Toying with a Capstone Design Course

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ABSTRACT

Oakland University has pioneered a unique approach to capstone design projects. Multidisciplinary student groups invent a new electrical, mechanical, or electromechanical game or toy, design it, and build a working prototype. The prototype is then delivered to an internationally-known toy and game agency. The best of the prototypes are then presented by the agency to major national and international game and toy companies. If the toy or game is selected for production, the possibility exists for significant financial benefit both for the school and the students.

Real world considerations such as creativity, project feasibility, and costs (particularly in mass quantity), all factor into the ultimate student goal, which is to have their project selected by the agents. The burden of devising the projects is largely removed from the professor and copying from earlier projects is virtually impossible. Design of a good game or toy is often much more difficult than it appears—projects invariably knit together the many engineering skills a student has acquired through the course of obtaining a bachelor's degree as well as from the rest of their life experiences. Ultimately, the engineering school also benefits from these projects through the possibility of substantial publicity, either with local display of student projects, or through press coverage surrounding a successful project picked up by a major international toy company.

I. INTRODUCTION

A significant problem shared by many professors teaching capstone design courses is finding projects that involve a number of real world engineering considerations while keeping in mind the time constraints of a one- or two-semester course.[1–3] The School of Engineering and Computer Science at Oakland University has developed a unique approach to capstone design projects. Through an industry partnership with Random Games and Toys (RGT) of Ann Arbor, MI, a preeminent international game and toy agency, students are introduced to the requirements of the toy and game industry. Multidisciplinary student groups then develop concepts for new electrical, mechanical, or electromechanical games or toys. Using RGT resources and expertise, the teams develop, design and build working prototypes that are then presented to RGT. The best of the prototypes are in turn presented by RGT to major national and international game and toy companies, with advances and royalties shared between RGT, the student designers and Oakland University.

Over the last three years, a total of 23 student design groups have presented RGT with more than 50 marketable toy ideas, all with working prototypes. To date, RGT has presented 46% of these prototypes to their toy industry contacts, compared with 5% of prototypes brought to RGT by independent toy and game inventors. Table 1 provides a sampling of typical prototypes accepted by RGT.

II. BACKGROUND

The toy and game industry is, to outsiders, a labyrinth—one that involves encyclopedic knowledge of successful and failed toys and games of the past and present; difficult-to-obtain access to a very small number of buyers; an ability to make presentations with flair and showmanship; understanding of the arcane aspects of contract negotiations; an ability to tweak, for example, a tired, worn-out idea (e.g., a talking Mr. Potato Head), into something really novel; and a polished eye for what an eight-year-old might consider fun.

However, good toy and game agents make navigating this labyrinthine world a snap. RGT stays in business through their ability to help sell ideas to toy and game companies such as Mattel, Hasbro, and Pressman. In exchange for their services, RGT requires the commonplace industry standard for agency representation—fifty percent of the royalties a toy or game might produce. Royalties in the toy and game industry are generally 5% of the wholesale value of the game. Even so, the payoff for a successful toy or game designer can be immense. A product that is nationally advertised on television can sell in quantities into the millions. This can bring in royalties amounting to five hundred thousand dollars or more a year—half of which goes to the game's inventor or inventors. This is not a bad take for the typical three year cycle before a product is retired.

The creation of a new electrical, mechanical, or electromechanical toy or game can present a formidable design challenge. Cost is key—the joke in the toy industry is that whatever is inside the box should cost about as much as air. Realistically, items should retail for between $5 and $25, with a good price point being $15. True manufacturing costs are roughly estimated to be 1/5 of the retail price. Thus, a product designer must ensure that a projected $10 item, for example, can be manufactured for less than $2 in quantities larger than, say, 100,000 pieces.

