Designing and Implementation of a Capstone Jet Transition Course in Collegiate Aviation Flight Program Curriculum

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ABSTRACT

Advanced regional jet simulators, specifically the Bombardier and Embraer series, have grown in popularity within the collegiate aviation world over the last two decades. Curricular and program applications for these simulators made way for improvements to advanced systems and crew resource management (CRM) courses, academic research, and student recruiting. At the same time, U.S. airlines, especially at the regional level, encouraged jet transition training for collegiate aviation students entering their domain. Additionally, collegiate aviation programs accredited by Aviation Accreditation Board International (AABI) must have a culminating upper-division experience in flight education, which may include a capstone course. Collegiate aviation programs could now create a capstone course using these jet simulators. Using a regional jet simulator in a capstone course would allow a program to evaluate pilot skills and assess aeronautical decision-making in a crew environment. It would allow a collegiate aviation program to assess its program goals and student learning outcomes and prepare students for the next phase in their aviation career. This paper discusses designing and implementing a capstone jet transition course using a regional jet simulator in collegiate aviation.

Keywords: Jet Transition Course, CRM, Capstone Course, Curriculum, Collegiate Aviation

INTRODUCTION

The Boeing Commercial Outlook for 2022-2041 forecast a market value of $7.2 trillion for new airplane deliveries, with the global fleet increasing by 80% through 2041, which constitutes 40,000 new aircraft **deliveries** in the he global air transportation system (Boeing. 2022). The Airbus Global Market Forecast for 2022-2041 also predicts similar numbers with a demand for 39.490 new passenger and freighter aircraft over the next 20 years, of which 31.620 typically Single Aisle and 7.870 typically Widebody. Airbus GMT forecasts that demand for passenger traffic will grow annually by 3.6% (2019-2041 CAGR - Compound Annual Growth Rate) over the next 20 years (Airbus, 2022).

Twenty years ago, The FAA was forecasting major growth in domestic routes with a 4.9% annual growth rate in passengers from 2003-2013 (FAA, 2002). Understanding the need for bigger airplanes to accommodate this potential growth, Collegiate aviation programs began purchasing and implementing regional jet simulators into their curriculum in the early 2000s. Most programs opted for a fixed-base simulator platform due to their initial cost and footprint. At that time, regional jets were overtaking turboprop aircraft in the regional airline world because of their faster speed, comfort, and positive public perception. Many collegiate aviation programs already had turboprop simulators and applicable curricula but now needed to transition. The University of North Dakota received its first Federal Aviation Administration (FAA)-certified Bombardier Canadair Regional Jet (CRJ) 200 Flight Training Device (FTD) from Aerosim-Mechtronix in 2003 (NIFA SAFECON, 2022). Jacksonville University in Jacksonville, Florida, purchased their Level 5 FTD of a CRJ 700 in 2013.

With the regional airlines moving away from turboprops to jet aircraft, collegiate aviation students would go from flight training in a light twin-engine airplane flying below 10,000 feet and 165 knots to flying regional jets at 37,000 feet and over 400 knots. Collegiate aviation programs changed existing senior-level turboprop aircraft systems courses to teach regional jet systems but now needed a new experiential course to bridge the divide between low-and-slow and high-and-fast.

Collegiate aviation programs began to develop jet transition training courses. These courses were designed to bridge the flight training gap for their students. In addition, for those aviation programs accredited by Aviation Accreditation Board International (AABI), these courses could be used as an upper-division culminating experiential learning capstone course. AABI, recognized by the Council for Higher Education in the early 2000s, established program criteria for flight education (Aviation Accreditation Board International, 2022). According to the AABI Accreditation Criteria Manual, Program Criteria for Flight Education 5.5.2, each program must provide a significant culminating upper division flight education experience, which could include a capstone course (Aviation Accreditation Board International, 2022). Jacksonville University, one of thirty-one four-year AABI accredited institutions, launched its new capstone jet transition course using its Level 5 CRJ 700 FTD in 2013.

CURRICULUM PATH TO THE JET TRANSITION COURSE

Before implementing the capstone jet transition course, Jacksonville University had a robust flight operations curriculum. Students began flight training and relevant ground courses in the first semester of their first year. Before taking the capstone jet transition course, students should have completed their commercial multi-engine certificate. This way, students have had

the instrument and commercial ground schools, which include aeronautical knowledge areas such as instrument procedures and multi-engine aerodynamics and operations.

