical framework*. London: Crop Publishing.
- Parnas, D. L., & Clements, P. C. (1986). A rational design process: How and why to fake it. *IEEE Transactions on Software Engineering*, SE 12(2), 251-257.
- Reigeluth, C. M. (1983). Instructional design: What is it and why is it? In C. M. Reigeluth (Ed.) *Instructional-design theories and models: A new paradigm of instructional theory: Vol. I*

- Instructional-design theories and models: An overview of their current status* (pp. 3–36). Hillsdale, NJ: Lawrence Erlbaum.
- Reigeluth, C. M. (Ed.) (1999). *Instructional-design theories and models: A new paradigm of instructional theory* (Vol. 2). Mahwah, NJ: Lawrence Erlbaum.
- Reigeluth, C. M. (1996). A new paradigm of ISD? *Educational Technology*, 36(3), 13–20.
- Reigeluth, C. M., & Frick, T. W. (1999). Formative research: Methodology for creating and improving design theories. In C. M. Reigeluth (Ed.) *Instructional-design theories and models: Vol. 2 A new paradigm of instructional theory* (pp. 633–652). Mahwah, NJ: Lawrence Erlbaum.
- Reigeluth, C. M., & Moore, J. (1999). Cognitive education and the cognitive domain. In C. M. Reigeluth (Ed.) *Instructional-design theories and models: Vol. 2 A new paradigm of instructional theory* (pp. 51–68). Mahwah, NJ: Lawrence Erlbaum.
- Reiser, R. A. (Ed.), & Dempsey, J. V. (Ed.) (2016). *Trends and issues in instructional design and technology* (3rd ed.). Boston, MA: Pearson.
- Richey, R. C., Klein, J. D., & Tracey, M. W. (2011). *The instructional design knowledge base theory, research, and practice*. New York, NY: Routledge.
- Rico, D. F. (2007a). *ROI of technology readiness assessments using real options: An analysis of GAO data from 62 U.S. DoD programs*. Retrieved from <http://davidfrico.com/rico07o.pdf>
- Rico, D. F. (2007b). *ROI of technology readiness using real options: A spreadsheet analysis of GAO data from 62 U.S. DoD programs*. Retrieved from <http://davidfrico.com/rico07n.xls>
- Rico, D. F. (2008). *What is the return on investment (roi) of Agile methods?* Retrieved from [http://www.afei.org/WorkingGroups/ADAPT/Documents/rico08a\[1\].pdf](http://www.afei.org/WorkingGroups/ADAPT/Documents/rico08a[1].pdf)
- Romiszowski, A. J. (1982). *Designing instructional systems: Decision making in course planning and curriculum*. New York, NY: Nichols Publishing.
- Romiszowski, A. J. (1984). *Producing instructional systems: Lesson planning for individualized and group learning activities*. New York, NY: Nichols Publishing.
- Sanders, G. (2015). *50140081 en route stage 1 course evaluation final report*. Washington, DC: Federal Aviation Administration, Air Traffic Organization, Safety and Technical Training (AJI-2120).
- Sanders, G. (2016). *Initial en route qualification training course design guide* (CDG-50148001-V-2016-8). Washington, DC: Federal Aviation Administration, Air Traffic Organization, Safety and Technical Training (AJI-2120).
- Seels, B., & Richey, R. (1994). *Instructional technology: The definitions and domains of the field*. Washington, DC: Association for Educational Communications and Technology.
- Sharp, B. M., Bergh, D. D., & Li, M. (2013). Measuring and testing industry effects in strategic management research: An update, assessment, and demonstration. *Organizational Research Methods*, 16(43). <https://doi.org/10.1177/1094428112470847>
- Sims, R., & Jones, D. (2003). Where practice informs theory: Reshaping instructional design for academic communities of practice in online teaching and learning. *Information Technology, Education and Society*, 4(1), 3-20.
- Smith, R. (2015, October). *Overview of air transportation environment: Technical training* [Presentation]. Symposium conducted at the meeting of the Center of Excellence on Technical Training & Human Performance, Arlington, VA.
- Stair, R. & Reynolds, G. (2014). *Fundamentals of information systems* (7th ed.). Boston, MA: Cengage Learning.
- Swanson, R. A. & Holton, E. F. (1999). *Results: How to assess performance, learning, and perceptions in organizations*. San Francisco, CA: Berrett-Koehler.
- Toister, J. (2016). Brinkerhoff's success case method. In *How to Measure Learning Effectiveness*. Retrieved from Lynda.com at <https://www.lynda.com/Higher-Education-tutorials/Brinkerhoffs-Success-Case-Method/479801/552854-4.html>

- Torrecilla-Salinas, C. J., Sedeño, J., Escalona, M. J., Mejías, M. (2014). Estimating, planning and managing Agile Web development projects under a value-based perspective. *Information and Software Technology*, 61, 124–144.
- Torrance Learning. (2015). Get Agile with the LLAMA – the lot like Agile methods approach. Retrieved from <http://www.torrancelearning.com/agile/>
- Training Industry. (n.d.). *Taxonomy: Successive approximation model (SAM)*. Retrieved from <https://www.trainingindustry.com>
- Tutorials Point. (n.d.). *SDLC - RAD model*. Retrieved from https://www.tutorialspoint.com/sdlc/sdlc_rad_model.htm
- Vesely, A. (2011). Theory and methodology of best practice research: A critical review of the current state. *Central European Journal of Public Policy* 5(2), 98-117.
- Visscher-Voerman, I., & Gustafson, K. L. (2004). Paradigms in the theory and practice of education and training design. *Educational Technology, Research and Development*, 52(2). 69-89. ProQuest.
- Watson, R. W. (1981). *The analysis and design of an instructional systems course* [Doctoral dissertation, University of Arizona] (Order No. 8117737). Available from ProQuest Dissertations & Theses Global database. (303097319).
- Weber, R. P. (1990). *Basic content analysis* (2nd ed.). Newbury Park, CA: Sage.
- Wedman, J., & Tessmer, M. (1993). Instructional designers' decisions and priorities: A survey of design practice. *Performance Improvement Quarterly*, 6(2), 43-57.
- Wedman, J. F., & Tessmer, M. (1991). Adapting instructional design project circumstance: The layers of necessity model. *Educational Technology*, 31(7), 48-52.