III. COURSE LAYOUT

A. Introduction of the Projects to the Students

Very early in the semester, typically in the first week, the President and Vice President of RGT make an introductory presentation to the design class. Among the topics covered in this initial meeting are an overview of how the toy and game industry works, a

Hula-hoop that lights up when used
Accessories to add smoke and rumbling action to radio-controlled cars
Barbie™ doll that can simulate a golf swing
Super-Soaker™ derivative with rotating nozzles
Magnetic fishing game
Soccer tee to promote correct soccer kicking form
Power water cannon for electric cars
Bungee cord accessory for games played on roller blades

Table 1. Sample list of projects accepted by RGT.

show-and-tell of RGT's successes and almost-successes in the past, war stories of the toy industry and of the toy ideas that got away, and a distribution of a list of toys that industry contacts have made known they are actively seeking in the near future. This initial meeting is crucial, for it drives the point home that the students are working for real people running a real company, with all the financial, ethical and competitive issues faced by all companies.

B. Breakdown into Student Groups

As the initial meeting ends, students are told to write down, for the next class meeting, five ideas for toys that they are interested in designing. This preliminary list becomes the basis for team selection. Students are also asked for information on their outside interests (hobbies, sports, etc.), any course work taken that is not required for the design course (drafting, computer-sided design, finite-element analysis, etc.), access to tools for fabricating prototypes, and any experience they might have sewing, crafts, home improvement, or making things of wood, plastic or metal. These last two points are vital for success in the design experience. Since the teams actually have to build things that work, at least one person in the group must have some experience at fabrication or construction; the group must also have access to the necessary tools.

The groups are assigned to teams by the professor primarily due to similarity of their preliminary list of toys. Secondarily teams are assigned based on tool access and manufacturing experience. Quite often a group can overcome a severe lack of manufacturing experience if they share a strong vision for the final product. Students are almost always grouped in teams of four. Teams of three can work well if matched optimally; teams of less than three or greater than four are almost always disappointments.

None of the above is to suggest that teams thus formed are homogeneous in any way other than interests. The remarkable creativity required for these projects draws mainly on extracurricular interests and experiences—the nontraditional student who was a former English teacher may prove to be just as creative, if not more so, in finding the basic idea on which a project will be based. Most groups opt to develop toys and games for children (although not required to do so by RGT), and the perspective of young women (who more often babysat as teens), and especially of mothers, becomes invaluable. We have also found that teams with more diverse backgrounds are generally more creative. In designing toys and games, diversity becomes not so much a buzzword as a necessity. These are not typical engineering projects and the toy industry is not a typical engineering industry, yet the engineering pressures and constraints (especially the economic constraints) are as severe as any seen in the highly competitive, more traditional engineering automotive industry.

Beginning in the 2000–2001 academic year, multidisciplinary design teams will be assembled as the mechanical and electrical engineering capstone design courses are combined. Aside from addressing ABET concerns, most modern toys are electromechanical devices and are a natural topic for multidisciplinary design courses.

C. Presenting Ideas to RGT

Once the design teams are formed, the students are then charged with developing their individual preliminary lists of ideas into team concepts or ideas. Each team is required to come up with at least five initial team ideas. These design ideas are then approved (rarely), rejected (often) or modified (sometimes) by RGT via e-mail. The process of coming up with novel ideas to pursue as design projects may take several weeks. It is remarkably difficult to come up with an idea for a toy that hasn't been done before; this is where the RGT expertise becomes invaluable. Students quickly become aware of the need to fill a specific market niche. They subsequently gain the experience of having to sell their ideas to experts in the field before receiving permission to start spending money to develop a prototype.

The use of e-mail to obtain feedback from RGT is useful in many respects. E-mail is quick, and a possible design idea can be approved, rejected or modified overnight. The very act of writing a description of a toy that does not yet exist sharpens the written communication skills of the students, for if the RGT experts don't understand the concept, they will not approve its development. A certain amount of negotiation also goes on at this stage, as students who are passionate about their ideas try to convince the experts in the field that one more attempt at a hula-hoop will knock the toy world on its ear. The instructor receives a copy of each e-mail sent to and from students—not copying the instructor on e-mails has severe grading penalties.