In addition, students started stand-alone aircraft systems courses scheduled appropriately during their degree plan (Appendix A, Figure 1). Students would take three systems classes before taking the capstone course. The first systems course, taken their first year, taught single-engine, technically advanced aircraft, and glass cockpit systems. This class was done concurrently during instrument flight training. The second systems course, taken in their third year, taught transport category aircraft systems using the Boeing 777 as the platform aircraft. Here students would learn the foundational principles of jet aircraft systems. This systems course is paramount for student rote memory and retention of key terms and major aircraft systems operations. In the third and final jet systems course taken prior to the capstone jet transition course, students learn the systems of the CRJ 700, the simulator they are to use for the capstone course. Normal and abnormal system operation, power-on, Auxillary Power Unit (APU) and engine starts, Flight Management Systems (FMS) usage, and checklist and flows should be incorporated into this course.

Also, before the capstone jet transition course, students took a crew resource management (CRM) course. This course introduced crew coordination, workload management, aeronautical decision-making (ADM), critical thinking, and human error management (Jacksonville University, 2022).

See Appendix B for a list of course descriptions for systems and CRM courses.

CAPSTONE JET TRANSITION COURSE DESIGN

The capstone jet transition course was designed as a 2-credit hour, 8-week course. The course was also slotted for only two students. This allowed for a maximum amount seat time for each student each lesson. Four hours a week with two hours for each student as the pilot flying and pilot monitoring. The course was divided academically into two 4-week sections and taught by an instructor with previous FAA 121 regional airline experience. Lessons with evaluation and assessment were conducted by an designated check instructor with FAA 121 line check-airmen experience.

The foundational principles of the course were built on Advanced Qualification Program (AQP). AQP came to the forefront of FAA 121 Air Carrier flight crew training in the 1990s after a series of accidents which were crew caused (Weitzel, 1992). In addition to the skills of flight training, AQP provides additional training safety benefits including integration of CRM; crew evaluation; and scenario-based training (Federal Aviation Administration, 2022). Elements of AQP training such as the Maneuvers Validation (MV) and Line Operational Evaluation (LOE) were added as evaluation and assessment lessons into the capstone course.

The first four-weeks of the course were designed for students to learn to fly the airplane while on schedule towards a MV at the end of week four. Emphasis was placed on basic attitude instrument (BAI) flying and flying the airplane at the lowest level of automation. The lowest level of automation is no autopilot or flight director. Higher levels of automation, which included flight director and autopilot were added later. This gave students confidence in hand-flying the airplane, and if automation failed later, then they felt comfortable hand-flying the airplane.

Also, during the first four-weeks students were training on normal takeoff profiles, high altitude maneuvers such as steep turns and stalls, and Instrument Landing System (ILS) landing and missed approach profiles. Simulator “Snaps”, where the simulator could be repositioned into

various phases of flights would be used for lesson efficiency. Students needed to gain proficiency in each maneuver to FAA Commercial Airmen Certification Standards (C-ACS). Half-way through the four-hour lesson, students would change seats to get experience in the previously stated maneuvers and profiles as pilot flying and pilot monitoring. Incorporated in the first four-weeks was a demo lesson where students would see and do high-altitude aerodynamic demonstration, constant-angle non-precision approaches, GPS approaches, no-flap landings, and visual approaches. At the end of week four students would conduct the MV with a check-instructor.

After the maneuvers validation, students and the instructor would discuss who would occupy each seat for the rest of the semester. Students already knew how to fly the airplane, so In the remaining four-weeks, students would conduct scenario-based flights and remain either as pilot flying or pilot monitoring. Scenario-based flights consisted of real-time flights that began at the gate with a flight plan to another airport. Students would go through the crew resource management aspect of flight which included running checklists, crew briefings which brought in threat and error management (TEM), crew coordination and communication with flight attendants, dispatch, and the passengers. During each flight, an abnormal scenario such as a passenger medical emergency, abnormal systems issue, in-flight fire, and more were given to the crew. Instruction on the ADM were provided in support of each scenario. Incorporated into the remaining lessons were additional demonstrations on aborted take-off, crew-member incapacitation, and aircraft evacuation. At the conclusion of week eight, students would conduct the LOE with a check-instructor.

