



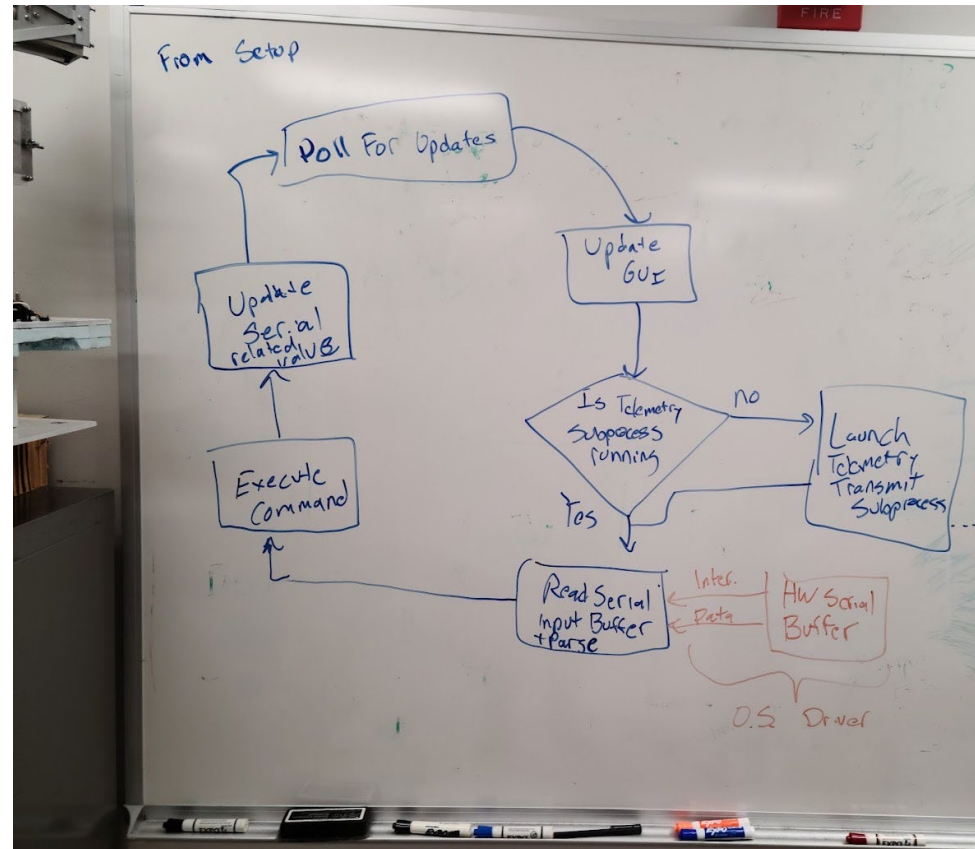
# L3.03 Software Flowcharts



# Planning Out Software



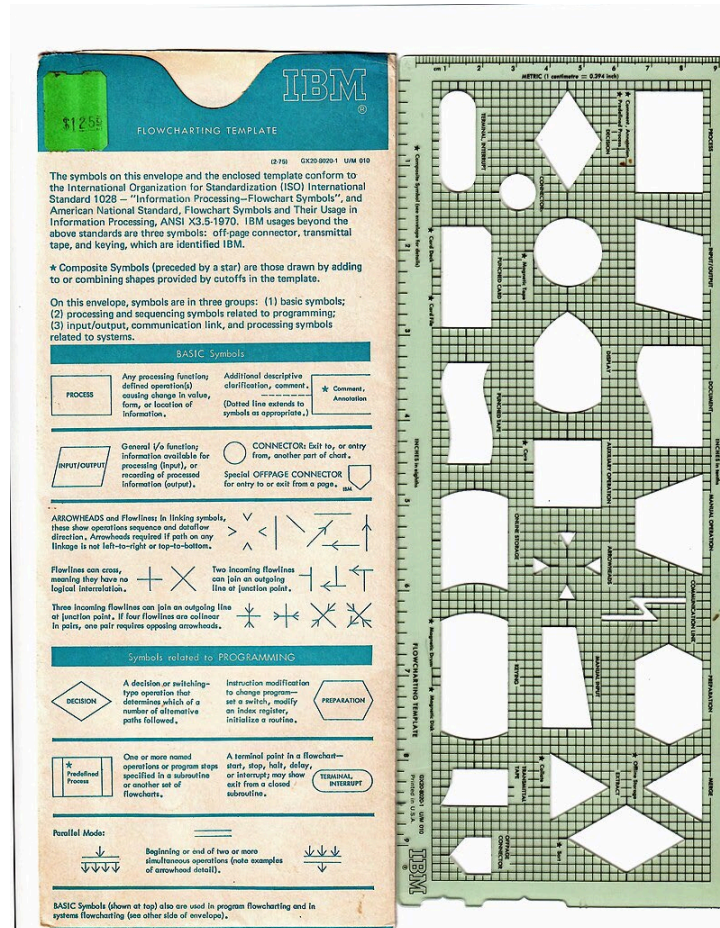
- When writing software, your first step should not be to open your IDE and just start writing code
- Good practice is to start with an outline of what the program needs to accomplish and in what order
- This will allow you to figure out what variables, functions, and operations your program needs



