Board 21: Work in Progress: Expanding Program Reach through Wine

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Expanding Program Reach through Wine

Abstract

With the increase in popularity of operating systems like macOS and Chrome OS, creating non-mobile applications that run cross-platform is becoming a challenge for developers all over the world [1]. It is costly to create non-Windows versions of applications since the Operating Systems (OS) differ in architecture and implementation. Many creators from various organizations choose different routes for increasing application compatibility but are not always willing to pay the overhead of developing the same application on another platform. As a result, consumers are stuck with not being able to use the software they need and end up resorting to workarounds ranging from running virtual machines to parallel booting the operating system.

Wine is a compatibility layer capable of running Windows applications on several POSIX-compliant operating systems, such as Linux, macOS, & BSD free of cost [2]. It is an excellent way to run Windows applications on macOS and other Linux machines without installing a resource intensive virtual machine or restarting the machine to dual boot. Wine has been in active use since 1993. Since then, it has been adopted by many large companies and integrated into their products, including Borland, Google, IBM and Oracle [3].

This paper describes how a National Science Foundation (NSF) funded project experienced a need to be able to run a Windows-only program on Macs or Chromebooks and explains how Wine may be used to overcome a similar OS-limiting challenge.

Introduction

Teaching Engineering Concepts to Harness Future Innovators and Technologists (TECHFIT) is a national program that seeks to spark Science Technology, Engineering and Math (STEM) interest in middle school children by demonstrating the impact information and technology have on the world. TECHFIT inspires this next generation of innovators to design and implement technology-based fitness games, exergames, to get people moving and having fun while simultaneously and positively improving their health [4].

TECHFIT participants to use a Windows-based software tool called nanoNavigator, which is a flowchart programming tool created by Phoenix Contact to program the Nanoline microcontroller that each school receives [5]. This Windows-only tool is a limiting factor in recruiting schools to join the program because many schools do not have Windows-based computer labs and rely on Chromebooks and/or Mac OS-based computers.

There are several approaches to run Windows-only software on other platforms, but all of them have some limitations that restrict their feasibility to be used as a potential solution to the above problem. Wine, a tool active since 1993 and supported by major companies like Google and IBM [3], [6], [7] was found to be the most feasible solution to help solve the problem faced by TECHFIT.

What is TECHFIT?

TECHFIT has been getting middle-schoolers excited about technology and computational thinking (CT) since 2013 [4]. Teachers complete an intensive, one-week, Professional

Development (PD) program in the summer prior to the school year when they will implement what they learn at their schools.

Each school participating in TECHFIT receives a technology toolkit valued at $4500. The toolkits are made possible through donations from industry partners, Phoenix Contact and Balluff [4]. Each kit contains a Programming Logic Controller (PLC) or microcontroller, buzzers, lights, push buttons, wires, different types of sensors, tools, and an instructional workbook. The Nanoline PLC uses nanoNavigator to program the microcontroller. Participants' exergames are physical, hardwired systems created with toolkit components that are controlled by the Nanoline through nanoNavigator programming.

During the summer PD, teachers use their toolkit to learn Scratch programming, nanoNavigator programming, wiring, electronics, safety, exergame design. They also engage in a variety of fitness activities, which provide ideas for future exergames they might create. By the fifth day of the PD, each teacher team has designed and implemented a functional exergame as a demonstration of their understanding of all concepts and their ability to put these concepts into practice.

The teachers implement the TECHFIT curriculum at their schools when school starts in the fall. The workbook contains illustrated lessons for each concept, along with possible implementation schedules based on the meeting pattern at the school [8]. After teaching the basics in all areas of the curriculum, teachers assign their students into teams on the program's culminating activity -- the innovation of an exergame that employs technology and programming to track, instruct, and assess participants' gameplay. Each team tackles different aspects, including wiring, programming, construction, marketing, animation, presentation, funding for materials and possible travel.

The TECHFIT program includes a showcase held in December where students from invited schools demonstrate their exergames and share their TECHFIT experiences. A panel of judges evaluates all teams to determine the champion of the showcase.

As of December 2018, TECHFIT has offered ten sets of PD programs to over 150 middle school teachers from 60 middle schools in eleven different states: Indiana, South Carolina, Ohio, Michigan, Wisconsin, Tennessee, Kentucky, New York, North Carolina, Florida, Virginia, and Washington [9].