CAPSTONE JET TRANSITION COURSE STUDENT EVALUATION AND ASSESSMENT

The capstone course had two lessons for graded evaluation and assessment, the MV and LOE at a scale of 50% each. Pilot skill would be evaluated against the FAA C-ACS. Crew ADM would be assessed on a 4-point rubric scale. AABI program assessments would be incorporated into the graded lessons.

At the end of the first four-weeks, students conducted the MV. The objective for the lesson was to evaluate the pilot's flying skills during maneuvers and profiles with varying degrees of automation usage. CRM and TEM would be assessed to a degree during flight profiles. The lesson would be conducted by a designated check instructor. A 4-point rubric with FAA C-ACS was incorporated as the grading scale (See Appendix D). Once again, simulator "Snaps" were used to reposition the aircraft for various profiles. This improved lesson proficiency and allowed both students to serve as PF and PM.

At the end of the week eight, students would conduct the LOE. The objective for this lesson was to assess and apply advanced aircraft systems knowledge to perform normal and abnormal systems procedures and demonstrate applied crew resource and TEM skills during crew operations in the jet simulator. The lesson would be conducted by a designated check instructor (See Appendix D).

Grades from Spring 2015 to Fall 2018 from the MV and LOE remained consistent with an average score of 82.7% on the MV with 27 grades reported and 81.3% on the LOE with 27 reported.

