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Data Acquisition in Aviation Maintenance Training

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FORUM

DATA ACQUISITION IN AVIATION MAINTENANCE TRAINING

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In the following article, I would like to share some of my experiences with integrating data acquisition and virtual instrumentation (VI's) in my powerplant courses at Purdue University. The implementation of the equipment and procedures into the classes was a natural evolution of our educational environment. The more we discussed the inner dynamics of an engine, the more the students and I wanted to measure specific parameters and show their values over time. This activity gave us a window of insight into the effects of changes that were introduced into the engines. Intentional modifications, as in a troubleshooting exercise, or unintentional, such as a component failure, both provided a host of indications to be measured and evaluated.

The evolution of the courses in this particular direction began with installation of standard aircraft EGT and CHT instruments in each of our piston engine running stands. This was a step foreword from the past. It allowed the students to more accurately diagnose engine malfunctions. The instruments were single probe, single cylinder units. Although an improvement, many of the students recognized the need for information on all of the cylinders in order to effectively pinpoint malfunctions. This led to the purchase and installation of a Graphic Engine Monitor system in one of our operational engine stands. The GEM provided multipoint EGT, CHT, and TIT during engine runs but lacked the ability to record data for later analysis. The unit was prohibitively expensive to install in all of our running stands. The need for a system that was portable, and could be used on multiple engines, was identified. Another disadvantage of the GEM was the display was fixed and could not be modified to more clearly show indications. The students had trouble distinguishing the bars from the gaps between bars, or the significance of EGT being a relative temperature while CHT was represented in degrees Celsius. Clearly, a multipoint system that was flexible in its display options, and easily transported, was needed.

The LabView diagnostic center was constructed with portability and flexibility as primary goals. The center could accommodate turbine, as well as reciprocating engine, data acquisition. This flexibility was of primary importance as the cost was shared between several areas of the curriculum.

The diagnostic center consists of a rolling stand, PC, monitor, keyboard, DAQ cards in a chassis, and the associated hoses and wiring to connect the components to ports on the outside of the stand. National Instruments Corporation provided all of the components except the PC. The labels for the various inputs were made from magnetic cards and can be easily moved around the side of the cabinet. The stand requires only a 110-volt source, and a harness consisting of the wires and hoses to connect the engine inputs to the appropriate port on the side of the stand. Each parameter to be measured is assigned a channel, and each channel is represented on the screen of the monitor. The signal can be shown as a conventional gage, a bar graph, a chart, or virtually any other visual representation imaginable, (virtual instrumentation). All of the signals can be displayed simultaneously, or a select channel can be shown.

During a typical run, the data acquisition equipment harness is attached. The data acquisition system is started, with the parameters being recorded to a file. The engine is then operated throughout its test sequence. At the conclusion of the run, the system is turned off and the harness stowed away for the next group. We have used this primarily at the end of the piston engine overhaul class as a way to measure the effectiveness and correctness of the overhaul. It has been invaluable in quickly identifying malfunctions such as mistimed magnetos, failed spark plugs, and plugged injectors.

The impact of this equipment and curriculum on the student's depth of knowledge has been very positive. Not only are students now more familiar with data acquisition engineering as a discipline, they are able to converse intelligently with industry personnel regarding engine performance and how that performance is measured. In speaking with personnel from Textron Lycoming, Caterpillar, and Teledyne Continental, among others, it became clear that this form of training would be valuable to employers as they make hiring decisions.

The curriculum, as it stands at this time, includes a brief classroom introduction to the hardware and programming principles involved. It also includes hands-on use of the equipment including harness and probe installation, operating, and data logging the results. The students are exposed to, and evaluated in, such fundamentals as: thermocouple operation and selection, transducer operation, and creation of simple VI's.

The future plans for this technology may include a complete package of course work built around data acquisition and virtual instrumentation. The material will quickly overtake a small, dedicated portion of an existing course, as even a basic introduction is rather lengthy. Of course, in our case, the work will be aviation powerplant specific. The examples and projects will all relate to some aspect of aircraft propulsion. I note this because this technology is used in many other disciplines including medicine, racing, manufacturing, and the automotive industry.

One of the apprehensions we had going into this initiative was the need for instructor training. This is not something that is "plug-and-play", it is not difficult to learn but the vast capabilities of the system can be overwhelming. The construction and initial set-up of the stand required support from our computing staff. I attended an introductory forty hour training course offered by National Instruments. This course covered the creation of simple, functional, temperature and pressure measurement devices. I have practiced with the creation and implementation of virtual instruments every opportunity I get. I visited our Mechanical Engineering labs where the students are introduced to this technology as a means of acquiring data for a host of engineering applications. I worked through their assignments on my own time and applied many of their techniques to my own projects. All of this effort was to elevate me to the level of beginner or novice. As I said before, this is a field of study, or career, in and of itself. I simply wanted to learn enough to apply it to our situation and to bring that level of insight to our students. My growth in this endeavor is ongoing.

In conclusion, I believe the application of this technology in our classes has had a very positive influence. Many students interviewing in the aviation manufacturing fields have reported being asked about their experience with data acquisition. Rather than muttering "data what" they were able to share their experiences with the interviewers. We are not trying to produce VI engineers. We are, however, trying to give our students a working vocabulary and some experience in this area. It seems that this was a natural evolution of our efforts to strengthen our applied research capability.

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