An early flowchart for the revised HASP flight software, notice how no specific programming language is used

# What is a Flowchart?

- A flowchart is a graphical representation of a process
- Each step in the process is represented by a box or block with arrows indicating the workflow from one step to another
- Can be used to describe any process
  - Originally used in 1920s to describe industrial processes to find bottlenecks
  - Because a computer program is a highly structured process, a flowchart is a useful tool to describe or plan out a program



IBM Flowchart template from

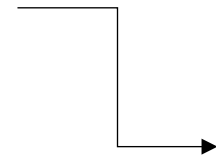
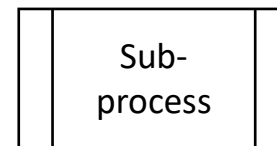
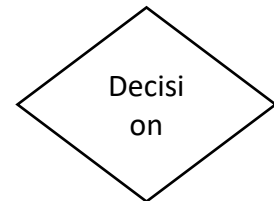
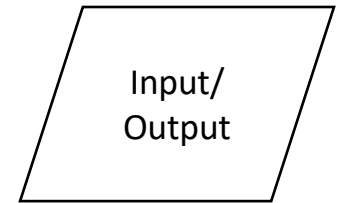
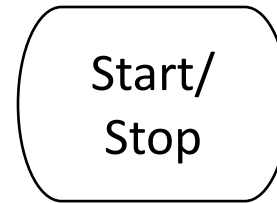
[https://en.wikipedia.org/wiki/Flowchart#/media/File:IBM\\_flowchart\\_template.jpg](https://en.wikipedia.org/wiki/Flowchart#/media/File:IBM_flowchart_template.jpg)



# Basic Components of the Flowchart



- A flowchart is made of 2 basic components: Blocks and Connectors
- Block – Used to show a step in the program
  - The shape details the type of action performed in the step
  - The text inside provides the details of what happens in the step
- Connector – Arrows connecting blocks
  - Shows the flow from one step to another
  - No action is occurring in the arrow





# Main Flowchart Symbols



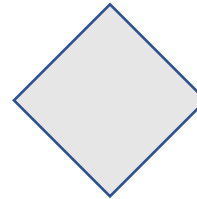
- Start/Stop Symbol



- Step Symbol



- Decision Symbol



- Subprocess Symbol

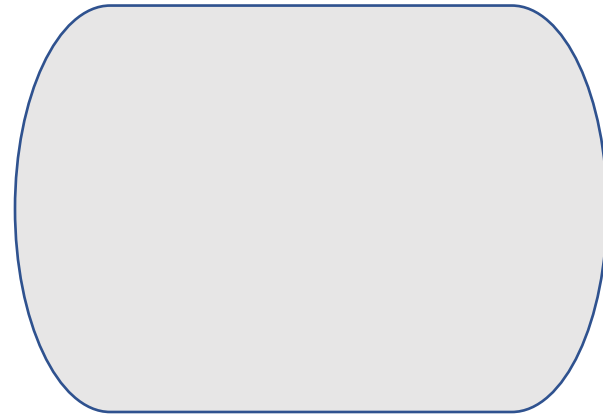




# Start and Stop



- Indicates the starting or ending point of a program or subprocess
- The start point to document any initialization that occurs
  - Avoid generic steps like “Declare variables” or “include libraries”
- The stop indicates where a program either finishes and stops, or where a subprocess returns to the program that called it.
- Should be only one Start
- If the function returns a value, be sure to indicate that in the Stop
- Multiple endpoints may be possible

