<u>Request for Proposal #2</u>

The Skittle Sort Competition

Goal

A specific number of Skittles (maximum 250) with a variety of colors (maximum 5, as in the original red package) is loaded into a container. Teams must design and construct a *<u>device</u>* that delivers a specific number of Skittles of specific colors to the customer in the shortest time. For example, the customer punches some buttons to order the machine 5 yellow, 3 red, 8 green, and 12 orange skittles. Time is measured from when the <*start*> button is punched, and the entire process (except for loading the feeder) must be performed after that time. A contest session will provide teams with the opportunity to compete against each other. Each run consists of 2 different orders, and the total speed and accuracy of both orders are the measured criteria.

Design Descriptors

Steps: Establishment of objectives and criteria, synthesis, analysis, construction, test, and evaluation.
Features: Creativity, examination of the specifications, using *logic* in design, generating alternative solutions, choosing the right instrumentation, and compromise in design.
Constraints: Time, accuracy of the operation, and certainly cost.
Efforts: Team of 3 people.

Limitations and Constraints

a. This is a *no touch* operation; designers can only *turn on* the machine. The entire operation starts when the customer hits the <*start*> button after making her/his choice. The Skittles are supplied before the operation starts.
b. No camera or commercial image-processing tool is allowed.
c. The system must be *compact*. The size of the setup should not exceed $0.3 \times 0.3 \times 0.5\ m^3$.
d. A run (order) is disqualified if the system crashes, hangs (for a reasonably long time), or the team declares the termination. If this happens to the first order, the team will have a limited time to fix the system and run for the second order, if they wish.
e. No interaction with an external PC is permitted during the run.
f. Remote control devices are not permitted.
g. There will be no control on the lighting condition of the contest environment. Any required light source must be integrated with the setup.
h. Skittles will be supplied by the judges. The total number of supplied Skittles and the nature of orders are not known before the contest.

Performance Evaluation

Each device will perform two specifically designed orders, and the total time and accuracy of the two operations are measured. Each second of operation adds one (1) point to the score, and the error, in terms of the sum of the absolute differences between the outcome number and the desirable number for different colors, will add points equal 10 times the total error to the score. The winning team is the one that gains the least score.

Expected Outcomes:

Design and Construction Process: The team must follow a logical process in accomplishing their tasks of design and construction. Conceptual design is the important step of this project where the team has to compromise among speed, accuracy, and cost. The detailed process must be reflected in the final report submitted by the team.

Proposal: Each team must work together to generate proposal documentation on the design. The design proposal should reflect the steps to be taken in the design, and the construction process to be followed in making the product.

Final Report: This report should include the following:

- **a.** Problem definition and objectives
- **b.** Limitations and requirements
- **c.** Preliminary ideas (sketches and brief description)
- **d.** Final detailed design (sketches and detail list of parts)
- **e.** Construction and integration
- **f.** Test and Debugging
- **g.** Conclusions

***Final Product*:** The final product developed by the team should reflect the work presented in the proposal. Any significant changes in the design of the product must be justified in the final report. The quality of the final product may vary widely depending on the background of the team, the difficulty of the concept, and other constraints. Many of the deficiencies of these products can be resolved later in the students' academic career. For this reason, a smaller portion of the student grade is allotted to the product construction and performance.

Team Dynamics: The team must propose a solution and the plan in the proposal, and remain *loyal* to the proposal during the entire process. Hence a close interaction between members of team is required initially to be able to *"plan ahead."* Early team dynamics may be strained, but interaction increases as the construction and integration of the *means* proceed. Maximum team interaction occurs during the test and competition. The instructor will enhance the team dynamics by spending some time with the teams evaluating the process. In many cases students remember this team experience (including their teammates) when they are seniors, or even when they are returning alumni.

Grade evaluation will be heavily weighted to the generated design concepts, proposal, final report, and the way each team has followed the tasks. The final product and performance evaluation (competition) will have less influence on the overall grade.

Statement of Work

Each team is composed of three students. The conceptual design must be performed through a close interaction of all members of the team. However, for the implementation, tasks can be broken into the following assignments:

Computer Software and Hardware
One student shall program all the software for the system. The software may be written in whatever language the group elects to use; however, for a low power portable computer the only language available will likely be assembly. This student also has the responsibility of programming the system processor. It is advised that the processor be functional and programmable by the end of Reading Week, so that subsystem integration and testing may begin. Often integration requires additional minor adjustments to the computer hardware. In addition, after Reading Week, the person responsible for computer hardware shall assist the Interface and electro-mechanical subsystem with duplication or fabrication of components and subassemblies.

Instrumentation and Actuation

One student shall be responsible for incorporating whatever actuators and transducers are required in the system. The person responsible for the electro-mechanical system shall also calibrate the I/O signals.

Interfacing

One student shall construct all the digital and analog interfacing electronics to connect the transducers and actuators to the computer interface card. Where the primary calibration for a transducer is positional in nature (such as a stop switch), it will be the responsibility of the electro-mechanical modules to provide and mount them. In all other cases, the transducers and their calibration are the responsibility of the interface subsystem.

Discussion

The sequence and logic of operation is an important decision to be made in this design. Further, while advanced digital cameras and image-processing tools can readily perform the task of "*color detection*", students should find the simplest and most economic alternative, by implementing their own sensor design.

The key point of design is the compromise between speed of operation and accuracy of outcome. The "*second order*" in the contest run has a crucial effect on the nature of design.

Students can encounter problems with construction of the product. With limited experience in shop practices, final products may not always work as anticipated. This can be frustrating to the student. As with any life experience, the product building will improve as the students gain maturity, not only in shop practice, but also in improved engineering science background. The contest session provides proof of the paper design. It also demonstrates to students that in real life the result does not always follow the prediction of theory. This is a good time to remind the students that ***"an ounce of application is worth a ton of abstraction."***