

## **ANNUAL REPORT TEMPLATE: CHAIRS IN DESIGN ENGINEERING<sup>1</sup>**

**Report Due Date: April 27, 2011**

**Please verify your personal information below and make the necessary corrections.**

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Titre de la chaire en génie de la conception : « NSERC- chair in design for aluminum (DFAI) »

Nº de dossier : 411611 - 08

Nom des partenaires, J.D. Laprise, CQRDA

G. Dufour, Alcoa Canada Itée

M. Fafard, REGAL Regroupement Aluminium

**Top 3 contributions for the year.**

**(Since the beginning of the Chair on January 1st, 2011 in this case)**

1.

Setting up the aluminum assembly workshop for capstone projects.

2.

Providing aluminum to students in their final year capstone project.

3.

Defining new, industry sponsored, capstone projects for the 2011 fall semester.

### **Best Practices**

Please share one best practice that was implemented to be shared with other CDE Chairholders.

**1. (Since beginning of the Chair on January 1st, 2011)**

No best practice has been implemented yet, but it is foreseen that some self-learning tools and strategy would be developed before the fall semester to allow students to get acquainted with the joining techniques and safety rules pertaining to the equipment tools of the aforementioned aluminum assembly workshop.

This again is necessary if the students are to properly and safely use the riveting equipment and bonding techniques made available in the assembly workshop. However, equipment such as the new welding station would only be made available to the technicians of the Department of Mechanical Engineering (DME).

## 1. Overview

### a. Chair Structure

Please provide an overview of the participation in and contributions to the CDE action plan of each member of the Chair's team (Chairholder(s), professional staff, company experts, collaborators, post-doctoral fellows, students, etc.).

Senior Chair : Prof. Alain Desrochers, P. eng., Université de Sherbrooke, Canada

All reported Chair activities have so far been conducted by the senior Chair, with the help of the regular staff from the Department of Mechanical Engineering (DME) and the personnel from the research office.

Industrial co-Chair : Russel Long, P. eng., Chief Design Engineer, Alcoa Technology Center  
 Mr. Russel Long was quick to respond to my requests and was instrumental in providing aluminum for student projects. He also got advices from the Alcoa Technical Center (ATC) team regarding the specifications for the welding and riveting equipments for the assembly workshop. He also extended to me an invitation to spend a couple of weeks at the ATC during the coming summer.

### b. 5 Year Term Objectives Overview

Please provide a brief overview of your Chair, its goals and objectives.

The objectives of the Chair in Design for aluminum are twofold :

1. To evaluate and integrate the strategic use of aluminum in products from a cost/benefit/performance perspective;
2. To develop and disseminate knowledge and expertise on the design of products, rather than prototypes, where reliability, manufacturing and assembly processes will be properly assessed.

### c. Annual Objectives/Tasks

Please provide a list of the activities that were to be achieved in the past year and your progress toward these objectives.

Chair program : (Achievements, since beginning of the Chair on January 1st, 2011)

1. Undergraduate training - Applying Knowledge in Aluminum Design (Mech. and Civil Engineering)
  - Gathering information & knowledge on aluminum and reliable product design;
    - ⇒ *Little progress has yet been made toward that objective. However, Russell Long has pledged its support in transferring knowledge to the Chair and has extended me an invitation to spend several weeks at the ATC, this coming summer.*
  - Developing courses on aluminum in engineering and product optimization and validation;
    - ⇒ *No work has been done regarding the production of academic material since this step should follow the information gathering phase, just above. Nevertheless, discussions have taken place with colleagues in material science so that the new*

*courses proposed would be part of a new "Design material" option or orientation. Altogether, three courses would make up the option or concentration and they would collectively cover the following topics and more: Properties and use of aluminum and composite materials in products; design of riveted and bonded joint including their application to multi-material structures; failure and fatigue behaviour of structures; and corrosion issues. Moreover, including the study of materials such as composites, addresses a concern of the Chair visiting committee that the students would become too narrowly focused on aluminum. As a first step toward the creation of the "Design material" option/concentration, a new course titled "Behaviour and failure of composite structures" has been adopted by the DME assembly on April 21<sup>st</sup>, 2011.*