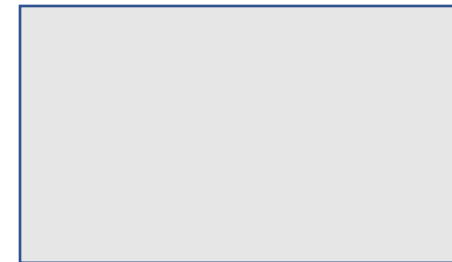




# Process Step Symbol



- Denotes a single step of a program accomplishing a single action
- Should represent a single, simpler operation, ie. a single line of code
  - Can be written in plain language instead of programming syntax
  - Increment counter  $c+1$
  - Read analog pin A1
- More complex operations requiring several steps should be multiple steps or a subprocess
- Should only have a single arrow exiting it
  - The next sequential step is specific
  - May have multiple arrows leading to it

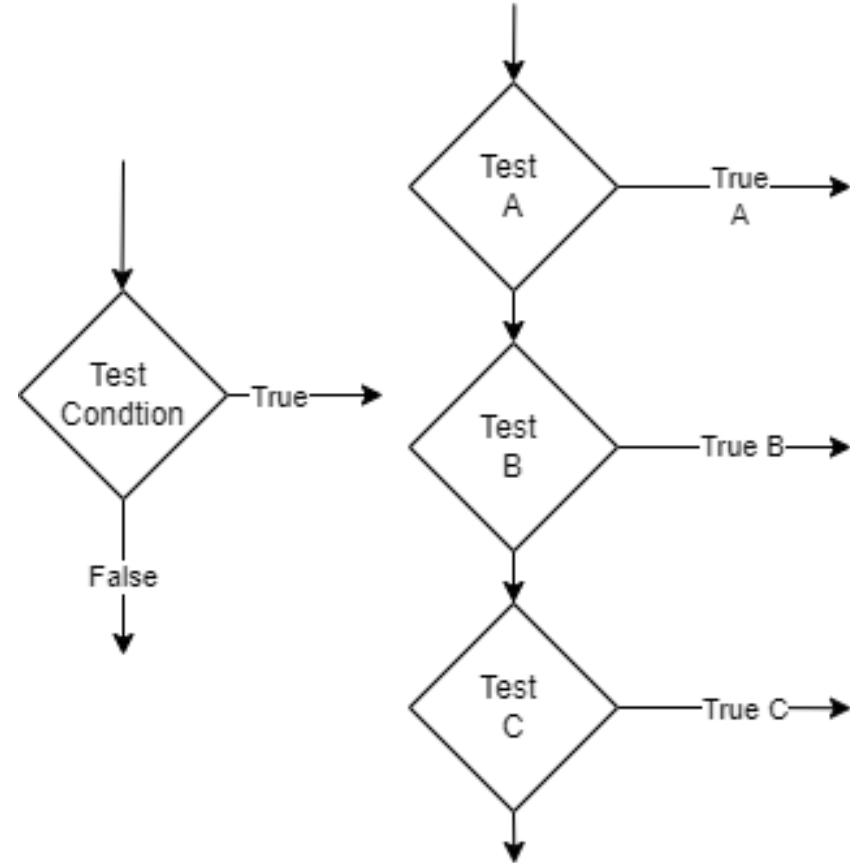




# Decision Symbol



- This corresponds to any sort of logical evaluation that occurs in a program
  - If ... statements are simple splits where two branches occur
  - For and While loops should connect back to the decision point (the start of the loop)
- Because Boolean logic can only be True or False, the decisions should only have two arrows leading out from it
  - The only type of block that should have multiple arrows leaving it
  - If you have more than two cases, you should have a series of decisions
- Each branch leaving the decision should have a clearly defined condition for when that path will be taken

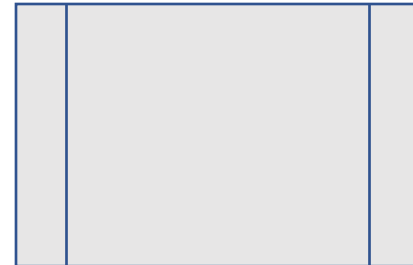




# Subprocesses



- More complex multistep operations – but allow a simpler diagram more readable diagram
  - A separate chart should eventually explain what the subprocess does
  - Should include the name and a brief description of what the subprocess does
- Subprocesses will have their own start and stop blocks showing where they start and when they returns
- Naturally map to functions within a program

