USING THE ARDUINO UNO WITH ECLIPSE

Milwaukee School of Engineering

Created: June 2011

Last Update: 26 September 2012

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ECLIPSE OVERVIEW

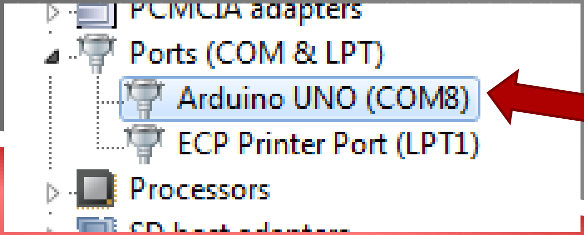
- Eclipse is an open-source software development system
- Can be used to program the Arduino UNO board in C or C++

- Allows greater access to and control of microcontroller subsystems

BEFORE CONTINUING…

- The Arduino UNO drivers must be installed!
  - For details, see the Arduino Installation tutorial: https://faculty-web.msoe.edu/prust/arduino
- Determine which COM port is assigned to the Arduino UNO board:
  - In Windows, click on the **Start Menu** and open the **Control Panel**
  - Choose **System and Security** and then, under **System**, open the **Device Manager**
  - Under **Ports (COM & LPT)** locate "Arduino UNO"

Device Manager



PCMCIA adapters
Ports (COM & LPT)
Arduino UNO (COM8)
ECP Printer Port (LPT1)
Processors
SD host adapters

IMPORTANT:
Note the "COM" port

OVERVIEW

- **Step 1**: Installing WinAVR
- **Step 2**: “Installing” Eclipse
- **Step 3**: Using Eclipse
- **Step 4**: Building a Project and Testing the UNO
- **Step 5**: Creating a New Project
- **Step 6**: Using the MSOE Support Functions

INSTALLING WINAVR

- WinAVR contains the AVR toolchain (plus many other useful tools):
  - avr-gcc: compiles our C programs
  - avr-dude: programs the Arduino UNO
- Eclipse will use WinAVR automatically – we just need to install it!
- Download the latest release of WinAVR from

  https://faculty-web.msoe.edu/prust/arduino
- Run the installation using default settings.

IMPORTANT: You must use the default installation directory!
C:\WinAVR-20100110

“INSTALLING” ECLIPSE

- Download the Eclipse archive (.zip file) from

  https://faculty-web.msoe.edu/prust/arduino

- Extract the .zip file to your D:\ drive
- After unzipping, you should see two folders:
  - D:\eclipse
  - D:\ARDUINOworkspace

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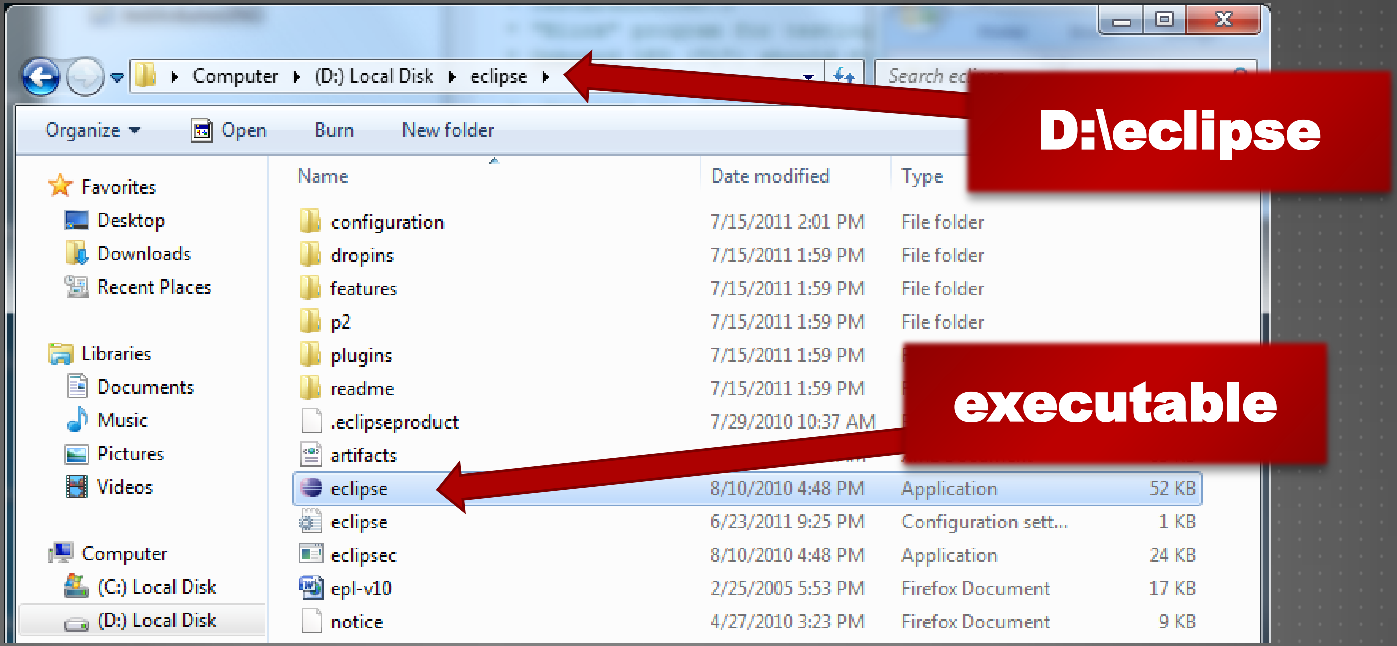
“INSTALLING” ECLIPSE

- The executable is located in D:\eclipse. Double-click to start Eclipse.