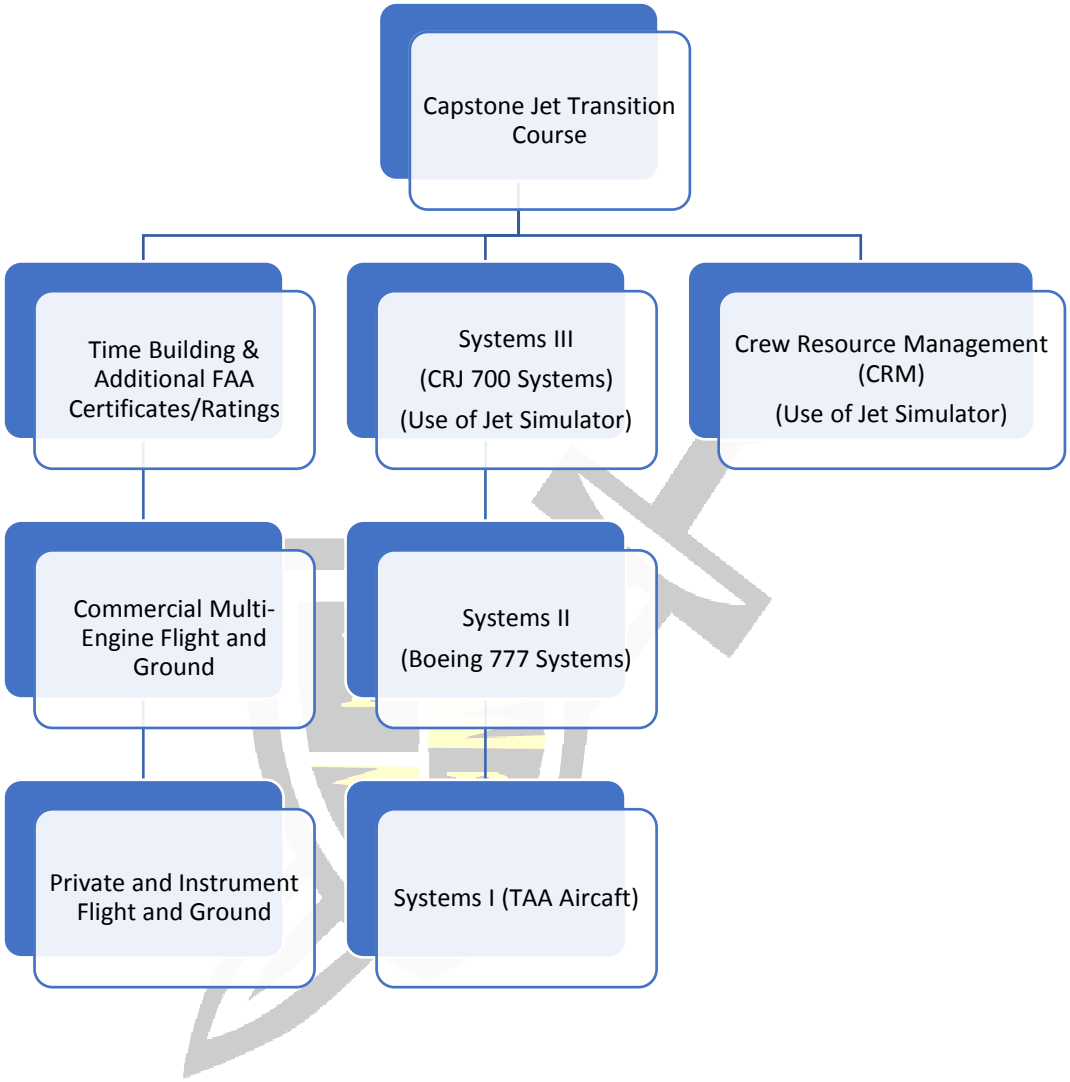
CONCLUSION

The designing and implementation of a capstone jet transition course for a collegiate flight program not only served as an accrediting course for curriculum but provided valuable information for program assessment. End-of-program evaluation of pilot skill showed flight deficiency in attitude instrument flying from instrument rating flight course. ADM assessment revealed crew coordination issues with aircraft limitations and considering suitable alternate airports. Systems knowledge assessment revealed a lack of understand of automation flight control panel inputs. Outside variables were found and considered such as students not being Part 91 instrument current and students who were behind in flight training and not working on their commercial multi-engine certificate.

It was determined that additional emphasis on BAI needed to be added to our instrument ground course, and additional FMS instruction was needed in our systems classes. As far as program assessment, the capstone course led to the creation of a new course designed to teach regulations and operations of FAA 121 environments. Also, that better student tracking of flight training was needed to ensure students kept pace with their ground and systems courses and flight training. These findings would not have been possible except for the creation of a capstone jet transition course. It's important for collegiate flight programs to consider the creation of such course to measure final student and program success or weakness in the areas of flight training and ADM.

APPENDIX A

Figure 1. Curriculum Path to Capstone Jet Transition Course



APPENDIX B

Jacksonville University Systems and Crew Resource Management Course Descriptions
Note: The following course descriptions come from the Jacksonville University 2019/2020 Academic Catalog (Jacksonville University, 2022)**.**

Introduction to Aviation Automation (Systems I) (3 credit hours)
Course introduces students to advanced automation, primary aircraft systems, and error management for the single aviator flight environment

Advanced Aircraft Systems II (3 credit hours)
Additional advanced studies of jet aircraft systems currently in use in the air carrier industry focusing exclusively on one specific type of transport category aircraft. Students will cover in detail aircraft systems and procedures primarily through the medium of computer-based training (CBT) using courseware obtained from the aircraft manufacturer.

Advanced Aircraft Systems III (3 credit hours)
The student will participate in advanced studies of aircraft systems in use on current generation (cutting edge) transport category aircraft. Topics will include glass cockpit, flight management systems, radar, aerodynamics, abnormal procedures, and all systems relating to modern- day jet aircraft. The course familiarizes a student with the basic technical knowledge needed to be successful in traditional airline pilot training courses. This course will include the use of an Advanced Flight Training Device (FTD).

Crew Resource Management (3 credit hours)
The study of psychological factors that affect the efficiency and safety of flight. The course emphasizes airline cockpit crew coordination, situational awareness, communication, workload management, decision-making, automation management, critical thinking, and human error management. This course will include the use of an Advanced Flight Training Device (FTD).

Jet Transition Training Laboratory (2 credit hours)
Capstone course for Flight Operations majors. The application of advanced systems knowledge and crew resource management skills in the operations of a jet aircraft. This course will also give students an understanding of FAA Part 121 regulations, high altitude flight theory, and advanced aerodynamics. The advanced Flight Training Device (FTD) and Flight Management Systems Trainer (FMST) will be used exclusively for this course.

APPENDIX C

Jacksonville University Capstone Jet Transition Course Syllabus

AVO 432 Jet Transition Training Lab
8-week course

Course Description:
The application of advanced systems knowledge and crew resource management skills in the operation of a jet aircraft. This course will also give students an understanding of FAA Part 121 regulations, high altitude flight theory, and advanced aerodynamics. The advanced Flight Training Device (FTD) and Flight Management Systems Trainer (FMST) will be used exclusively for this course.

Prerequisites: Senior status; AVS 432 and AVM 407. Capstone course for AVO majors.

Course Objectives:
Students will obtain the necessary aeronautical knowledge and instructional background on flying a modern advanced jet aircraft in a crew environment and will meet the requirements for jet transition training per our airline agreements.

