
AC 2012-4543: GLOBAL DESIGN COMPETITION

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Global Design Competition: Enabling Creative and Innovative Digital Design

Abstract

College graduates should be prepared to work in culturally diverse workplaces, work across national borders and understand global challenges. Engineering students seem to have fewer opportunities during their studies, than those in liberal arts and business, due to a very packed technical curriculum and sometimes the high cost of education.

In the electrical and computer engineering, as the complexity of microelectronic systems is steadily increasing, universities must update their curricula to cope with the increased demands of research and development required in industry. By integrating Digital Design competitions into the undergraduate and graduate education, students are better prepared to enter the field of engineering and make more meaningful contributions to their firms at an earlier rate. According to published reports, looking at particular skills and attributes needed for engineers, top priorities in terms of future skills will be: practical applications, theoretical understanding and creativity and innovation.

Trying to address the above mentioned issues, instructors at different universities in Europe, USA, China and India joined efforts and have integrated an annual Digital Design Competition open to students enrolled in Electrical and Computer Engineering and similar majors such as Electronics and Telecommunications, Computer Science, etc.

This paper presents the results of organizing regional competitions in Europe, USA, China and India and the results of the First Global Diligent Design Competition, collocated with FPGAWorld conference in Munich, Germany. The logistics and challenges of the regional and global competitions, the results of the past editions and plans regarding the future of the regional and global competitions are presented. Evaluations of the competition and students' perceptions as an alternative learning experience were investigated through student surveys.

Introduction

College graduates should be prepared to work in culturally diverse workplaces, work across national borders and understand global challenges. Engineering students seem to have fewer opportunities during their studies, than those in liberal arts and business, due to a very packed technical curriculum and sometimes the high cost of education.

In the past years, industry evolution has proved that the need for well-prepared engineers with good practical skills is constantly increasing. A study of Royal Academy of Engineering, Educating Engineers for the 21st Century, reported that industry seeks for engineering graduates who have “practical experience of real industrial environments”¹.

Trying to address the current and future needs of the industry in the context of global economy, and giving electrical/electronics/computer engineering graduates the right skills, instructors from all the below mentioned locations have integrated an annual Digital Design Competition open to engineering students from the Electronics and Telecommunications, Computer Science, etc. All

the competitions are sponsored by Digilent² and Xilinx³. These companies produce state of the art PLDs boards and CAD tools.

The paper is organized as it follows:

The logistics and challenges of the last years competitions at the Technical University of Cluj-Napoca (TUCN), Romania and Rose Hulman Institute of Technology (RHIT), Indiana, USA; the section presents the criteria the organizers used for evaluation of the projects and the methods of motivating students into participating in the competitions. It also analyses the growth of the number of participants, their affiliation with universities and majors and their orientation towards different technologies (HDL programming or basic C language usage).

The first contest experience at the Sir Padampat Singhanian University, Udaipur, India and Tsing Hua University, Beijing, China; presents the logistics of the first editions held in India and China, the results and the quality of the projects compared to the number of participants and finalists.

Munich worldwide finals in conjunction with FPGAWorld Conference; regional winners have been invited to attend to the worldwide competition and to present their work at the conference. It was a great opportunity for students to receive appreciations from industry representatives and share their knowledge with participants from different regions of the world.

World Competition evaluation and participants' perceptions as a learning experience; quotes from advisers' and students' feedback received after the competition, cumulative information about what they have experienced during the entire competition and the skills they have developed or improved.

