



# mpideXcode

*Embedded Computing Template on Xcode 4.3*

## Installation Guide

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Documentation <http://embedXcode.weebly.com/>

GitHub repository <http://github.com/rei-vilo/embedXcode>

Contact <http://embedxcode.weebly.com/contact.html>

### How to Help



Contribute to the project on [GitHub](#).



Help me buy books on Xcode through my [Amazon Wish List](#).

# Summary

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# 1. Install the Template

Before installing the template, you need to install at least one IDE.



If you plan to use Arduino boards:

- Download and install Arduino 0023 or Arduino 1.0.
- Launch it.
- Define the path of the sketchbook in the menu `Aduino > Preferences > Sketchbook location`.

embedXcode identifies the version of Arduino automatically.

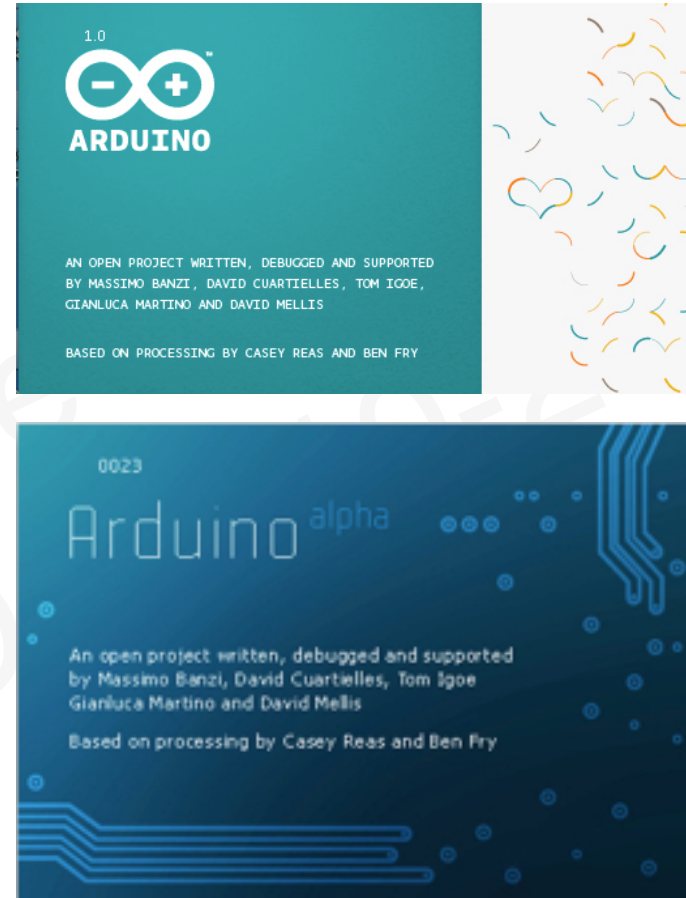
As a matter of fact, Wiring is considered as the framework of reference for embedded computing.

Arduino 0023 should be preferred over Arduino 1.0 because Arduino 0023 is Wiring compliant. So is chipKIT MPIDE 0023.

Arduino 1.0 has introduced many small changes in the syntax which are not compatible with previous release. Energia 1.0 is derived from Arduino 1.0.

So I strongly recommend to pick the release of Arduino which is compatible with the other platforms you plan to use:

- either Arduino 0023 with chipKIT MPIDE, Wiring and Maple IDEs,
- or Arduino 1.0 with LaunchPad Energia IDE.





If you plan to use chipKIT boards:

- Download and install Mpipe 0023.
- Launch it.
- Define the path of the sketchbook in the menu Mpipe > Preferences > Sketchbook location.



If you plan to use Wiring boards:

- Download and install Wiring 1.0.
- Launch it.
- Define the path of the sketchbook in the menu Wiring > Preferences > Sketchbook location.

The two following files require to be deleted.



Multiplatform Arduino compatible IDE  
Arduino 0023 Compatibility

Modified version of the Arduino IDE created by  
Rick Anderson and Mark Sproul of Fair Use Building  
and Research on May 21, 2011.  
This software is not supported by the Arduino LLC

Version 1.0 Build 100

 **Wiring**

An open project initiated by Hernando Barragán

The Wiring team is composed of Hernando Barragán, Brett Hagman and Alexander Brevig

Special thanks to contributors: Paul Stoffregen, Michael Margolis, Hans-Christoph Steiner, Annelie Franke, Maarten Lamers, Christoph Waltmann, Etienne Ribeiro, Nicholas Zambetti, Thomas Ouellet Fredericks, Mikal Hart, Pascal Stang, Brian Dean, Carlos Mario Rodriguez, James Partaik, Sawad Brooks, Yaniv Steiner, Tom Igoe, David Cuartielles, David Mellis, Massimo Banzi, Bill Verplank, Gillian Crampton-Smith and many others listed at [wiring.org.co/about.html](http://wiring.org.co/about.html)

© 2004-2010 Hernando Barragán, © 2011 Hernando Barragán, Brett Hagman and Alexander Brevig

Processing is © 2004-2011 Ben Fry and Casey Reas  
© 2001-2004 Massachusetts Institute of Technology

/Applications/Wiring.app/Contents/Resources/  
Java/cores/AVR8Bit/program.cpp

/Applications/Wiring.app/Contents/Resources/  
Java/cores/AVR8Bit/makefile



If you plan to use LaunchPad boards:

- Download and install Energia 1.0.
- Launch it.
- Define the path of the sketchbook in the menu Energia > Preferences > Sketchbook location.



If you plan to use Maple boards:

- Download and install MapleIDE.
- Launch it.
- Define the path of the sketchbook in the menu MapleIDE > Preferences > Sketchbook location.

The Maple reset script — which sends control signals over the USB-serial connection to restart and enter the bootloader — is written in Python and requires the PySerial library:

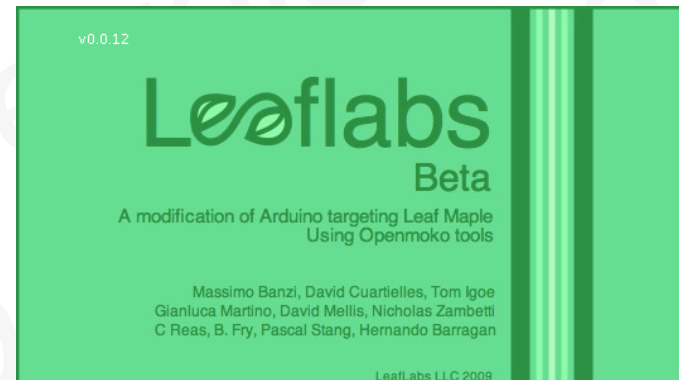
- Read the instructions at <http://leafflabs.com/docs/unix-toolchain.html#os-x> and
- Download PySerial library from <http://pypi.python.org/pyserial/>.



## Energia 1.0

Modified version of the Arduino IDE for the Texas Instrument LaunchPad MSP430 created by Robert Wessels on January 2012.

This software is not supported by the Arduino LLC.



For other boards with a Processing-based IDE, same procedure:

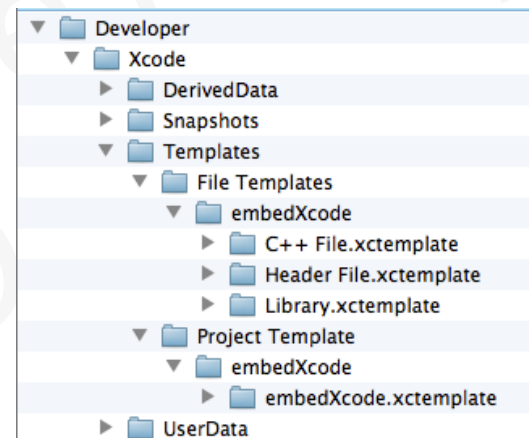
- Download and install the corresponding Processing-based IDE.
- Launch it.
- Define the path of the sketchbook.
- Additionally, develop a specific makefile and adapt the Step1 makefile.



