NORTH SOUTH UNIVERSITY

Department of Electrical & Computer Engineering (ECE)

CSE499B SENIOR DESIGN II
Section: 11
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Project Title: Precise Control Drone

Usability and Manufacturing

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SCORE:	REMARKS:
PENALTY:	

Usability and Manufacturing

Integrated Usability:

End users, regulatory authorities, developers, service providers, and suppliers are the key stakeholders in this drone.

End users: The stakeholders of this drone are the end users from a range of sectors, including agriculture, construction, infrastructure inspections, film production, and environmental monitoring. Some specialties, such as ease of control, precision in flight and data collection, and compatibility with their specific applications, make this drone more usable for them.

Regulatory Authorities: The organizations in charge of airspace management and enforcing safety and privacy laws. To them, usability means complying with the rules and making it easy to verify their compliance. Certifications obtained, audits by the regulatory authorities, and regulatory approvals may be included in the measurement. The Civil Aviation Authority of Bangladesh formulates laws regarding manufacturing, importing, and using drones inside Bangladesh. The drone that we have made falls under type B (খ-শ্রেণী), i.e., this drone is made for educational or research purposes. However, this drone also maintains all the rules and regulations that are declared for all four types of drones.

Developers: The team responsible for designing, manufacturing, and maintaining the drone's software and hardware. The primary usability elements are ease of assembly, component integration, easy software interface, and maintenance and troubleshooting. Proper instruments for measuring this are internal testing, input from development teams, and product reliability and production efficiency measures.

Service Providers: Businesses or persons who provide drone-related services, e.g., data analysis, maintenance, repair, and training. In their case, usability includes factors such as compatibility with their services, ease of repair of drones, and the availability of documentation and support resources. The evaluation process may also use customer satisfaction surveys, responses from service providers, and quality indicators.

Suppliers: Companies that supply the parts, components, and services required to manufacture drones. For them, the factors considered part of usability include supply chain reliability, ease of communication and cooperation with drone producers, and easier connection between their products and drones. This evaluation may be carried out using quality control processes, supplier performance measures, and supplier feedback.

Manufacturing:

Manufacturing is an essential step for developing precise-controlled drones. The manufacturing plan includes design, component selection, PCB design, coding, prototyping, debugging, cost reduction, etc.

Our estimated budget for manufacturing this precise-controlled drone was 40,000 BDT ($364 USD). Still, using advanced component selection, cost reduction techniques, and optimal design, we could reduce this drone's cost to **22,000 BDT ($200 USD).** This price is much lower compared to precise-controlled drones available in the market. The cost can be further reduced if this drone is manufactured in bulk. Some of the essential considerations for the manufacturing of this drone are stated below:

a) **Optimal Circuit Design:** This is the most crucial step for a budget drone. Initially, we planned to use ready-made flight controllers, transmitters, and receivers available in the market. This approach was time-saving but not cost-effective. So, we focused on redesigning the flight controller on our own. We designed PCB for the flight controller, object detection, transmitter, and receiver using sensors that are required for those specific functionalities.
b) **Component Selection:** Selecting the components is another critical consideration when manufacturing this drone. The sensors used in the controller should be precise enough to produce almost accurate output. Time is another consideration in this regard. The sensors used in the design should have a time delay of less than 10 Nanoseconds. Time plays a vital role in controlling the drone in a natural environment. If there is a long delay, we won't be able to control the drone precisely.
c) **Optimal Programming:** Along with hardware, optimal programming is another key. By optimal programming, we can boost the performance of drones. We can ensure the optimal use of hardware through optimal programming. Optimal

programming can also increase the stability and precision control of the drone. There are some memory limitations also. So, the algorithm used for programming the drone should be optimal, memory efficient, and scalable.

d) **Application-centric design & manufacturing:** Drones provide a wide range of services. The hardware elements integrated inside a drone depend entirely on its real-life use. For example, a drone that is used for precision agriculture requires components such as a water tank, humidity sensor, temperature sensor, spray nozzle, water pump, and camera, along with the basic components. However, a drone used for videography doesn't require the integration of such elements. That's why the designer, engineers and manufacturers should focus on developing application-centric drones.