Worldwide Digital Design Competitions; Logistic and Challenges

According to a predecessor paper⁴ regarding the topic, "design contest is a good vehicle to offer students, outside the class, a consistent design experience". Trying to organize a competitive design contest, organizers have set the following criteria:

- a) the complexity of the project relative to the author's level of knowledge;
- b) the hardware is used to its capacity, in an ingenious and effective manner;
- c) the software is mainly original and fully functional;
- d) the core underlying idea is understandable, believable, innovative, creative, feasible, path-breaking;
- e) the feedback from the community, if existing, has influenced the project in a progressive manner;
- f) the written report is thorough, clear, compelling, logical, elegant, and professional;
- g) the presenters are professional, confident, comfortable and enthusiastic in presenting their work;
- h) the presentation is thorough, well structured, clear, compelling, logical, informative, and professionally delivered;
- i) the project solves a problem, the idea is feasible or could be commercialized, or the presenter made a good sales pitch.

All the above presented criteria guide the participants in choosing a competitive project and stimulate them to take into consideration all involving aspects, such as the technical one, the time scheduling, the marketing approach, the ability to present and sale their work. The feedback from the community is an important factor. The motivation increases when the students present their project to the friends, professors and family and receive positive feedback. The students are encouraged to present and post their work on public websites, or social network websites, in order to receive feedback from the viewers.

The contest is mainly dedicated to undergraduate students but it is also open to Master students. The openings are in late November or beginning of December with an enrollment period of one month or more. The students have approximately three to four months to finalize their projects and to present them in May each year. They are pre-evaluated a month before the finals in order to verify the status and the timetable set by each team. This method helps the students to plan and respect the deadlines, thus being more prepared to reach efficiency in the shortest time period as employees.

Contest Rules were the same for all the regionals in 2011, proving once again the fact that the contest is a worldwide event, with only different locations throughout the world. Also, each region's participants received the hardware free of charge and get to keep it after the final presentations. Winners of the four regionals were invited to participate in the Finals held in Munich, September 2011, in conjunction with the FPGA World Conference.

There were multiple factors that contributed to creating successful regionals and finals:

- students - they were dedicated, ambitious and competitive, also willing to invest a lot of time and even money where the case (when additional hardware not available from Digilent was needed for their project, , travel costs, accommodation for regionals)

- universities - each region had a host university that partnered with Digilent. most of them managed to find the resources to support the students for regionals or even finals (ex. The Technical University of Cluj-Napoca hosted all the EU regional editions, helped with accommodation and sponsored the two participating students in the finals with travel and accommodation costs; the Rose-Hulman University of Technology hosted all the US regionals and sponsored the participating finalists with travel costs, the Loras College also supported the travel costs for its students, the Sir Padampat Singhania University hosted the India regionals, helping with logistics and the Tsing Hua University, Beijing helped in organizing the China regional)

- sponsoring companies - Digilent and its regional offices sponsored the contest. Other companies also sponsored portions of contest costs

- organizers - Digilent Ro was the organizer of the regionals in Europe, supporting the logistics and helping with accommodation. Digilent Ro also organized the Munich finals. Digilent Inc. supported all the free hardware given for the three regionals: US, EU and India, offered prizes and also supported accommodation and travel costs for some of the students in the finals

Digital Design Competitions at the Technical University of Cluj-Napoca, Romania

The contests held at the Technical University of Cluj-Napoca have become a tradition, the 2012 edition being the eighth edition already. The first editions were local then became national and for the last four years, international. More detailed information about the schedule of the two competitions, implementation of the projects and level of the students entering the competition is present in a previous paper referring to this contest, reference ⁴.

The majority of the participants are Computer Science, Electronics and Telecommunications majors. The Microcontroller or FPGA platforms were chosen by the students based on their major and their previous experience with these platforms. If in the first editions the percentage of FPGA-based projects was higher, starting with the sixth edition the number of projects using microcontroller boards or even combined platforms increased, reaching at approximately 50 percent in the last edition of 2011.

The number of enrolled teams in the past three editions has also increased, exponentially (exception being the current year), due to the appreciation coming from universities and to the advertising techniques. Each edition was launched by sending an official e-mail to all the contacts from universities from the country or abroad and to the former contestants and their advisers as well. Posters are presented throughout university and students dorms and the Digilent website has a dedicated page for the contest announcement with all the information needed for the students. All the enrollment papers are received via e-mail, analyzed and an answer is provided.

