CIMA+
Partners in excellence

Accomplishing the C2MI project

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2012 CANADIAN CONSULTING ENGINEERING AWARDS

Project management

THE MIQRO INNOVATION COLLABORATIVE CENTRE

ASSOCIATION OF CONSULTING ENGINEERING COMPANIES | CANADA
ASSOCIATION DES FIRMES D'INGÉNIEURS-CONSEILS | CANADA

CANADIAN CONSULTING engineer

A complex project

In 2009, the Université de Sherbrooke (UdeS) launched an ambitious project in Bromont, establishing an applied research and development centre in nanotechnology, in partnership with IBM and Teledyne Dalsa, two pioneer multinational corporations in this sector. The MiQro Innovation Collaborative Centre (C2MI) includes a design facility and a manufacturing building that contains approximately 30 laboratories.

The C2MI represents a $218 million investment, from public (KIP[1] and MDEIE[2]) and private sectors. Delivery was planned on October 31, 2011 at latest, after only 26 months of work. Managing the budget was a complex task, because the project was subject to numerous constraints imposed by government legislation, the UdeS, and the multinational partners. In addition, the KIP was coming to an end on October 31, 2011, which meant that the $82.03 million construction budget would lapse at the end of that program.

Given the scale of the challenge, the UdeS called upon the expertise of professional project managers. At the outset, the project limits were rather vague. CIMA+ was actively involved in defining the budget envelope for the project and specifying the nature of the facilities. We were also responsible for converting the highly aggressive schedule desired by the clients into a realistic one. CIMA+ decided to stick to the delivery of a functional centre and to limit any changes that were not strictly necessary while at the same time endeavouring to spend the committed funds as quickly as possible.

In order to meet the expectations of the very aggressive schedule, CIMA+ proposed to the UdeS that the construction work be carried out in a number of construction packages, which would make it possible to accelerate the delivery of the centre. However, managing a project in multi-package mode is a difficult exercise that requires a great deal of coordination and supervision in order to ensure continuity. The great expertise of CIMA+ made it possible to resolve all of these problems in a context in which the construction work was executed at an average cash flow of $3 million per month, with peaks in excess of $8 million.

From a technical perspective, the C2MI is a highly complex building that includes a 50,200 sq. ft. design facility and a 113,600 sq. ft. manufacturing building containing approximately 30 laboratories. 60% of the space is devoted to clean rooms. The heart of the laboratory consists of class 10 (ISO 4) rooms, making it the most highly controlled environment in Canada. The requirements that must be respected to obtain this classification are ten times more restraining as those that apply to hospital operating suites. In addition, the functionality of the building depends on a network of complex services, including ultra-pure water, de-ionized water, and nitrogen.

The technical complexity of C2MI took on its full significance in the project closeout phase. Indeed, it was necessary to qualify the installations, certify the clean rooms and obtain the conformance of the anti-vibration slab. These validations had to be completed successfully on the first attempt, because we had no additional time to start over.

Innovation and original solutions

CIMA+ proposed the preparation of a management plan in which all management elements of the project were clearly specified. We also adopted an action plan designed to ensure the quality of the works while meeting the difficult budget and schedule requirements.

The regulatory framework subjected us to some very heavy procedures, and CIMA+ worked toward making the work of the other stakeholders as efficient as possible throughout the project. We sought to reduce lead times wherever possible. We favoured a parallel approach to the work rather than a sequential one, and we got more closely involved in the coordination process than in any traditional project. Using this approach, we estimate that we have delivered the project almost two years earlier than what would have been possible following the traditional model (strictly sequential single-package approach).

CIMA+ was able to deal efficiently with all the challenges of this project by setting up control tools and follow-up registers, and by documenting every major decision. By keeping complete mastery of the project situation at all times, we were able to constantly analyze and monitor the impacts of changes on the budget and provide our client with the best possible advice.

[1] Knowledge Infrastructure Program
[2] Ministère du Développement Économique, de l'Innovation et de l'Exportation

Satisfied clients

The C2MI is intended to be a world leader in the packaging of the next generations of electronic microchips. Therefore, no compromise would be possible in terms of quality of the works. In light of this, we have to highlight the technical feats that were accomplished for the anti-vibration slab and the clean rooms. Not only the results obtained were positive right from the first tests, but the C2MI will henceforth be cited as a pilot project and model for success throughout North America.