D. Construction of the Projects and the Final Presentation

Once an idea has been approved for prototyping, its design and construction begins. Depending on the number of design ideas approved for a group, (which in the past has ranged from one to five), students within a group will form sub-groups to develop each idea. In extreme cases, each group member has primarily developed his or her own individual idea, with input from the rest of the team members, while continuing to influence the development of the other projects of the group. During this stage, students meet at least weekly with the instructor for guidance, ideas or advice, and to submit weekly progress reports. During this time, they are also in constant e-mail communication with RGT. At least three times during this phase, usually at three or four week intervals, RGT makes class visits to inspect the progress of the prototypes, makes suggestions for improvement or, in rare cases, changes the focus of the group to something more marketable or more cost-efficient. As the instructor has gained experience, class meetings with RGT have become less frequent, since most questions and modifications can be handled by the instructor. Each design group is given a budget, $100–$125, from which all prototyping costs must come. Students are required to submit weekly progress reports that include hard copies of their e-mail communications, their progress for the past week, and their plans for the coming week. They are also required to deliver a final public oral presentation (complete with demonstrations of how their toys work), prepare a written

final presentation, and prepare a 60–90 second video of their toys for RGT to present to their industry contacts.

E. After the Final Presentation

After the final presentations for the class and RGT, the students retain their prototypes. In most cases, RGT then presents a student-supplied video of selected working prototypes to their industry contacts. If sufficient interest is shown, students are contacted and asked to arrange delivery of the prototype to RGT. As RGT takes possession of the prototype, a contract is signed between RGT and those students who were directly involved with its development—this could be a single student, a subset of the design group, or the entire group. Only once has a group been dysfunctional enough to name only a single student on a contract, but it can happen, should be anticipated and allowed. If industry wishes to place a retainer while they further consider the game, or if industry decides to go directly into production, money begins to roll in to the student group, the school, and RGT.

IV. Discussion

We have found that students who undergo toy training as their capstone design experience seem to have a far better feel for the nitty-gritty surrounding true engineering design. For example, discussions of the economics behind price points and true manufacturing costs are often revelations to students. Knowing that a project cannot even be built unless it passes the financial test reaffirms those revelations in a way that no exam could ever equal. As an example, past students have excitedly proposed a new Battleship type game that uses magnets. The shock of finding that magnets are relatively expensive, and are far too heavy to ship, changes their whole attitude about the prototype.

Indeed, through this type of capstone design course, students become intimately aware of greater societal issues involving the engineering design of a product, for example, safety considerations (a topic of major importance when building for children); shipping costs; product sizzle that lends itself to television advertising; competition and competitive pricing; and ethics (for example, a toy company could easily steal a student team's idea for a game from RGT—but then RGT would stop coming and would spread word of the deceit, and all-important fresh and creative ideas would go elsewhere).

Design involving toys and games also showcases the work of the engineering school to the rest of the university, as well as the outside world. For example, Oakland University was founded as a liberal arts institution; engineering students are often stereotyped by the rest of the campus as being rigid, uncreative thinkers. Displays of toy and game prototypes in the student center go a long way towards dispelling that notion. Likewise, in recruiting efforts at community colleges, displays involving toy and game prototypes attract the attention of both students and their parents. Lastly, the media attention surrounding a prototype that is selected for mass manufacture by a company such as Mattel can be enormous—and enormously beneficial for the school.

V. Conclusions

We believe that the success of this program opens new horizons to other universities seeking to improve the quality of their capstone design courses. Agencies similar to RGT operate in virtually every major metropolitan area in the country. Once the reputation of the agency was established, overtures could be made by individuals from an academic institution's engineering program and a new industrial partnership set in place. Of course, toys and games are not the only industry that relies upon a steady supply of fresh, innovative ideas—product design firms of all types often have the same requirements. The only essential requirement to a successful program, we believe, is a commitment of the principals in both industry and academia to making the program work.

References

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