The TECHFIT curriculum is intended to expose students to computational thinking through programming in Scratch, programming in nanoNavigator, and physical computing in the construction of their exergames. Of these, the flowchart programming in nanoNavigator not only runs the physical system, but it is an excellent tool for helping novice programmers learn to think logically and computationally. The inability of this software to be run on non-Windows platforms has led to many schools not being able to participate and leverage the TECHFIT curriculum as a way of introducing CT in their classrooms.

Possible solutions

TECHFIT has used different ways to overcome this problem in the past but none of the methods used have been ideal. A Virtual Machine (VM) like Parallels Desktop or VMware Fusion is the most convenient option because the user can run a complete Windows installation without rebooting the computer. Although these approaches are convenient,

considering that each school will need 15 to several hundred licenses, the software is too expensive, ranging from USD $79 to $100 dollars for each perpetual license [10] [11].

Dual booting Windows OS on a Macintosh is a faster alternative approach since it does not require the overhead of virtualization, but it does require restarting the computer. There can also be incompatibility issues due to the different file formats both operating systems use. Also, dual booting requires the user to purchase a Windows 10 license separately, which comes at $139 [12]. Multiplying this cost for all the students and all the schools results in the above two solutions not being financially-feasible options.

Wine, on the other hand, is a compatibility layer that allows users to run Windows applications on MacOS without virtualization. Wine makes this possible by converting Windows Application Programming Interface (API) calls into Portable Operating System Interface (POSIX) calls on-the-fly and avoids using Windows OS completely. This technique has allowed users to run Windows applications on Linux machines without having to purchase licenses. However, the conversion of all Windows API calls correctly is a big task. Missing out on some APIs might result in some features of the program not running correctly, which would result in an imperfect application translation. The installation of Wine is performed through the Command Line Interface (CLI) via the Terminal application on Linux operating systems, which makes it a difficult experience for inexperienced experts.

This complex task becomes easier with a program called CrossOver by CodeWeaver which provides the user with a Graphical User Interface (GUI). It helps the user translate the application's API calls automatically. Similar to Wine, there is a list of applications that CrossOver supports officially, but it can be used to run any Windows application. The application used by TECHFIT, ran successfully on a MacOS as well as Chrome OS computer using this technique. The commercialized version of Wine is available for a one-time fee of $39.95 [13]. Table 1 depicts a comparison of all of the approaches discussed above.

Approach	**Pros**	**Cons**	**Price (USD)**
Virtualization	Restart not required	Slow	$79-100
Dual-Boot	Fast	Have to restart native OS	Cost of Windows license
Wine	Free, fast	Manual process to convert app, not all applications might be supported	Free
CrossOver	GUI, fast	Not all applications might be supported	$39.95

Table 1. Comparison of possible solutions

Using Crossover (Wine) to create a Mac executable

In order to run Windows executables on a Mac using Crossover and Wine, the following prerequisites must be met:

- Computer with MacOS X Yosemite or above
- Access to an administrator account with password
- Working Internet connection
- Latest version of CrossOver by CodeWeaver
- Latest version of nanoNavigator
- At least 4 GB RAM
- At least 3 GB of free disk space for the installation of the above software

The following steps were carried out to run nanoNavigator successfully on a Mac OS based computer:

1. Download the latest version of nanoNavigator through their website [14].
2. Download the latest version of CrossOver for Mac through their website [13].
3. Launch CrossOver and double-click on *Install a Windows Application* button on the bottom bar. (Figure 1)

