

AMPL Toolpaths: Dependent Libraries and Developer Notes

In addition to over 100,000 lines of C++ that I have coded, *AMPL Toolpaths* is also dependent on various open source projects. Notably, the CAD engine in *AMPL Toolpaths* relies on Open CASCADE Technology 7.1.0 while the front-end, or Graphical User-Interface (GUI), was designed using Qt 5.8.0. As mentioned earlier, these C++ libraries were chosen in an effort to keep *AMPL Toolpaths* free in terms of licensing while simultaneously providing a modern, intuitive implementation similar to that of today's popular CAD technology.

Open CASCADE Technology is a software development kit (SDK) intended for development of applications dealing with 3D CAD data. It includes a set of C++ class libraries providing services for 3D surface and solid modeling, visualization, data exchange, and rapid application development. Existing software packages that illustrate the capabilities of this powerful library can be readily seen in industry including CAD pre/post-processors like SALOME ("SALOME Software Suite," n.d.) as well as internal testimonials by BMW, GE Oil & Gas, Siemens, Sony, and many others ("Trusted by Industries," n.d.). Hence, Open CASCADE Technology was chosen to be the core CAD technology in *AMPL Toolpaths* to visualize, manipulate, and query the common freeform topologies present in ISF.

Although Open CASCADE Technology contains graphics functions to render CAD objects, there was still a need to create a GUI that visualized dialog windows, clickable buttons, and status prompts. Qt (pronounced "cute") was an obvious choice: it is a mature library, powerful while being user-friendly, well documented, and popular amongst industry. Some notable examples of Qt in practice include Autodesk Maya ("Autodesk," 2011), Mathematica ("Mathematica by Wolfram Research," 2013), and Ubuntu ("Ubuntu - Built with Qt," 2018).

AMPL Toolpaths can be compiled using the Microsoft Visual Studio 2015 toolset, which is currently available in both the Microsoft Visual Studio 2015 and Microsoft Visual Studio 2017 suites. The resultant executable will run on any Microsoft Windows 7 (X64) or newer Windows operating system. If the Windows machine is being used to simply run the executable and does not have Microsoft Visual Studio 2015 installed, then the system must also be installed with the Visual C++ Redistributable for Visual Studio 2015 (X86 and X64). This redistributable package installs run-time components required to run C++ applications built using Visual Studio 2015 and is easily obtained on Microsoft’s website (“Visual C++ Redistributable for Visual Studio 2015,” 2015). Any overview of additional minimum system requirements to run *AMPL Toolpaths* is provided in Table C.1.

Table C.1. Minimum system requirements to run *AMPL Toolpaths*.

	Minimum	Recommended
Graphics Memory:	512 MB	1 GB
Available Memory (RAM):	1 GB	2 GB
Free Disk Space:	512 MB	2 GB
Run-Time Dependencies:	Visual C++ Redistributable for Visual Studio 2015	
Operating System:	Windows 7 or newer (64-bit)	
Graphics API:	OpenGL 3.3 or newer	

To further develop *AMPL Toolpaths* in the future, a development environment must be setup within Visual Studio 2015 which involves successfully compiling the Open CASCADE Technology source code and its dependencies. By doing so, a set of C++ libraries (.lib files) will be created that expose the Open CASCADE functions during the development of *AMPL Toolpaths* without having to repeatedly compile the source code. Upon compilation of *AMPL Toolpaths*, all of the linked C++ libraries will then create dynamic-linked libraries (.dll files) which must be available during run-time either by being in the same directory as the executable

or appended to the system PATH variable. Detailed instructions on compiling Open CASCADE Technology for Windows using CMake are available online (“Open CASCADE 7.1.0 - Building with CMake,” n.d.). And the dependencies, also termed third-party components, can be downloaded as pre-compiled libraries for Visual Studio 2015 (“3rd Party Components,” n.d.). The specific versions of the third-party components used in compiling Open CASCADE Technology 7.1.0 for the development of *AMPL Toolpaths* are summarized in Table C.2.

Table C.2. C++ dependencies for compiling Open CASCADE Technology (OCCT) and *AMPL Toolpaths* in Microsoft Visual Studio 2015 (VC14 64-bit v140 toolset).

Open CASCADE Technology (7.1.0)		AMPL Toolpaths (0.9.6)	
Compiled Library	Version Number	Compiled Library	Version Number
FFmpeg	3.3	OCCT	7.1.0
Freeimage	3.17.0	Qt	5.8.0
Freetype	2.5.5	Cereal	2017
Angle-gles2	2.1.0	Fast Cpp CSV Parser	2015
Gl2ps	1.3.8		
TBB	4.4		
VTK	6.1.0		
Tcl/Tk	8.6		
zlib	1.2.8		

The Open CASCADE Technology library is available under the GNU Lesser General Public License V2.1 (“GNU Lesser General Public License, version 2.1,” 1999), while Qt is available under the GNU Lesser General Public License V3.0 (“GNU Lesser General Public License,” 2007). Both Cereal and Fast Cpp CSV Parser are libraries available under the 3-Clause BSD License (“The 3-Clause BSD License,” n.d.). None of the source code was altered in these C++ dependencies for the development of *AMPL Toolpaths*. As of this writing, *AMPL Toolpaths* is still officially in beta testing with the current version being 0.9.6.

Bibliography

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