Design Process for Embedded Systems
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The design of an embedded system is complex because it involves both hardware and software as well as timing to meet desired performance. Achieving a good system design that functions as required is easier if the design process is intentional and good design methods are employed. Design process is a topic that much has been written about but also changes as technology evolves. What follows is intended to be an introduction to a topic about which we hope a student will learn the basics and about which deeper study will then be motivated.

(CAUTION: Student beware - this might be useful information when tackling a senior project)

How a project happens - and then what?

A new design project happens when there is a need or when someone has an idea they think is useful and for which some "widget" or system is needed. A client, i.e. the person with the bright idea, may approach an engineer, that is you, asking to have their bright idea designed. They know you are talented and likely figure you can knock out their "little" project in a few evenings of effort. You of course wish to determine not only how long it will take you but also exactly what their "little" widget is suppose to do. Their description is rather simple, seems doable, but you have a hunch that their vision has not been fully revealed to you and it would be wise to know more.

Here is a big picture or first order outline of steps used to tackle a design project and is applicable to a range of project types.

0) Project start
   A client with a "wonderful" idea describes something they wish to have designed. The description is ok but you need to know more. So you ask questions of the client and possibly research a bit to competently discuss details with the client.
1) Problem definition
   The first and very important design step is to create a written problem definition. This definition often has at least two parts: a clear statement of functionality from the view point of the user and quantitative specifications that defines how fast, how much, how big, etc. This is an important step. You likely will further interact with the client asking questions, giving them a preview of the problem definition, and getting their ok that the definition covers their vision of what the project is suppose to do. This problem definition will guide your design decisions and when the design is finished will be the standard against which success is judged.
2) Information gathering
   With a good problem definition in hand there often is a "research" phase. This may include searching for suitable technology (i.e. possible components or families of components, algorithms, etc.), learning more about the technology that has been found, identifying software to help with the design, reviewing similar designs to learn how others have solved a similar problem, etc.

3) Detailed design
   This is the step typically thought of when design is mentioned. The stated problem may be subdivided (decomposed) into smaller problems or subsystems. Signal or information flow between subsystems is determined. Major components are chosen, circuit topologies determined, and analysis performed to confirm choices made including selection of component values for resistors, capacitors, etc. Analog or digital simulations may be performed to predict circuit and system operation. (Please note, this is a very short introductory note. There is much to learn regarding how to approach and do good design)
4) Component procurement
   Usually it is good to order components after the detailed design is complete and thereby order exactly what is needed. Occasionally it is known that there will be a long delay between placing an order and taking delivery and an order for a component will be placed before detailed design is finished (ordering in parallel with design) to potentially shorten project development time (with risk of ordering the wrong components).
5) Prototyping
   Construct the system or circuit. Often prototyping is done using breadboards or for surface mount components small generic circuit boards on which surface components can be mounted and then interconnected with hook-up wire. (companies such as ElectroBoards, Schmartboard, and Capital Advanced Technologies make generic surface mount boards). For embedded system designs most microcontroller companies sell low cost development boards (sometimes called Discovery boards) that can be used. For radio frequency circuits it may be necessary to create a custom circuit board (PCB) to properly evaluate circuit operation.
6) Verification
   The constructed prototype must be rigorously exercised to verify that the design performs according to the specifications and function defined in step (1) above. If the design functions properly and within specifications then it is a good design.

   Within the electronics industry the term verification is used to imply confirming that a design functions correctly and within specifications. The term testing is used in digital circuits or systems to imply that a newly constructed copy of a previously verified design functions, i.e. that basically each node in the circuit will change from logic 0 to 1 and back again.
7) Iterate if needed
   If during verification the functionality or specifications are not met, then modify the design and again verify.

8) After your design is verified then create the final product. This may mean laying out a circuit board, having it fabricated, mounting parts, and then testing to confirm operation. Or it may mean simply packaging the prototype parts into a suitable enclosure for ultimate use. It depends on the project and user goals.

   And don't forget documentation. If the design is to be used by yourself, or others, create a document set that includes the obvious, i.e. schematic, parts layout, operating instructions, etc., but should also include design notes. This is particularly useful for a design that will be used for the known future. Over time you will forget details about the design and if you have to service or modify it in the future having original information is invaluable.