Now, the template can be installed:

Check and create `~ /Library/Developer/Xcode.`

Copy the folder Templates into `~/Library/Developer/Xcode`

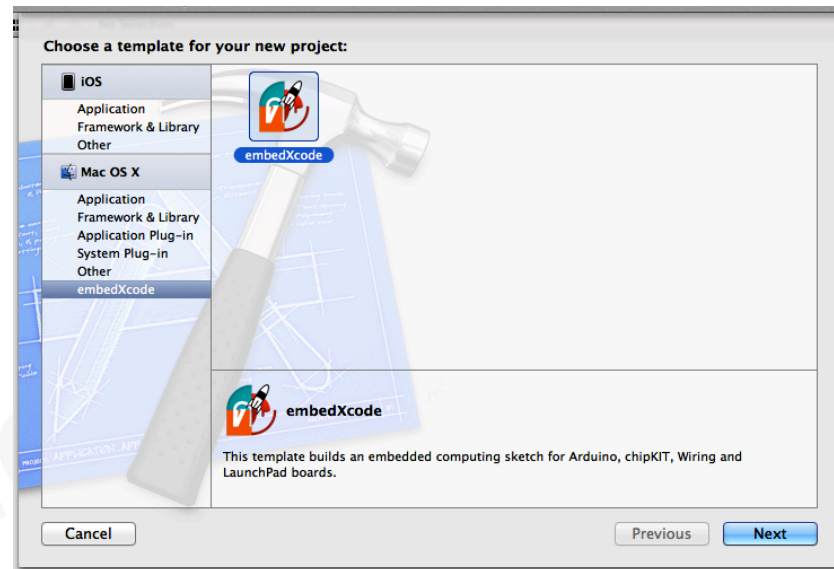


## 2. Create a New Project

Call the menu File > New > New Project... or press  
⇧⌘N.

Select embedXcode > embedXcode.

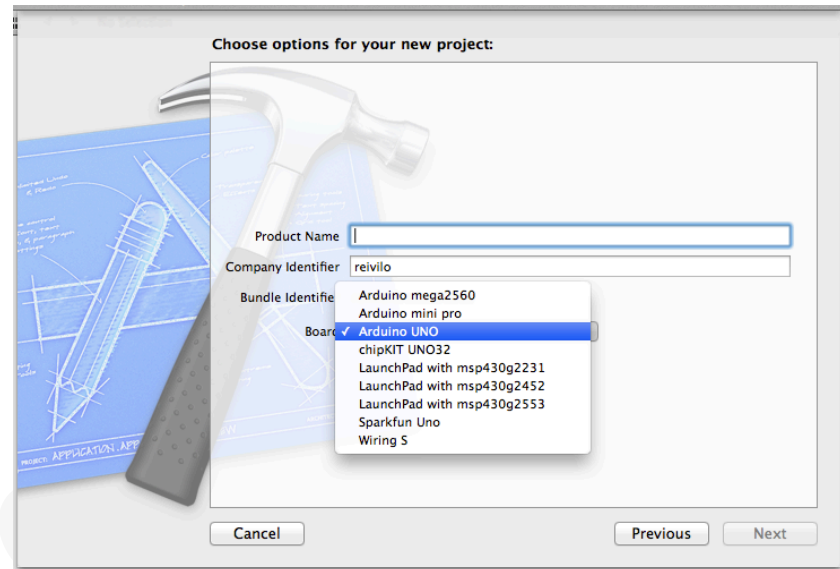
Click on Next to proceed to the next step.



Type in the name of the project.

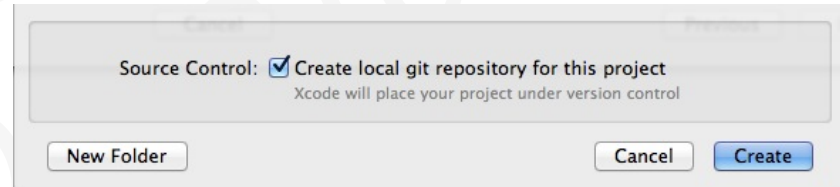
Select the board on the drop-down list.

Click on Next to proceed to the last step.



Select the folder where the project is going to be saved and check Create local git repository for this project if you want so.

Then click Create to confirm and create the project.



### 3. Configure the Project

The template doesn't define all the parameters, so some of them need to be set manually.

The goal is to have the following work done by the template, provided the right keywords are known.

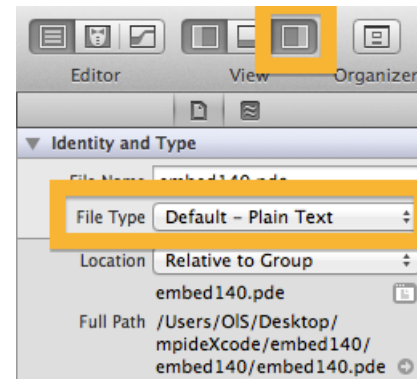
#### 3.1. *Declare Sketch .pde File as C++ File*

The sketch .pde file is considered as plain text. For code-sense, it should be declared as C++ file.



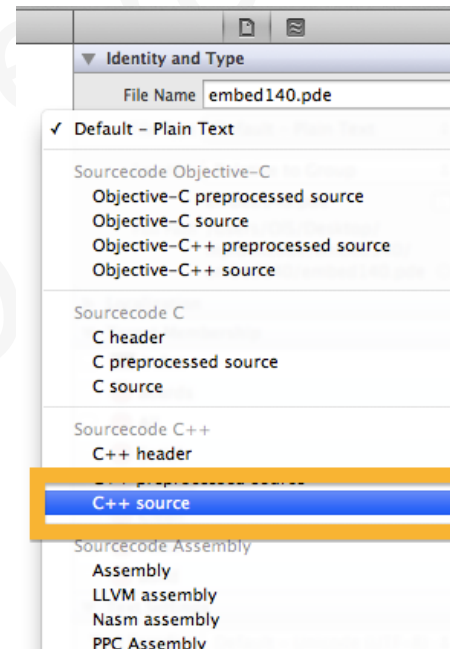
Select the sketch .pde file.

In the right-most column,

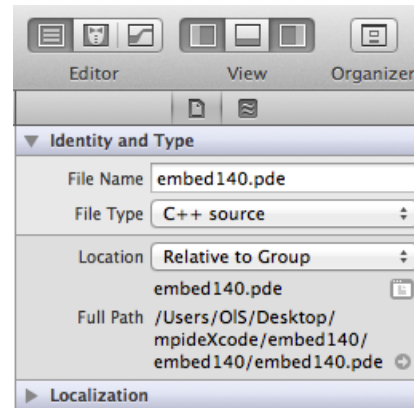


Click on the drop-down list of File Type.

Select C++ source.



Now, the sketch is considered as C++ code for code-sense.

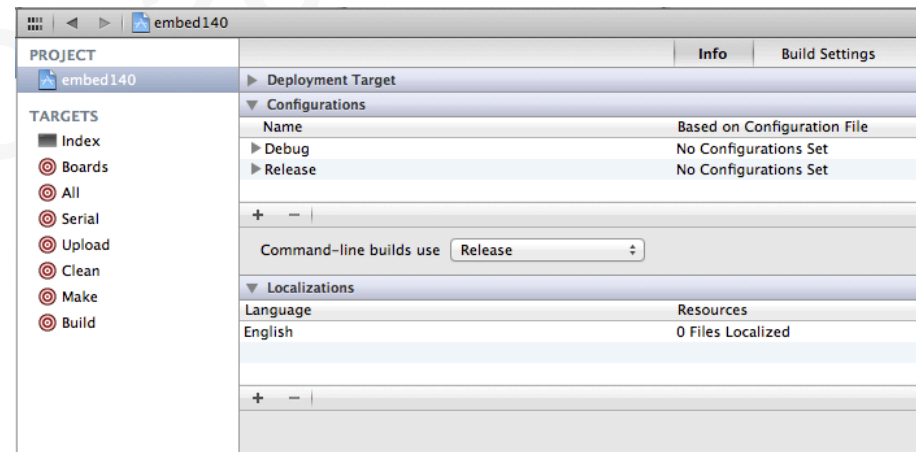


This manual procedure is considered as an issue and reported under [#3 Declare PDE File as C++ Source](#).