PAGE INTENTIONALLY LEFT BLANK

Appendixes

Appendix A: TTHP Task 10: Alternative ID Models Survey

Appendix B: List of Definitions

Appendix C: AJI-2000 SOP ISD Process

Appendix D: REDACTED

Appendix E: REDACTED

Appendix F: JO 3000.22A Requirements Checklist for Technical Training

Appendix G: REDACTED

Appendix H: Proposed Agile AJI-2 Process

Appendix I: Researchers' Biographies

Appendix A

TTHP Task 10: Alternative ID Models Survey



TTHP Task 10: Alternative ID Models Survey

Instructions

This online survey is part of an FAA-funded research study into alternative instructional design methods and has been coordinated, reviewed, and approved by PAACE and AMA. The goal of this study is to provide the ATO with recommendations for improving the efficiency of the instructional development (ID) processes used by AJI-2. This study involves an examination of the best practice literature, AJI-2 course production materials, and interviews of instructional systems specialists (ISS) from AJI-2 and from the Academy. The researchers are Steven Hampton and Jan G. Neal from Embry-Riddle Aeronautical University.

You are being asked to participate because you are currently employed as an ISS or ID lead and are instrumental to the development of technical occupational training for the FAA. Your responses will be confidential and stored in a secure location. Only the researchers will have access to the raw data. We will not use your name or any other personal identifying information in the reporting of data from this study.

We anticipate it will take about 30 to 45 minutes to complete this survey. Because it is voluntary, you may take a break or stop at any time without reason. However, this online survey is only available for 10 days, so it needs to be completed within that period.

We will coordinate through PAACE and contact you within two weeks to ask you follow-on questions for clarifications, so please provide your preferred contact method and the best days/times to contact you. We anticipate this follow-up interview will not take more than 1 hour.

Please answer every question, as your contributions are vital to this research effort.

1. How many years have you worked in the instructional design field? (e.g., 1, 5.5, 20)

The rationale for this question is to quantify ISD work experience. The response data are demographic, so we will use the information to describe the population or sample of instructional designers interviewed. We may also use the information observationally if it relates to our recommendations. This question along with its similar questions, and with other related questions, enables estimation of internal consistency reliability.

2. Indicate the highest college degree attained that relates to instructional design or project management.

This question seeks to quantify ISS education and training. The response data are demographic, so we will use the information to describe the participants. We may also use the information observationally if it relates to our recommendations. This question supports internal reliability.

- ☐ None
- ☐ Associate's or Equivalent
- ☐ Bachelor's or Equivalent
- ☐ Master's or Equivalent
- ☐ Doctoral or Equivalent

3. Indicate the range with the number of certifications attained that relates to instructional design or project management.

This question seeks to quantify ISS education and training. The response data are demographic, so we will use the information to describe the participants. We may also use the information observationally if it relates to our recommendations. This question supports internal reliability.

- ☐ 1 – 10
- ☐ 11 – 20
- ☐ 21 – 30
- ☐ +30

4. What Instructional Design and Development models have you used?

This question seeks to identify what ISS training needs might arise if we recommend an unfamiliar ISD process or processes. An important consideration when adopting any new processes is training needed for users who are unfamiliar with the processes. Responses will also provide insight into what process steps ISSs either have or might be inclined to fall back on if a new process is difficult or arduous or if simply given the chance. We will use this data to describe the participants. We anticipate using this information when contrasting and comparing ISD practitioners and/or practices with the best practice case literature. We may also use it observationally if it relates to our recommendations. This question supports internal reliability.

Most Used Model:

2nd Most Used Model:

3rd Most Used Model

4th Most Used Model

All other Models Used:

5. Describe the formal training have you had in each model.

The rationale for this question is essentially the same as that for question 3. Someone may have formal training in one approach but have more experience in different approaches or vice versa. While neither should be favored, it is important to distinguish between experience and education to avoid ambiguity. We will use the response data to describe the participants. We anticipate using this information when contrasting and comparing ISD practitioners and/or practices with the best practice case literature. We may also use the information observationally if it relates to our recommendations. This question supports internal reliability.

6. How many years have you worked as an FAA ISS? (e.g., 0, 1, 2.5, 15.)

We will use the response data to quantify the amount of ISS experience with the ATO ISD process by location or by ownership of the Air Traffic and Tech Ops occupational training. We anticipate using this information when contrasting and comparing ISD practitioners and/or practices with the best practice case literature. We may also use the information observationally if it relates to our recommendations. This question supports internal reliability.

7. How many years have you worked with AJI as an ISS? (e.g., 0, 1, 2.5, 15.)

We will use the response data to quantify the amount of ISS experience with the ATO ISD process by location or by ownership of the Air Traffic and Tech Ops occupational training. We anticipate using this information when contrasting and comparing ISD practitioners and/or practices with the best practice case literature. We may also use the information observationally if it relates to our recommendations. This question supports internal reliability.