Figure 1 and Figure 2 below represent a synthesis of the contest European editions in terms of participation and regions' affiliations (number of teams enrolled compared to the number of finalists). The graphs prove the expansion and growth of the competition as well as its international recognition.

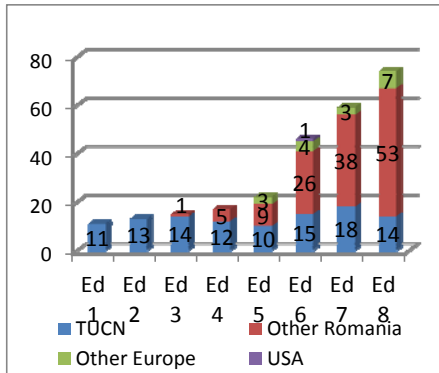


Figure 1: Enrolled teams' provenience in each edition of the Europe contest

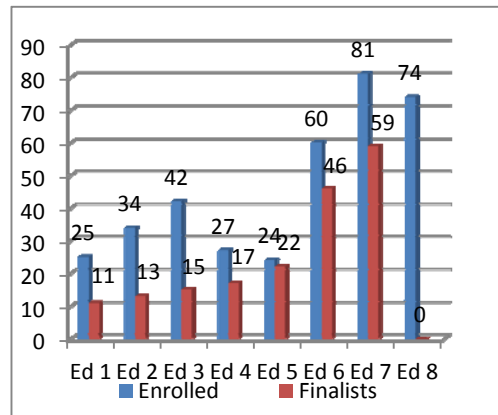


Figure 2: Number of finalists compared to enrolled teams for Europe region

Figure 4, Figure 5 and Figure 3 represent a different type of analysis, from the point of view of the study majors of the students, project category and the type of used platforms, for the last

edition of the contest. Robotics are the most spectacular projects presented and the Computer Science and Automation students enrolled in the largest number in the competition, presenting an increased interest towards logic design and digital circuits in general.

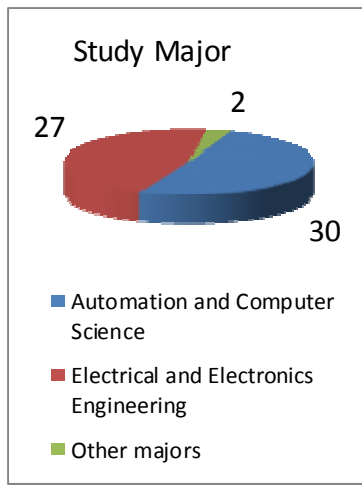


Figure 3: Europe region teams' majors

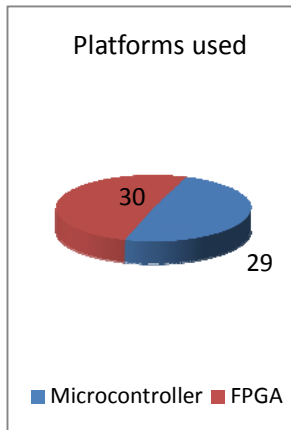


Figure 4: Europe region platforms used

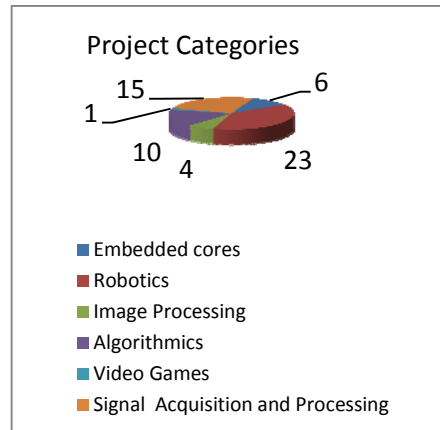


Figure 5: Europe region projects categories

The complexity of the projects increased over the years. A relevant proof for the quality of the projects from last year edition was the difficulty to differentiate the best ones; three projects were awarded with first prize, two with second prize and one with third prize.



