Web Chart Application

Graduate Project

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Abstract

The purpose of the Web Chart ActiveX Control project was to develop and implement a software-based system to process, convert and transmit Navy performance charts from commands throughout the United States to a centralized web server. The final project, an ActiveX control, is vital for transmitting statistics to the web for evaluation by personnel at all levels throughout the Navy. Building this system required the integration of Visual C++, the Microsoft Foundation Classes (MFC), ActiveX, the File Transfer Protocol (FTP) and Portable Network Graphic (PNG) conversion algorithms.
I. Background and Rationale

This is an introduction to the Naval Aviation Production Process Improvement (NAPPI) initiative, Navy Cockpit Charts, and why the Web Chart Program was necessary for the success of the NAPPI team.

The current Navy flight program was designed in the early months of 1942. It was necessary to produce large quantities of pilots and navigators in response to the outbreak of WWII. Students were rushed in from all over the country to Pensacola, Florida and Corpus Christi, Texas for the abridged syllabus that had one goal in mind: maximum aviator production.

Over the years the program has been revised many times to handle different aircraft and differing student supply and fleet demand. However, the core of the program is still rooted in the program designed one-half century ago. The system works well in times such as WWII and the early 1980's when maximum, or near maximum, production of aviators is required. However, history has proven that the system is unresponsive to relatively small changes in aviator supply and demand.

There is no other area that exposes the weakness of the old system better than the reporting system used as input for recruitment planning. The system utterly fails and causes naval planners to actually plan in direct opposition to what is truly necessary. This is because their measurements are based on data taken from current demand levels, not expected demand levels.

In order to understand the program, a further explanation of the training process is required. To become Naval Aviators, college graduates start by attending a two month-
long school called Aviation Pre-Indoctrination (API). There, they learn flight basics including flight dynamics, weather, and airspace management. Next, the student begins a ten to eleven month-long Primary Training phase (Primary) and Intermediate Training phase (Intermediates). At both schools, they learn how to fly single-engine training airplanes. After graduating, each student branches out to his/her respective platform. This platform could be helicopters, fixed-wing patrol aircraft, or jet aircraft. This next phase of training, called Advanced, takes approximately six more months. Finally, the student is sent to a training squadron with the exact aircraft that they will fly in the fleet. This phase, called the Fleet Replacement Squadron (FRS), takes approximately six more months.

Additional time must be figured into a student's time to train besides the time to actually go through school. They must add additional time for Leave, which averages 22 days per year, and they must add several weeks to the curriculum schedule for school overlaps. Table 1 shows a rough estimate of a student's Total Time to Train (TTT) (NAPPI).
Table 1. Average Time to Train Calculation

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<tr>
<td>API</td>
<td>2 Months</td>
</tr>
<tr>
<td>Primary</td>
<td>8 Months</td>
</tr>
<tr>
<td>Intermediates</td>
<td>2 Months</td>
</tr>
<tr>
<td>Advanced</td>
<td>6 Months</td>
</tr>
<tr>
<td>FRS</td>
<td>6 Months</td>
</tr>
<tr>
<td>Assorted</td>
<td>2 Months</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>26 Months</strong></td>
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When a Student Naval Aviator enters the fleet, s/he will have been exposed to over two years of training. The aviator will have achieved the rank of Lieutenant Junior Grade or sometimes even full Lieutenant. Most importantly, the taxpayer will have invested millions of dollars into this person's education.

The length of this training process creates a logistical problem. When the aviator is finally ready to enter the fleet, the original conditions that figured into calculating the fleet's needs are now two-years old. In many cases, an aviator finishes training and has to wait for many months before being assigned because the fleet's demand has drastically shrunk. At other times, the fleet demand has increased dramatically and the fleet cannot wait for the student to finish.

Today, the fleet is in a desperate post-cutback situation. In the first half of the 1990s, cutbacks shrank the fleet. Since naval planners were taking current supply and demand levels into consideration for future training, they saw that they must cut the
number of aviators coming through the system. Recruitment levels were slashed and many students in the system were released.

It took several years for the effects of the great cutback to trickle down into the fleet. Suddenly, it was determined that the cutbacks were too large. In fact, due to a strong economy, many fleet aviators were getting out of the Navy. By the time the effects of the reduced manpower became apparent in the fleet, the training pipeline was utterly powerless to meet the demand. Even sending the maximum number of students immediately through the system would not help. This is because when the system works at maximum capacity, it cannot work faster. It still takes the same amount of time for each individual to go through the system.