- Setting up an assembly workshop for aluminum related students projects;
  - ⇒ *A welding station has been purchased and received and quotations for riveting equipments have been obtained. This task is being done in close collaboration with Russell Long, industrial co-chair, and the technicians from the DME.*
- Supporting aluminum usage in undergraduate capstone design projects.
  - ⇒ *Aluminum has been provided by Alcoa for two ongoing capstone projects due to terminate in December 2011. Other capstone projects have also been proposed aluminum but did not need it.*
  - ⇒ *two new projects have been defined with Alutrec, a Chair collaborator with the Centre Québécois de Recherche et Développement de l'Aluminium (CQRDA). These new projects will be proposed to students in the fall 2011 semester. The first project aims at designing a dedicated Fixture/machine for the assembly of a novel flatbed aluminum trailer while the second is targeted at the design of a lowered version of the same flatbed trailer. A grant proposal was prepared by me and has been submitted by Alutrec to CQRDA to support these projects. Discussions regarding the financial aspects of these projects still need to be finalized however.*

## 2. Graduate and post-graduate training - Creative Design for Innovative Aluminum Products

- Development of methodologies and advanced design tools;
  - ⇒ *Even though he is paid with my NSERC Discovery grant, I have a Ph.D. student (Cristian Iorga) working on the development of integrated, detailed design and validation methodologies adaptable to various product development contexts. his work directly addresses the second objective of the Chair, as stated at the beginning of this report. This student was also instrumental in producing the papers presented to the Canadian Engineering Education Association (CEEA) Conferences in 2010 and 2011 as well.*
- Development of innovative products and materials.
  - ⇒ *In July 2010, I have obtained a 11.3 million\$ total grant from the Automotive Partnership Canada, for the "Development of a hybrid propulsion roadster" with Bombardier Recreational Products (BRP). Among the many graduate students involved in the project, two master degree students have subjects in relation to aluminum structures: the first (Walid Ben Romdhane) to identify the vehicle load cases and design a corresponding special jig for a fatigue testing servo hydraulic machine and the second (Maxime Tacher) to design a new optimized aluminum frame for the future hybrid version of the roadster.*

## 3. Chair resources

- Hiring a professional/Mechanical Engineer with the funds released by my salary and the Chair budget;
  - ⇒ *A job description has been prepared jointly with François Charron, head of the DME. The professional mandate will be comprised of four elements:*
  - 1) *Canvass industry and Small to Medium Enterprises (SME) for sponsored*

<p><i>capstone projects;</i></p> <p>2) <i>Identify and channel the most promising unsponsored capstone projects toward the University start-up support organization known as the "Technological Enterprise creation accelerator" (ACET);</i></p> <p>3) <i>Assist in the various chair activities toward the achievement of the Chair program, including project follow-up, course preparation, assembly workshop completion, technological watch, etc.;</i></p> <p>4) <i>Manage, use and maintain a servo hydraulic testing machine for the structural validation of prototypes regarding reliability and fatigue life testing, including safety issues.</i></p> <p>⇒ <i>The recruitment process is ongoing and an internal candidate has been identified so far. Preliminary contacts have been made to verify the candidate interest for the position. We are looking for the selected professional to start work in early June at the latest.</i></p> <p>4. Other Chair matter</p> <ul style="list-style-type: none"> <li>• Intellectual properties issues;           <p>⇒ <i>Before proceeding to the formal announcement of the Design Chair, the University research office requested that a mutual agreement be reached by all Chair collaborators regarding intellectual property ownership. After a short round of consultation, all agreed that the intellectual property most likely to arise would come from student capstone projects and master student works and that it should be negotiated on an individual basis with the companies or industrial partners involved, if any. Otherwise, the Chair being mostly oriented toward undergraduate training, no intellectual property is expected to arise from the Chair activities themselves. Hence, a letter of agreement has been drafted where partners relinquish their right to any intellectual property from the Chair endeavour. Of the three current Chair partners, Alcoa, REGAL and CQRDA, only CQRDA has not signed the letter of agreement yet, even though it consented to do so.</i></p> </li> <li>• Formal Chair announcement           <p>⇒ <i>The Université de Sherbrooke (UdeS) research office personnel has set the official launch of the Design Chair, contingent upon the signature of the intellectual property letter of agreement by all Chair partners. It is not clear whether this was an NSERC requirement however;</i></p> <p>⇒ <i>In any case, the formal announcement of the Chair will be made in close collaboration with NSERC personnel, as it should.</i></p> </li> </ul>
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#### d. Objectives/Tasks for Upcoming year

Please provide a list of the activities that you are planning for the upcoming year.