### 3.2. Declare User's Sketchbook

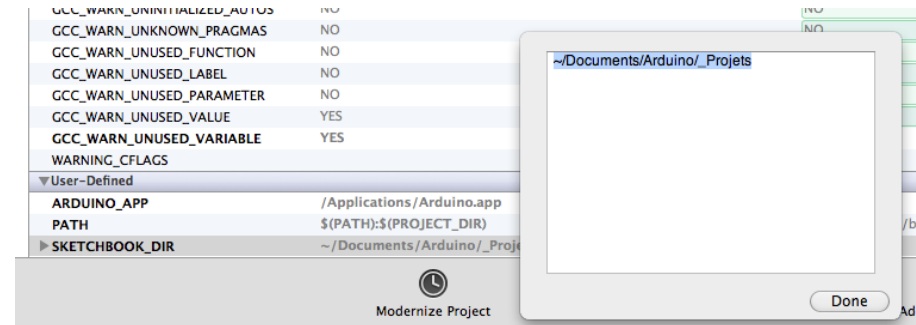
The user's sketchbook is a folder where the user's sketches are saved, among them the libraries in a dedicated sub-folder Libraries.

Select the project and the Build Settings pane.



At the very bottom, double-click on SKETCHBOOK\_DIR and either type in the name of the folder or drag-and-drop it from a Finder window.

The ~ character is accepted.



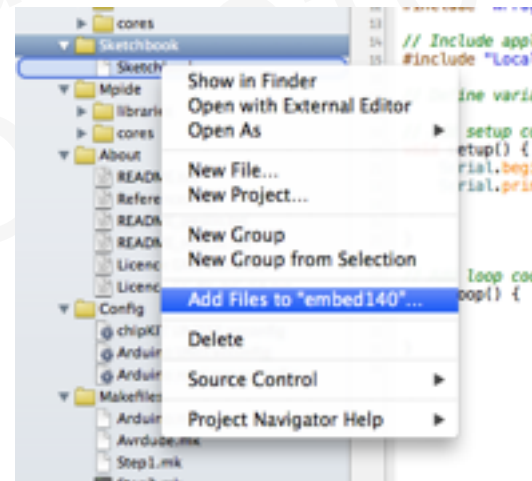
If no sketchbook is defined, SKETCHBOOK\_DIR takes the value defined for Arduino or chipKIT during the installation process.

### 3.3. Add User's Libraries

Open the Sketchbook group on the project hierarchy.

Right-click to obtain the contextual menu.

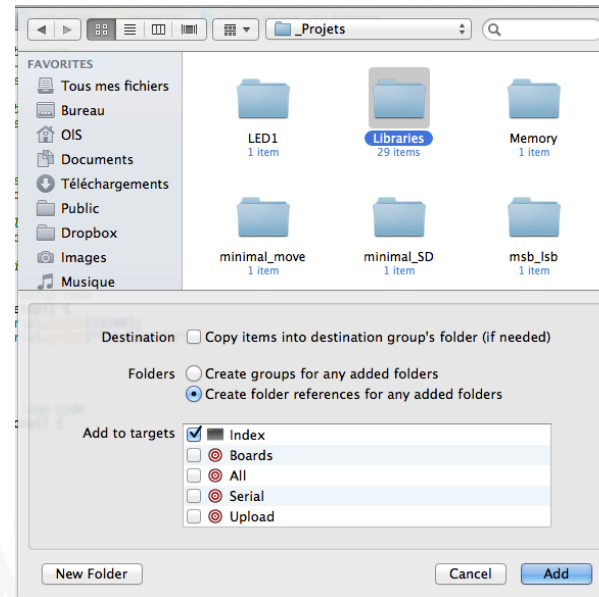
Choose Add file to...



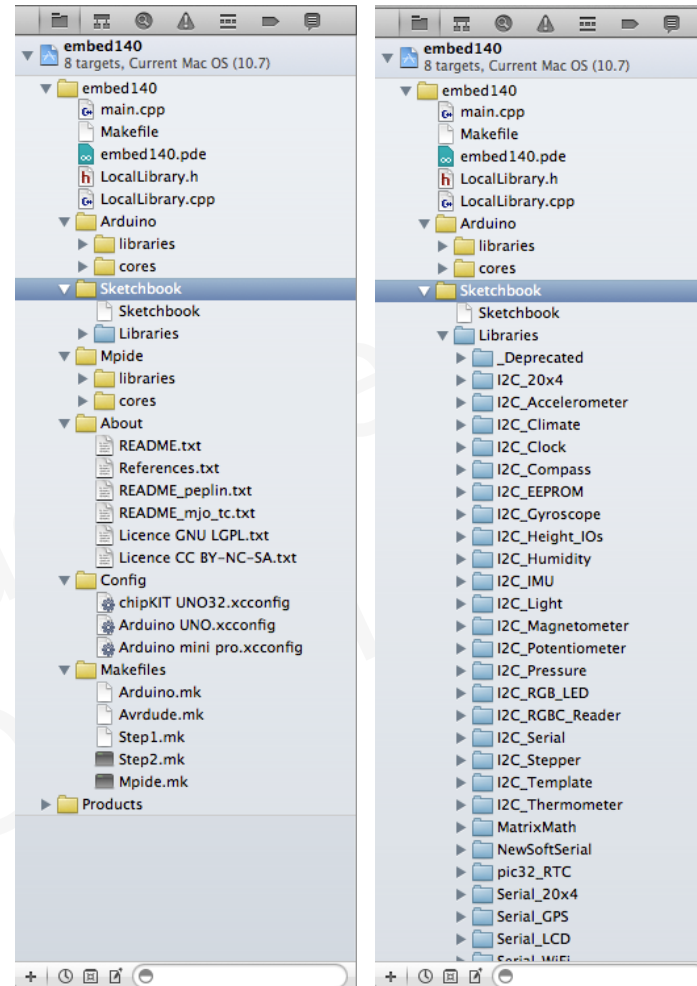
Select the Library sub-folder on the sketchbook folder, tick Add to target > Index and validate with Add.

Both Create group for any added folders and Create folder references for any added folders are relevant.

Don't tick Copy items into destination group's folder (if needed) folder (in needed) to avoid duplicating files.



The project hierarchy shows all your libraries.



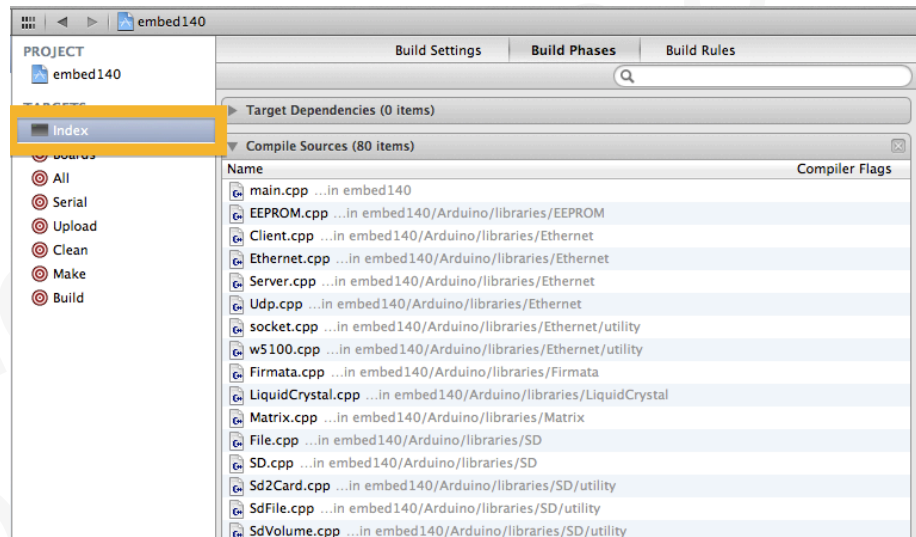
### 3.4. Declare Sources for Code-Sense

Standard C++ keywords are already known, but not some Arduino and user's library keywords.