Change management was one of the keys to the success of this project. We defined a clear process from the very beginning of the project that was approved by all the stakeholders, wherein the roles and responsibilities of each party were defined. Every effort was made to ensure that there was no ambiguity, and that the decision-making process would be efficient.

Based on this approach, CIMA+ was able to advise and guide the client through certain difficult decisions. The client was aware of the opportunities and risks facing the project at all times, taking into consideration the contingencies available to deal with them. We then documented all the changes that were proposed and all the decisions that were made.

As planned, the C2MI was delivered to the project partners at the end of October 2011, in full compliance with the schedule and the budget. Thanks to our collective expertise and the customized solutions we adopted, we can take pride in having delivered a research and development centre designed and built in 26 months, at a cost 7% below the initial planned budget.

CIMA+ earned the heartfelt thanks of its clients for the quality of the management of this exceptional project. One of the partners moved into its accommodations as soon as November 7, 2011which was only 7 days after the signing of the provisional acceptance certificate for the works.

A process of reflection on environmental impacts

The UdeS has committed itself to a reflection and action process in the area of sustainable development. This project was no exception, and CIMA+ assisted the UdeS in promoting sustainable development throughout the project.

Although the clients initially wished to obtain a LEED certification for the centre, we soon realized that the very nature of the project would not allow it. However, the manufacturing building was designed in accordance with sustainable development principles. We should also note that certain LEED certification criteria would have compromised the very function of the building.

For its part, the design of the office building would have led to a silver level LEED certification . Efforts were undertaken in various areas covered by this certification, ranging from efficient water management to local sourcing of materials, and from waste management to energy savings.

Social and economic benefits

The C2MI is at the heart of the creation of a Québec microelectronics cluster. This corporate-university partnership has the potential to position Québec as a world leader in the packaging of electronic microchips and the manufacturing of MEMS[3] devices. Among other things, this project represents:

- 1,000 jobs per year related to the construction of the centre;
- The preservation of 3,200 jobs among industrial partners;
- The training of a highly qualified workforce;
- The attraction of foreign resources and researchers.

Throughout the project, CIMA+ did its best to demonstrate to all its collaborators the substantial added value that comes with a dedicated project manager who manages the project on a full-time basis. CIMA+ clearly demonstrated its undeniable effectiveness in the rather specific and unique situations that were encountered the C2MI construction project.

As a result, thanks to the involvement of qualified project managers like those of CIMA+, we here in Canada are able to deliver large complex infrastructure projects within budget and schedule baselines. We are convinced that the C2MI project will be cited throughout North America as an example of success and exceptional technical feats.

[3] Microelectromechanical systems

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1. COMPLEXITY

In the province of Québec, the Université de Sherbrooke (UdeS) is pushing the boundaries of knowledge in a number of innovative fields, including nanotechnology. In order to meet future demands, both nationally and internationally, it launched an ambitious project in Bromont in 2009, establishing an applied research and development centre in partnership with IBM and Teledyne Dalsa, two pioneer multinational corporations in this sector. The MiQro Innovation Collaborative Centre (C2MI) is involved in the development of microelectronics, which is a strategic industry that generates highly skilled jobs in Canada.

The centre includes a 50,200 sq. ft. design facility and a 113,600 sq. ft. manufacturing building containing approximately 30 laboratories. 60% of the space is devoted to clean rooms, or in other words, laboratory rooms in which the temperature, pressure and air particle count are controlled. The heart of the laboratory includes class 10 rooms (ISO 4) totalizing more than 2.350 sq. ft., where powerful ULPA filters and compulsory strict protective clothing protocols constantly maintain the air quality at less than 10 particles, 0.5 micrometers in diameter, per cubic foot, making it the most highly controlled environment in Canada.