Figure 6: Three of the winning projects of the past two editions

Digital Design Competition at Rose Hulman Institute of Technology, USA

A more recent competition had taken place at the Rose Hulman Institute of Technology, Indiana, starting in 2006. Initially open only to the students enrolled in that university, the US regional has grown last year, having participants outside RHIT and even outside US (a Mexico team).

Eight teams from other US states and Mexico were initially enrolled in the 2011 contest, but only two were present in the finals. The lack of experience with enrolling in such competitions and probably a bad time management are considered the causes, since the ones that dropped out stated that the time was an issue or the exams overlapped with dates of the contest.

Nine teams from the RHIT enrolled and six of them entered the finals. The RHIT students have more experience with the contest; therefore the number of teams present in the finals relative to the enrolled ones remains constant.

Nevertheless, the participants have shown a lot of interest and enthusiasm.

A common feature of the two regionals is the starting point and evolution: students from RHIT participated in the first editions of the contest in US, the same in Romania, where TUCN students competed; the number of outside teams increased and both the regionals can be called now international. Also, the platforms used for developing the projects are mainly FPGAs for the teams in US, the same interest being shown in Romania in the first years of national competition.

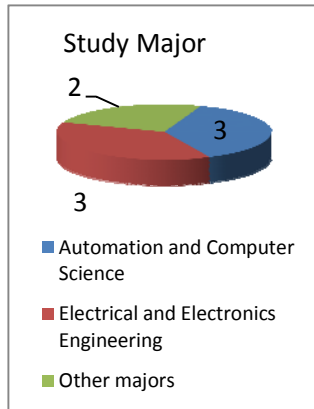


Figure 7: US region teams' majors

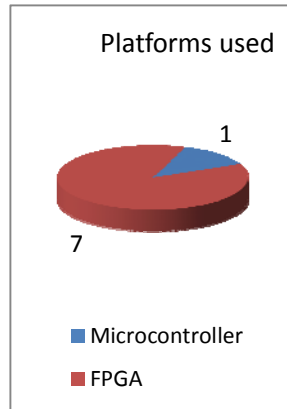


Figure 8: US region platforms used

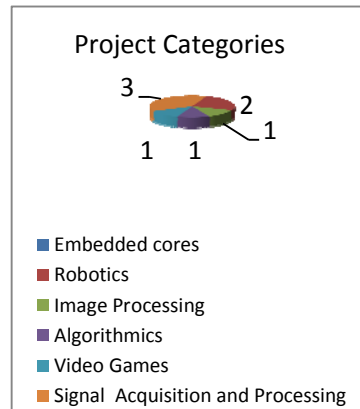


Figure 9: US region projects categories

Digital Design Competitions at Sir Padampat Singhania University, Udaipur, India and Tsing Hua University, Beijing, China

The 2011 editions were the first editions held in India and China. The students' interest to participate in such a competition was proven in the previous editions, where teams from India, Brazil and Turkey had enrolled in the Europe region. The two universities that hosted the finals cooperated with Digilent organizers very well and the feedback from the instructors was extremely positive. The rules were the same as the ones for Europe and US. The contests took place in June and the winners were invited to participate in the Munich final, in September 2011.

Ten teams were initially enrolled in India, but only two of them managed to enter the finals because of the exams period that overlapped with the final presentations. The cause is the different structure of the academic year than in US or Europe, as well as the different structure from one university to another. The experience of those present in the finals was a great one and they said they've acquired a lot of knowledge during the implementation of the project.