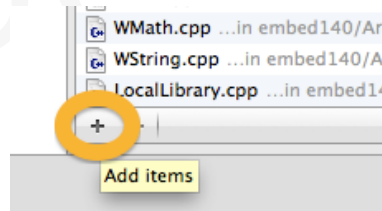
The selection of a board defines the headers for code-sense.

So Xcode needs to be taught where to find them.

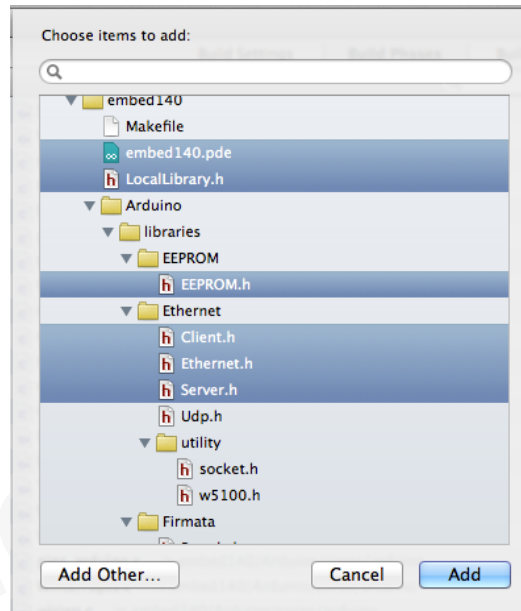
Select the target Index and the Build Phases pane.



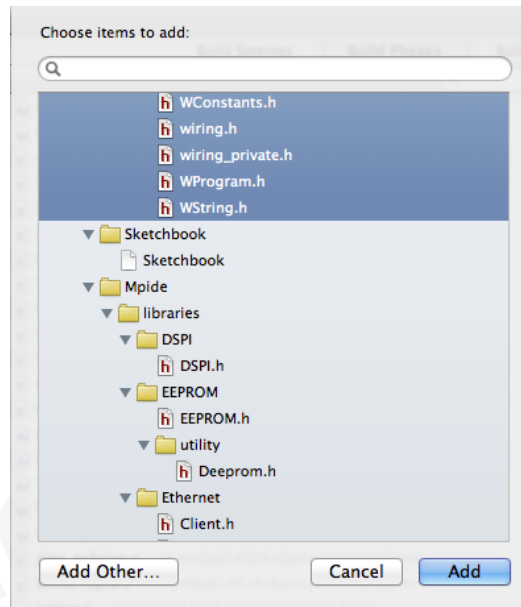
Go to the bottom of the list and click on the + button.



A list shows up.



Select all the .h and .cpp files and click on Add.



This manual procedure is considered as an issue and reported under [#2 Populated Sources List for Code-Sense](#).

### 3.5. Define the Directories for the Target

The template doesn't allow to specify the exact directory for the target. In case of an building error, the click-to-error feature may not work properly for the main sketch and the local libraries.

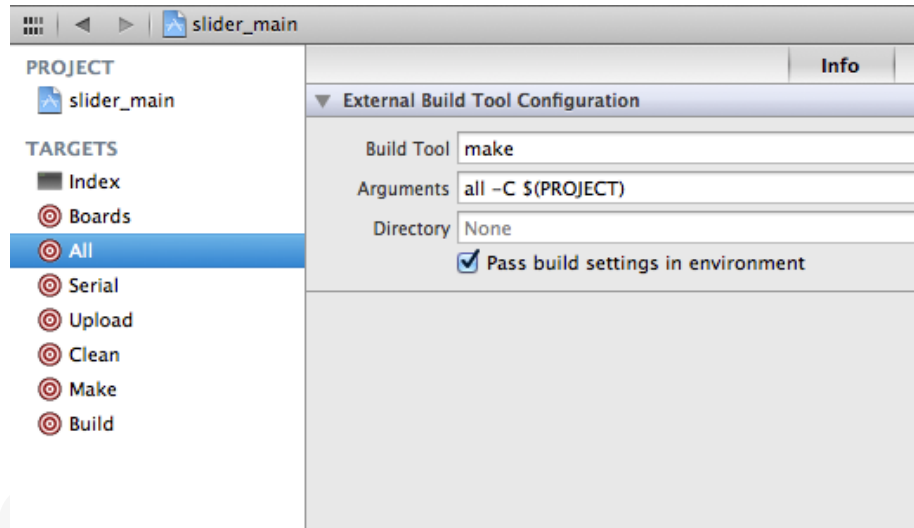
So Xcode needs to be taught where to find them.

This is an optional procedure.

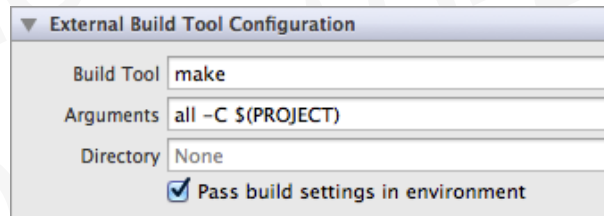


Select the target All.

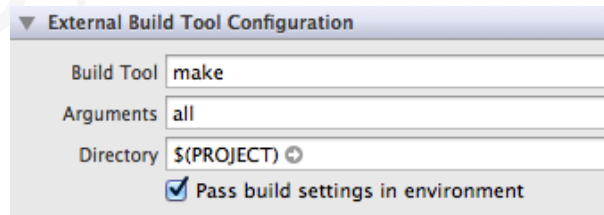
Feel free to update other targets you use often, as Build and Make.



By default, the template mentions `all -C $(PROJECT)` as arguments.



Remove `-C $(PROJECT)` from the arguments and add `$(PROJECT)` into directory.



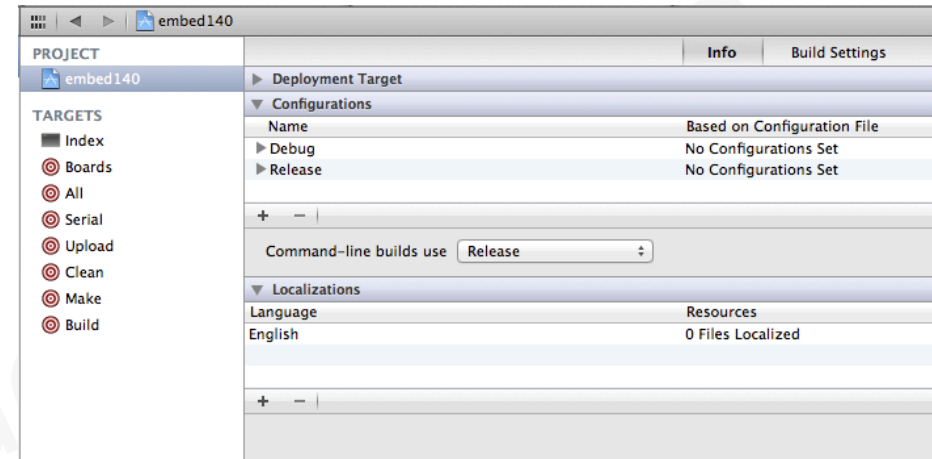
This manual procedure is considered as an issue and reported under [#12 Define Directory for a Target](#).