8. How many years have you worked with AMA 400 as an ISS? (e.g., 0, 1, 2.5, 15.)

We will use the response data to quantify the amount of ISS experience with the ATO ISD process by location or by ownership of the Air Traffic and Tech Ops occupational training. We anticipate using this information when contrasting and comparing ISD practitioners and/or practices with the best practice case literature. We may also use the information observationally if it relates to our recommendations. This question supports internal reliability.

9. How many years have you worked with AMA 20 as an ISS? (e.g., 0, 1, 2.5, 15.)

We will use the response data to quantify the amount of ISS experience with the ATO ISD process by location or by ownership of the Air Traffic and Tech Ops occupational training. We anticipate using this information when contrasting and comparing ISD practitioners and/or practices with the best practice case literature. We may also use the information observationally if it relates to our recommendations. This question supports internal reliability.

10. How much experience in terms of the number of projects do you have in using the current ATO ISD process? (e.g., 1, 2.5, 15.)

We are seeking to quantify the ATO project management experience of the participants. We will use the response data to describe the participants. We anticipate using the information when contrasting and comparing ISD practitioners and/or practices with the best practice case literature. We may use the information observationally if it relates to our recommendations. This question supports internal reliability.

11. On a scale where 1 is low degree of expertise (still learning the process) and 7 is a very high degree of expertise (teaching others), please rate your level of expertise with the ATO ISD process.

We are seeking to quantify participant perceptions about usage of the phases of the ATO ISD process. We will use this information descriptively when contrasting and comparing ISD practitioners and/or practices with the best practice case literature. We may use the information observationally if it relates to our recommendations.

1 = low (still learning); 7 = high (teaching others)

1 7

12. On a scale where 1 is not satisfied (negative) and 7 is very satisfied (positive), rate your satisfaction using the ATO ISD process as compared to what you consider to be the best ISD process (model) that you have used.

We are seeking to quantify participant perceptions about usage of the phases of the ATO ISD process. We will use this information descriptively when contrasting and comparing ISD practitioners and/or practices with the best practice case literature. We may use the information observationally if it relates to our recommendations.

1 = low (negative); 7 high (positive)

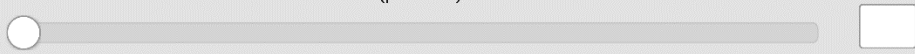
1 7

13. On a scale where 1 is very difficult or problematic (negative) and 7 is very easy or non-problematic (positive), rate the typical difficulty in managing the **Analysis phase** ending with delivery of the Analysis Report of the ATO ISD processes for **ILT**.

We are seeking to quantify participant perceptions about usage of the phases of the ATO ISD process. We will use this information descriptively when contrasting and comparing ISD practitioners and/or practices with the best practice case literature. We may use the information observationally if it relates to our recommendations.

1 = low (negative); 7 high (positive)

1 7

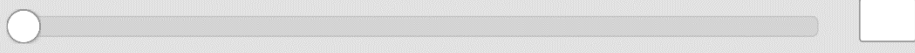


14. On a scale where 1 is very difficult or problematic (negative) and 7 is very easy or non-problematic (positive), rate the typical difficulty in managing the **Analysis phase** ending with delivery of the Analysis Report of the ATO ISD processes for **WBT**.

We are seeking to quantify participant perceptions about usage of the phases of the ATO ISD process. We will use this information descriptively when contrasting and comparing ISD practitioners and/or practices with the best practice case literature. We may use the information observationally if it relates to our recommendations.

1 = low (negative); 7 high (positive)

1 7

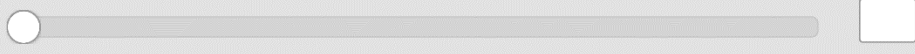


15. On a scale where 1 is very difficult or problematic (negative) and 7 is very easy or non-problematic (positive), rate the typical difficulty in managing the **Design phase** ending with delivery of the Course Design Guide of the ATO ISD processes for **ILT**.

We are seeking to quantify participant perceptions about usage of the phases of the ATO ISD process. We will use this information descriptively when contrasting and comparing ISD practitioners and/or practices with the best practice case literature. We may use the information observationally if it relates to our recommendations.

1 = low (negative); 7 high (positive)

1 7



16. On a scale where 1 is very difficult or problematic (negative) and 7 is very easy or non-problematic (positive), rate the typical difficulty in managing the **Design phase** ending with delivery of the Course Design Guide of the ATO ISD processes for **WBT**.

We are seeking to quantify participant perceptions about usage of the phases of the ATO ISD process. We will use this information descriptively when contrasting and comparing ISD practitioners and/or practices with the best practice case literature. We may use the information observationally if it relates to our recommendations.

1 = low (negative); 7 high (positive)

1 7

17. On a scale where 1 is very difficult or problematic (negative) and 7 is very easy or non-problematic (positive), rate the typical difficulty in managing the **Development phase** ending with the delivery of the Instructor Guide and Student Guide for ILT of the ATO ISD processes for **ILT**.

We are seeking to quantify participant perceptions about usage of the phases of the ATO ISD process. We will use this information descriptively when contrasting and comparing ISD practitioners and/or practices with the best practice case literature. We may use the information observationally if it relates to our recommendations.

1 = low (negative); 7 high (positive)

1 7

18. On a scale where 1 is very difficult or problematic (negative) and 7 is very easy or non-problematic (positive), rate the typical difficulty in managing the **Development phase** ending with the delivery of the programmed WBT of the ATO ISD processes for **WBT**.

We are seeking to quantify participant perceptions about usage of the phases of the ATO ISD process. We will use this information descriptively when contrasting and comparing ISD practitioners and/or practices with the best practice case literature. We may use the information observationally if it relates to our recommendations.