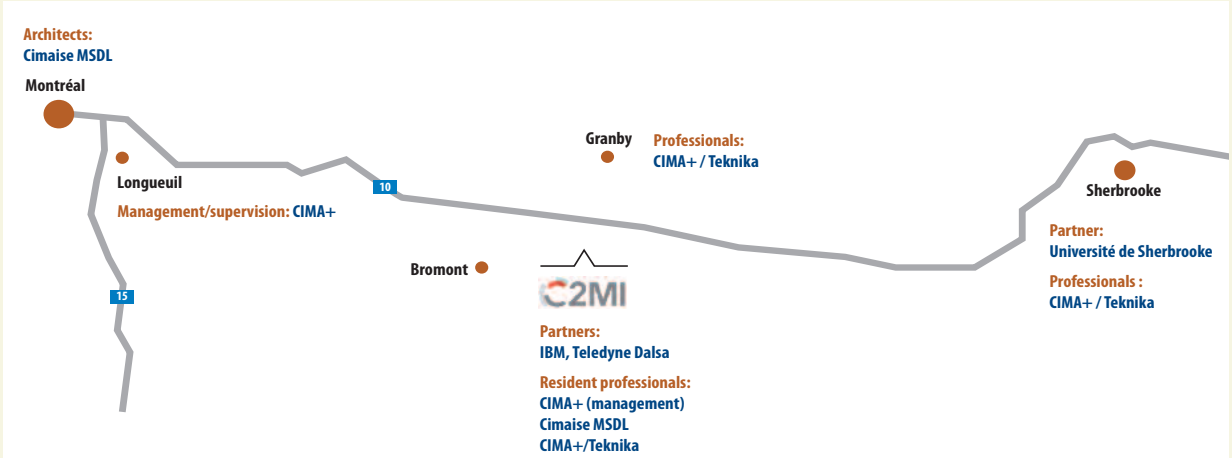
The C2MI represents a public and private investment of $218 million. Delivery was planned for no later than October 31, 2011; only 26 months after the Prime Minister of Québec launched the project. Considering the scope of this challenge, the UdeS called upon the expertise of professional project managers.

1.1 PARTICIPATION IN THE PROJECT DEFINITION

At the beginning, the entire project was rather vaguely defined. In fact, neither the scope of the work nor the availability of financial resources were clearly identified. In light of this, CIMA+ had to prepare the project preliminary scope statement. In concrete terms, this meant defining the project objectives, the scope, and requirements, which in turn required each partner to contribute to the exercise.

CIMA+ was actively involved in defining the budget envelope for the project and specifying the nature of the facilities. We were also responsible for adapting the highly aggressive schedule desired by the clients into a realistic one. We received full collaboration of around thirty representatives of the stakeholders in order to ensure that all the design criteria were covered.

Then, we had to quickly orchestrate the value analysis of the pre-concept and to weight the content of the budgetary estimate, considering the risks related to the nature of work and the reference schedule, all this in order to comply with the approved budget. Not only was the scope of the project frequently changing, but we also had to plan flexibility into the facilities in order to facilitate ongoing adaptation to state-of-the-art equipment, which is subject to very rapid change from a technological perspective.



The challenge: Geographic breakdown of the various stakeholders involved in the project

1.2 PUBLIC-PRIVATE PARTNERSHIP

The C2MI obtained financing from the KIP[1], the MDEIE[2] and a number of private partners and equipment suppliers. **This was the largest investment in Canada within the context of this program, amounting to $218.45 million** for construction of the building and the acquisition of the necessary research equipment.

This meant that the C2MI project was subject to the regulatory constraints of the Act respecting contracting by public bodies, the Framework Policy for the Governance of Major Public Infrastructure Projects, the UdeS standard general conditions, and many corporate constraints imposed by IBM and Teledyne Dalsa.

In addition, because the KIP was coming to an end on October 31, 2011, any invoices that were not sent by that date would have been rejected.

The direct impacts were significant, considering the fact that the $82.03 million construction budget would lapse at the end of the program. In other words, the budget was equal to the maximum amount that we would have invoiced as of October 31, 2011, up to a limit of $82.03 million, which meant that 100% of the works had to be completed within this authorized maximum.