You're ready now!

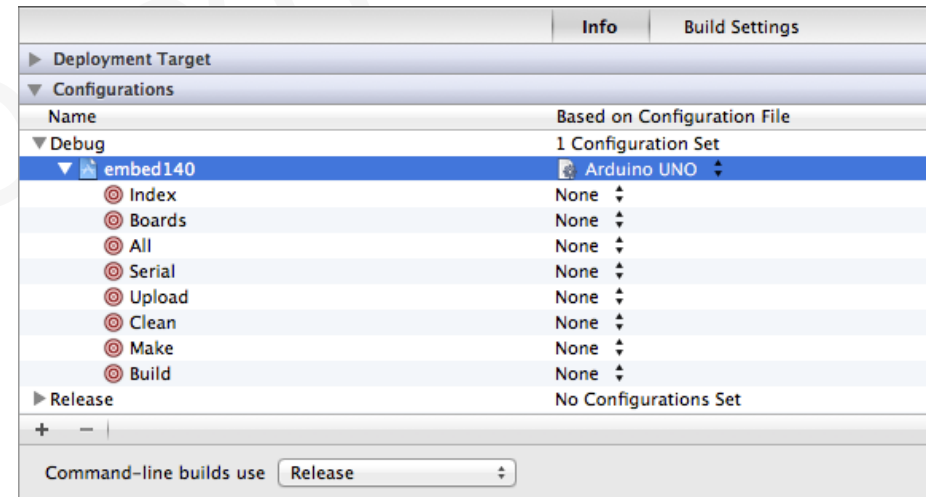
## 4. Use the Project

### 4.1. Change the Board

To change the board, select the project and the Info pane.

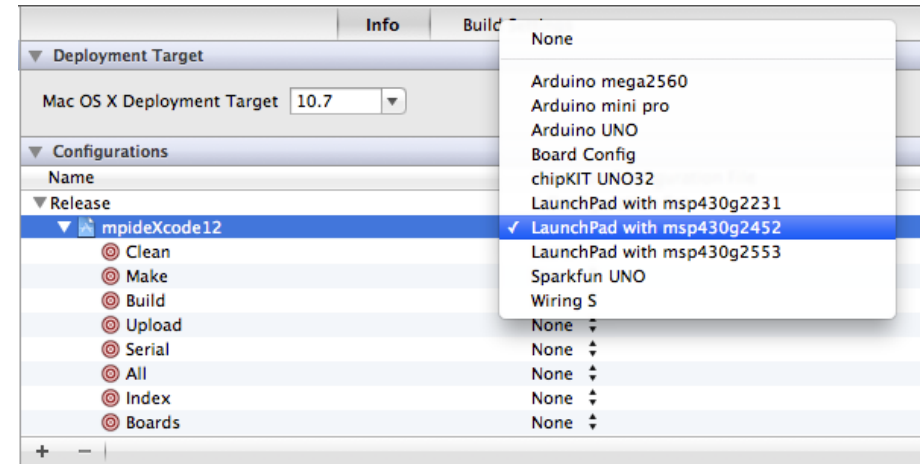


A drop-down list shows the boards available.



Just select one.

If your board isn't listed, you can create a configuration file.  
Please refer to [§6 Add a file](#).



The sketch contains conditional `#include` for the supported IDEs.

They are based on the micro-controller reference or on the IDE version. For more information, please refer to [Manage Code for Multiple Platforms](#).

The version of Arduino, either 0023 or 1.0, is detected automatically and the corresponding library `Arduino.h` or `WProgram.h` selected accordingly.

Those `#include` statements are included on a code snippet for easy use.

Please refer to [Insert Code Snippet with #include Statements](#).

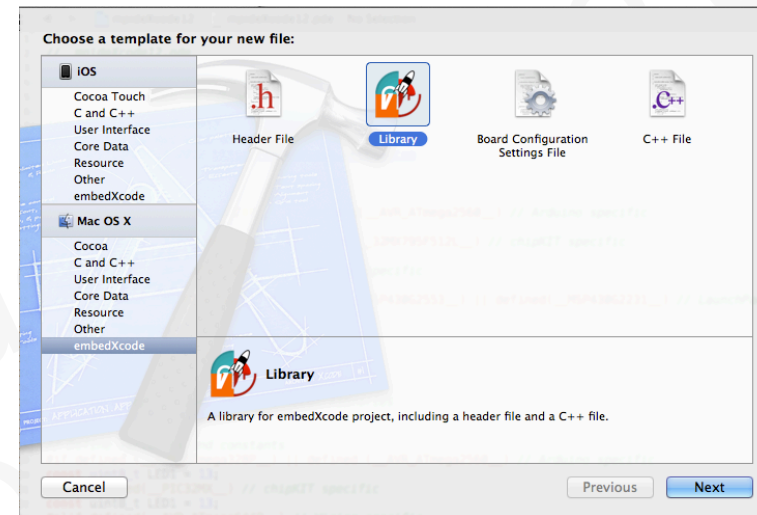
```
// Core library – MCU-based
#if defined(__AVR_ATmega328P__) || defined(
  (__AVR_ATmega2560__) // Arduino specific
  #if defined(ARDUINO) && (ARDUINO >= 100)
    #include "arduino.h" // – for Arduino 1.0
  #else
    #include "WProgram.h" // – for Arduino 23
  #endif
#elif defined(__32MX320F128H__) ||
  defined(__32MX795F512L__) // chipKIT specific
  #include "WProgram.h"
#elif defined(__AVR_ATmega644P__) // Wiring specific
  #include "Wiring.h"
#elif defined(__MSP430G2452__) ||
  defined(__MSP430G2553__) || defined(__MSP430G2231__) //
  LaunchPad specific
  #include "Energia.h"
#elif defined(MCU_STM32F103RB) ||
  defined(MCU_STM32F103ZE) || defined(MCU_STM32F103CB) ||
  defined(MCU_STM32F103RE) // Maple specific
  #include "WProgram.h"
#endif
```

When a board is selected, the configuration file defines parameters for code-sense.

## 4.2. Add a File

Call the menu File > New > New File... or press ⌘N

Select embedXcode and then Header File, C++ file, Library or Board Configuration Settings File.



Library creates a header file and a C++ code file with the `#include "LocalLibrary.h"` statement ready!

Board Configuration Settings File allows to define the settings for a new board.

Specify:

- BOARD\_TAG is the unique identifier of the board, found in the Boards.txt file.
- BOARD\_PORT defines the USB port to be used. This parameter is optional.
- GCC\_PREPROCESSOR\_DEFINITIONS is the name of the micro-controller of the board, found in the Boards.txt file.
- HEADER\_SEARCH\_PATHS needs to be updated with the reference of the IDE, ARDUINO\_APP for Arduino, MPIDE\_APP for Mpide, WIRING\_APP for Wiring, or ENERGIA\_APP for Energia.

The last two parameters improves the selection of the headers for code-sense.



```
1 //
2 // Board Config.xcconfig
3 // Board config file
4 //
5 // Developed with embedXcode
6 //
7 // Project mpideXcode12
8 // Created by Rei VILO on 17/04/12
9 // Copyright (c) 2012 http://sites.google.com/site/vilorei
10 //
11
12 // Board identifier
13 // see Boards.txt for <tag>.name=Arduino Uno (16 MHz)
14 //
15 BOARD_TAG = uno
16
17 // Port (optional)
18 // most common are /dev/tty.usbserial* and /dev/tty.usbmodem*
19 BOARD_PORT = /dev/tty.usbserial*
20
21 // References for Xcode code-sense
22 // see Boards.txt for <tag>.build.mcu=<GCC_PREPROCESSOR_DEFINITIONS>
23 // specify ARDUINO_APP for Arduino, MPIDE_APP for Mpide, WIRING_APP for Wiring, ENERGIA_APP for Energia
24 //
25 GCC_PREPROCESSOR_DEFINITIONS = __AVR_ATmega328P__
26 HEADER_SEARCH_PATHS = $(ARDUINO_APP)/** $(SKETCHBOOK_DIR)/Libraries/**
27
```

### 4.3. Insert #include Statements From Code Snippet

A code snippet includes all the #include statements for selecting the core libraries.