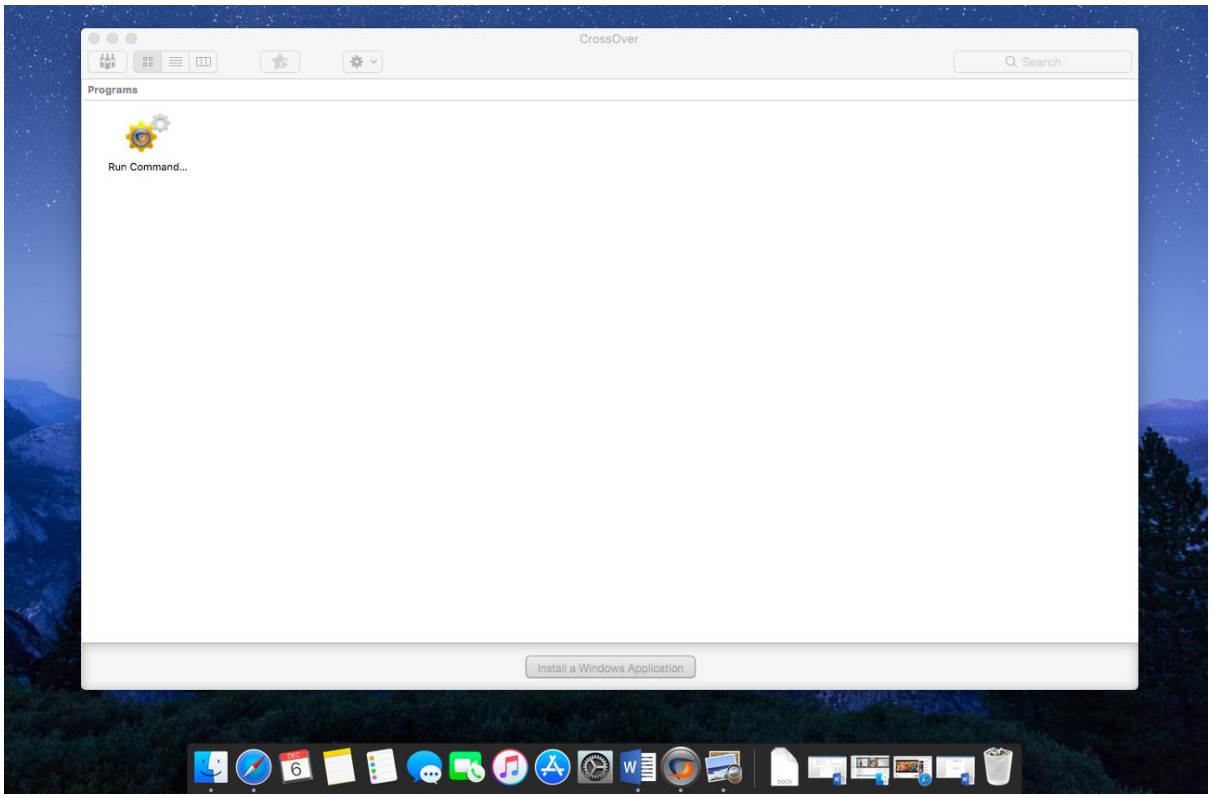

Figure 1. Landing Screen of CrossOver

4. Choose *Unlisted Application* from the next screen and click on *Continue.*
5. Click on *Select Installer* from the top navigation bar and *Choose Installer File*.
6. Click *Install* to begin installation. This may take several minutes depending on the computer specification.
7. Browse to the nanoNavigator executable downloaded in step 1, select it and click on continue. (Figure 2)