<p>Chair program :</p> <ol style="list-style-type: none"> <li>1. Undergraduate training - Applying Knowledge in Aluminum Design (Mech. and Civil Engineering)           <ul style="list-style-type: none"> <li>• Gathering information &amp; knowledge on aluminum and reliable product design;               <p>⇒ <i>This will definitely be a top priority for the upcoming months and year. This important task will be conducted both by the Chair holder (me) and the Chair professional. To this end, the following actions will be undertaken:</i></p> <ol style="list-style-type: none"> <li>1) <i>Contact the Chair partners to garner information pertaining to the use of aluminum in product design (Chair professional);</i></li> <li>2) <i>Involve the industrial co-chair in this endeavour since this was the initial trust</i></li> </ol> </li> </ul> </li> </ol>
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<p><i>to designate him in the first place (Chair holder);</i></p> <p>3) <i>Spend time at the Alcoa Technical Centre in Pittsburgh, learning about design with aluminum and collecting case studies (Chair holder);</i></p> <p>4) <i>Seek information from other sources such as libraries, journals and other organizations related to material such as the National Research Council - Aluminum Technology Centre (NRC-ATC) in Saguenay, Québec (Chair professional).</i></p> <ul style="list-style-type: none"> <li>• Developing courses on aluminum in engineering and product optimization and validation;           <ul style="list-style-type: none"> <li>⇒ <i>This task will naturally follow from the preceding one. It is foreseen that the following targets will be achieved:</i> <ol style="list-style-type: none"> <li>1) <i>Preparation of a guide for sizing welded and riveted joints with details on the actual use of the specific tooling for riveting (Chair professional);</i></li> <li>2) <i>Prepare a short course (45 min.) on "Design of aluminum components and products". The course will be given on October 2<sup>nd</sup> at the COM 2011 Conference of Metallurgists in Montréal and will encompass part of the material for the DME undergraduate course (Chair holder);</i></li> <li>3) <i>Prepare the course documents with detailed content needed to create a new undergraduate course on "Design for aluminum" (Chair professional).</i></li> </ol> </li> </ul> </li> <li>• Setting up an assembly workshop for aluminum related students projects;           <ul style="list-style-type: none"> <li>⇒ <i>This will be a continuation of what has already been undertaken since January 2011. the selection of the riveting equipment will be completed and information will be sought regarding bonding products and applications;</i></li> <li>⇒ <i>Bonding requires cautious investigation as the performance of a joint does not depend solely on the "glue" itself but very much on surface finish and preparation. Additionally, various parameters must be factored in choosing the right "glue" and proper ventilation could very well become an important health issue for the students and personnel (Chair professional).</i></li> </ul> </li> <li>• Supporting aluminum usage in undergraduate capstone design projects.           <ul style="list-style-type: none"> <li>⇒ <i>Supporting capstone projects will be a continuous undertaking throughout the full five years of the Design Chair. Hence, aluminum will continue to be provided to the students who need some and new projects will be sought as part of the Chair professional mandate;</i></li> <li>⇒ <i>In real terms, it is expected that the budget issues with Alutrec will be overcome and new industrial partners will be identified. More specifically, Posi-Plus Technologies, a manufacturer of cradle elevators for trucks, has vowed to propose projects, with the financial support of the CQRDA. I also met, on March 4<sup>th</sup>, with the director of research at Verbom, a manufacturer of dies, cast and matrixes, to envision a project on the design of boat hulls using "super plastic" aluminum alloy sheets. The meeting was initiated by the local CQRDA agent. It is hoped that all of these projects will be completely "packaged" in time for the fall 2011 semester. It will be the task of the Chair professional to follow-up on this.</i></li> </ul> </li> </ul> <p>2. Graduate and post-graduate training - Creative Design for Innovative Aluminum Products</p> <ul style="list-style-type: none"> <li>• Development of methodologies and advanced design tools;           <ul style="list-style-type: none"> <li>⇒ <i>The Ph.D. student (Cristian Iorga) referred to in the preceding section will carry-on his work toward the development of dedicated methodologies for product validation at the outset of the detailed design phase, hence providing material for the "prototype to product" stream. Indeed, some of the work of this student would be the basis for the material of a second Design Chair course on product reliability and manufacturing assessment.</i></li> </ul> </li> <li>• Development of innovative products and materials.</li> </ul>
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⇒ *Ongoing projects will be continued. However, no new project is scheduled unless some industry sponsored project turns out to suit master degree requirements more than capstone projects. Moreover, if an industry sponsored project is not selected in the fall semester, it could be "recycled", with appropriate modification and support, into a suitable graduate student project that could be offered in the following January, when our graduating student arrive on the job market.*