However, the partners' interpretation was slightly different. They wished to carry out all of the essential and possible works for proper operation of the centre and to maximize the utilization of the financing. CIMA+ had to deal with their needs within a highly regulated context beset with restrictive public call for tenders procedures and limited time in order to complete what was already a very ambitious initial scope of work.

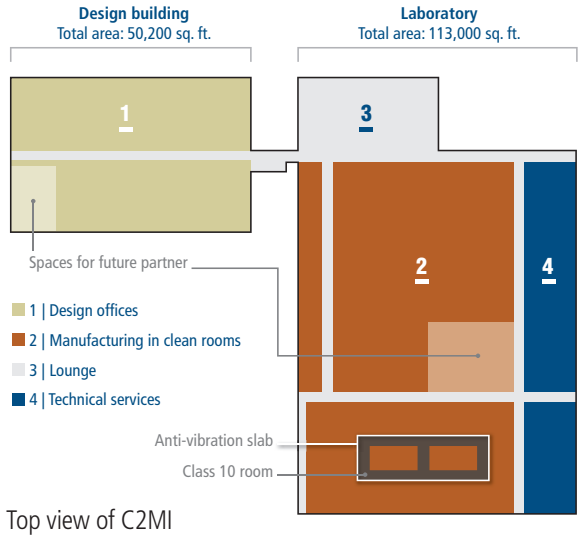
1.3 REQUIREMENTS OF A HIGHLY COMPRESSED SCHEDULE

In order to meet the demands of the very aggressive schedule, CIMA+ proposed to the UdeS that the works be carried out in a number of construction packages. In fact, the overlapping of the design and construction works along with the execution of the various construction packages in parallel made it possible to accelerate the delivery of the centre.

However, managing a project in multi-package mode is a complex exercise. We had divided the works into 7 construction packages and sub-packages and 4 pre-purchasing packages. Regardless of the size of the packages, each one represented a complete life cycle that had to be managed and coordinated with the others. Therefore, we had 7 contract openings, 7 public call for tenders processes to run, 7 start-up meetings with the various contractors in order to establish the management and monitoring processes and procedures, 7 acceptances of work, and 7 contract closings, not to mention the technical and administrative coordination and supervision.

CIMA+ had undertaken de facto responsibility for ensuring continuity among the contractors. We had to manage conflicts related to cohabitation on the construction site and to identify the contractor responsible for correcting defective work or coordination errors from among a jungle of contractors, each of whom was more irreproachable than the others, in their opinions. The great expertise of CIMA+ made it possible to resolve all of these problems in a context in which the works were proceeding at an average cash flow of $3 million per month, with peaks in excess of $8 million.

[1] Knowledge Infrastructure Program
[2] Ministère du Développement Économique, de l'Innovation et de l'Exportation



Top view of C2MI

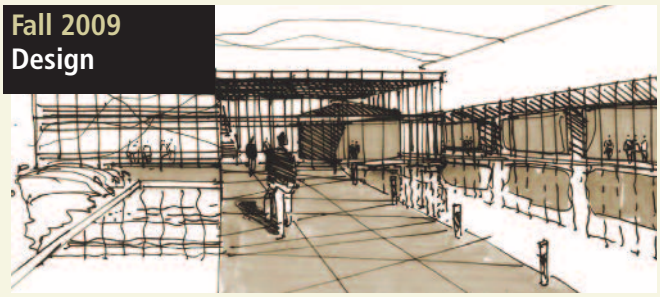
Laboratory includes:
- 1 class 10 clean room
- 1 class 100 clean room
- 3 class 1,000 clean rooms
- 12 class > 10k clean rooms

Class 10 means:
< 10 particles of 0.5 µm diameter/cu. ft.