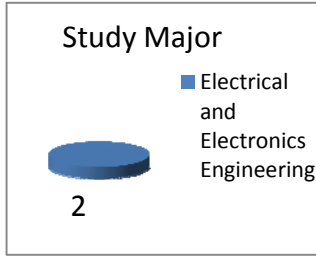


Figure 10: India region teams' majors

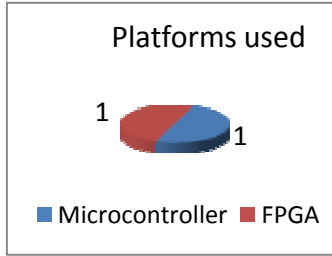


Figure 11: India region platforms used

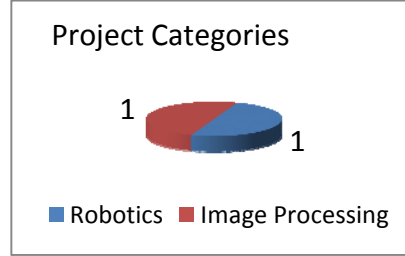


Figure 12: India region project categories

The China regional was more successful, having 36 teams enrolled and 17 finalists. Four teams were selected for the worldwide finals.

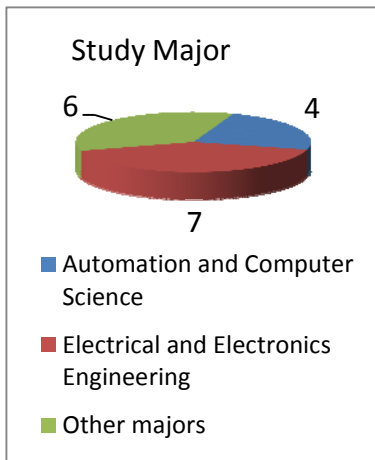


Figure 13: China region teams' majors

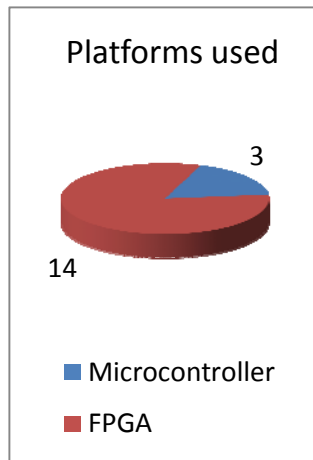


Figure 14: China region platforms used

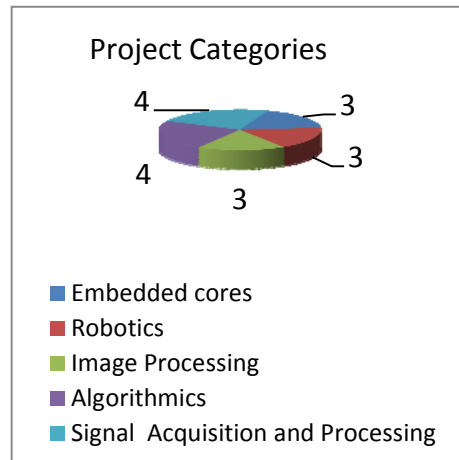


Figure 15: China region project categories

Munich worldwide finals in conjunction with FPGAWorld Conference

As a reward and recognition of their hard work, the winners from each region were invited to improve and defend their projects again at the Worldwide Finals, in Munich, September 2011. The projects were also exhibited at the FPGAWorld Conference, which was chosen as a strategic place to host the contest due to its participants and recognition. The opportunity was priceless since the students could meet industry representatives, present the projects to them and receive feedback about their work.

The members of the jury invited to evaluate the projects were selected from important companies in the technical industry: Digilent Inc. - USA, Digilent Taiwan, Analog Devices - Germany, Trezz Electronic - Germany, ESG Elektroniksystem und Logistik - Germany, Mirifica - Italy and Computer Measurement Laboratory - USA.