The effect of this "Variable volume - Maximum speed" system is that the aviation schools are always out of sync with what the fleet really needs. Figure 1 shows graphically what happens as the fleet's needs change. First, when the fleet requests many new aviators from the school, the normal response is to open the floodgates and rush many new aviators into the program. Then two years later, when the floods of aviators arrive at the fleet, the fleet finds itself inundated and asks for reduced training. The vicious cycle of incorrect estimates continues.
Figure 1. The Aviation Supply and Demand Curves (NAPPI)

Everyone familiar with Naval Aviation, from the Chief of Naval Operation down to the individual students, knew that the process needs drastic improvement. The Navy needed a special group that could find out what the baseline requirements of the fleet were, and that had the authority to make naval planners adhere with their conclusion. Thus, the Chief of Naval Operations (CNO) and the Chief of Naval Aviation Training (CNATRA) formed the Naval Aviation Production Process Improvement Team (NAPPI - http://www.hq.navy.mil/air warfare/NavySite/NAVhome.htm). The team is a collection of individuals from both the military and civilian sector commissioned to analyze and change the aviation training process.

The civilians are contracted from a company called The Thomas Group. The Thomas Group specializes in improving assembly-line processes. Normally, the company is hired to look at a manufacturing technique for finding ways to improve production and efficiency. After careful analysis, it was determined that the production
of aviators is an assembly-line process, much like the manufacturing of cars or computers. By improving the process, TTT can be reduced.

In order to relieve the problem, NAPPI has been studying every aspect of aviator training. They have settled on a set of key statistics that every training command must collect and report every month to the NAPPI group. These statistics show production of every aspect of the training and determine where bottlenecks in the process are located.

The representation of these statistics, reported in graphical format, are called "Cockpit Charts." The numbers are first collected in Microsoft Excel and then sent to NAPPI for review and analysis. An example Cockpit Chart can be seen in Figure 2.
Figure 2. Cockpit Chart for Advanced Pilot Production

To promote intra-command communication, every squadron in the Navy's aviation training pipeline must be able to see each other's Cockpit Chart for the preceding months. At first, commands were to e-mail the charts to each other whenever a new chart was available. After some time, it was decided that a web page would be devised to allow the posting of the charts in graphical format. This allowed the users to view the charts on-demand, but placed the responsibility of maintaining the charts on some individual.
In November 1998, the Training Management Systems 2 (TMS2) office in Corpus Christi was selected to be the maintainer of the Navy Cockpit Charts Web Site and to be responsible for ensuring that each chart be posted to the web in a timely manner. Thus, each month anywhere from 20-30 charts were e-mailed to the TMS2 office for posting. Each chart took about 15 minutes to convert and post to the web. The TMS2 time cards indicated that approximately 40 hours per month were spent on the process. Hence, a considerable amount of time - approximately one man-week per month - was spent each month to transmit the charts and post information on the site in a timely manner.

After studying the conversion process thoroughly, it became apparent that a conversion program could be produced to convert a Cockpit Chart to a graphic format and send it to the web automatically. This was the reason that the Web Chart Program was commissioned.

The benefits of using such a conversion program have proven to be two-fold. First, it reduces manpower for the conversion of the Cockpit Charts. As commands complete their monthly analysis, the charts are automatically sent to the web with a few simple keystrokes. There is no third party involved in the conversion and posting process.

The second benefit of the automated system is actually more important to individual commands than saving time. Each command is able to post their charts when they want. If they have corrections to their charts, they can re-post them as many times as necessary. No longer are there early deadlines to submit material. Each command posts their charts when it is most advantageous to them.
In the final analysis, the Web Chart program is proving to be an important product for the NAPPI team. The use of the Web Chart program allows users to post on-demand charts to the web. In addition, since July, when the Web Chart program went into service, forty man-hours have been saved per month in the TMS2 office. It is clear that the Web Chart program is key in meeting the goal of distributive analysis of Cockpit Charts on the World Wide Web.
II. Narrative

A. Overview

To be successful, the Cockpit Chart web-conversion tool or "Web Chart" had to be an extremely easy-to-use program. This was the most important goal for the program. The program had to hide all complexity from the user to minimize errors due to user inexperience. This meant that the program had to setup itself with no user interaction and provide a simple step-by-step interface for getting its job done. With the goals of ease of use and setup in mind, the Web Chart program was created.