By way of comparison, a human being
at rest emits 3,000,000 particles/m³/min
A hair has a diameter of between 50 and 100 µm

Technical services include:
- 1 wastewater treatment plant
- 1 de-ionized water treatment plant
- 1 nitrogen and oxygen plant

Fall 2009
Design

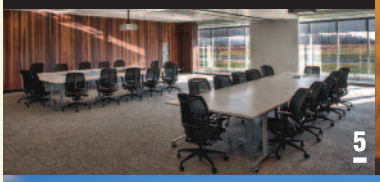


February – May 2010
Packages 1.1, 1.2, and 1.3
Site development

April – October 2010
Package 2
Foundations

June – December 2010
Package 3
Steel framework

October 2010 - October 2011
Package 4
Main package



June 2010 - June 2011
Package 5
Miscellaneous package (parking)

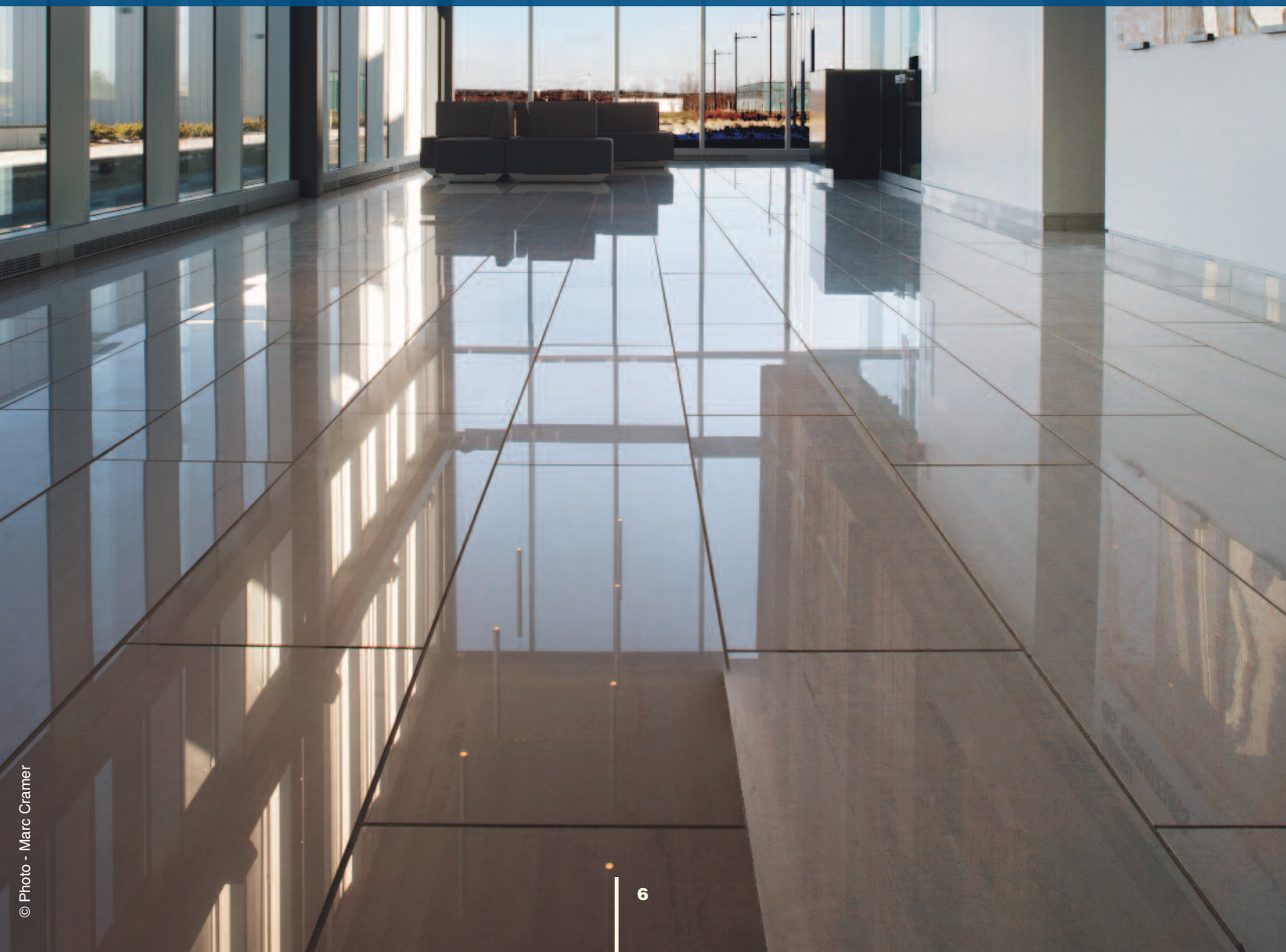
1. Developed site - **2.** Foundation works - **3.** Caissons for the anti-vibration slab bearing piles
4. Erection of the steel structure - **5.** Conference room - **6.** Clean room suits - **7.** Clean room services
8. Water treatment plant - **9.** General view of the C2MI as delivered on October 31, 2011 - **10.** Parking lot