There are two versions: one MCU-based and another IDE-based.

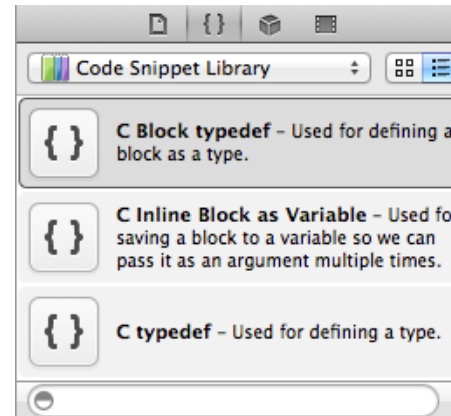
For more information, please refer to [Manage Code for Multiple Platforms](#).

```
// Core library – MCU-based
#if defined (__AVR_ATmega328P__) || defined
(__AVR_ATmega2560__) // Arduino specific
  #if defined(ARDUINO) && (ARDUINO >= 100)
    #include "arduino.h" // – for Arduino 1.0
  #else
    #include "WProgram.h" // – for Arduino 23
  #endif
#elif defined(__32MX320F128H__) ||
defined(__32MX795F512L__) // chipKIT specific
#include "WProgram.h"
#elif defined(__AVR_ATmega644P__) // Wiring specific
#include "Wiring.h"
#elif defined(__MSP430G2452__) || defined(__MSP430G2553__)
|| defined(__MSP430G2231__) // LaunchPad specific
#include "Energia.h"
#elif defined(MCU_STM32F103RB) || defined(MCU_STM32F103ZE)
|| defined(MCU_STM32F103CB) || defined(MCU_STM32F103RE) //
Maple specific
#include "WProgram.h"
#endif
```

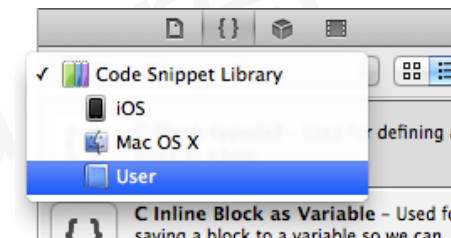
To display the code snippets, click on the right button of the View selector.



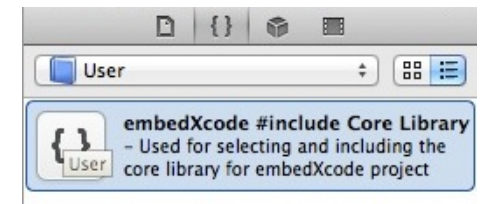
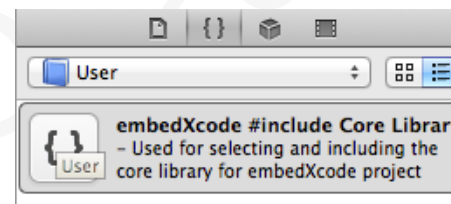
The library of code snippets is at the bottom of the right-most pane.



Select User on the drop-down list.



Select the embedXcode #include Core Library snippet.



Click and drop to the destination.



The pointer changes for

The cursor appears on the code.

A screenshot of an IDE window titled 'mpideXcode12' with a sub-tab 'LocalLibrary.h'. The code is a C header file. It starts with a comment block on lines 1-10, followed by a blank line on line 11, a vertical bar on line 12, and a preprocessor directive block on lines 14-19. A cursor is positioned at the end of line 12. A small icon, identical to the one in the previous block, is overlaid on the code area near line 12.

```
1 //  
2 // LocalLibrary.h  
3 // Library header  
4 //  
5 // -----  
6 //  
7 // Developed with embedXcode  
8 //  
9 // Project mpideXcode12  
10 // Created by Rei VILO on 27/03/12  
11 // Copyright (c) 2012 http://sites.google.com/site/vilorei  
12 //  
13 |  
14 #ifndef embed1_LocalLibrary_h  
15 #define embed1_LocalLibrary_h  
16  
17  
18  
19 #endif  
20
```



The code is inserted.

```
mpideXcode12 > LocalLibrary.h > No Selection
1 //
2 // LocalLibrary.h
3 // Library header
4 //
5 // -----
6 // Developed with embedXcode
7 //
8 // Project mpideXcode12
9 // Created by Rei VILO on 27/03/12
10 // Copyright (c) 2012 http://sites.google.com/site/vilorei
11 //
12 // Core library
13 #if defined (__AVR_ATmega328P__) || defined (__AVR_ATmega2560__) // Arduino specific
14 #include "WProgram.h" // - for Arduino 0023
15 // #include "Arduino.h" // - for Arduino 1.0
16 #elif defined (__32MX320F128H__) || defined (__32MX795F512L__) // chipKIT specific
17 #include "WProgram.h"
18 #elif defined (__AVR_ATmega644P__) // Wiring specific
19 #include "Wiring.h"
20 #elif defined (__MSP430G2452__) || defined (__MSP430G2553__) || defined (__MSP430G2231__) // LaunchPad
21 // specific
22 #include "Energia.h"
23 #endif
24
25 #ifndef embed1_LocalLibrary_h
26 #define embed1_LocalLibrary_h
27
28
29 #endif
30
```

#### 4.4. Manage Code for Multiple Platforms

Managing code for multiples platforms is a real issue, and needs to take into account two dimensions:

- the boards, as Arduino Uno or Wiring S,
- and the frameworks, some of them with incompatible releases, as Arduino 0023, Arduino 1.0 or Wiring.

This can be done in two ways, MCU-based or IDE-based. Both are valid from an embedXcode point of view.

The first approach is **MCU-based** and relies on the micro-controller type.

This approach is compatible with the respective IDEs, as no new environment variable is created or required.

In the Arduino case, two frameworks exist so the IDE variable is required for disambiguation.

The second approach is **IDE-based**. The IDEs defines a specific environment variable combine boards type and framework version.

For example, the Arduino IDE defines ARDUINO=101 and passes it on to the tool-chain with -D, as -DARDUINO=101.

As at today, this approach is compatible with all IDEs.

The Arduino, Wiring and Maple IDEs set one single environment variables: ARDUINO=23, ARDUINO=101, WIRING=100 and MAPLE\_IDE.

The remaining two IDEs, MPIDE and Energia defines two environment variables, their own on top of the default one: MPIDE=23 and ARDUINO=23, ENERGIA=6 and ARDUINO=101.

So embedXcode tests ARDUINO after the specific variables.

```
// Core library – MCU-based
#if defined (__AVR_ATmega328P__) || defined
(__AVR_ATmega2560__) // Arduino specific
  #if defined(ARDUINO) && (ARDUINO >= 100)
    #include "arduino.h" // – for Arduino 1.0
  #else
    #include "WProgram.h" // – for Arduino 23
  #endif
#elif defined(__32MX320F128H__) ||
defined(__32MX795F512L__) // chipKIT specific
  #include "WProgram.h"
#elif defined(__AVR_ATmega644P__) // Wiring specific
  #include "Wiring.h"
#elif defined(__MSP430G2452__) || defined(__MSP430G2553__)
|| defined(__MSP430G2231__) // LaunchPad specific
  #include "Energia.h"
#else // error
  #error Platform not defined
#endif
```

```
// Core library – IDE-based
#if defined(WIRING) // Wiring specific
  #include "Wiring.h"
#elif defined(MAPLE_IDE) // Maple specific
  #include "WProgram.h"
#elif defined(MPIDE) // chipKIT specific
  #include "WProgram.h"
#elif defined(ENERGIA) // LaunchPad specific
  #include "Energia.h"
#elif defined(ARDUINO) && (ARDUINO >= 100) // Arduino 1.0
specific
  #include "Arduino.h"
#elif defined(ARDUINO) && (ARDUINO < 100) // Arduino 23
specific
  #include "WProgram.h"
#else // error
  #error Platform not defined
#endif
```

The second approach allows more compact and easier to read code, and doesn't require maintenance at code level when a new MCU appears.

```
#if defined(WIRING) // Wiring specific
    text = in.trim();
#elif defined(ARDUINO) && (ARDUINO>=100) // for Arduino 1.0
    text.trim();
#else // all other cases
    text = text.trim();
#endif
```

#### 4.5. Re-Index the Keywords for Code-Sense

Code-sense is a major feature of Xcode.