Name	Date modified	Type	
configuration	7/15/2011 2:01 PM	File folder	
dropins	7/15/2011 1:59 PM	File folder	
features	7/15/2011 1:59 PM	File folder	
p2	7/15/2011 1:59 PM	File folder	
plugins	7/15/2011 1:59 PM		
readme	7/15/2011 1:59 PM		
.eclipseproduct	7/29/2010 10:37 AM		
artifacts			
eclipse	8/10/2010 4:48 PM	Application	52 KB
eclipse	6/23/2011 9:25 PM	Configuration sett...	1 KB
eclipsec	8/10/2010 4:48 PM	Application	24 KB
epl-v10	2/25/2005 5:53 PM	Firefox Document	17 KB
notice	4/27/2010 3:23 PM	Firefox Document	9 KB

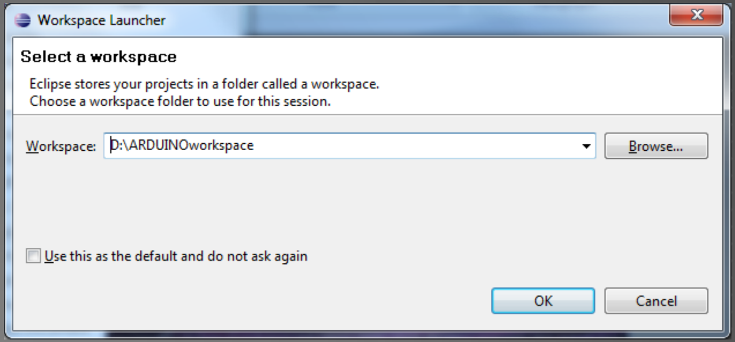
D:\eclipse

executable

- For quicker access to Eclipse, create a shortcut to the executable.

USING ECLIPSE

- You will see the following screen - it defines "D:\ARDUINOworkspace" as the location for your Arduino projects
  - Select "OK"


Workspace Launcher

Select a workspace

Eclipse stores your projects in a folder called a workspace.
Choose a workspace folder to use for this session.

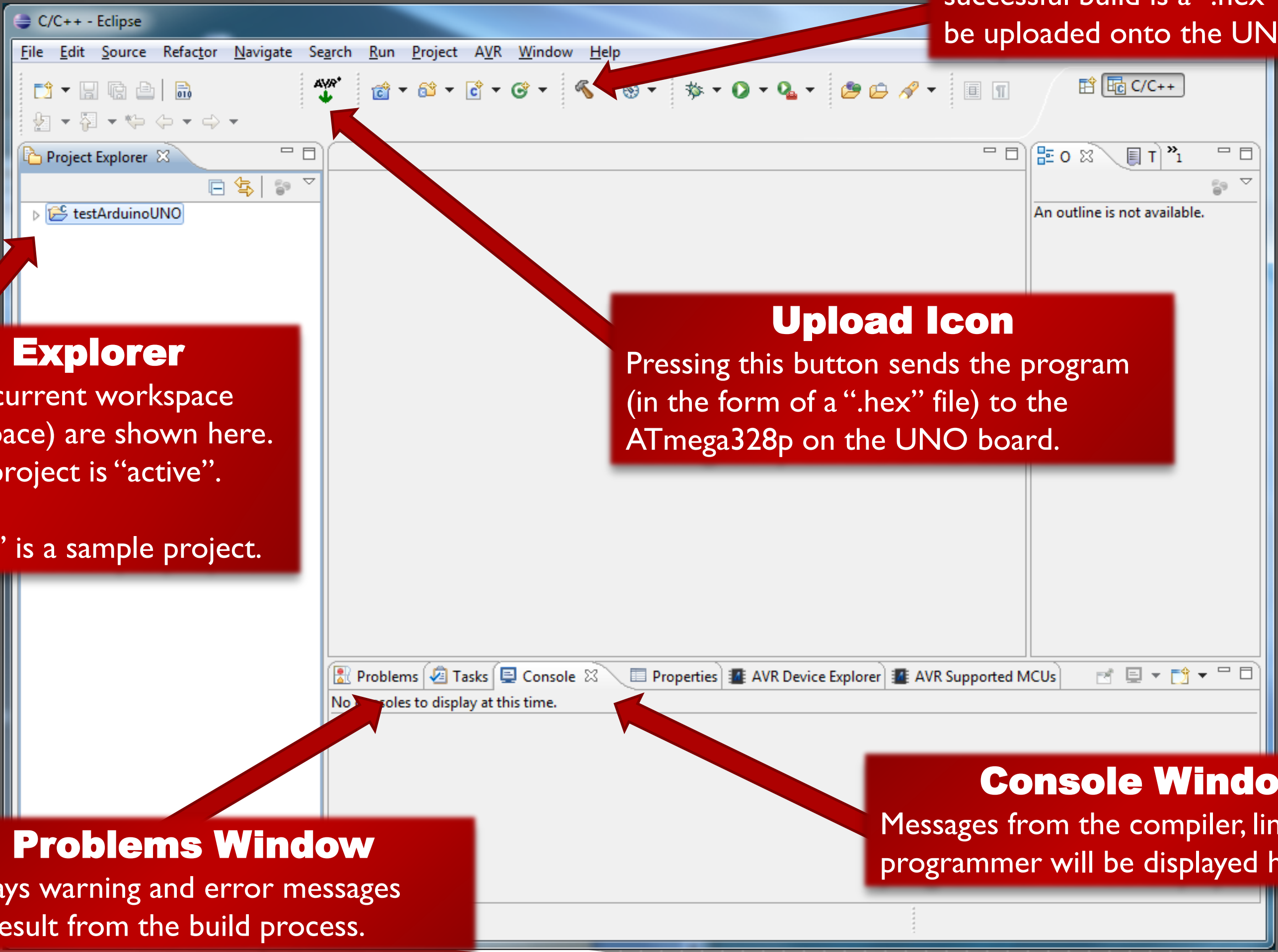
Workspace: D:\ARDUINOworkspace

□ Use this as the default and do not ask again

- You will then see the Eclipse workbench

(continued…)

USING ECLIPSE



An outline is not available.