3. Practicing engineers - Increased competencies in aluminum design

⇒ *Regarding practicing engineers, no action is planned in the first two years of the Chair operation. Focused is to be placed on getting things started with undergraduate student related activities.*

e. Impact of Semi-Annual meetings

Please describe the influence last year's semi-annual meetings have had on your Design Chair. Note any impact or changes as a result of the meetings.

I have attended my first such meeting in January 2011, coincidentally with the start of my own Design Chair. It proved very helpful to get acquainted with the challenges the more experienced Chairholders face, their achievements and the latest trends in engineering education. The split between sharing experience and the media training workshop was also an interesting one.

However, I was surprised by the high number of attendees who were busy working on their personal computers during the meeting. It is not something I see when I sit on Bombardier Recreational Products (BRP) meetings or on University meetings when I was acting as associate dean for that matter. Moreover, I doubt that we would appreciate that behaviour in our own classrooms.

**2. Established Partnerships**

Briefly describe the nature and extent of the involvement of the partners. Include details on how the results have been communicated to the partners (e.g. meetings, reports) and how the industrial partners have transferred knowledge and know-how to the university students, staff, and faculty.

The Design Chair is currently supported by three partners: REGAL, Alcoa and CQRDA. The following lines will explicit the extent of their involvement.

REGAL: The REGAL is a research centre on aluminum, supported by the Fonds québécois de la recherche sur la nature et les technologies (FQRNT), the provincial equivalent of NSERC in Québec. REGAL was instrumental in the creation of the Design Chair as it was part of its strategic plan. REGAL is also the only partner whose contribution is in cash and not contingent upon the completion of specific projects or grant proposals. Being responsible of a research axis on aluminum product design and manufacturing within REGAL, I have pledged to disseminate to all member institutions, the course material and good practices that are to be generated through the Chair activities. There is no such material yet however, but there should be some in the coming year.

Alcoa: Alcoa's contribution is in kind, but it is central to the good operation of the Chair. Indeed, it includes the involvement, as industrial co-chair, of Russell Long, Chief Engineer, Ground transportation, at the Alcoa Technical Center (ATC) in Pittsburgh. In this role, he has so far been very responsive to my requests and provided me with valuable information regarding the equipment for the aluminum assembly workshop. He is also keen to share knowledge and test

case studies regarding the design of aluminum products and components in the transportation industry. Finally, he has been very quick and collaborative in providing aluminum for our ongoing student capstone projects.

CQRDA: The contribution of the Centre québécois de recherche et développement de l'aluminium was through grants to Small to Medium size Enterprises (SME) for projects involving students from the Université de Sherbrooke. In the initial Chair proposal, two such SME had been identified: Alutrec, a maker of aluminum flatbed trailers and Posi-Plus Technologies, a manufacturer of cradle elevators for trucks. As mentioned in a preceding section, two projects were drafted with Alutrec and a grant proposal prepared for the CQRDA. Posi-Plus has repeatedly committed its interest to do projects with the Design Chair but a meeting has yet to be setup to discuss the details of the potential projects. On the other hand a meeting did take place with the director of research at Verbom, a manufacturer of dies, cast and matrixes, to envision potential collaboration with the Chair. Finally, I must report the strong backing and close follow up of the local CQRDA representative, Mr. Georges-Henri Goulet, who has been instrumental in initiating contact and organizing meetings and communications with the SME's in the process of identifying interesting projects for the Chair.

### 3. Sources of Financial Support

Please provide information about the cash and in-kind contributions received during the past year, noting the impact on the Chair activities as well as the estimated values for Chair leverage.

First and foremost, it is worth noting that the Chair on Design for Aluminum has started its activities less than 5 months ago, on January 1<sup>st</sup>, 2011. Hence, the contribution so far received both in cash and in-kind does not cover a complete year of operation.