The Web Chart program is a Component Object Model (COM) control. Microsoft has named this technology "Active Control" or "ActiveX control". Using an ActiveX control for this application has two advantages. First, it allows the user to insert the control into any COM container such as Microsoft Internet Explorer or Excel. The user has the freedom to use it directly by starting Internet Explorer from their desktop, going to a designated web page (http://navaltx.navy.mil/ctw-4/cockpits/updates/default.htm), and updating their command’s chart whenever they want. If the user is comfortable with adding controls to the Cockpit Chart Spreadsheet, they can even add the control directly to the spreadsheet in which they create their charts.

The second advantage to implementing the program as an ActiveX control is that it automatically updates and installs itself on the computer system from the web server. This aids the novice computer by avoiding a complex download and setup process.

The Web Chart control is the vital link between Microsoft Excel, which commands use to track their flight statistics, and the web server, which displays the
cockpit charts to the end-user. The process of taking the charts from Excel and placing them on the web is shown in Figure 3. It is the responsibility of the command statisticians to use Excel to update the Cockpit Charts and copy them to the clipboard. S/he then uses the Web Chart control to convert the chart to the PNG image format and send it to the web server. The web server is responsible for displaying the chart images to browsers on the World Wide Web.

![Diagram](image)

**Figure 3. MS-Excel to Web Server System Diagram**

**B. Program Operation**

When Web Chart starts, it is ready to accept Cockpit Charts and post them to the web. Figure 4 shows Web Chart in its start-up or “Ready” state. To begin the process, the user starts Microsoft Excel, opens the Cockpit Chart spreadsheet, and selects the region containing the charts that are to be posted to the web. After the region is selected, the user copies the information to the clipboard by pressing Ctrl-C or selecting Edit → Copy from the Excel Edit menu.
Figure 4. **Web Chart Program in its "Ready State" After Startup**

After the chart is copied to the clipboard, the user returns to the Web Chart program. To transfer the copied chart from the clipboard to the Web Chart program, the user selects the “Paste” button on the Web Chart control. The chart is then automatically converted to a bitmap graphical format and displayed within the static preview box. An example of this can be seen in Figure 5.
Figure 5. Example Web Chart Copy Operation

If the graphic to be converted is larger than the preview box, the user is still able to preview it by placing his cursor over the graphic. The cursor turns into a hand that allow the user to drag the graphic within the preview box and view the entire image.

After visually verifying the graphical view of the chart, the user is ready to send the graphic to the web. To carry out this final step, s/he presses the “Transmit” button. The Web Chart program then checks to see if it knows the name of the file to be updated on the web server. If it does not, it prompts the user for the filename (Figure 6). The Cockpit Chart Web Site administrator determines and distributes a unique filename for each appropriate command. Every end-user should know the filename to use for their assigned chart and they are held accountable for naming their charts correctly.
Figure 6. Web Chart Prompt for Graphic Filename

After obtaining the name of the file, Web Chart then converts the graphic from its raw bitmap format into a highly compressed Portable Network Graphics (PNG) format. The file is then sent to the Web Chart Homepage (http://navaltx.navy.mil/ctw-4/cockpits) via the File Transfer Protocol (FTP). The file is automatically placed in the correct location with the appropriate filename on the web server.

Filenames can be provided to the web chart automatically. In Excel, the administrator can enter the filename, in clear text, into any cell near the Cockpit Chart. It must be in the format: **Filename:name.png** where **name.png** is the assigned name of the destination graphic (Figure 8). During its conversion, Web Chart searches through the selected area looking for the filename. If it finds it, the user is not presented a dialog box asking for the filename. When “Transmit” is pressed, Web Chart automatically converts
the file, names it correctly, and posts it to the Cockpit Chart image directory of the Web Chart web site.