No consoles to display at this time.

Build Icon

Pressing this button results in a "build" of the active project. The result of a successful build is a ".hex" file which can be uploaded onto the UNO board.

Upload Icon

Pressing this button sends the program (in the form of a ".hex" file) to the ATmega328p on the UNO board.

Project Explorer

All projects in the current workspace (ARDUINOworkspace) are shown here. Only the selected project is "active".

"testArduinoUNO" is a sample project.

Problems Window

Displays warning and error messages that result from the build process.

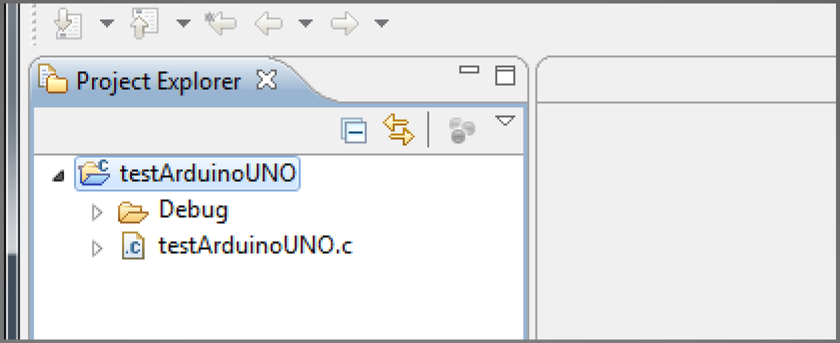
Console Window

Messages from the compiler, linker, and programmer will be displayed here.

BUILDING A PROJECT

- The project "testArduinoUNO" has been included as a sample project

- Expand the project in the Project Explorer. You should see the following:



- "testArduinoUNO.c" is the source code. Double-click to open and examine the code.

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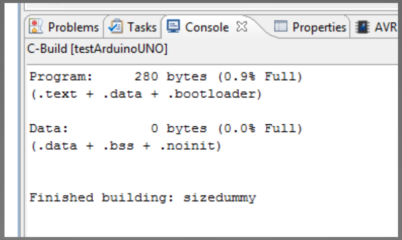
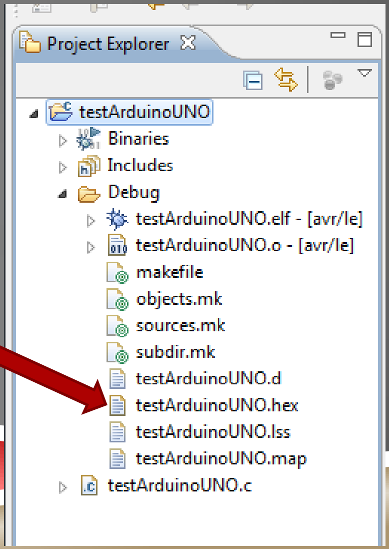
BUILDING A PROJECT

- To build the project, click the build icon
  - The build may take a minute or two
- Information regarding the build process is shown in the console window.



```
C-Build [testArduinoUNO]

Program:     280 bytes (0.9% Full)
(.text + .data + .bootloader)

Data:          0 bytes (0.0% Full)
(.data + .bss + .noinit)


Finished building: sizedummy
```

- The build process generates several files, which can be seen in the Project Explorer window:

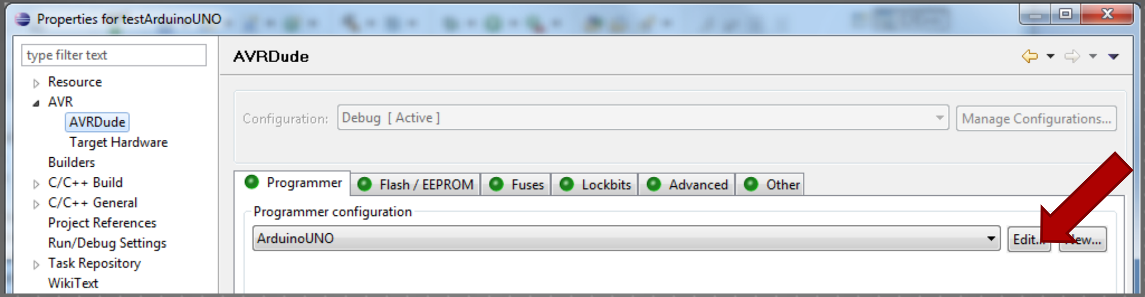


```
testArduinoUNO
  Binaries
  Includes
  Debug
    testArduinoUNO.elf - [avr/le]
    testArduinoUNO.o - [avr/le]
    makefile
    objects.mk
    sources.mk
    subdir.mk
    testArduinoUNO.d
    testArduinoUNO.hex
    testArduinoUNO.lss
    testArduinoUNO.map
  testArduinoUNO.c
```