Nevertheless, REGAL has completed its contribution for the current year, providing 27 000\$ in cash. More specifically, 10 000\$ were from the REGAL fiscal year 2010-2011 while another 10 000\$ was the contribution for 2011-2012. Finally, 7 000\$ were provided as a support and recognition for my efforts as one of the three REGAL research axis coordinators, a task which closely match my role as Chair holder.

As indicated in the Chair proposal, the contribution of the CQRDA is in cash for a total of 17 000\$ and is to be made through projects with partners such as Alutrec and Posi-Plus Technologies. Those projects have been described in details in previous sections so they will not be covered again here.

The contribution from Alcoa has been up to expectations both in terms of time devoted by the industrial co-chair Russell Long and in terms of aluminum provided, even though only a few hundred dollars worth of aluminum ( $\approx$ 500\$) have been requested by students. However, it is expected that the bulk of Alcoa in-kind contribution will be in the fall 2011 semester, as it is during that particular semester that new capstone projects are selected and started and ongoing capstone projects reach their manufacturing and assembly phase, in order to be ready for the annual December exhibition. These activities will imply exchanges during the summer to define new aluminum related projects and assess the scope and challenges presented by the industry sponsored projects. Toward the end of the summer, another aluminum order will be made to meet the requirements of those teams completing their detailed design during that semester. Then, during the fall semester, at least two visits by the industrial co-chair are planned over several days:

1. The first visit will be for the first concept review of those students tackling the new proposed aluminum related projects but also other projects involving vehicles, even if the use of aluminum does not constitute their initial design target. This first visit will also be

- an opportunity to meet and coach the teams whose projects reached their manufacturing and assembly phase. In addition, the co-chair will provide critics and advices regarding the actual assembly workshop for which an opinion has been solicited earlier on this year.
2. The second visit, in early December, will target the same students but will constitute a final assessment of their work. More specifically, the co-chair will participate in the final design review regarding the selection of concepts for the new projects and he will also evaluate the prototypes, posters and presentations of the graduating teams.

#### **4. Progress to Date**

Please describe the progress to date made toward the following objectives.

##### a. Training

Please include all relevant information about courses developed or modified by the Chair focusing on design, the impact of these courses as well as any involvement in competitions etc. Please include the number of students impacted.

###### I. At the undergraduate level

As previously indicated, a course on *Design for aluminum* is planned as a classic way of transferring knowledge.

More specifically, the course will address various topics pertaining to the use of aluminum in product design: Aluminum physical properties and cost; comparison with steel and composite materials; corrosion resistance, galvanic corrosion and surface treatment such as anodizing; assembly of aluminum components: Conventional welding, friction stir welding, riveting and bonding, multi-material assembly; design criteria: Safety factors, ultimate strength, yield strength, fatigue resistance, endurance limit, rigidity (strain); application spectrum and typical design guidelines and ratios for the productive use of aluminum in components and products; case studies and examples of aluminum products.

The course content will be assembled mainly by the Chair professional, using knowledge and references from the industrial co-chair and my colleagues from the REGAL research Centre. This task should be completed in the coming year. The exact title and final scope of the course still need to be finalized however.

###### II. At the graduate level

The focus of the Chair is mainly targeted toward undergraduate students on whom it hopes to have the biggest impact. Nevertheless, part of the Chair program includes graduate student training mainly through projects related to the Chair objectives. More specifically, these projects will either cover *advanced methodologies and design tools* or *the development of generic aluminum-related design technologies*. In either case, these projects will fit the requirements for the research-based track of the master's degree program or the new integrated bachelor's-master's degree program. This last program however, is still under development at the faculty and department levels. The Design Chair will most certainly be involved in the discussions related to it, as this is also seen as a unique opportunity to add course content related to *Material selection and assembly in design* or *Design for aluminum* as well as *Design from prototype to product*.

There is no timetable set for completing and starting the integrated bachelor's-master's degree program as this initiative has been faced with hurdles in the way of financing and course credit

dual recognition. In any case, a reasonable guess would be that it should be up and running in the coming year and a half.