1 = low (negative); 7 high (positive)


1 7

19. On a scale where 1 is very difficult or problematic (negative) and 7 is very easy or non-problematic (positive), rate the typical difficulty in managing the **Validation phase** ending with the First Course Conduct of the ATO ISD processes for **ILT**.

We are seeking to quantify participant perceptions about usage of the phases of the ATO ISD process. We will use this information descriptively when contrasting and comparing ISD practitioners and/or practices with the best practice case literature. We may use the information observationally if it relates to our recommendations.

1 = low (negative); 7 high (positive)

1 7

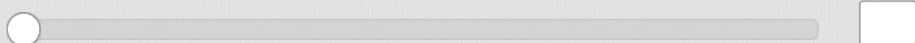


20. On a scale where 1 is very difficult or problematic (negative) and 7 is very easy or non-problematic (positive), rate the typical difficulty in managing the **Validation phase** ending with the First Course Conduct of the ATO ISD processes for **WBT**.

We are seeking to quantify participant perceptions about usage of the phases of the ATO ISD process. We will use this information descriptively when contrasting and comparing ISD practitioners and/or practices with the best practice case literature. We may use the information observationally if it relates to our recommendations.

1 = low (negative); 7 high (positive)

1 7



21. Please describe your duties as an ISS for each phase of the current ID process.

We are seeking to understand the job scope and project management process. For example, do different designers use different project management tactics like communication strategies? Do they add or omit steps or tasks or use slightly different task sequences? We will use the response information when describing the current ISD process. We anticipate using this information when contrasting and comparing ISD practitioners and/or practices with the best practice case literature. We may also use the information observationally if it relates to our recommendations. This question supports internal reliability.

22. Please describe the typical bottlenecks and other issues that tend to arise with the development of ILT courses and with WBT courses.

We are seeking to understand the different needs between ILT and WBT and between ATO and Academy course development projects. We will use this information to describe potential inefficiencies in current practices. We anticipate using this information when contrasting and comparing ISD practitioners and/or practices with the best practice case literature. We may also use the information observationally if it relates to our recommendations. This question supports internal reliability.

23. Please describe alternative ISD practices or sequences that you believe could speed-up or shorten the production processes for new courses, workshops, and briefings, respectively, without sacrificing the quality of the completed product.

We are seeking to learn best practices from the informed experiences of the participants. We will use this information to describe possible improvements to current practices. We anticipate using this information when contrasting and comparing ISD practitioners and/or practices with the best practice case literature. We may also use the information observationally if it relates to our recommendations. This question supports internal reliability.

24. We will coordinate with PAACE to conduct any follow-ups. Please provide your full name, preferred method of contact, and days/times you are available over the following two weeks for our follow-up questions.

Appendix B

List of Definitions

ADDIE Model	Analyzing the problem, Designing a training solution, Developing the courseware, Implementing the solution, and performing Evaluations throughout the process (FAA, 2014a).
AGILE Model	An incremental and iterative development process in which fully functional components or features are developed and delivered through work sprints by fixed or locked-down development teams (Rico, 2007a).
Blended	A blended approach of both self-paced and facilitated delivery (FAA, 2013a). Virtual Classroom Training: A live, internet-based training solution. VCT does not require special equipment or software, yet it is dynamic and robust (FAA, 2013b).
Briefing	Organized information delivered to learners (FAA, 2014a).
CDG (Course Design Guide)	The contractor's plan for laying out the various parts of a training course that accounts for training outcomes and each objective (FAA, 2000, 2009, 2014a). This document specifies the training outcomes, sequence of lessons, lesson and topic objectives, sequence of objectives, specific instructional methods and media to be used, and the assessment strategy. Course Design Guides must be used for all courses, workshops, and are optional for briefings (FAA, 2014a). The CDG: (1) Establishes training objectives, ranging from instructional objectives, which directly support the outcomes in the approved TDP, to the detailed lesson (enabling) objectives. (2) Includes an outline of course content specifying the skills/knowledge the employee must acquire to develop the capability(s) stated in the instructional objectives. (3) Specifies the methodology/media to be employed in meeting each outcome. (4) States the employee achievement measures which must be used to determine the extent to which instructional and enabling objectives are achieved. (5) Establishes a logical learning sequence of course structure. (6) Establishes estimated time parameters for the achievement of instructional objectives. (7) Establishes a basis for the evaluation of training (FAA, 2009).
CEDAR	Comprehensive Electronic Data Analysis and Reporting (FAA, 2014b).
Course Walk-Through (CWT)	The course walk-through ensures that previous corrections and/or revisions have been made, instruction is sequenced logically, materials are consistent and of high quality, and any logistical problems are identified and resolved. The course is presented in its entirety, but at a faster than normal pace, so that SMEs, instructional system specialists, and instructors may observe the general flow of the course (FAA, 2009). An abbreviated presentation of training to subject matter experts (SMEs), instructional systems specialists (ISSs), and instructors to ensure that revisions from technical and instructional reviews were made, instruction is logically sequenced, materials are of required quality and consistency, and any logistical problems have been resolved (precedes Operational Tryout in Validation process) (FAA, 2014a).

