

# Using the “Multi-scale cardiac simulation framework” on Windows

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This document goes over steps necessary to run the MSCF library on Windows using Visual Studio. The steps were created based on Windows 7 and Visual Studio 2017, using `Single_cell_3D_main.cc` as the main function.

## 1. Create project

Create a new project in Visual Studio (VS), selecting ‘Visual C++/Windows Console Application’. I call the project ‘MSCSF\_test\_windows’ for the purpose of this step-by-step. ‘Location’ at the bottom of the screen gives the location where the project codes are stored. Now, open this folder with the project (the folder with MSCSF\_test\_windows’.cpp code, NOT with MSCSF\_test\_windows’.sln) and copy there:

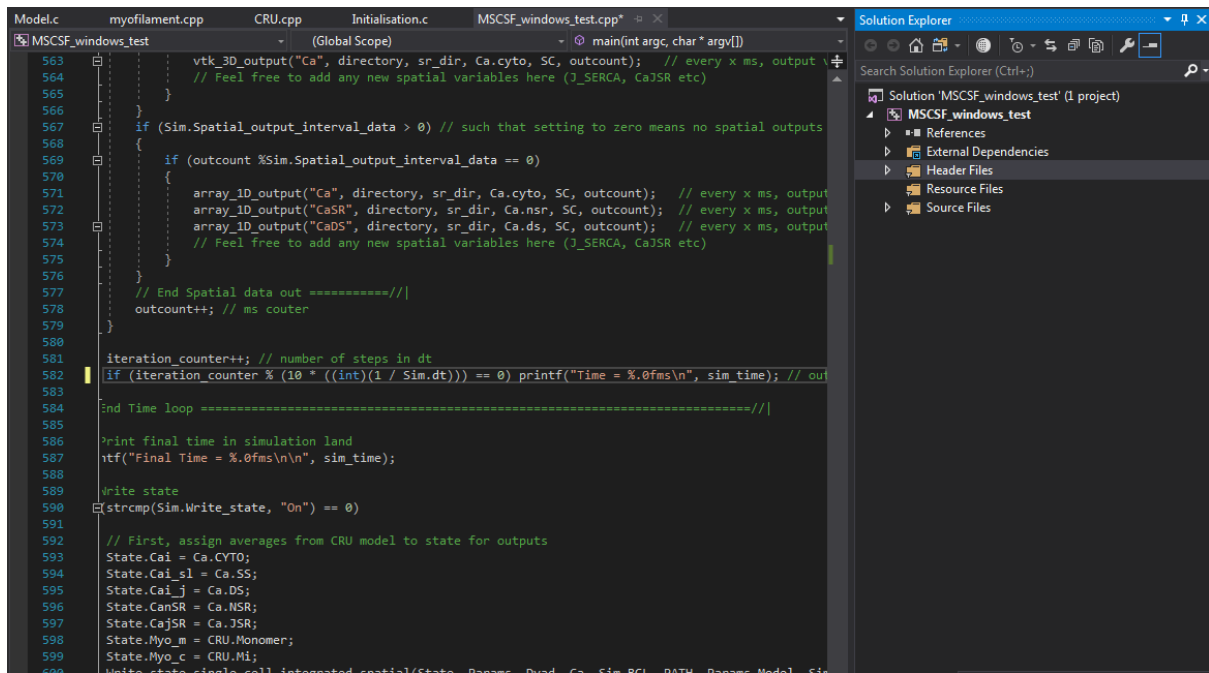
- ‘lib’ folder from MSCSF/CODE
- ‘MSCSF\_state\_and\_geometry\_files’ folder from MSCSF\_distribution (the archive in which the library is distributed).
- ‘PATH.txt. from MSCSF\_distribution.

