Initial Project and Group Identification Document
UCF Flight Simulator

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Motivation

Many users of home computer flight simulators lack the use of a fully functional realistic cockpit aside from what is seen on the computer screen. Previously this was considered either too difficult, too expensive or too time consuming [1]. While now it is easy for the end user to "build a cockpit" with a few basic instruments connected to a computer it still lacks the feel of actually sitting in an actual cockpit. This is crucial when training a new pilot on the ground. Ground based training simulators are common within commercial aviation, but still remain out of reach financially for the aspiring sport or private pilot. This project is to prove that a realistic (via the use of an actual Aero AT-4 Cockpit) simulator cockpit for ground based pilot training can be built relatively cheaply.

Goals and Objectives

The primary objective for this project is to produce a flight simulator for the (Aero AT4 / GoBosh 700S) aircraft provided by our sponsor Dave.

Function of the Project

The project shall be simple and easy to use with an Instructor Operator Station (IOS) that will enable the user to setup the different parameters for the simulation. These will include Environment, Scenario to run, and any other configuration for the simulator that the sponsor may wish to have implemented.

Flight dynamics and visuals will be provided by Microsoft FSX or X-Plane. This can be done through the FSX SDK which is available for FREE to download. Performance parameters shall be established in the flight simulator as necessary. External view visuals shall also be created.

Out the window view shall be based on a three monitor design (120 degrees field of view). This can also be done with the help of the EST SDK, there is a Camera Configuration part of the SDK. Cameras can be added to aircraft and other objects, and the camera view can

adjusted from a menu option. This will need to be changed to listen to our software. Cameras can be defined that track certain objects, or that move on a fixed course, or that move relative to another object (such as the user aircraft.

I/O shall be USB based for all flight controls and heads down instrumentation. Flight instruments shall be 'analog/servo' based. Placement shall be per the traditional six-pack. Since the sponsor wants to use USB, we may be able to get away with just using simple servo control boards that are controlled through USB. If this proves to be impossible we may need to write our own controller to control each of the servos. The control of these heads down instruments will come from the Microsoft FSX or X-Plane software that is running our model.

Along with the instrument panel there will be joystick control for actually flying the simulator. The actual control of this is not yet known and won't be until we receive more information about the actual cockpit that we are going to use.

Specification and Requirements

Prior to starting the software or hardware we know that the sponsor wants a few trade studies on different parts of the project. First, is X-plane vs. MSFS – (his words) "Conduct a trade study as to which system will best model the actual aircraft (including the adjustment of internal flight-sim parametric data to best suit the flight characteristics of the selected aircraft and which system will best allow a visual representation of the selected aircraft).
Second, is the I/O (interfacing) should also be considered (i.e. ease of access into the token variables of interest)". So these decisions will need to be looked into.

A) Simulation Software
    a. The visuals will be run on a PC using either Microsoft FSX or X-Plane.
    b. Flight dynamics will hopefully be able to be adjusted to mimic the Aero AT4 / GoBosh 700S the aircraft the sponsor wishes to simulate
    c. One or more PCs will be used in a network setting to run the simulation. (2 computers IG and IOS)
    d. The simulation software may need to be fine-tuned and developed for many aspects of the simulation. Microsoft FSX contains an open interface (SDK) that can be used for these:
        i. The flight model of the aircraft (Modeling SDK)
        ii. The database that will be flown in (Terrain SDK)
        iii. The Environment needs to be able to be modified by IOS (Weather SDK)
    e. The simulation PC requires an interface to Microsoft FSX or X-Plane to read data in order to drive the simulator cockpit and to feed back data to control the aircraft (SimConnect SDK)
    f. The IOS which will be remote needs to have a communication interface with the flight simulator computer (IG), for setting up the simulator's various parameters.
        i. Using TCP or UDP depends on our reliability of the messages.
    g. The sound system should use the sound from the FSX or X-Plane piped into the cockpit through speakers unless the sponsor wants something more powerful.
B) Interface
    a. Communication between our program and the Cockpit
        i. If we are using USB controlled servo's then we will need to find these boards, if not we will need to go to an alternate solution

ii. A controller for driving the servo's and also it will need the capability to talk over the USB. This will be more known when we get to talk more with the sponsor.
iii. Any switches in the cockpit can be talked to through some sort of serial communications or any kind of I/O control module this depends on budget and the number of switches that need to be implemented.

b. Keyboard emulators can be used to interface switches to Microsoft FSX. Many commands in Microsoft FSX can be given in a single keystroke or a combination of keystrokes. Interface boards for Microsoft FSX can be used to build cockpit components.
c. Joystick of the cockpit needs to be considered, if USB this will be simple but if there is no USB interface we will need to think about some sort of simple interface for reading in values from the device. Of course this depends on the cockpit and our sponsor.