Course	A training event structured by measurable objectives that is designed for a particular target audience (FAA, 2014a).
Criticality	A characteristic that indicates how essential it is to perform the task or subtask (FAA, 2000).
DDIF	Difficulty to Learn (DL), Difficulty to Perform (DP), Importance (I), Frequency (F). Scales of 1 (low) to 4 (high). Used to calculate the initial training priority (FAA, 2013b). (See DIF.)
Difficulty	A task characteristic that indicates how hard it is to perform the task or subtask (FAA, 2000).
DIF	Difficulty/Importance/Frequency: Coding used in the Preliminary Analysis Report (PAR) and in the Job Task Analysis (JTA) when rating the proficiency of job tasks (AJI-2000, 2016a). (See DDIF.)
Effectiveness	The foremost consideration in the development of a Technical Operations training course is that it must be effective in accomplishing the objectives established by the TIR (FAA, 2009).
Efficiency	Regardless of the training method, the distribution of material for each course must be accomplished in the way that maximizes overall efficiency at the minimum cost possible (FAA, 2009).
eLMS (Electronic Learning Management System)	The Department for Transportation system for tracking training that serves as the official database containing employees training histories. All training courses, OJT, performance examinations, and demonstrations of proficiency will be entered into eLMS. The FAA's electronic learning management system for employees to take online training, register for course offerings, and view their learning histories (FAA, 2009).
FCC (First Course Conduct)	The first presentation of a course developed by a contractor to the student population. This is the last step in the validation process (FAA, 2000; AJI-2000, 2016c). Delivery of training to target audience, observed by technical content lead and training development lead to determine if training meets validation criteria (for example, instructional materials and associated documentation are complete, accurate, ready for delivery), and determine whether the training is effective, adequate and acceptable to the learners during the first delivery (FAA, 2014a).
IGCE (Independent Government Cost Estimate)	An estimate that requires detailed analysis and rigor. This estimate is usually based on an engineering or "Bottoms Up" approach using labor hours, labor rates, and material. It can also rely on subject matter experts, analogous systems, parametric modeling, actual historical costs, etc. to derive the final estimate. Well suited for all phases of the acquisition process (FAA, n.d.f).
ILT (Instructor Led Training)	Training accomplished by the individual with an instructor/facilitator. Courses delivered by one or several instructors and/or subject matter experts and can be in a traditional classroom setting. Instructors may be using white board, PowerPoint, or other media (FAA, 2013b). Traditional, face-to-face training method where instructors and learners are collocated in a physical locale (FAA, 2014a).
ISS (Instructional Systems Specialist); also Instructional Design Lead (ID Lead)	An AJI-2120 representative, appointed by AJI-2120 management, who (a) leads instructional systems specialist tasks, (b) ensures instructional integrity of course content, including text, graphics, and animation; (c) provides project oversight and project

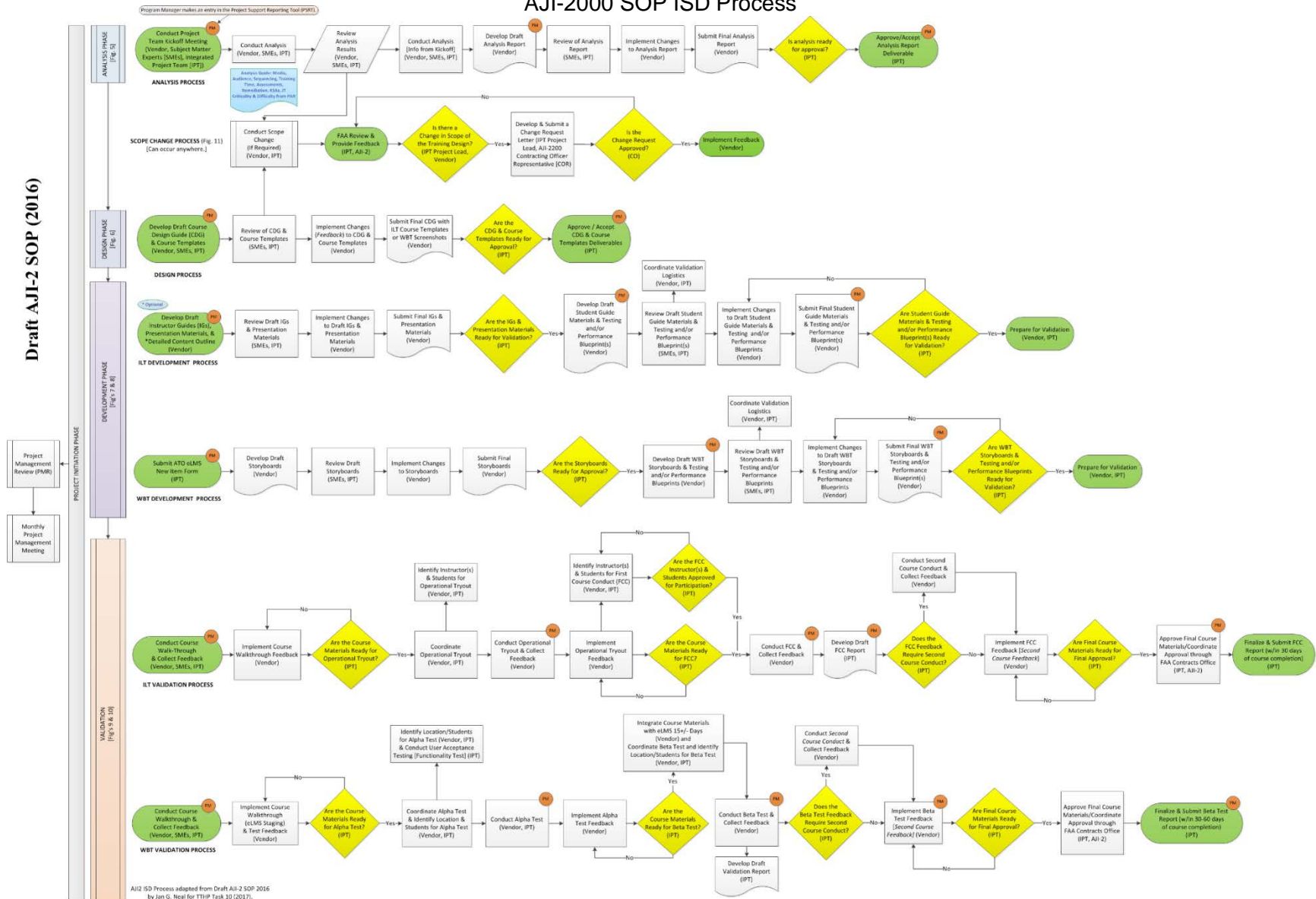
	management support; (d) assists with various other training development tasks associated with a training development project; (e) responsible for ensuring that the Project Status Report Tool is updated and submitted in accordance with prescribed schedule (AJI-2000, 2016b).
Integrated Project Team (IPT)	A cross-matrixed team assigned to a Training Request Form (TRF)/Requirement, made of a Project Lead, AJI-2100 Instructional Systems Specialist (ISS) Lead, AJI-2200 Contracting Officer Representative (COR), and AJI-2300 Requirements Lead. The AJI-2100 ISS Lead or the AJI-2300 Requirements Lead may be designated as the Project Lead and serve a dual role on the IPT (AJI-2000, 2016b).
JTA (Job Task Analysis)	Part of the Curriculum Architecture documentation that identifies the job tasks performed by controllers and technicians as part of their daily work, how each task should be taught, and in what potential order. For each task, the JTA includes analysis of its difficulty to learn, difficulty to perform, importance, and frequency, and well as the level of proficiency required (FAA, 2014a).
MBI	Mandatory Briefing Item (AJI-2000, 2016b).
OTO (Operational Tryout)	A step in the validation process for training materials (FAA, 2000). Delivery of training as intended for target audience, but allowing learners the opportunity to comment on each lesson. The purpose is to resolve any remaining problems, such as time allocation for lessons, logistics associated with delivery, sequence of training within and between lessons or modules, check of previous corrections, achievement of outcomes and objectives, and validity of test items. Provides instructor orientation to materials and methods and allows other stakeholders to review [<i>precedes First Course Conduct in Validation process</i>] (FAA, 2014a).
Order 3000.22A	This order applies to all national ATO technical training. Each ATO job specialty has a training order that specifies training requirements for that workforce to achieve certification in the respective job. National training for each specialty must comply with that specialty's training order as well as with any relevant bargaining agreements (FAA, 2014a).
PTT (Part Task Training)	Equipment training provided through the physical mock-up of specific elements of the real equipment. (FAA, 2013b)
Phase, Analysis	This is the foundation for all other phases of instructional system design. All instructional programs must be planned and developed so as to assure that stated training requirements are fulfilled satisfactorily and on a cost-effective basis. Training must be operationally oriented and job-centered and designed to achieve the outcomes specified in the TIR, TASA/JTA, and TDP. All planning, development, presentation, and testing must be based upon the trainee's need, improved efficiency, and job specific effectiveness (FAA, 2009).
Phase, Design	This involves using the products from the Analysis Phase to plan a strategy for developing training. The CDG provides an outline for development or revision of a course. It includes the goals and/or outcomes for the course, the skills and knowledge to be provided