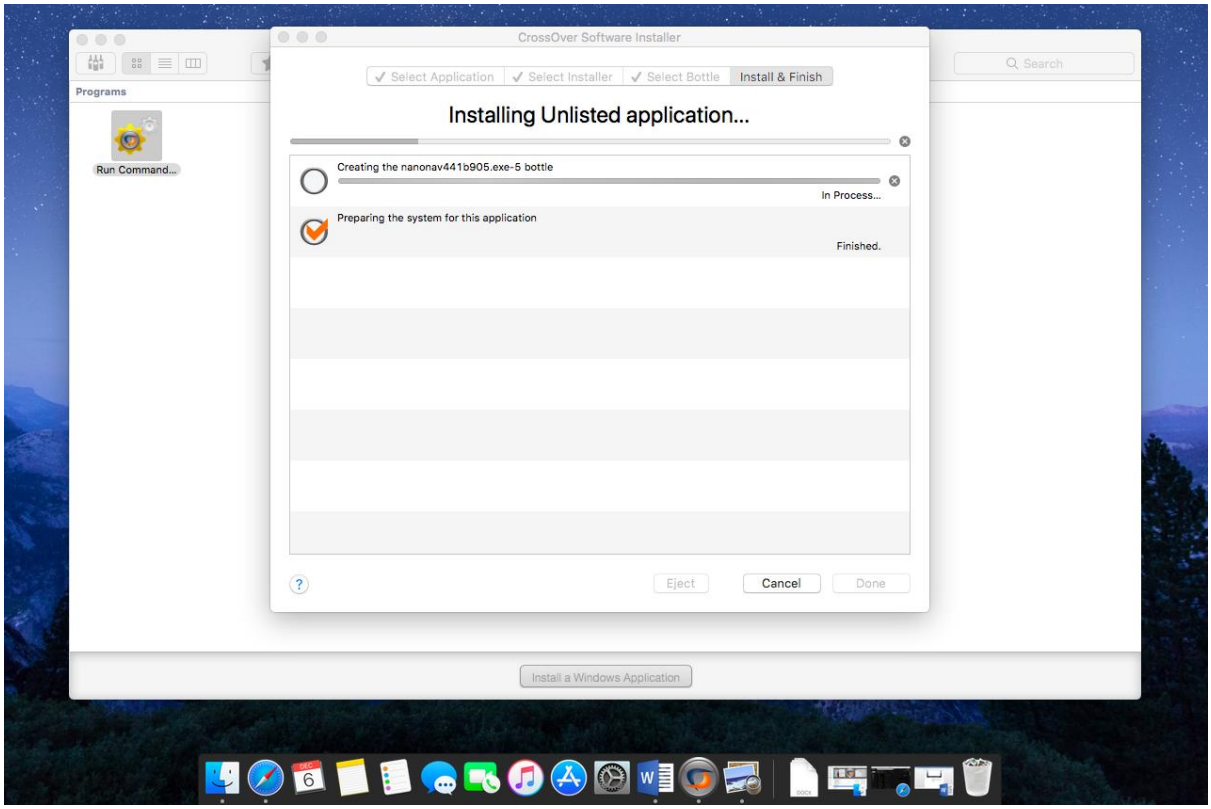

Figure 2. CrossOver Installation Screen

8. Click on *Select Installer* from the top navigation bar and Choose Installer File. Browse to the download exe file, select it and click on continue. (Figure 2)
9. After a few minutes, the nanoNavigator installer will begin installing the software like it would on Windows OS. (Figure 3)

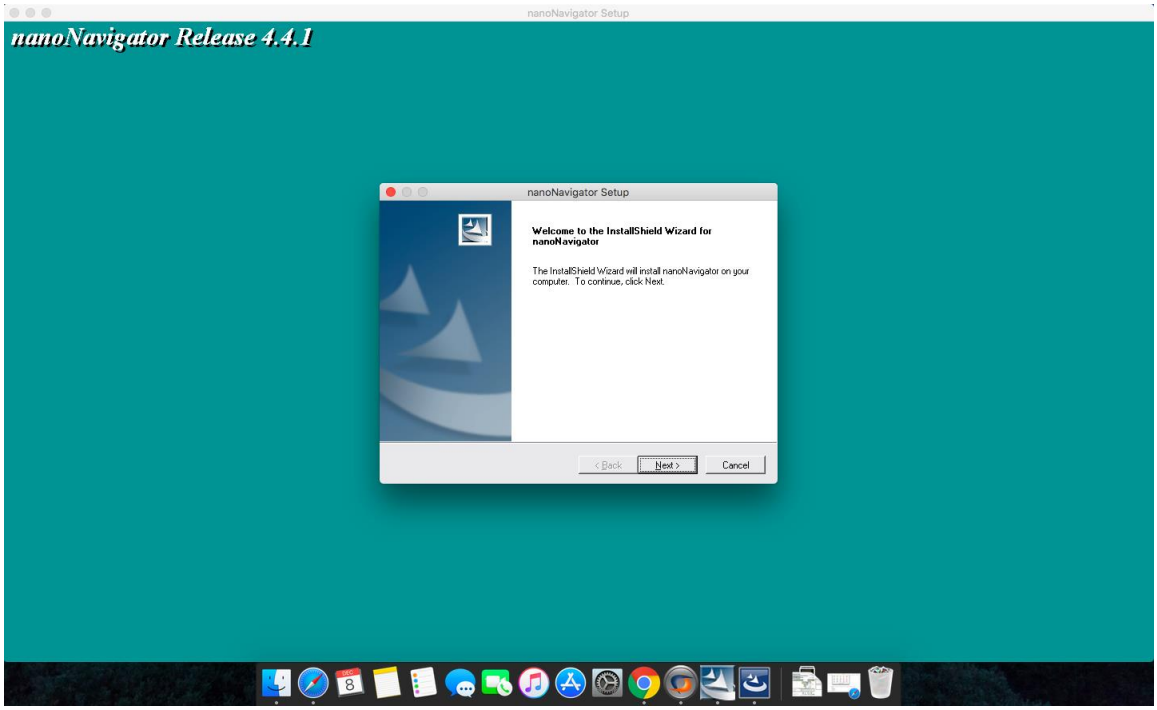

Figure 3. nanoNavigator Installation

10. Figure 4 shows the screen that is displayed after the installation is successfully completed. By clicking on the nanoNavigator icon, the user can launch the application.