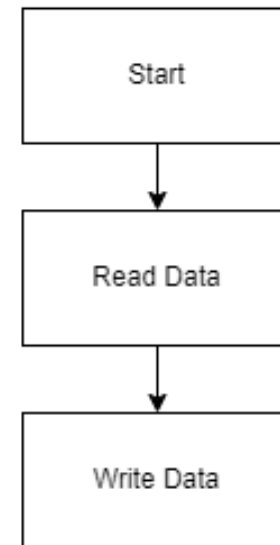
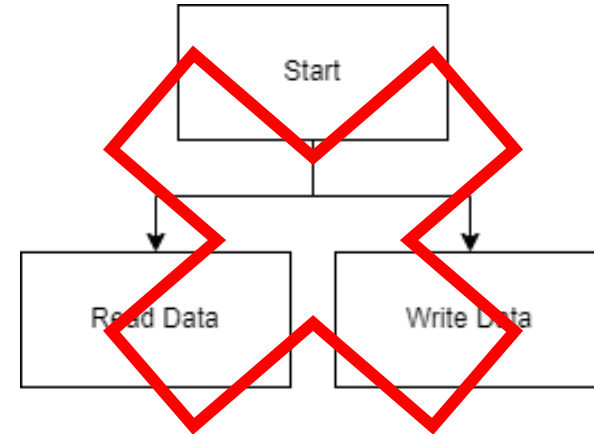




# Arrows



- Should only point in one direction
  - Arrows can point back to early points of the flowchart
- Each arrow should clearly show a starting point and an ending point
  - Steps proceed sequentially
- Blocks can have multiple arrows leading into them
- Only decision points should have multiple arrows pointing out from them
  - Arduino has no parallel computing
- Try to avoid crossing arrow lines for clarity

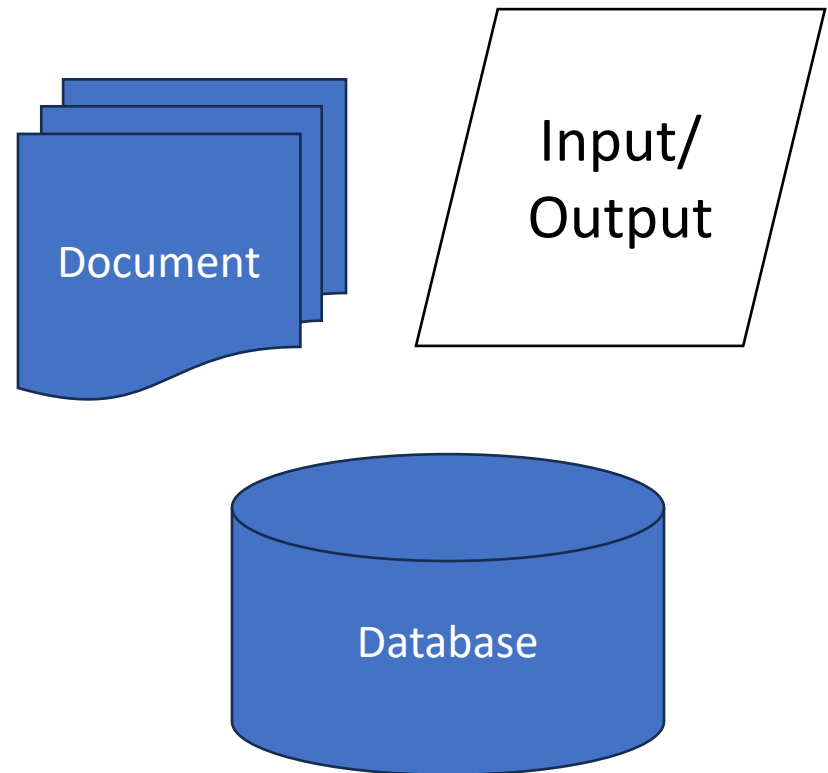




# Other Symbols



- Several other symbols exist for use in flow charts
- Many of these are for human input or more complex operations like reading and writing files
- Since our goal will be an automated payload that writes a simple data stream, we will likely not need to use them