	to employees, and the methods and techniques to be used in the conduct of the course. All information needed to develop the course, including objectives, testing techniques, tools and equipment, teaching strategies, and content are outlined (FAA, 2009).
Phase, Development	This phase builds on the Analysis and Design Phases to generate all required training materials and evaluation of the final developed products. The course developer should design the course to provide the knowledge and skill levels necessary for progression to the technical specialist's full performance level. The types of course development or revision include new course development, major revision to an existing course, and conversion of a course to a new delivery media (FAA, 2009).
Phase, Evaluation	This phase measures the effectiveness and efficiency of the instruction. The Tech Ops Training and Dev Group must conduct both formative and summative evaluations (FAA, 2009).
Phase, Implementation	This is the actual delivery of instruction, including classroom, laboratory, CBI, ATN (formerly interactive video teletraining), correspondence, OJT, or any combination of these methods. This phase must promote the employee's understanding of material, support mastery of objectives, and support the transfer of knowledge to the job setting. This phase represents the final product, which is a completed course (FAA, 2009).
PM	Project Manager (FAA, 2014a).
PAR (Preliminary Analysis Report)	A document providing information about training, including a job task listing, a Difficulty/Importance/Frequency (DIF) analysis and proficiency requirement for each of the tasks, and a list of other courses that address a specified topic (AJI-2000, 2016a).
Proficiency Training	Training conducted to maintain and update the knowledge and skills necessary to apply air traffic procedures in a safe and efficient manner. This training includes Recurrent, Refresher, Supplemental, and Skill Enhancement (FAA, 2013b).
Project Management Team	This team, comprised of Project Management Support, reports to AJI-2200 and is responsible for providing project management oversight across all AJI-2000 training efforts. The purpose is to provide consistent oversight and ensure that cost, schedule, and milestone requirements are monitored and met (AJI-2000, 2016b).
Recurrent Training (Web-Based Recurrent Training, WBRT)	Collaboratively-developed national safety training delivered via electronic means, instructor-led presentations, or any combination thereof (FAA, 2013b).
Requirements Lead	An AJI-2310 2320/2330 representative, appointed by AJI-2300 management, who (a) leads technical requirement tasks; (b) identifies and provides Government Furnished Information (GFI), as appropriate; (c) ensures technical accuracy of course content, including text, graphics, and animation; (d) assigns Course Owner; (e) coordinates SME and facilities support; (f) works with Labor Relations to approve SME selection; (g) coordinates student enrollment and instructor selection for course Operational Tryout and First Course Conduct (FCC); (h) assists with various other tasks associated with a training development project; and (i) responsible for ensuring that the Project Status Report Tool is