Sixteen teams from the four regions have competed in the finals: seven teams representing Europe region, four teams from United States region, one team from India and four teams from

China regionals. Three of the winning teams represented Europe region and two other the China region. The winners of the worldwide finals are listed in the table below:

Table I: The winners of the 2011 Munich Worldwide Finals

	Project	Description
1st Prize	BitHound	"BitHound" is a 32-channel logic analyzer implemented on the Atlys Spartan-6 board and a custom interface board. BitHound is capable of sampling 32 channels at 200MHz and sends the data to a client PC for display (via Ethernet). It can also inspect and debug digital circuits.
2 nd Prize	Pathfinder Rover	Explores the idea of creating a versatile, minimalist and low cost platform that could replace humans in hostile surveillance and exploration missions.
3 rd Prize	IsoRouter	"IsoRouter" is a Xilinx® FPGA-based NetFPGA virtualized router that supports parallel virtual networks with a completely isolated network layer.
4 th Prize	Bomb Disposal Robot	Bomb Disposal Robot, a microcontroller-based rough terrain navigation system with a precisely-controlled 4-DOF robotic arm. The robot can navigate a wide variety of terrain and can even climb stairs
"Crowd Favorite" Prize	Smart Shopping Cart	The "Smart Shopping Cart" is capable of following a shopper automatically but is also strong enough to be ridden. The cart is started stopped with an RFID key and has an on-board UPC scanner for self-checkout.

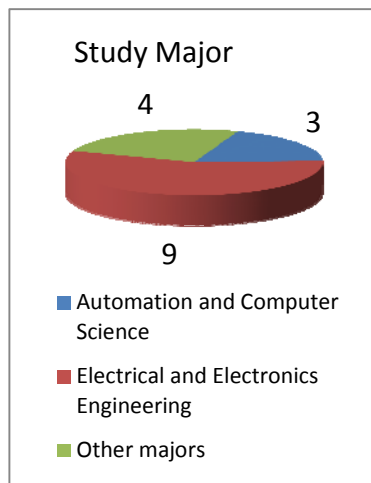


Figure 16: World finals teams' majors

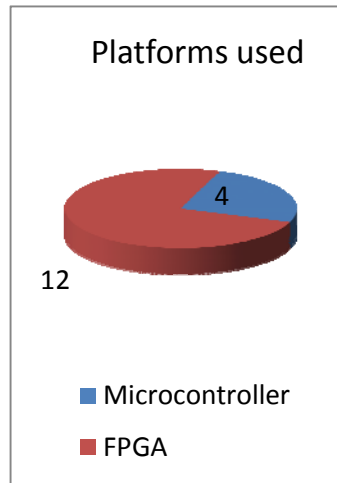


Figure 17: World finals platforms used

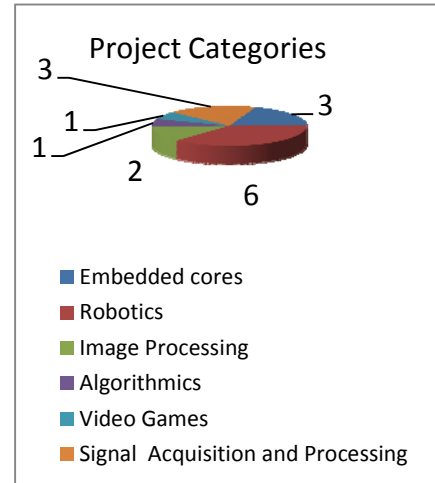


Figure 18: World finals project categories

Besides the two days dedicated to contest and exhibition, the participants, including students, advisers, jury members and organizers attended to cultural tours organized by Diligent representatives around Munich, having the chance to establish contacts and exchange information. This was seen as a reward for the participants' hard work and dedication, a proof that such contests can also be enjoyable and fun can be mixed with work. It is a way of stimulate students to be competitive, to create interesting projects and be challenged to be the best.

World Competition evaluation and participants' perceptions as a learning experience

The Europe regional of the contest has gained tradition and prestige over the years, followed closely by the one in United States, but it was the worldwide finals that had proven its popularity, appreciation and prestige. The survey that followed the competition was meant to evaluate the entire event from the perspective of a learning experience and cultural exchange.