e) **Cost Reduction:** In the case of mass manufacturing, the cost of the drone can be further reduced. Some of the cost-reduction strategies are mentioned below:

   i. The frame used for this project costs 999 BDT. This is a plastic build frame, and it is possible to make this frame using 3D printing technology or by injection moulding process. For bulk production, making the frame using the injection moulding process is the cheapest and fastest option, and the price of the frame can be reduced to 200 BDT if locally produced.

   ii. All sensors used for this project are brought from online retail stores. If these sensors are imported directly from the manufacturer or brought from any wholesale store, then the cost per sensor will be much lower. This will help in reducing the overall manufacturing cost.

   iii. We can print the PCB and power distribution board in Bangladesh; this will also reduce the cost of the drone.

   iv. The propellers used in this project can be produced locally using the injection moulding process. This will also help in reducing the overall cost of this drone.

   v. The battery used in this drone is a lipo-battery. This battery produces 12V output. The cost of this battery is 2350 BDT. This contributes 10% of the overall cost of this project. Producing this battery locally or importing them directly in bulk quantity can help in reducing the price of this drone significantly.

   vi. The electronic speed controller (ESC) can be integrated into the power distribution unit. This will reduce wiring costs.

Maintaining Manufacturing workflow: Manufacturing drones using a systematic approach can reduce manufacturing time and ensure optimal use of resources. Collaboration among different units of production and manufacturing can be ensured using a well-structured workflow. The manufacturing work starts from the design phase, where engineers and designers design the drone following the scientific principles of aerodynamics. They also select specific hardware based on the use of the drones. Trained technicians in the assembly unit usually perform the assembly work. They assemble all the drone components in a systematic manner.

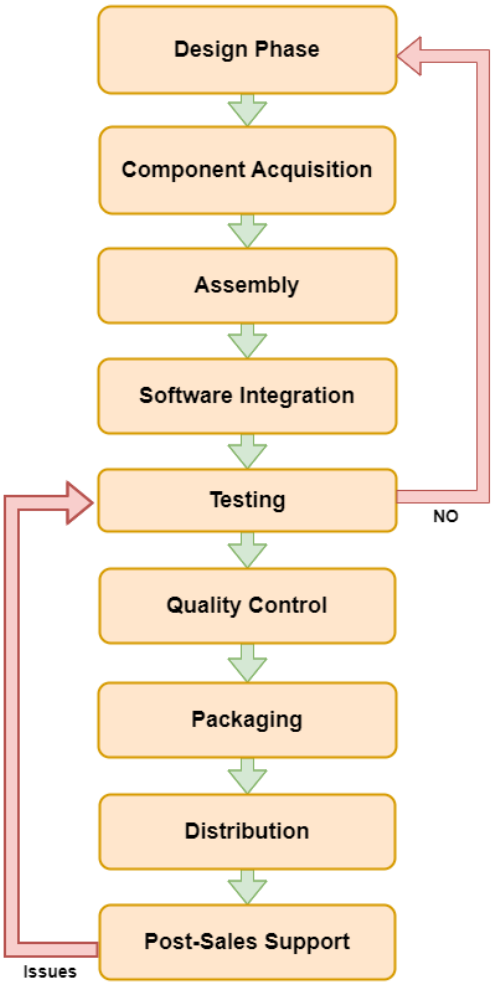

Figure: Manufacturing workflow

After the hardware assembly phase, the drone is programmed using various software tools in the software integration phase. Then, the drone passes through the testing and quality control phase. In this phase, engineers check if there are any hardware or software issues. If there is no error in this phase, they are forwarded to the next step.

The next step is packaging. All the components used in a drone are sensitive. So proper safety measures should be followed during packaging. After packaging, the product is finally ready for distribution.

Manufacturers should also provide post-sales support, such as warranty claim options, repair options, etc., for the end users. They should also encourage recycling programs. Post-sales support plays a vital role in the development and manufacturing process because the customer feedback collected can help in further modification and development of the drone.

In this way, by ensuring a proper manufacturing plan, we can increase the efficiency in production and reduce the wastage of time and resources.