Apart from pretty colours on the code and enhanced visibility, code-sense brings:

- auto-completion,
- code-snippets and check-as-you-type code monitoring,
- click-to-definition



If code-sense doesn't work, we need to force a re-indexing of the key words.

To do so, first close the project.

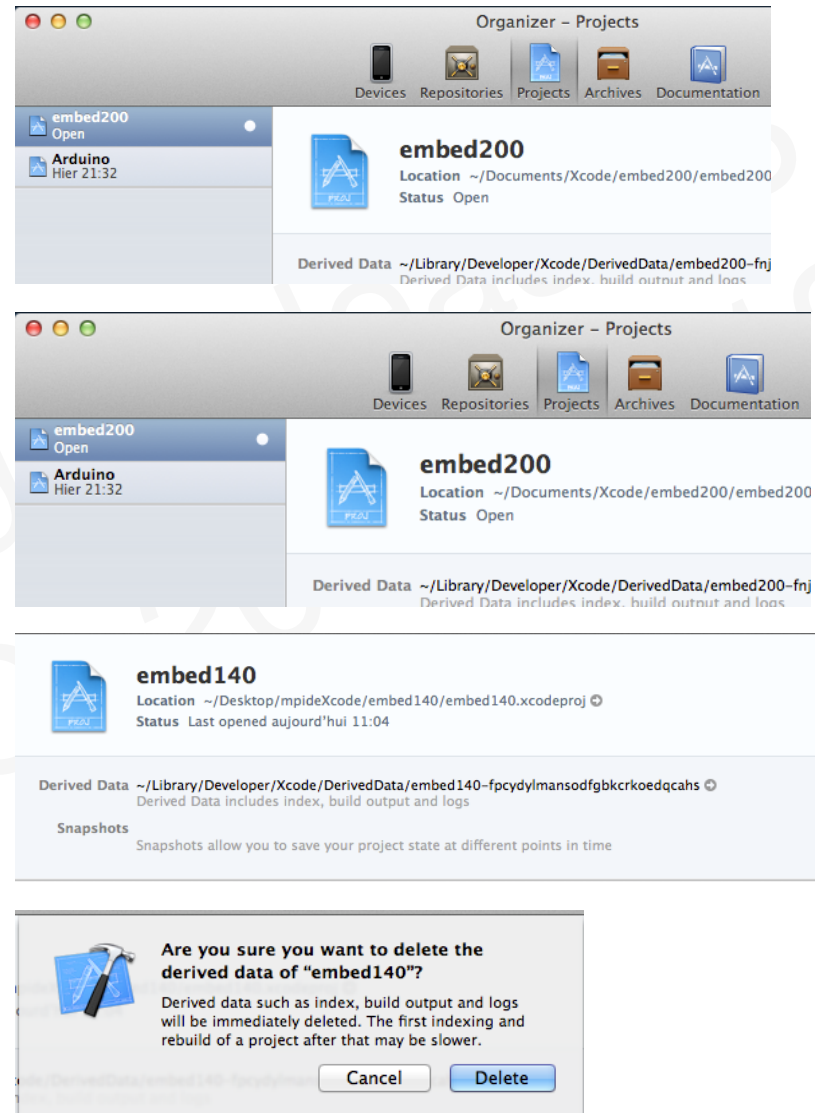
Call the menu Window > Organiser and select the Projects pane.

Select then the project.

The index is saved within the Derived Data folder.

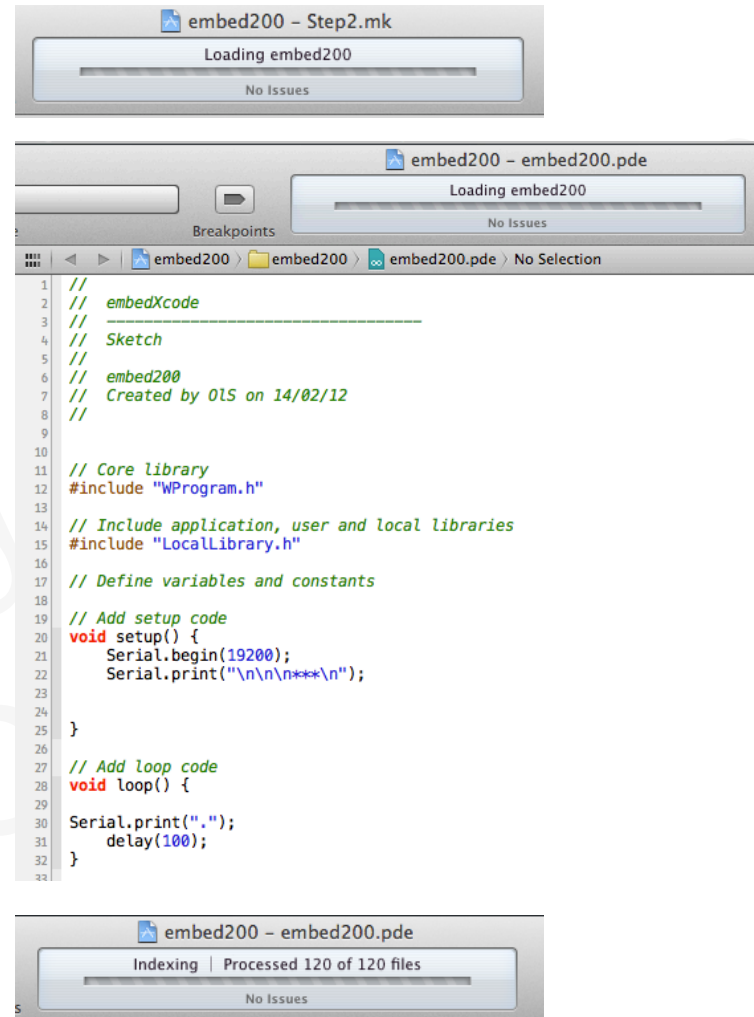
Click on the Delete button to delete them.

Confirm the deletion.



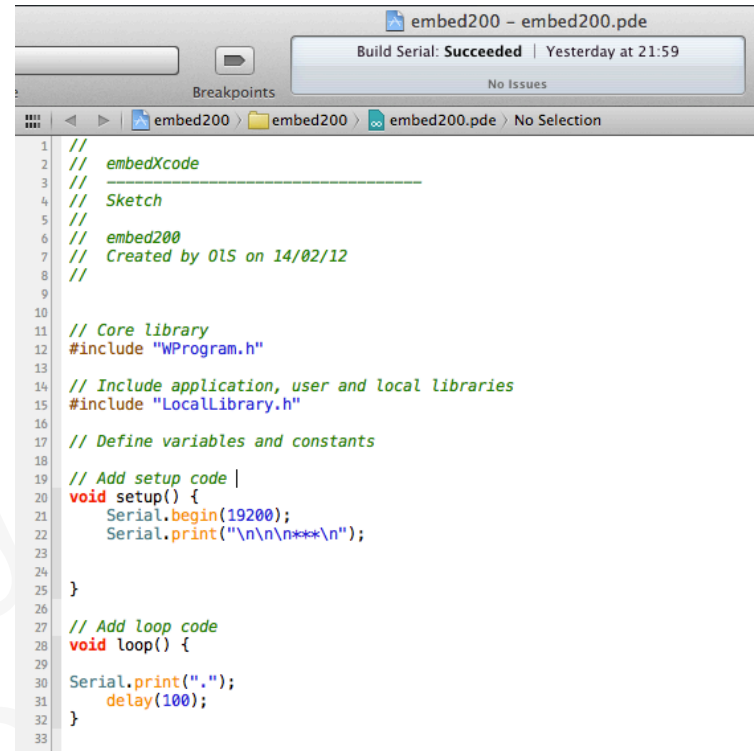
Load the project.