General Program and Aviation Core Outcomes:
The following student learning outcomes will be addressed to AVO majors in AVO-432
Taught: 1A, 1B, 1C, 1D, 1E, 1F, 1G, 1H, 1I, 2C, 3D, 4A, 4B, 4D, 4E, 4F
Assessed: 1J (Apply advanced aircraft systems knowledge to perform normal and abnormal systems procedures in a current generation transport category aircraft);
4G (Demonstrate applied resource and error management skills during crew operations in a current generation transport category aircraft)

Text Books and Equipment:
Required:
1. Access to Flight Management System Trainer (FMST) in aviation lab - FREE
2. Jeppesen Instrument Charts and Approach Plates (See instructions on Blackboard)
3. CRJ 700 Flight Deck Posters – Found in Bookstore

Grading Scale:
For the purpose of computing your Jacksonville University grade, only first attempt test scores will be considered. Jacksonville University letter grades will be computed as follows:
A 90-100 B 80-89 C 70-79 D 60-69 F ≤59
(+ or – may be awarded as per JU grading policies)

- Flight Skills will be evaluated using the Commercial Pilot Airmen Certification Standards (ACS)
- Decision Making will be assessed on a four-point rubric scale

Grading Policies:
The principles of Advanced Qualifications Program (AQP) will be used for course evaluation and assessment. The goal of AQP is to achieve the highest possible standard of individual and crew performance. A leading objective of AQP is to provide effective training that will enhance professional qualifications to a level above the present standards. In order to achieve this goal, AQP seeks to reduce the probability of crew-related errors by aligning training and evaluation requirements more closely with the known causes of human error.
Maneuvers Validations: 50%
Line Operational Evaluation: 50%

Course Outline:

Week 1	**Lesson 1***	**Normal Takeoff Profile/Maneuvers/ILS Profile**
Week 2	**Lesson 2***	**‘’ ‘’**
Week 3	**Lesson 3***	**‘’ ‘’**
Week 4	**Lesson 4***	**Maneuvers Validation (MV)**
Week 5	**Lesson 5***	**ATL – MCO**
Week 6	**Lesson 6***	**ATL – JAX**
Week 7	**Lesson 7***	**DEN – SLC**
Week 8	**Lesson 8***	**Line Operational Evaluation (LOE)**

***Refer to detailed lesson descriptions in Blackboard**

APPENDIX D

Jacksonville University Jet Transition Training Lab Evaluation and Assessment

AVO 432 Jet Transition Training Lab AVO Capstone Course Evaluation and Assessment

Overview:
The following student learning outcomes will be addressed to AVO majors in AVO-432
Taught: 1A, 1B, 1C, 1D, 1E, 1F, 1G, 1H, 1I, 2C, 3D, 4A, 4B, 4D, 4E, 4F
Assessed: 1J (Apply advanced aircraft systems knowledge to perform normal and abnormal systems procedures in a current generation transport category aircraft);
4G (Demonstrate applied resource and error management skills during crew operations in a current generation transport category aircraft)

Lessons 1 — 4 (Maneuvers Training)
Maneuvers training consists of maneuvers SNAPS designed to teach maneuvers in an environment that permits repetition and immediate feedback. Maneuvers will be evaluated to Commercial Pilot Airmen Certification Standards.

Components

- Normal/Crosswind Takeoff
- Basic Attitude Instrument Flying (RAW DATA)
  - Straight-and-Level Flight
  - Climbs and Descents (included with turns at the instructor's discretion)
  - Standard Rate Turns
  - Acceleration and Deceleration
- Steep Turns (RAW DATA)
- ILS Approaches (two-engines) (one with FD ONLY; one RAW DATA)
- Normal/Crosswind Landing

Maneuvers Validation – At the end of the maneuvers training segment, the student will be able to perform all the required maneuvers and approaches. The student will be capable of satisfactorily completing the Maneuvers Validation (MV) at the end of this segment. MV will evaluate the AVO pilot's skill to Commercial Pilot Airmen Certification Standards.

Lessons 5 — 8 (Line Operational Training)
Line operational training consists of line operational scenarios, including normal and non-normal operations in a line environment. In addition, advanced maneuvers will be introduced. The student will be taught to incorporate aircraft systems knowledge, maneuvers, procedures as well as Threat and Error Management in a "real time" environment that prepares the student for line flying.