.hex file used to program the ATmega328p microcontroller

TESTING THE UNO

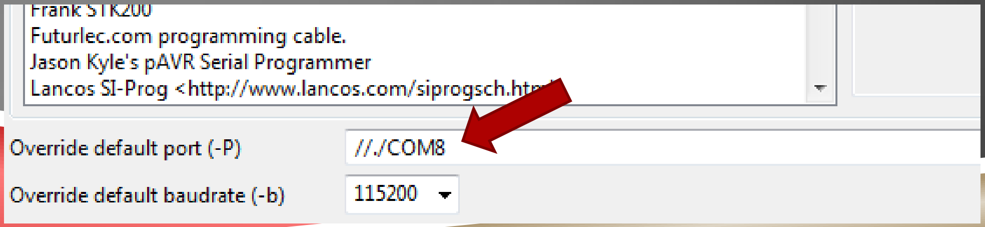
- Eclipse must know which COM port the UNO board is connected to.
- Select "Project" then "Properties"
- Expand the "AVR" arrow and select "AVRDude"
  - The "Programmer configuration" should read "ArduinoUNO". Click the "Edit" button



Configuration: Debug [Active]

Programmer configuration: ArduinoUNO

- Change the "Override default port (-P)" setting to the correct COM port, and select "OK" (twice)
  - For example, the correct setting for COM5 would be: //./COM5



Frank STK200
Futurlec.com programming cable.
Jason Kyle's pAVR Serial Programmer
Lancos SI-Prog <http://www.lancos.com/siprogsch.htm>

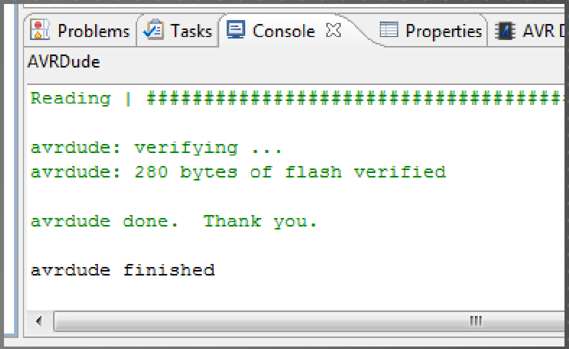
Override default port (-P) //./COM8

Override default baudrate (-b) 115200

TESTING THE UNO

- Connect your Arduino UNO board to your laptop
- Press the upload icon AVR

- Information regarding the upload process is shown in the console window.
  - A successful upload results in the following message:



AVRDude

```
Reading | ####################################

avrdude: verifying ...
avrdude: 280 bytes of flash verified

avrdude done.  Thank you.

avrdude finished
```

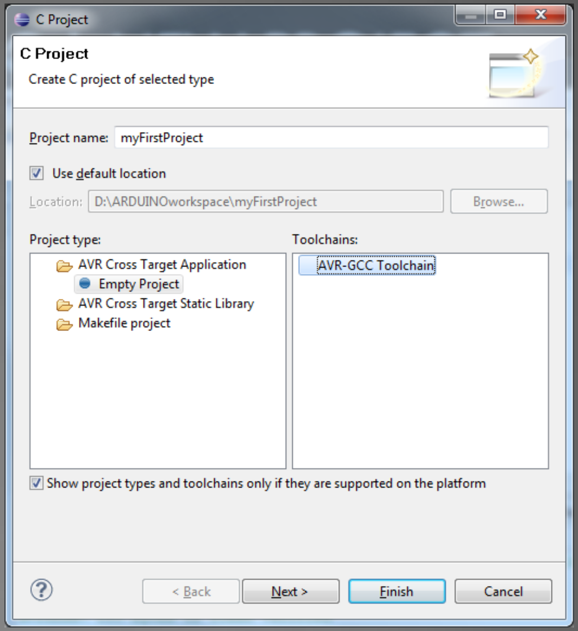
- The **yellow** LED (marked "L") should be blinking!

CREATING A NEW PROJECT

- You will need to create new projects in Eclipse, for example, when you begin a new laboratory assignment.
  - **IMPORTANT**: Keep all of your projects in "ARDUINOworkspace"!

- Select "File – New – C Project"
- Give the project a descriptive name
  - e.g., "myFirstProject"
- Project type: "Empty Project"
- Toolchain: "AVR-GCC Toolchain"

- Select "Next"



C Project

C Project

Create C project of selected type

Project name: myFirstProject

☑ Use default location

Location: D:\ARDUINOworkspace\myFirstProject

Project type:

- AVR Cross Target Application
  - Empty Project
- AVR Cross Target Static Library
- Makefile project

Toolchains:

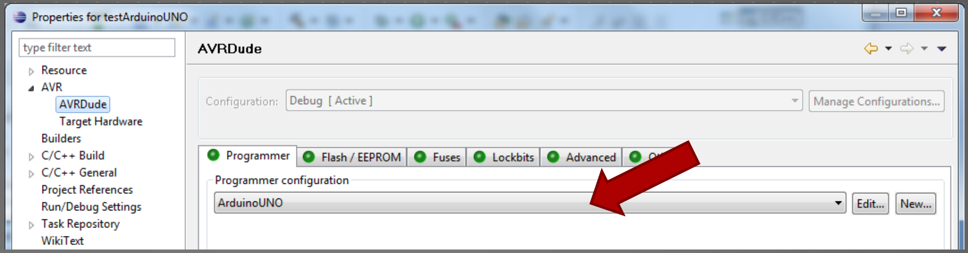
- AVR-GCC Toolchain

☑ Show project types and toolchains only if they are supported on the platform

(continued…)

CREATING A NEW PROJECT

- Click the "Advanced Settings" button
- Expand the "AVR" arrow and select "AVRDude"
- Under "Programmer configuration", use the drop-down box to select "ArduinoUNO"



Properties for testArduinoUNO

type filter text

- Resource
- AVR
  - AVRDude
  - Target Hardware
- Builders
- C/C++ Build
- C/C++ General
- Project References
- Run/Debug Settings
- Task Repository
- WikiText

AVRDude

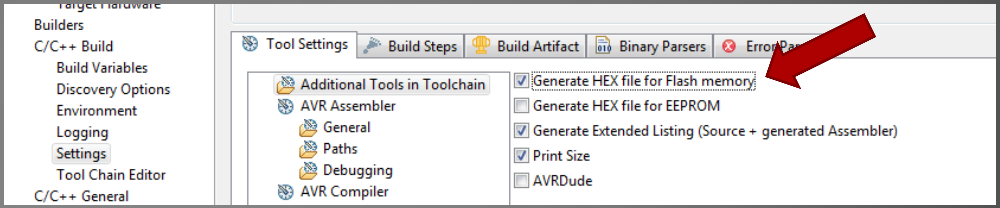
Configuration: Debug [Active] | Manage Configurations...