	updated and submitted in accordance with prescribed schedule (AJI-2000, 2016b).
ROM (Rough Order of Magnitude)	An estimate that must be produced quickly with little time for detailed analysis. This estimate relies heavily on analogy of similar system costs and subject matter expert opinions. Well suited for budgetary planning wedges or "What If" type exercises (FAA, 2000).
SAT	Systematic Approach to Training
SCC (Second Course Conduct)	If the AJI-2000 Director determines a SCC is necessary because feedback from the FCC indicated significant changes to the course materials are necessary, the procedure for scheduling the logistics and running the FCC is repeated (AJI-2000, 2016a).
SET (Skill Enhancement Training)	Training designed to improve an individual's knowledge, skills, and abilities (FAA, 2013b).
SOJT	Structured On the Job Training: Employee training at the place of work while he or she is doing the actual job (FAA, 2013b).
STNA	Strategic Training Needs Assessment (FAA, 2016a).
SME (Subject Matter Expert)	This person (a) identifies and provides Government Furnished Information (GFI), (b) ensures the technical accuracy and relevance of course content, including text, graphics, and animation; (c) provides comments and necessary changes to modules within the required project schedule; (d) ensures that content is at the appropriate level for the target audience, does not contain any unneeded information, and is directly related to the development of required job skills (AJI-2000, 2016b).
Technical Training	Instruction intended to prepare employees to perform the tasks specific to their job using applicable tools, equipment, and processes within the air traffic controller and technical operations technician workforces (FAA, 2014a).
Validation	A process where premises are set and from which conclusions can be drawn (FAA, 2000). The process through which instructional designers and technical content personnel verify instructional materials and associated documentation are complete, accurate, ready for delivery, and are effective, adequate, and acceptable to the learners (FAA, 2014a).
Vendor	FAA contract support are the various contract representatives who are responsible for directly supporting Technical Training by performing training analysis, design, development, and other tasks in accordance with their contract(s) (AJI-2000, 2016b).
WBT (Web-Based Training)	Comprises all forms of electronically-supported learning and teaching. The technology communication system, whether networked or not, serves as a specific media device to implement the learning (eLearning, computer-based instruction, etc.) (FAA, 2013b). On-demand instruction where instructional content is stored on a server and accessed across a distributed electronic network (FAA, 2014a).
Workshop	A structured training event designed for a particular target audience (FAA, 2014a).

Appendix C

AJI-2000 SOP ISD Process



REDACTED FOR PUBLIC DISSEMINATION

APPENDIX D
REDACTED

APPENDIX E

REDACTED

Note. REDACTED.

Appendix F

JO 3000.22A Requirements Checklist for Technical Training

Order 3000.22A, Air Traffic Organization Outcomes-Based Technical Training, prescribes the requirements for the design and development of technical training for the Air Traffic Controller and Technician workforces. The order specifies the conditions for validating a course (or workshop [optional]) in the following 7 criteria that must be met:

1. Materials are developed in accordance with the course design guide.
 2. Materials are developed in accordance with specified formats or other requirements.
 3. *Instruction is complete and accurate.
 4. Instruction is effective (meaning that evaluators determine that learners are able to demonstrate through measurable skills or written tests that they can perform the outcomes).
 5. The instruction is adequate (meaning that learners and others who evaluate the training believe it is adequate preparation to enable the learner to perform their job duties or proceed to the next stage of training).
 6. The instruction is accepted by learners (meaning that learners do not find that the presentation of the instruction objectionable or that it interferes significantly with learning the material).
 7. Tests are valid and reliable and have appropriate integrity
- *Criteria #3 is determined by the technical accuracy of the content – not a design or development factor. This is verified by the training requirements office.*

The following checklist is used to indicate whether these bare-minimum requirements from order 3000.22A have been met in a training product:

- Indicate “Y” for yes – that a product fully meets the requirement
- Indicate “N” for no – that a product predominantly does not meet the requirement
- Indicate “P” for partial – that a product partially meets the requirement (at least 75%)

The comments at the end can make recommendations based on best practices and additional guidance found in Technical Training guidance documents and templates.

3000.22 A	Requirement	Validation Criteria	Met?
3-2, a	The job tasks from the Curriculum Architecture (CA) Job Task Analysis (JTA) ... must for the basis of training.	1) CDG	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y N P
3-2, b	Each course or workshop must be traceable to the job tasks or associated knowledge, skills, and abilities found in the CA JTA.	1) CDG	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y N P
3-2, k	...must follow a standard Instructional Systems Design approach (see Chapter 4) for a detailed description) and ensure development of specified training documentation, unless waived.	1) CDG	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y N P
3-4, b	The Course Design Guide must include the testing strategy [with rater reliability plan, weighing of scores, remediation]	1) CDG	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y N P
4-4, b	There must be a CDG for every course and workshop [which must be updated as changes are made to the design of the training] – [includes outcomes, objectives traceable to job tasks, testing strategy, topics, associated resources, instructional strategies, and media choices]	1) CDG	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y N P
3-2, g	No copyrighted material will be used without written permission.	2) Formats	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y N P
3-2, i	Electronically accessed content meets Section 508 requirements	2) Formats	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y N P
3-2, d	...web-based technical training ... must build the content interactivity within the requirements for levels of interactivity.	2) Formats	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y N P
3-2, e	...technical training simulation ... must build the simulation within the fidelity definitions.	4) Effective	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y N P
3-4, a	All objectives must be tested. Tests must measure objectives at a level appropriate for the objective.	4) Effective 7) Testing	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y N P
1-10, a	(Congressional Restrictions) ...identified needs for knowledge, skills, and abilities bearing directly upon the performance of official duties.	5) Adequate	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y N P
3-2, c	Instructional strategies, including the use of simulation, must be appropriate to the associated objective and job task being taught.	5) Adequate	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y N P
1-10, c	(Congressional Restrictions) ...require prior employee notification of the content and methods to be used in the training and written end of course evaluation.	6) Acceptable	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y N P
3-4, c	All tests will have a test blueprint [with alignment of test items to objectives, correct responses, assessment tools or performance standards]	7) Testing	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y N P
3-4, e	...ensure all test scores are recorded in a manner that allows for future item analysis	7) Testing	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y N P
3-4, g	All tests must be shown as valid as part of the training validation and reliable for subsequent evaluations [one that accurately measures the learners' performance as identified in the job tasks]	7) Testing	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Y N P