Possible Interface Solutions

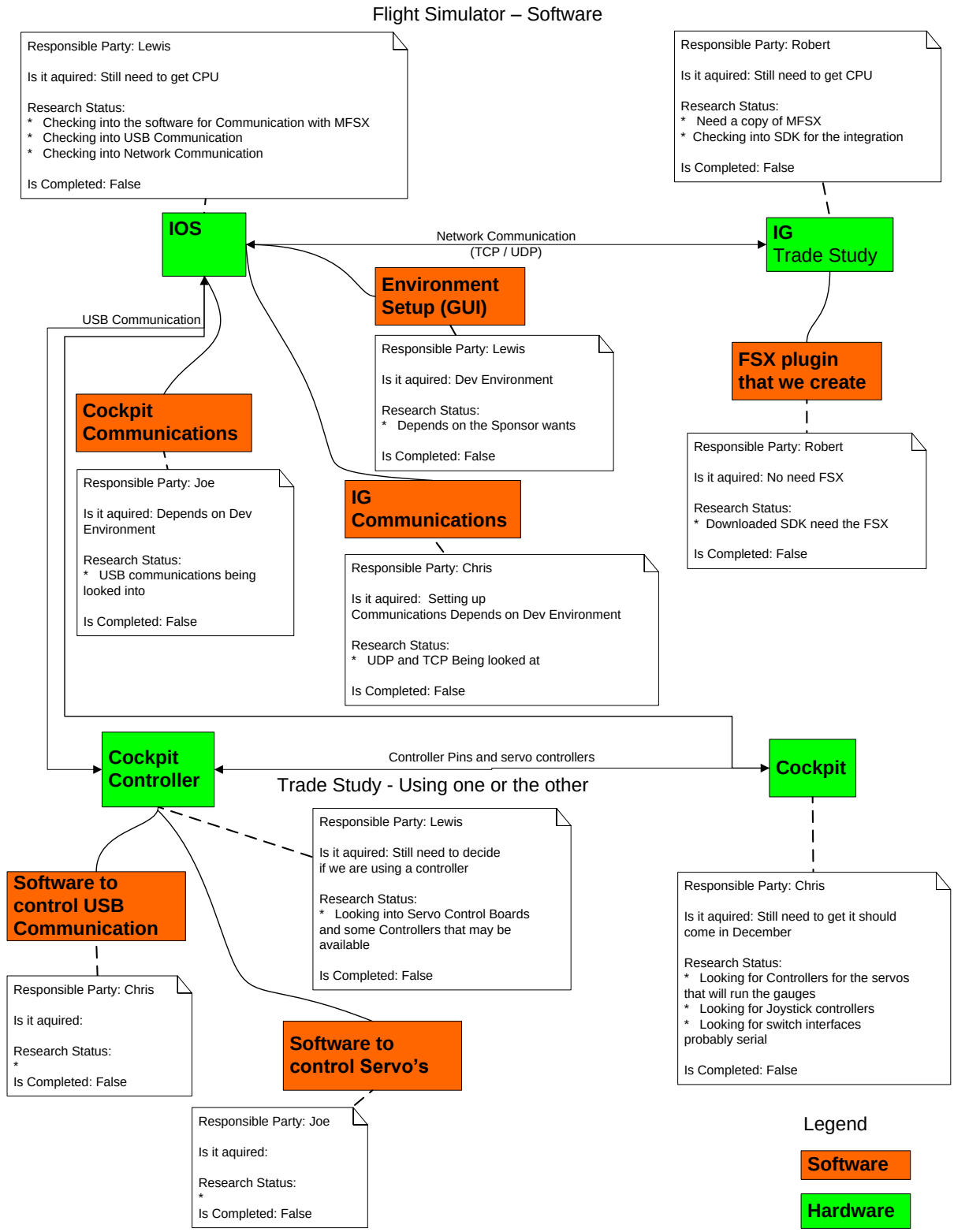
a. EPIC (Extended Programmable Input/output Controller) USB
    i. Contains ability to read the position values of analogs 0 through 15 in approximately 28µs
    ii. Supports bi-directional command and data queuing and can generate hardware interrupts
    iii. Up to 22 analogs (potentiometers can be controlled)
    iv. Up to 255 buttons can be controlled
    v. Includes EPICenter programming enviroment
b. InterfaceIT
    i. Contains the ability to integrate switches and display/LED's to Microsoft FSX
    ii. USB based system
    iii. Main controller contains 70 configurable inputs
    iv. Connection panel can be added to enable easy connection of switches
    v. Rotary Decoder board for conversion of rotary encoders output
    vi. Display Driver board can output to 64 7-Segment displays, 512 individual LED's or any combination
c. IOCards
    i. Interfaces with computer by parallel or USB port
    ii. Contains 72 digital inputs and 64 digital outputs
    iii. Can be setup to control LED displays, controlling relays, A/D converter, encoder circuit, servo motor circuit, stepper motor circuit.
    iv. 4 master cards can be connected to 1 computer.
    v. Can operate in a network setting
d. MJoy
    i. Multifunction plug-and-play USB joystick controller.
    ii. 8 analogue axes inputs, 64 pushbuttons, 16 toggle switches, 4 rotary switches and 1 8-way hat switch are supported.
e. PHCC
    i. Open source hardware and software initiative

ii. Contains analog out, 1024 switches/push buttons, Relays/solenoids, 35 channels analog in, unlimited 8bit digital for 7 segment displays, stepper control via H-bridge drivers, character LCD Displays, lamps/Korry switches and indicators, servos.