Programmer | Flash / EEPROM | Fuses | Lockbits | Advanced | Ot

Programmer configuration

ArduinoUNO | Edit... | New...

- Expand the "C/C++ Build" arrow and select "Settings"
- Under the "Tool Settings" tab, check the "Generate HEX file for FLASH memory" option



- Target Hardware
- Builders
- C/C++ Build
  - Build Variables
  - Discovery Options
  - Environment
  - Logging
  - Settings
  - Tool Chain Editor
- C/C++ General

Tool Settings | Build Steps | Build Artifact | Binary Parsers | Error Par

- Additional Tools in Toolchain
- AVR Assembler
  - General
  - Paths
  - Debugging
- AVR Compiler

☑ Generate HEX file for Flash memory

□ Generate HEX file for EEPROM

☑ Generate Extended Listing (Source + generated Assembler)

☑ Print Size

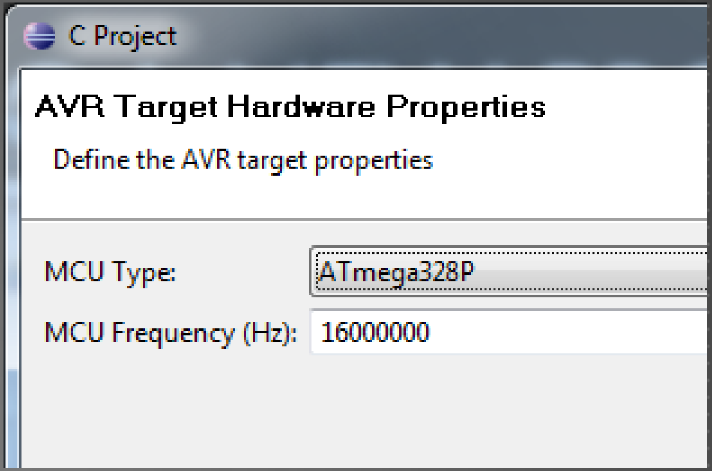
□ AVRDude

- Click "OK", and "Next"

(continued…)

CREATING A NEW PROJECT

- Set the MCU Type to "ATmega328p"
- Set the MCU Frequency (Hz) to "16000000"
  - The Arduino UNO board has a 16MHz crystal which provides the CPU clock to the ATmega328p
- Choose "Finish"



C Project

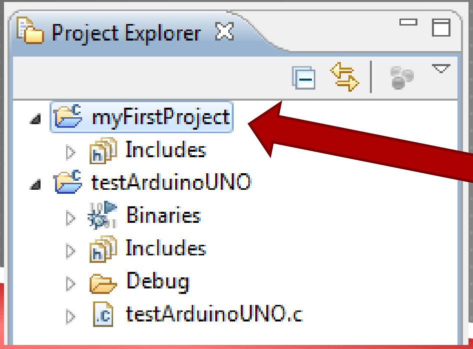
AVR Target Hardware Properties

Define the AVR target properties

MCU Type: ATmega328P

MCU Frequency (Hz): 16000000

- You will see your new project in the Project Explorer

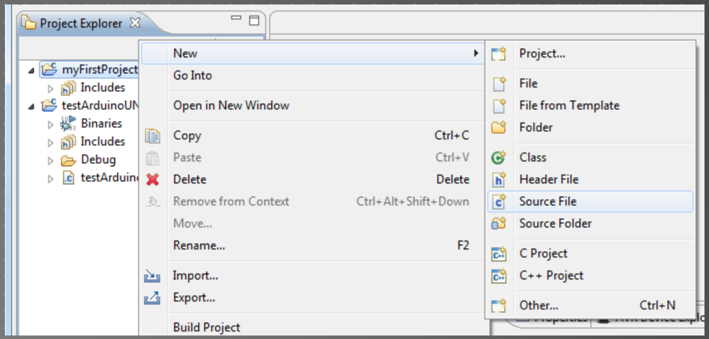


Note: The selected project is "active"

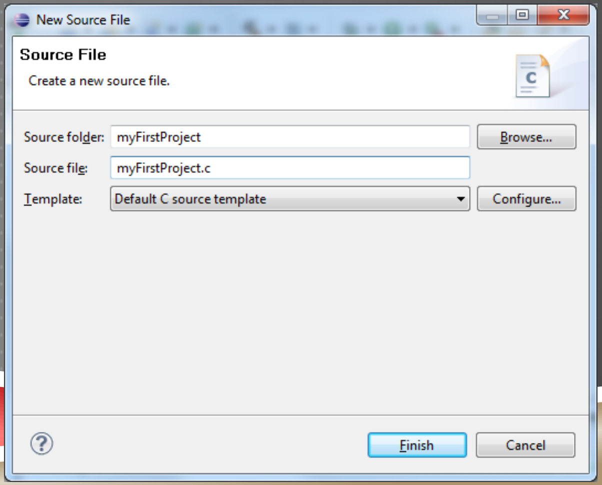
(continued…)

CREATING A NEW PROJECT

- We now need to add a source file (.c)
- From within the Project Explorer, right-click on your project and select "New – Source File"



- Give your source file a descriptive name
  - e.g., "myFirstProject.c"
  - **IMPORTANT:** the file name must end with ".c"
- Choose "Finish"


New Source File

Source File

Create a new source file.