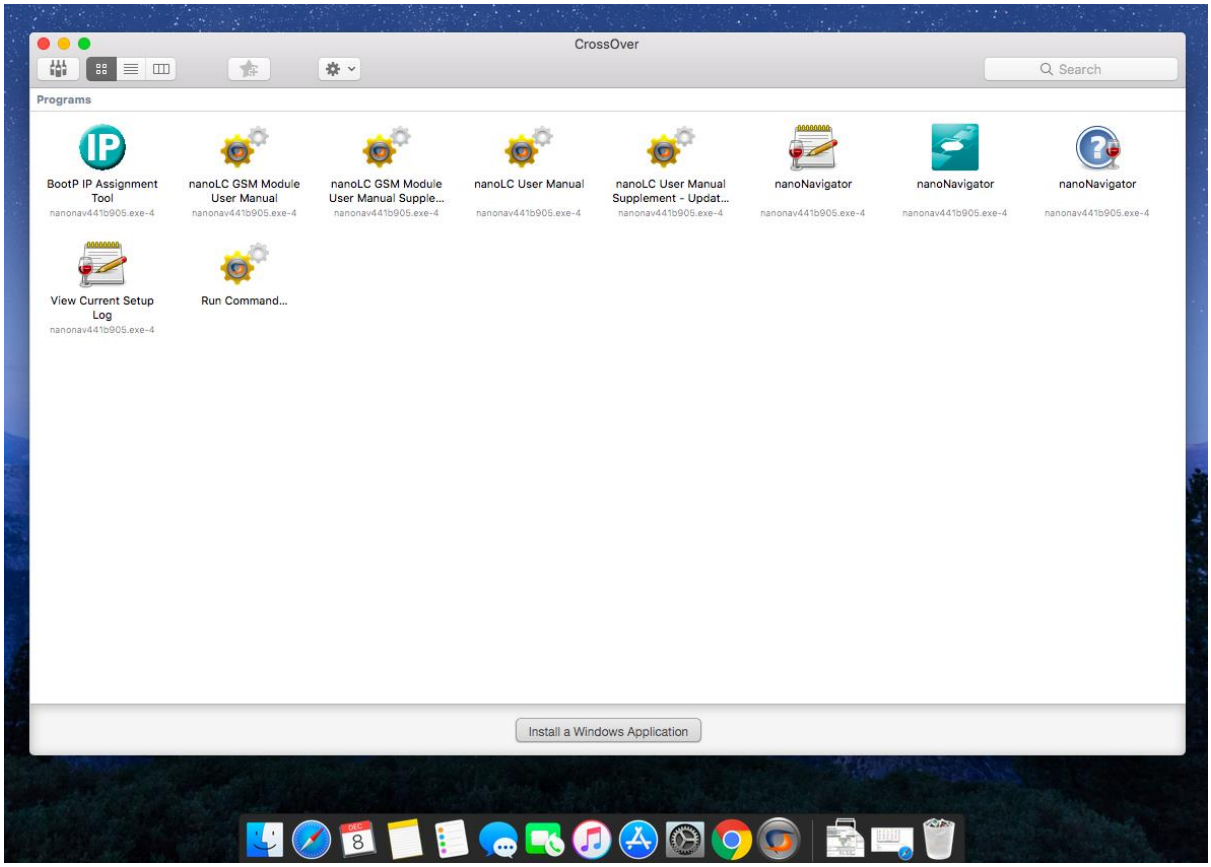

Figure 4. Post Installation

Figure 5 shows nanoNavigator successfully running on a Mac OS computer using Wine. CrossOver created a shortcut of the *bottled* application and nanoNavigator can be launched directly from the Mac Launchpad or the Applications folder. However, this process still has the following limitation: The COM ports do not work in the application, which means the users cannot download the program they create in nanoNavigator to the physical PLC. Having this functionality requires customization of CrossOver by the developers at the company which is a costly affair. An alternate solution to this problem used by TECHFIT is that all the students download their program to a flash drive and use one Windows machine to download it on the controller when needed.