Regarding actual graduate student projects, my Ph.D. student Cristian Iorga will continue its work and investigation on the development and integration of validation methodologies as a means of feedback toward those product specifications targeted at reliability, production and cost. Another student, Maxime Tacher, will pursue its master degree work on the design of a new aluminum frame for the CAN-AM roadster by Bombardier Recreational Products (BRP). Additionally, as previously implied, if one or both of the Alutrec sponsored projects do not appeal to students as capstone projects, these could be offered as master degree subjects. We should know more regarding this possibility in September, as the students must choose their capstone project at the beginning of the fall semester.

#### b. Design and Development

Describe all relevant information about the design and development of innovative products, processes, systems and technologies.

Design and development of innovative products is central to the Chair on Design for Aluminum and the Université de Sherbrooke Mechanical Engineering program. However, after less than 5 months operation, there is little to report in the way of design projects that would have benefited from the Chair support.

In any case, it might be worth describing shortly the two projects which have been provided with aluminum from Alcoa.

The first is Maelstrom (7 students), which is, as its web site puts it, "an academic project which aims to design and build a mobile hydrokinetic turbine adapted to Quebec's rivers to harvest the province's hydrodynamic potential". A hydrokinetic turbine is an underwater turbine which uses the energy of marine or waterway currents, like a wind turbine uses the kinetic energy of the air. The hydrokinetic turbine's blades allow transformation of the hydraulic energy into mechanical energy, which is then transformed in electric energy by an alternator.

The second project to have benefited from Alcoa's aluminum is hUSki (7 students), whose aim is to design and construct a sled to allow injured people to be rescued and towed by a snowmobile in mountain ski resorts. This project is to provide a new tool for the Canadian Ski Patrol at the small Moncalm ski resort in Québec.

Both projects will be formally presented at the annual DME project exhibition in December 2011.

#### c. Collaboration

Describe any collaborations and interaction of the Chair with the department, faculty, university and outside colleagues during the past year in connection with the CDE action plan. Include collaborations with other CDEs, but do not include the Chairs regular workshop meetings.

Considering the history of the DME as a leader in project based learning and the many partners involved in the Chair, collaboration is definitely a strong aspect of the Chair on Design for Aluminum.

At the DME level, I benefit from the backing and experience of François Charron, head of Department and former Design Chair holder. Incidentally, the job description for the Chair professional was drafted with his insight. I can also count on the strong support from Patrik Doucet, the associate dean academic, who is also the professor responsible of the general follow

up of the capstone design projects in Mechanical Engineering. So far, an internal presentation of the Chair has been made to the DME professor's assembly and other will follow suit, as the Chair reports on its achievements.

The Chair description and status has also been presented to the member of REGAL earlier this year. This was necessary for the support money to be released for 2011-2012. Moreover, the REGAL Centre is due to renew its support from the FQRNT next year. This provides an invaluable opportunity to link the Chair actions to the research centre future program, hence creating strong bonds with other academic and industrial partners. As responsible of the research axis on design and manufacture of aluminum product, I will be actively involved in the definition of the research program and activities of the REGAL Centre for its second mandate.

No specific action has yet been taken with the other Design Chair however. This could be a target for the upcoming year or two.

#### d. Promotion

Describe any events and activities that were organized to raise the awareness and appreciation in the research and outside communities for all aspects of design engineering.

Promotion of Design engineering as been made on a de-facto basis, throughout the various and frequent interactions that the Chair holder has had since the beginning of the Chair on Design for Aluminum last January. A more formal event that is being prepared is the official announcement of the Chair, hopefully in the coming weeks. This issue is important, not only for the Design Engineering community, but also for the Chair partners who see an opportunity for visibility and recognition of their efforts to promote the strategic use of aluminum in product design.

### 5. Problems Encountered

Identify the main problems encountered during the past year, their impact and the steps taken to resolve each issue.

No major problems have been encountered since the start of the Chair, last January.

One difficulty, to name one, is related to financial support, especially from CQRDA where the cash contribution is to be provided through a grant to support projects with SME such as Alutrec and Posi-Plus. This proves to be very time consuming. However, the good side of it is that it also provides projects for students, which is, incidentally, an integral part of the Chair program.

Regarding Alcoa's contribution, keeping track of the amount of time devoted by their personnel toward the Chair activities and objectives as well as getting the exact value of the aluminum provided to the projects does not appear to be a trivial task either.

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<sup>1</sup> In this document references to Chairs in Design Engineering (CDE) also should be interpreted as referring to Chairs in Environmental Design Engineering (CEDE).