Source folder: myFirstProject

Source file: myFirstProject.c

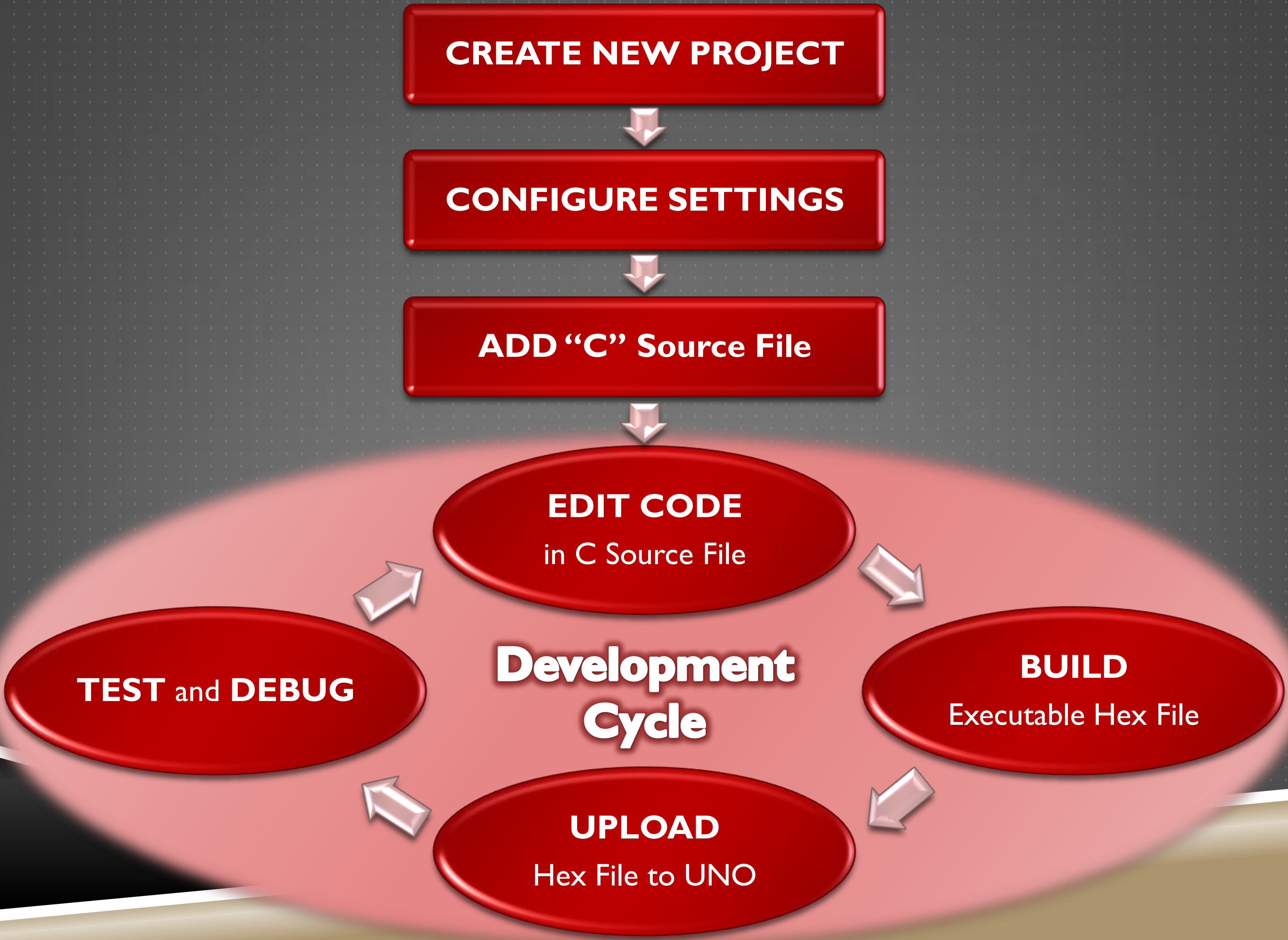
Template: Default C source template

CREATING A NEW PROJECT

- The source file is now part of your project and will be used during the build process.
- As a test, copy/paste the source code from the "testArduinoUNO" project into your new project:
  - Experiment with the delay function to alter the blink rate and pattern
  - Build the new project
  - Upload the .hex file to the UNO board

IMPORTANT:
Only the "active" project will be built!
Make a project "active" by **selecting** it in **Project Explorer**

SUMMARY: USING ECLIPSE



CREATE NEW PROJECT

CONFIGURE SETTINGS

ADD "C" Source File

EDIT CODE
in C Source File

BUILD
Executable Hex File

UPLOAD
Hex File to UNO

TEST and DEBUG

Development Cycle

USING THE “MSOE” SUPPORT FUNCTIONS

- Within “D:\ARDUINOworkspace” is a directory named “MSOE” containing a variety of functions:
  - delay.c – time delay functions
  - lcd.c – LCD control functions
  - bit.c – general purpose functions