Line Operational Evaluation – At the end of this simulator training curriculum segment the student will be able to satisfactorily complete the Line Operational Evaluation (LOE). LOE will

assess the AVO pilot's decision making in a crew operation and knowledge of advanced aircraft systems with normal and abnormal scenarios. A four-point rubric scale will be used for assessment.

Maneuvers Validation

Lesson Objective

The objective for this lesson is to evaluate the pilot's flight skills during maneuvers and profiles with varying degree of automation usage. CRM and TEM will be assessed to a degree during profiles. The lesson will be conducted by a Designated Check Instructor.

Lesson Content

Normal/Crosswind Takeoff

Basic Attitude Instrument Flying (B.A.I) – accomplished without automation (NO FD OR AP)

- Straight-and-Level Flight
- Climbs and Descents (included with turns at the instructor's discretion)
- Standard Rate Turns
- Acceleration and Deceleration

Intercepting/ Tracking Navigation Aids (FMS & Raw data)

Steep Turns

ILS Approach (RAW DATA to Landing)

ILS Approach (with FD/No AP to Missed Approach)

Normal/Crosswind Landing

Grading

	A	**B**	**C**	**D**
Lesson Items	**4**	**3**	**2**	**1**
Normal/Crosswind Takeoff				
Basic Attitude Instrument Flying				
• Straight-and-Level Flight				
• Climbs and Descents				
• Standard Rate Turns				
• Acceleration and Deceleration				
Intercepting/ Tracking Navigation Aids (FMS & Raw data)				
Performance Maneuver				
• Steep Turns				
Approaches				
• ILS Approach (RAW DATA to Landing)				
• ILS Approach (With FD; NO AP to Missed Approach)				
Normal/Crosswind Landing				
CRM				

• Crew Resource Management and Threat Error Management				
• Normal Checklist Usage				
48 Total				

Rubric Scale- Evaluating Pilot Skill
4 = A (Consistently aviates aircraft well within ACS standards and operational profile)
3 = B (Aviates aircraft at ACS standards and operational profile)
2 = C (Slightly Deviates from ACS standards and/or operational profile but corrects)
1 = D (Consistently exceeds ACS standards and/or operational profile with no correction)

Rubric Scale- Assessing CRM
4 = A (Consistent Satisfactory Knowledge of Aircraft Systems and CRM TEM Skills)
3 = B (Threat to Aircraft Systems or CRM not identified)
2 = C (Error – Aircraft Handling, Procedural, Communication Error with Aircraft Systems and/or CRM TEM Skills)
1 = D (Management – Undesired Aircraft State)

Line Operational Evaluation

Lesson Objective

The objective for this lesson is to assess and apply advanced aircraft systems knowledge to perform normal and abnormal systems procedures and demonstrate applied crew resource and TEM skills during crew operations in a current generation transport category aircraft. This lesson will be used as final assessment for AABI accreditation SLO 1J and 4G. The lesson will be conducted by a Designated Check Instructor.

Lesson Content

Normal/Crosswind Takeoff
IFR Departure/Climb
Abnormals (Systems or Flight Operations)
FMS Operations/Usage
FMS Operations/Usage
Descent/Arrival
Instrument Approach (ILS or Non-Precision)
Normal/Crosswind Landing

Grading

	A	**B**	**C**	**D**
Lesson Items	**4**	**3 (T)**	**2 (E)**	**1 (M)**
Ground Operations (prior to takeoff)				
Normal/Crosswind Takeoff				
IFR Departure/Climb				
FMS Operations/Usage				
Abnormals (Systems or Flight Operations)				
Descent/Arrival				
Instrument Approach (ILS or Non-Precision)				

Normal/Crosswind Landing				
Ground Operations (after landing)				
Normal Checklist Operations/Usage				
QRH Checklist Operations/Usage				
Crew Coordination				
Use of External Resources				
52 Total				

Rubric Scale- Assessing CRM

4 = A (Consistent Satisfactory Knowledge of Aircraft Systems and CRM TEM Skills)
3 = B (Threat to Aircraft Systems or CRM not identified)
2 = C (Error – Aircraft Handling, Procedural, Communication Error with Aircraft Systems and/or CRM TEM Skills)
1 = D (Management – Undesired Aircraft State)

- **While the MV evaluated the student pilots flight skills all profiles and maneuvers in the LOE will be flown to Commercial Pilot Airmen Certification Standards**

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