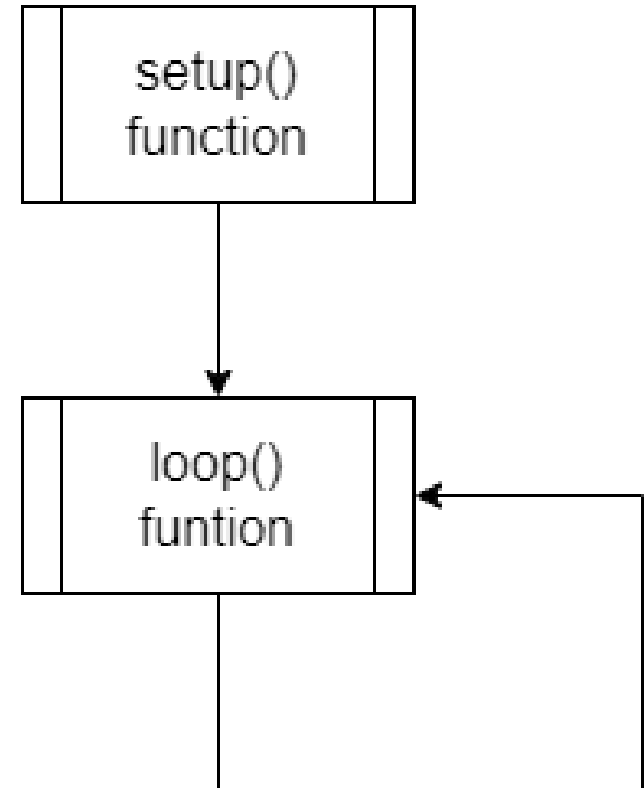




# Uses of a Flowchart



- Plan out the intended operation of a program
  - Good to start with a sketched-out version, then add details as you develop
  - Help organize and outline the flow of a program **before** we start writing code
  - Allows planning out the usage of variables and functions
  - Can be used to break up the
- Document the function of an existing program
  - Used to explain the operation of our program, ie, document our software in design documents
  - Ensure the charts are readable by breaking into subprocesses and multiple pages
  - Will be helpful for troubleshooting unexpected program behavior



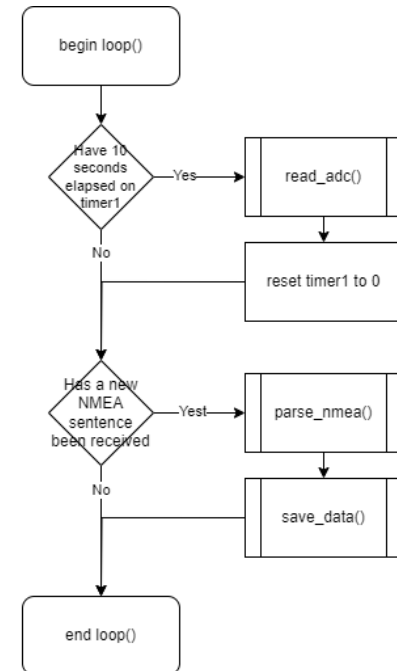
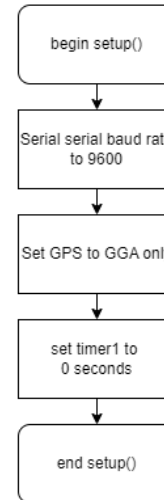
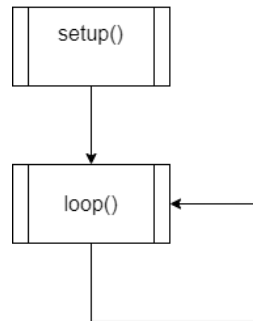
A basic flowchart showing the operation of code on the Arduino



# Designing your Flowchart



- Start with the highest level with a plain English description of the steps
- Identify your tasks
  - What things does the program need to do?
  - Identify the required steps to complete the task
- Layout the flowchart
  - Draw the steps in their logical order,
- Test the flow of your design
  - Follow through the steps and determine if accomplishes your goal
  - You may realize you need to reorder steps or add additional steps



A more realistic set of flowcharts describing a simple Arduino program, notice how the setup() and loop() functions have their steps detailed



# Flowchart Software



- Drawing by hand on paper or whiteboard
  - Useful during planning and brainstorming
  - Take a photo and transfer to a more permanent medium
- Microsoft Office Suite
  - Visio – Standalone diagram software, part of the Office web
  - Word and Powerpoint have the Shape tool have the flowchart symbols
- Gsuite - <https://docs.google.com/drawings>
- Recommended Draw.io/[diagrams.net](https://diagrams.net)
  - Web App or Download
  - Good library of shapes
  - Arrows can be locked to blocks for easy moving around
  - Can export drawing as image