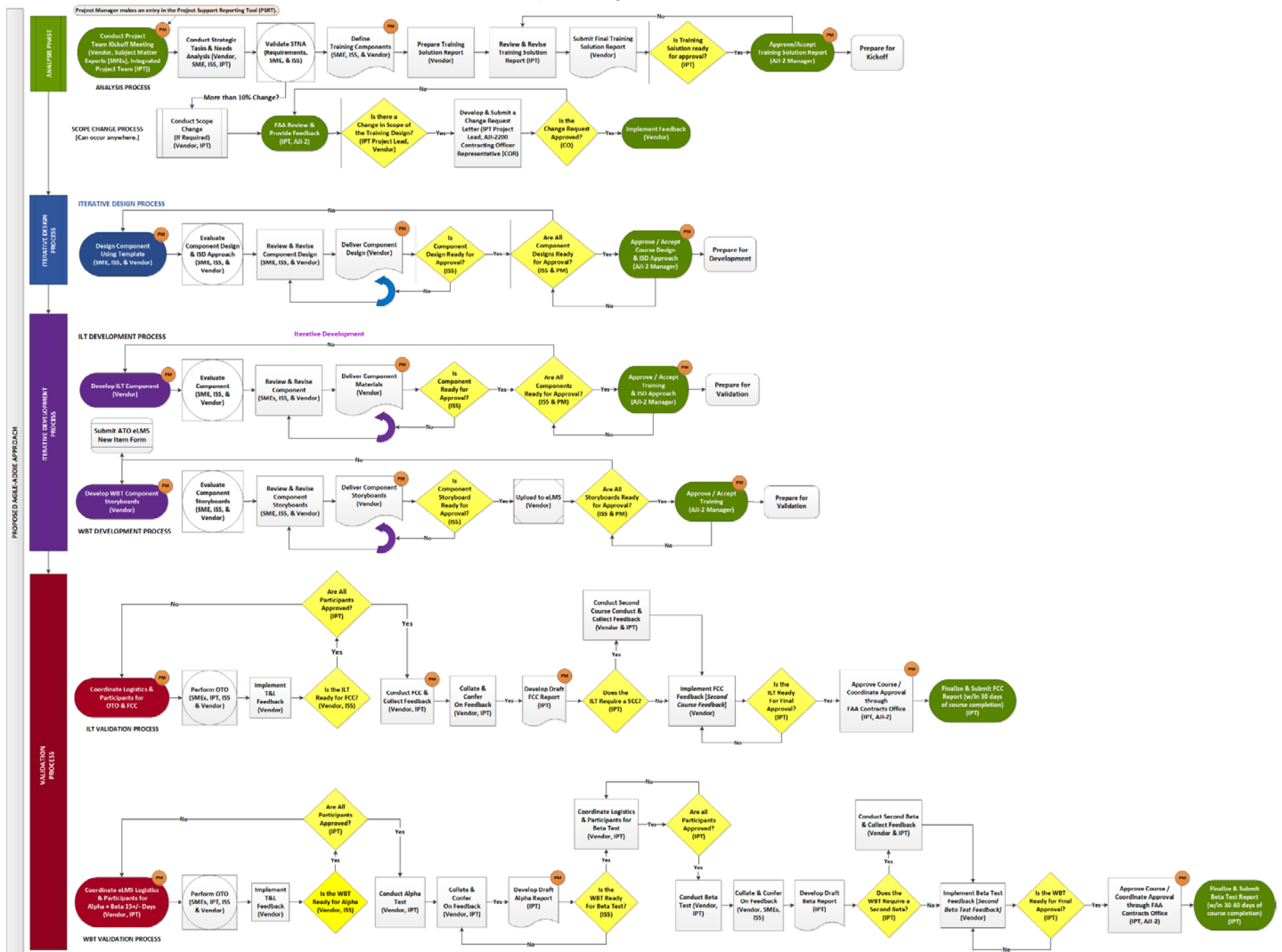
Appendix G

REDACTED

[illegible]

Note. REDACTED.

Appendix H Proposed Agile AJI-2 Process



Appendix I

Researchers' Biographies

Steven Hampton (PI), Nova University, has over 40 years of experience in aviation higher education. He has supported NASA programs (AGATE and SATS) focusing on training curriculum needs for the general aviation pilot and led the FAA's Center of Excellence for General Aviation (CGAR) for 13 years. Dr. Hampton is currently a faculty member at Embry-Riddle in the School of Graduate Studies.

Jan Neal (Co-PI) has a Master of Science degree in Aeronautics with dual specializations in Education Technology and Safety from ERAU. Her experience includes over 20 years in industry as a respected author, instructor, instructor trainer, and curriculum developer. She is the lead instructional designer for the Ph.D. in Aviation program in the School of Graduate Studies at ERAU and has designed, built, and updated hundreds of Worldwide online courses in Blackboard® and Canvas®, and has won seven Blackboard® Catalyst awards for exemplary course design.