The survey was also used to give useful feedback to the sponsors related to the quality of their products, support materials, the organizing methods and evaluation criteria. All the teams have provided a feedback.

One question investigates how beneficial is the competition for the students' professional development and future career as an engineer. Students' comments range from: "*it helped me get a job in the embedded design*" to "*consolidate the professional knowledge*" and improving practical skills or team management skills. Suggestive examples of students' comments: "*I learned a lot while developing the project itself. It required getting used to a lot of new tools and features. I now have a much deeper understanding of Xilinx FPGAs than before.*" "*I think it gave me more research abilities and international work partners.*"

The second question investigates in which area the students think that they improved their understanding and engineering abilities: Hardware-digital, Hardware-analog, Software-HDL or others. The majority of students mentioned Hardware Digital and Software HDL skills as the main skills developed participating in the competition, but also analog skills through the design of different additional modules or connecting circuitry. Other mentioned abilities like: mechanics skills building robots, programming languages (C++, assembly, Java).

Some of the skills they said they've developed during the projects implementation were how to manage their time, creativity, problem solving, debugging techniques, project management, innovation spirit.

The last question was related to students' motivation to enroll in this competition. Answers like making their own tools or improving their hardware and software skills were registered. Suggestive students' comments include:

"I wanted to share research experiences with the other student teams and receive feedback and advices from other engineers". "Meet new people, show others my ideas."

The answers the student gave to all the questions prove that they are motivated to learn, to share the ideas with other people, to evaluate themselves. Some of the suggestions they made for the competition improvements were to compete in different regions with people coming from all over the world.

Another survey was sent to the advisers with slightly different questions. One of the questions was related to encouraging students to participate in such competitions. Answers were that "*the students are also self-motivated*" and that "*we find students to participate every year*". Hardware support coming from the organizers is very appreciated and thought to be a starting point for students in developing competitive projects.

The reasons they would encourage the students to participate again were” *For the experience of meeting other contestants. It is a great chance for the cultural exchange” or “It familiarizes students with how a complete project should be solved, starting with planning, implementing, managing errors, and time constraints such as deadlines”.*

Conclusions

Based on the results of the competition and on the feedback received, the authors of this paper have reasons to believe that the Design Competitions bring benefits to all the involved parties.

For students:

- give the opportunity to demonstrate their creativity, problem solving skills, competitive skills and motivation to work for a project outside class requirements.
- the chance to directly meet and present their work to industry representatives.
- get used to writing a technical documentation and provide a good practical presentation of their work
- learn how to implement a project from scratch and manage their resources and time
- scan the market for job opportunities and the chance to receive a job offer
- learn about the industry requirements and the possibility to meet them
- the opportunity to interact with people coming from different environments and having different cultures
- comparison to other levels and educational programs
- motivate them to enlarge their field of interest, to stimulate their creativity and to be opened to new approaches and ideas
- economic support by receiving pieces of hardware from the organizers at no cost

For advisers:

- gain experience in coordinating individuals or teams to create complex applications
- have the opportunity to meet people with similar positions and share the teaching experiences with them, or learn new educational techniques

For universities:

- increase of prestige by having representatives to participate in an international competition or even winning teams
- get in contact to well-known technical industry companies through the students achievements
- improve the contacts with other universities and create new contacts

For company representatives:

- evaluate the students in order to spot potential future employees
- learn about the existent educational level of the future graduates

For organizers:

- be able to receive valuable feedback about their products
- receive good projects that use their products
- find out what the students are interested about and what are the new requirements for products
- improve their portfolio based on the feedback received

The universities involved in organizing each regional edition participated actively and offered logistic and financial support. A great achievement is the interaction between cultures and curriculum from different countries and regions of the world. Gathering representatives from different parts of the world to present their ideas and level of knowledge was a welcomed and innovative idea for design competitions.

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