The folder should look as follows:

Name	Date modified	Type	Size
lib	02/05/2019 16:08	File folder	
MSCSF_state_and_geometry_files	02/05/2019 16:08	File folder	
MSCSF_test_windows.cpp	02/05/2019 16:12	CPP File	32 KB
MSCSF_test_windows.vcxproj	02/05/2019 16:07	VC++ Project	9 KB
MSCSF_test_windows.vcxproj.filters	02/05/2019 16:07	VisualStudio.vcxpr...	2 KB
MSCSF_test_windows.vcxproj.user	02/05/2019 16:07	Per-User Project O...	1 KB
PATH.txt	02/04/2019 12:09	TXT File	1 KB
pch.cpp	06/04/2019 16:27	CPP File	1 KB
pch.h	06/04/2019 16:27	VisualStudio.h.14.0	1 KB

## 2. Add source and header files to the project

Right-click ‘Header Files’ in the Solution Explorer (pane at the right part of VS):



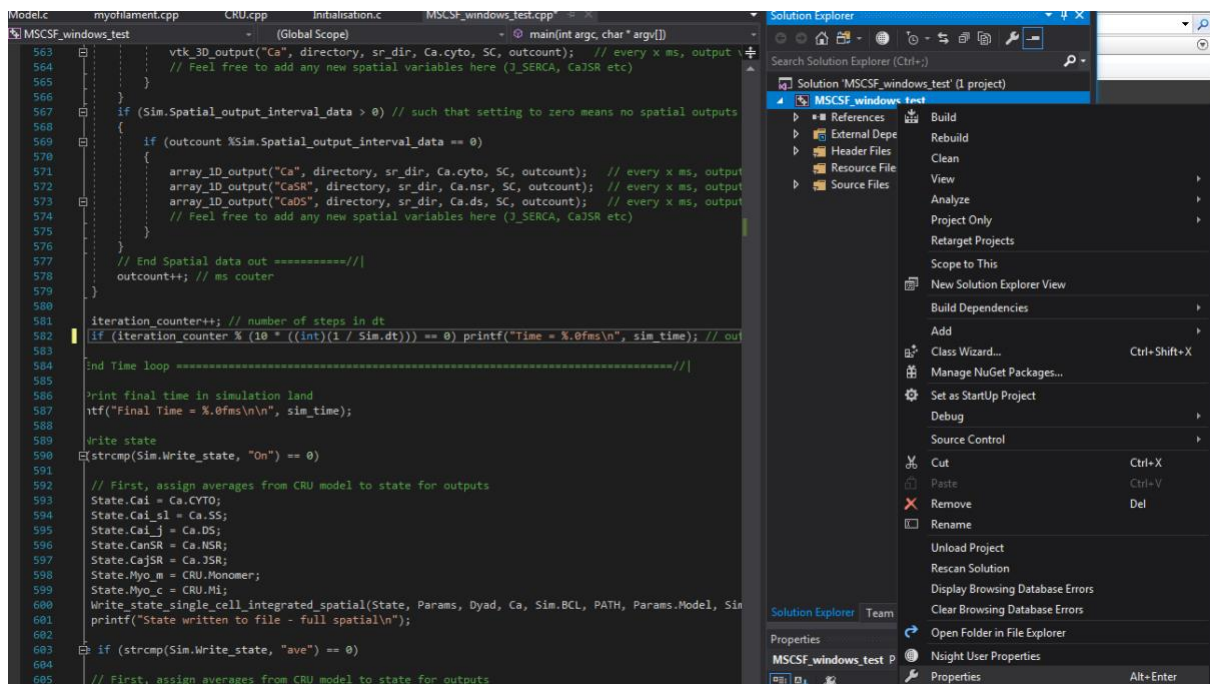
Click Add-Existing Item, and navigate to your project folder/lib, and select all files with extension .h or .hpp (if you sort the folder by Type, c/cpp and h/hpp become separated). Then right-click 'Source Files' and likewise select and add all .c or .cpp files.