There's no code-sense yet: everything is black-and-white, except standard C++ keywords.



The index is being built.

When the index is built, code-sense shows pretty colours.



The screenshot shows the Arduino IDE interface with a file named 'embed200.pde' open. The top status bar indicates 'Build Serial: Succeeded' and 'No Issues'. The breadcrumb navigation shows the file path: 'embed200 > embed200 > embed200.pde'. The code editor displays the following code with syntax highlighting:

```
1 //  
2 // embedXcode  
3 // -----  
4 // Sketch  
5 //  
6 // embed200  
7 // Created by OLS on 14/02/12  
8 //  
9  
10  
11 // Core library  
12 #include "WProgram.h"  
13  
14 // Include application, user and local libraries  
15 #include "LocalLibrary.h"  
16  
17 // Define variables and constants  
18  
19 // Add setup code |  
20 void setup() {  
21   Serial.begin(19200);  
22   Serial.print("\n\n\n***\n");  
23  
24 }  
25  
26  
27 // Add loop code  
28 void loop() {  
29  
30   Serial.print(".");  
31   delay(100);  
32 }  
33
```

## 5. Appendixes

### 5.1. What Has Been Tested

| Platform  | What Has Been Tested          | What Has Not Been Tested | Reference Boards  |
|-----------|-------------------------------|--------------------------|---|
| Arduino   | Sketch compilation and upload |                          | Arduino Uno, Arduino mega2560 and Arduino mini pro      |
| chipKIT   | Sketch compilation and upload |                          | chipKIT UNO32   |
| Wiring    | Sketch compilation and upload |                          | Wiring S  |
| LaunchPad | Sketch compilation and upload |                          | LaunchPad with MSP430G2542, MSP430G2331 and MSP430G2553 |
| Maple     | Sketch compilation and upload |                          | Maple revision 5  |

### 5.2. Known Issues

Most of the issues are related to unknown keywords for the Xcode 4.3 template.

Most critical issues are:

[#2 Populated Sources List for Code-Sense](#)

[#3 Declare PDE File as C++ Source](#)

[#12 Define Directory for a Target](#)

### 5.3. Contributions and References

See documents on the About folder for additional contributions and detailed references.

## 5.4. Version History

| Date         | mpideXcode | embedXcode | Installation Guide | Comment   |
|--------------|------------|------------|--------------------|---|
| Jan 22, 2012 | a          |            |                    | Initial release   |
| Feb 02, 2012 | b          |            |                    | chipKIT operational   |
| Feb 04, 2012 | c          |            |                    | Code-sense operational  |
| Feb 06, 2012 | d          |            |                    | User libraries  |
| Feb 06, 2012 | e          |            |                    | Code checking while typing with Index as target                           |
| Feb 08, 2012 | f          |            |                    | Code-sense, click-to-error with standard targets                          |
| Feb 14, 2012 | g          | 1          | 1                  | Multi-application, check-as-you-type, template                            |
| Feb 18, 2012 | 6          | 2          | 2                  | Improvements  |
| Feb 26, 2012 |            | 3          |                    | Modular makefiles   |
| Mar 06, 2012 | 7          | 4          | 3                  | Arduino 1.0 implementation  |
| Mar 12, 2012 | 8          | 5          |                    | Bugs fixed  |
| Mar 15, 2012 | 9          | 6          | 4                  | All Arduino/chipKIT/Wiring/Energia and user libraries included by default |
| Apr 05, 2012 | 10         | 7          | 5                  | Wiring 1.0 and Energia 1.0 implementations                                |
| Apr 08, 2012 | 11         | 8          | 5                  | Bugs fixed  |
| Apr 16, 2012 | 12         | 9          | 6                  | Code-sense reference defined by selected board                            |
| May 23, 2012 | 13         | 10         | 7                  | LeafLabs Maple implementation   |
| Jun 03, 2012 | 14         | 11         | 8                  | MCU- or IDE-based platform identification for #include library            |
| Jun 05, 2012 | 15         | 12         | 8                  | IDE-based identification for all platforms                                |



## 5.5. Referenced Boards

Not all boards have been tested. Please refer to [What Has Been Tested](#) for more details.

According to the Boards.txt files:

| Arduino  | chipKIT                              | Wiring                                | LaunchPad                  | Maple                                 |
|--|--------------------------------------|---------------------------------------|----------------------------|---------------------------------------|
| Arduino Uno  | chipKIT UNO32                        | Wiring S @ 16 MHz                     | LaunchPad with mps430g2452 | LeafLabs Maple Rev 3+ to Flash        |
| Arduino Duemilanove or Nano w/ ATmega328             | chipKIT MAX32                        | Wiring S with Play Shield @ 16 MHz    | LaunchPad with mps430g2231 | LeafLabs Maple Rev 3+ to RAM          |
| Arduino Diecimila, Duemilanove, or Nano w/ ATmega168 | chipKIT MAX32-USB for Serial         | Wiring V1.0/Wiring Mini V1.0 @ 16 MHz | LaunchPad with mps430g2553 | LeafLabs Maple Mini Rev 2 to Flash    |
| Arduino Mega 2560                                    | Cerebot MX3cK                        | Wiring V1.1 ATmega1281 @ 16 MHz       |                            | LeafLabs Maple Mini Rev 2 to RAM      |
| Arduino Mega (ATmega1280)                            | Cerebot MX4cK                        | Wiring V1.1 ATmega2561 @ 16 MHz       |                            | LeafLabs Maple RET6 Edition to Flash  |
| Arduino Mini   | Cerebot MX7cK                        |                                       |                            | LeafLabs Maple RET6 Edition to RAM    |
| Arduino Fio  | Cerebot 32MX4                        |                                       |                            | LeafLabs Maple Native (Beta) to Flash |
| Arduino BT w/ ATmega328                              | Cerebot 32MX7                        |                                       |                            | LeafLabs Maple Native (Beta) to RAM   |
| Arduino BT w/ ATmega168                              | Microchip PIC32 Starter kit          |                                       |                            |                                       |
| LilyPad Arduino w/ ATmega328                         | Microchip PIC32 Ethernet Starter kit |                                       |                            |                                       |
| LilyPad Arduino w/ ATmega168                         | Microchip PIC32 USB Starter kit II   |                                       |                            |                                       |

| Arduino  | chipKIT                                 | Wiring | LaunchPad | Maple |
|--|---|--------|-----------|-------|
| Arduino Pro or Pro Mini (5V, 16 MHz) w/ ATmega328  | Microchip PIC32 Explorer 16             |        |           |       |
| Arduino Pro or Pro Mini (5V, 16 MHz) w/ ATmega168  | MirkoElektronika PIC32 Multimedia Board |        |           |       |
| Arduino Pro or Pro Mini (3.3V, 8 MHz) w/ ATmega328 | MirkoElektronika PIC32 mikroMedia Board |        |           |       |
| Arduino Pro or Pro Mini (3.3V, 8 MHz) w/ ATmega168 | Pic32 UBW32-MX460                       |        |           |       |
| Arduino NG or older w/ ATmega168                   | Pic32 UBW32-MX795                       |        |           |       |
| Arduino NG or older w/ ATmega8                     | Pic32 CUI32-Development Stick           |        |           |       |

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