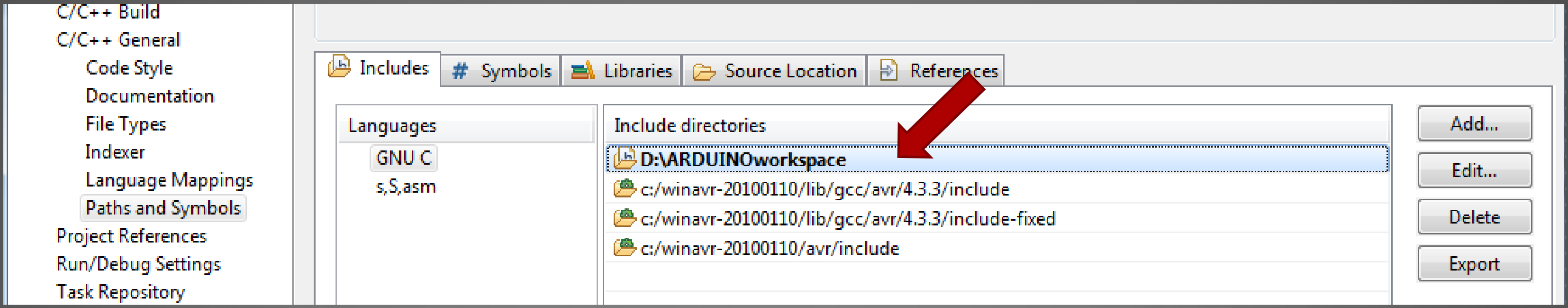
- These functions can easily be used within Eclipse:
  - Must tell Eclipse their location on the filesystem
  - Must “include” the files in our source code
  - Must properly “call” the functions within our program

- Next, we will modify our program to allow precise timing of the “blink”

(continued…)

USING THE "MSOE" SUPPORT FUNCTIONS

- Step 1: Tell Eclipse the location of the MSOE support functions
  - Select "Project" then "Properties"
  - Expand the "C/C++ General" arrow and select "Paths and Symbols"
  - In the "Includes" tab, "Add" an Include directory "D:\ARDUINOworkspace"



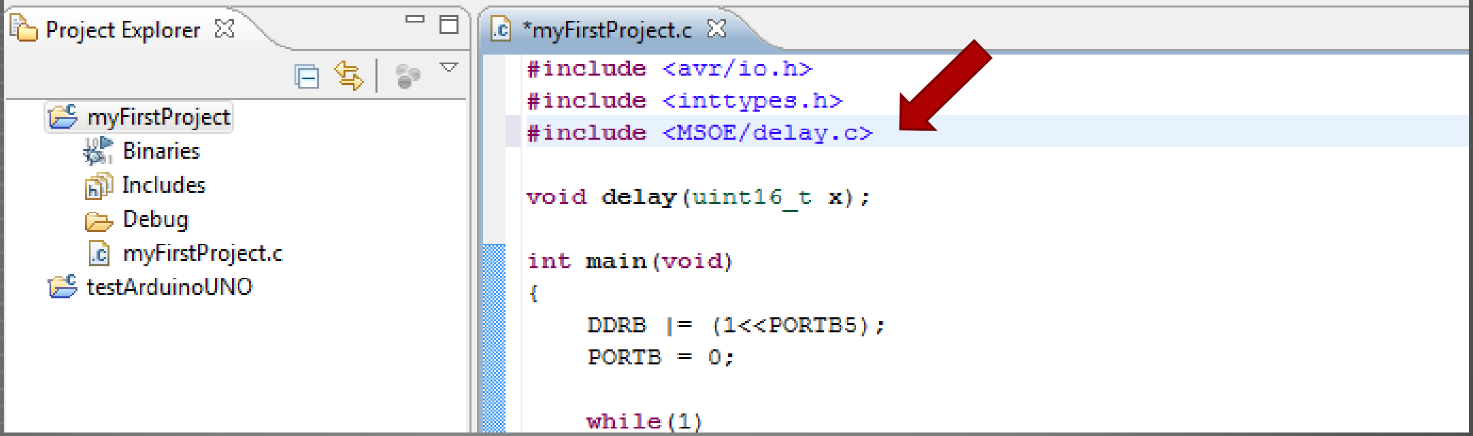
Include directories
D:\ARDUINOworkspace
c:/winavr-20100110/lib/gcc/avr/4.3.3/include
c:/winavr-20100110/lib/gcc/avr/4.3.3/include-fixed
c:/winavr-20100110/avr/include

  - Select "OK"
  - You may be prompted to "rebuild". Choose "Yes".

(continued…)

USING THE "MSOE" SUPPORT FUNCTIONS

- Step 2: Include the MSOE support functions in the source code
  - We will use the "delay_ms()" function to control the timing
  - The function source code must be "included" within our program
    - The function itself is contained in a file called "delay.c"
  - Add the following line of code:

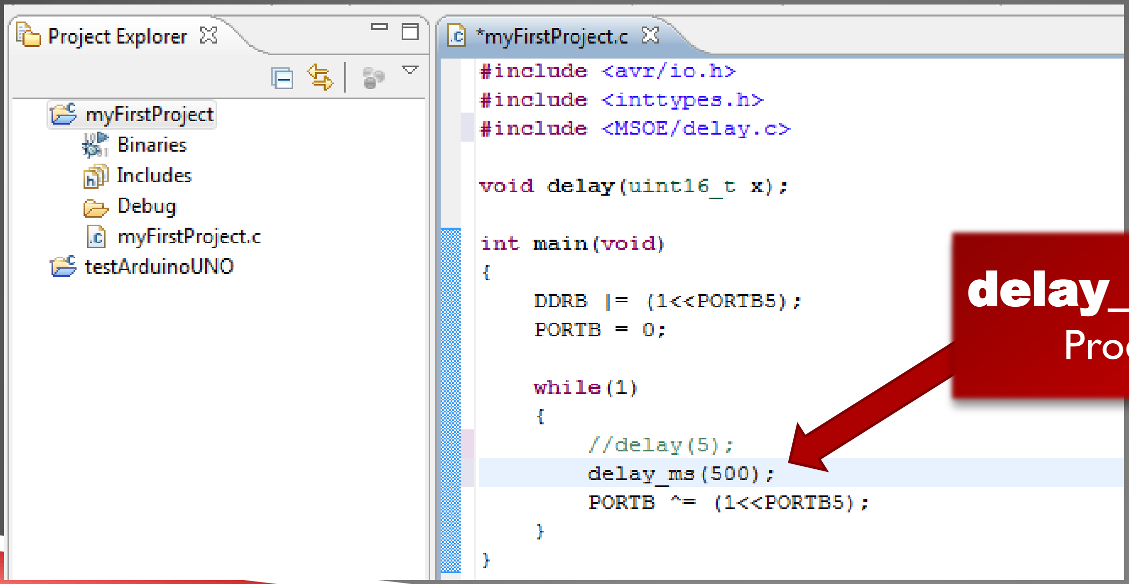


```
#include <avr/io.h>
#include <inttypes.h>
#include <MSOE/delay.c>

void delay(uint16_t x);

int main(void)
{
    DDRB |= (1<<PORTB5);
    PORTB = 0;

    while(1)
```

(continued…)

USING THE “MSOE” SUPPORT FUNCTIONS

- Step 3: Call the function within our program
  - The “delay_ms()” function accepts an unsigned 16-bit integer parameter that controls the time delay (in milliseconds)
  - Make the following modifications:



```
#include <avr/io.h>
#include <inttypes.h>
#include <MSOE/delay.c>

void delay(uint16_t x);

int main(void)
{
    DDRB  |= (1<<PORTB5);
    PORTB = 0;

    while(1)
    {
        //delay(5);
        delay_ms(500);
        PORTB  ^= (1<<PORTB5);
    }
}
```

delay_ms(500);

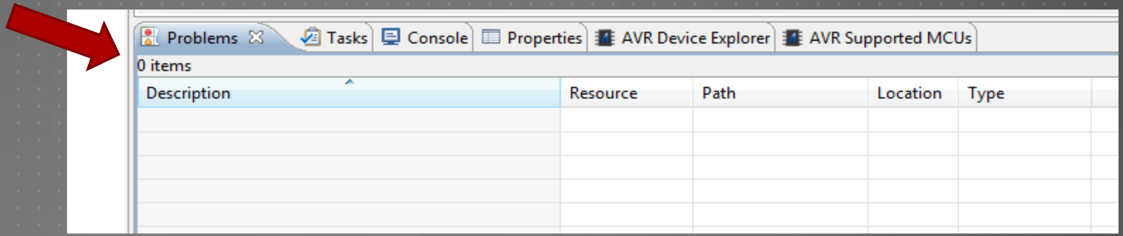
Produces a 500 millisecond delay

(continued…)

USING THE "MSOE" SUPPORT FUNCTIONS

- Save your program and build it!

- The "Problems" tab will alert you to any errors or warnings that resulted from the build process:
  - "0 items" means a successful build!



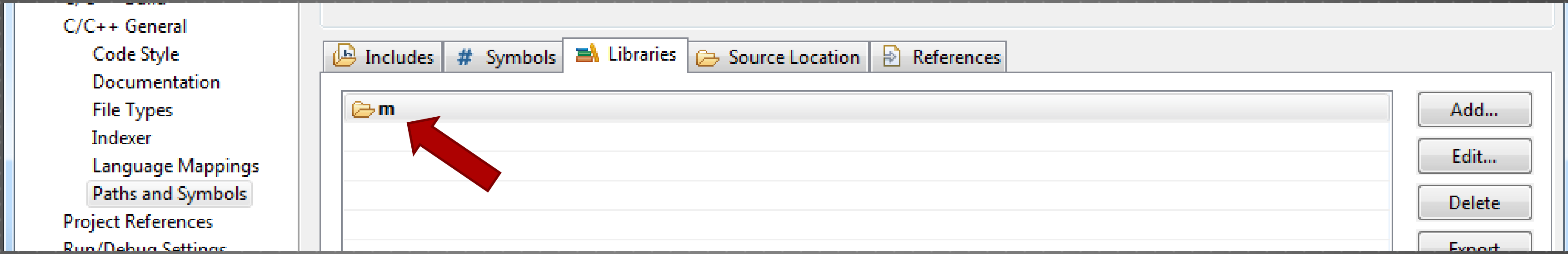
0 items

Description	Resource	Path	Location	Type

- Upload the .hex file to the UNO board
  - Experiment with the "delay_ms()" function to alter the blink rate and pattern

ONE FINAL NOTE: THE AVR MATH LIBRARY

- When a program is doing lots of calculations (e.g., floating point, calls to functions such as "sqrt", "cos", etc) it is a good idea to use the AVR Math Library
- The AVR Math Library contains code which has been optimized for use on the AVR microcontrollers – so things run fast and efficiently!
- To use it:
  - Select "Project" then "Properties"
  - Expand the "C/C++ General" arrow and select "Paths and Symbols"
  - In the "Libraries" tab, "Add" an entry named "m"



  - Select "OK"

CONGRATULATIONS!!!

- You now have a fully functioning Arduino UNO development system in Eclipse!
- Programming the Arduino board in C unlocks the full functionality of the ATmega328p microcontroller!
- Writing software in C also provides greater flexibility:
  - For example, your C programs could easily be “built” for a different microcontroller!