### 3. Set up the main code

In your main code (MSCF\_test\_windows.cpp), replace the contents with contents of 'Single\_cell\_3D\_main' which is in 'CODE' subfolder the original MSCSF\_distribution archive

### 4. Set compiler to C++

Go to Project Properties (right click the project – not the Solution – in Solution explorer):



There, go into C/C++ - Advanced, and under 'Compile As', select 'Compile as C++ Code (/TP)'. Without this step, there would be many compiler errors later.

## 5. Disable precompiled headers

In Project properties, expand C/C++, go to Precompiled headers, and select 'Not Using Precompiled Headers' by clicking on the contents of the 'Precompiled Header' line, and opening the drop-down menu at the end of the line. Then Apply and OK this change at the bottom.

## 6. Dealing with fopen/fclose safety

If you try to Build after the previous step, there are still many errors left; most are complaints about fopen/fclose. To deal with this, go to Project properties - C/C++ - Preprocessor, and there, in 'Preprocessor Definitions', add '\_CRT\_SECURE\_NO\_WARNINGS;' after '\_CONSOLE;'.

Preprocessor Definitions	WIN32;_DEBUG;_CONSOLE;_CRT_SECURE_NO_WARNINGS;%(PreprocessorDefinitions)
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Apply, OK.

## 7. Compiler limit of if/else

When trying to Build, the number of errors should be getting quite low. The first one ('compiler limit: blocks nested too deeply') is the trickiest – the simplest thing is to replace Arguments.c with the function provided [\[here\]](#).

What happens is that VS compiler does not like deep nesting of if-else (256 is the limit). The default structure of argument parsing in Arguments.c does just that, unfortunately. The provided alternative file rewrites the elseifs into a sequence of non-nested ifs with a small modification to how invalid parameter names are detected (which is functionally equivalent).

## 8. Finding PI

Now, the top error is 'M\_PI': undeclared identifier. The compiler says that it doesn't know where to find the definition of  $\pi$ . To remedy this, go to lib/Tissue.cpp, and after #includes, add '# define M\_PI 3.14159265358979323846'.

## 9. Treating undefined variables

Unfortunately, the behavior of undefined variables is platform and compiler-dependent, which can cause various sorts of headache. Visual Studio compiler can detect some cases – such as the case of 'ihit' in 'lsoda.hpp'. This is easy to treat by explicitly zero-initializing ihit (after ihit is defined in 'lsoda' function, just include 'ihit = 0;').

Similarly, in 'Model.c' and 'CRU.cpp', there are instances of 'potentially uninitialized local pointer variable 'I\_out\_individual''. To solve this, simply set the respective variables to NULL after they are defined in the functions containing the offending lines. In the current version, of the code, such a definition is, e.g., at the line 1337 of 'CRU.cpp'; you can add 'I\_out\_individual = NULL;' at the line 1339.

Another change is needed in myofilament.hpp (this one is not picked up by the compiler and would cause havoc if unchanged) – uncomment the line containing 'dt\_myof = 0.05;'.

Now, the project should Build without errors.

## 10. Making sure that folders can be created.

The last outstanding issue is Linux-style creation of relevant folders. In the main function file ('MSCSF\_windows\_test.cpp'), change 'mkdir -p' to 'mkdir' (Windows can create nested folders by default). In the current version, there are four such instances on lines 132-143. Subsequently, also on these lines, change forward slashes ('/') which serve as path separators to double backslashes ('\\'). This is actually not necessary for lines after 'printf(">Creating output files...\n");' (currently on line 147).

## 11. Specify PATH to data

Find the file PATH.txt in your project folder. There, simply put 'MSCSF\_state\_and\_geometry\_files' as the only content of the file.

## 12. Running the code

Build the project. Now, find the .exe file, which is in the Debug folder. Cunningly, this is not in Debug folder in your *project* folder, but it is in the *solution* folder, i.e., one level above the project folder (the same folder where 'MSCSF\_windows\_test.sln' is present). Take the exe file and copy/move it to the project folder. There, it can be run from the command line similarly to the Linux version. E.g., 'MSCSF\_windows\_test.exe BCL 500 Beats 2' runs two beats of the model with default parameters at BCL 500 ms.