Figure 7. Automated Filename Placed In Excel

There are two possible outcomes of the graphic transfer. Either it will complete the conversion and transfer the image successfully, or an error will be raised for a variety of reasons. In either case, a message box will be shown to return the program status to the user. In the case of a successful transfer, the message box in Figure 8 is shown.
Figure 8. Successful Conversion and Transfer Message Box

If an error occurs, Web Chart presents a message box to the user that describes the problem and tells the user how to solve the problem. For example, Figure 9 shows the error message that is raised when an FTP connection cannot be established. If the user follows the directions shown on the message screen, most errors encountered in the conversion can be resolved without further technical assistance.
Figure 9. *Unsuccessful Transfer Message Box*

The final component of the Web Chart control is the About box. By pressing the button labeled “About”, a message box is displayed that displays product and copyright information. Figure 10 shows the Web Chart About box.
Figure 10. Web Chart About Box

C. Graphic Image Formats

The Portable Network Graphic (PNG) was selected as Web Chart’s output image format for several important reasons. The Joint Photographic Experts Group (JPEG) file format and the Graphic Interchange Format (GIF) have historically been the web graphic image formats of choice. However, these formats were not the best choices for Web Chart for two different reasons.

Web Chart produces graph images that are essentially line drawings. To accurately display line drawings, a proper graphic format must be “lossless.” This means that it cannot distort the picture during compression. This requirement prevents the JPEG from being considered for an output format. The JPEG compression scheme
produces “lossy” output that purposely throws away input data during encoding to gain better compression ratios (Murray p. 1084).

The GIF file format has a problem of its own that prevents it from being chosen to represent Cockpit Charts. The algorithms that compress GIF images are protected under copyright law by the UNISYS Corporation (UNISYS). While the code for compressing GIF images is widely distributed, UNISYS prevents unlicensed applications from writing the images unless they pay a costly licensing fee. The license cost makes the use of the GIF format unsuitable for use by the Web Chart control.

The PNG file format, pronounced “Ping”, was made specifically to fill the hole left by the GIF and JPEG formats. It is a lossless compression format that has no fee-based licensing issues. All algorithms are public domain and available freely through the Internet. The image’s format description is readily available and its compression scheme is based on LZ77 compression.

Just as important as its physical and legal characteristics is PNG’s recognition within the Internet and graphics communities. Since 1996, the W3 consortium has recognized PNG as a viable alternative to the GIF standard. Hence, widely-used browsers including Microsoft Explorer 3.0+, Netscape Communicator 4.0+, and Opera 1.1+ support the PNG standard. All three browsers can access the PNG graphic through the IMG or OBJECT tag. By best meeting all of the graphical criteria, it is evident that the PNG format was the best choice for the Web Chart control.

D. Software Distribution

As mentioned earlier, one of the great advantages of implementing the Web Chart Control with ActiveX technology is that the required nationwide distribution of the
program has proven to be easy. This is because distribution of the control is left to the
web server and Microsoft Explorer. Other browsers besides Microsoft Explorer can be
used to display ActiveX controls. However they must have special plug-ins to enable this
functionality.

The automatic distribution works by placing the control on the Cockpit Chart
When a user goes to that page, Microsoft Explorer checks to see if the computer has that
control loaded on the machine. If it does not, it automatically downloads it from the
specified directory. Additionally, it registers the control in the user’s system registry and
sets it up for use. Therefore, to the user, setup and installation of the program only entails
going to a designated page at the Web Chart web site. Explorer handles the rest.

ActiveX and Microsoft Internet Explorer also verify that the user has the most
current version of the Web Chart Control on the client computer. If a more current
version exists on the web site, Explorer automatically downloads and installs the
specified version. After the component downloads, the program automatically launches
and is seen as a control on the web page. The control is actually only a small part of the
page. The rest of the page is used as a help area to show users how to use the control. A
copy of the Web Chart Update Page can be found in Appendix A.

Internal configuration of the Web Chart Control is the responsibility of the
program maintainer. The address to FTP the image file to, the username and password,
and protocol information are all hard-coded into the program and are the responsibility of
the maintainer to change and post. This is needed to protect the security of the web
server. Whenever any changes to this information are necessary, the modifications are
made in the source code, the program is re-compiled and posted to the web site. The
version number on the referring web page is changed to reflect the new program’s
version number. After that, whenever a user accesses the page, the newly compiled
control is automatically downloaded and used.

The basic design and operation of the program has met the goal of being very
simple. Without exception, the twenty-two novice users who utilize the Web Chart
program have been able to learn its operation in one thirty-minute training session given
by the author. The real program complexity lies in the inner-workings of the control,
which shields the user from the complexities of completing the task.