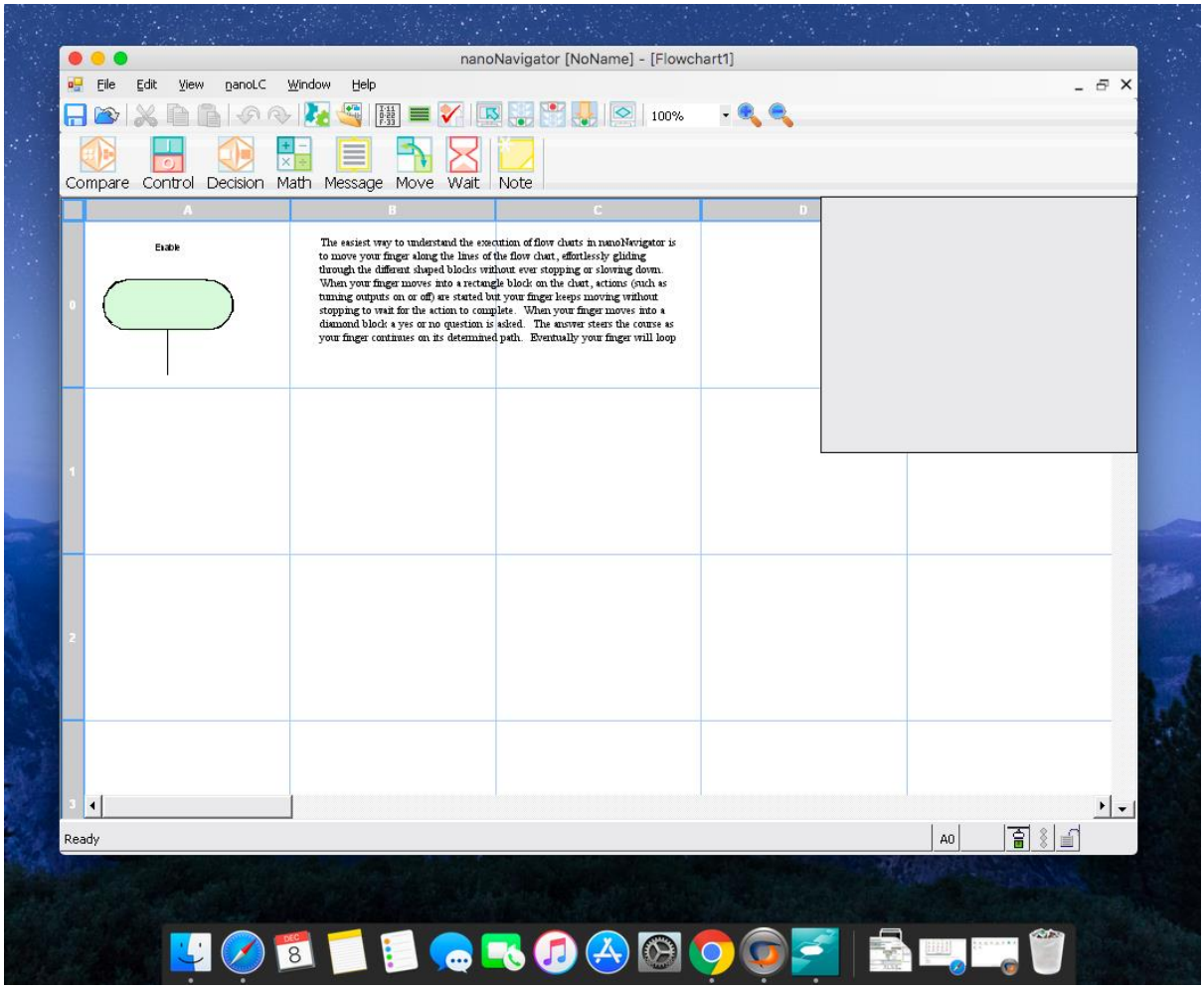

Figure 5. nanoNavigator running on Mac OS

Conclusion

As discussed, Wine is a tool that can be used to create compatible software for non-Window operating systems. TECHFIT used it to create a version of the Windows OS nanoNavigator application for MacOS and Chrome OS-based computers. Because budgets in K-12 are usually quite restrictive, this approach has proved to be the most feasible solution. It has enabled TECHFIT to consider schools that have standardized to MacOS and Chromebooks as long as the teacher team had access to at least one Windows machine.

Other projects that rely on Windows-only software can likewise expand their reach using Wine with CrossOver. However, this technique depends on Windows API calls being converted to POSIX calls on the fly, and, depending on the OS version, all calls might not be supported as was the case with nanoNavigator's feature for downloading the program to the microcontroller due to the COM port incompatibility.

Wine is being continuously developed and supported by big organizations including Google, IBM, and Oracle and has a rich online community for help. The commercial version of Wine, Crossover, comes with a license and tech support as well. Programs, like TECHFIT, whose reach have been restricted due to software availability on limited platforms, may want to consider employing Wine with CrossOver to develop comparable software for other platforms used by their participants.

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