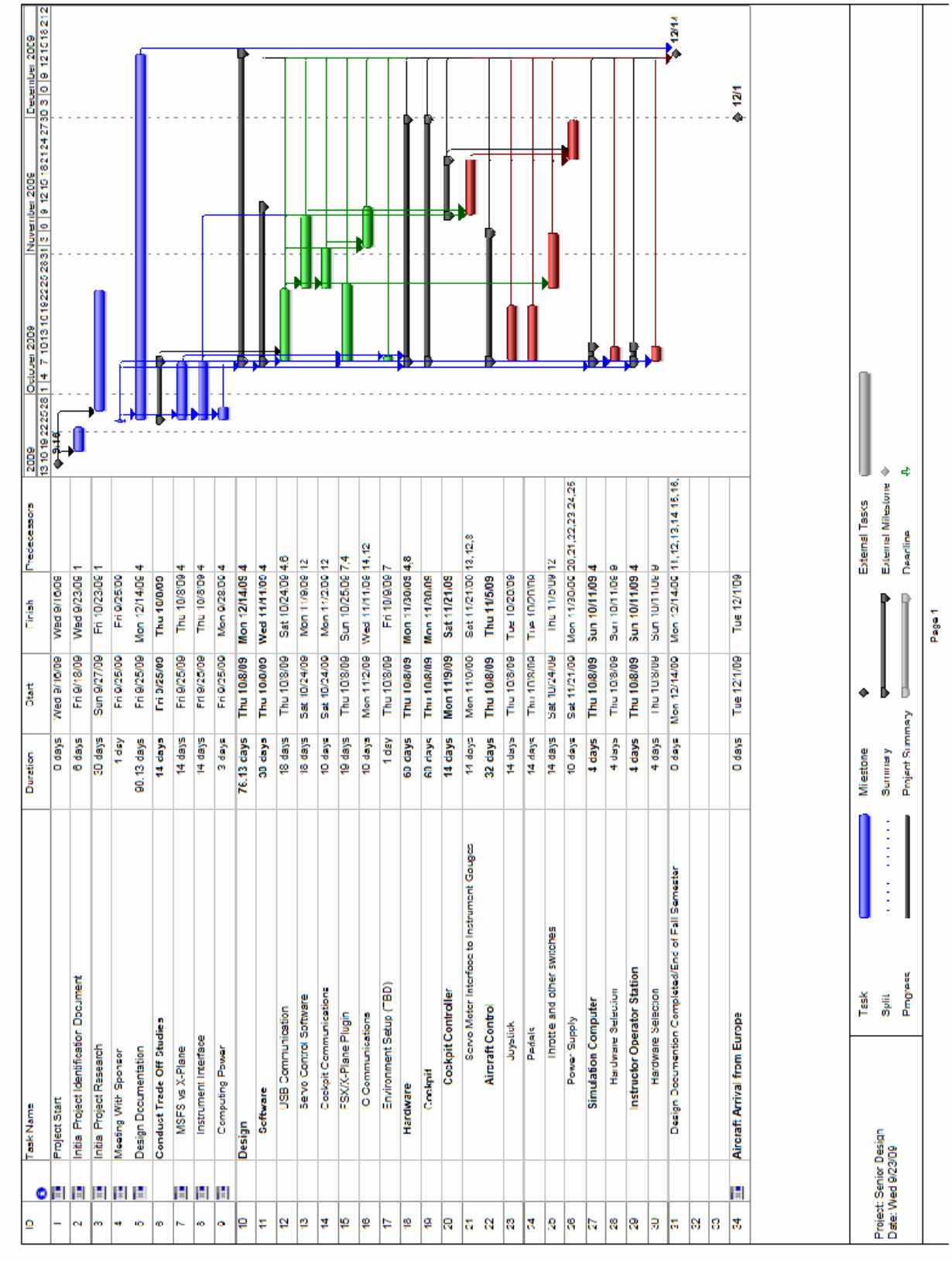
Budget

Depending on the project needs and the sponsor the budget will be discussed toward the end of the design phase. There are some known expenses that will need to be sorted out but, our sponsor thinks we will not need anything until the end of this phase. This makes us think we will need to make this project as inexpensive as possible. There is the need for purchasing software either Flight Sim X (FSX) or XPlane and maybe even a microcontroller or a few controller boards. This will all be decided after the trade studies.

Block Diagram



Project Milestones



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1. (2009, Sept.). Microsoft Flight Simulator: Building Your Own Simulator Cockpit *[Online]. Available: http://www.fsinsider.com/freeflight/Pages/BuildingASimulatorCockpit.aspx*

2. (2009, Sept.). Special interface solutions [Online]. Available: http://www.fscockpit.com/specialinterfacesolutions.html