1.4 BALANCING FUNCTIONALITY AND COMPLIANCE WITH THE BUDGET

Budget management for this project was very particular, because the availability of funds depended directly on the schedule, and therefore, it was closely intertwined with time management. We were constantly required to limit changes and avoid surpassing the budget, while at the same time, trying to spend the committed funds as quickly as possible.

The contradictory nature of these two objectives had a detrimental effect on the project. On the one hand, the desire to control costs and avoid changes might have put the functionality of the centre at risk. Yet, the unused budget would have literally disappeared on October 31, 2011. On the other hand, if we wished to speed up the works, the acceleration measures would obviously have come at a cost that must have been determined, not to mention the risk to lose of productivity on the construction site resulting from a workers' overload. The challenge resided in the way to incorporate the changes requested by the partners over the course of the project without putting the budget or the schedule at risk. More than in any traditional project, having a budget with a use-by date forced us to maximize the utilization of the budget while maintaining a reasonable contingency that would guarantee compliance with it.

CIMA+ decided to stick to the delivery of a functional centre and to limit any changes that were not strictly necessary in order to achieve this objective. We preferred to have too much money at the end, rather than not enough. Therefore, our strategy involved establishing some maneuvering room ahead of the process for client changes. In each major construction package contract, we included an allocation for changes in order to give the partners sufficient flexibility and to allow them to modify the initial project in order to incorporate any absolutely essential technological developments. In this way, we could save the construction contingency for unforeseen costs and requirements related to construction site coordination.



1.5 A TECHNICALLY VERY COMPLEX BUILDING

Nanotechnology requires a very controlled environment. Therefore, the heart of the C2MI laboratory includes class 10 (ISO 4) clean rooms. The requirements that must be respected to obtain this classification are ten times more restraining as those that apply to hospital operating rooms.

In light of this, CIMA+ had to ensure efficient work coordination of all design engineers, industrial process specialists and partners' clean room specialists. We needed to find a way to ensure that all the services required for the operation of the centre (ultra-pure water production, leading-edge wastewater treatment system, vacuum supply lines, chilled water, warm water, de-ionized water, nitrogen supply, oxygen supply, ventilation with HEPA and ULPA filters, etc.) would be perfectly synchronized within the maze of pipes and ducts while avoiding any contamination of the ultra-clean environments, all within a context where technological developments result in constantly-changing outfitting requirements.

endue to this, strict protocols for construction of the clean rooms were imposed at the construction site, including specific clothing requirements, decontamination zones, clean room tents, ducts cleaning and sealing, restricted access, housekeeping using specified products, materials storage management, etc.

We had to implement training sessions for construction workers, a controlling and monitoring process throughout the learning curve and corrective measures under the supervision of the client's specialists. The constant challenge that we faced was to maintain the delicate balance between rigorous application of the protocol, as requested by the partners in the purpose of guaranteeing the quality of the work, and the flexibility required for the work progress, as requested by the contractor in the purpose of ensuring workers productivity. We had to ensure quality while respecting the timeline.

the technical complexity of C2MI took on its full significance during the project closeout phase,. Indeed, it was necessary to qualify the installations, certify the clean rooms and obtain the conformance of the anti-vibration slab. **These validations had to be completed successfully on the first attempt, because we had no additional time to start over.**

Pipes sealed in workshop in order to avoid contamination

Working conditions in a controlled environment

Anti-contamination air lock installed during construction

1.6 A MULTITUDE OF STAKEHOLDERS

We had to manage the three principal actors in the project, along with their differing or even divergent cultures and goals. The organizational influence of UdeS in this context was mainly directed at establishing a technology innovation pole. For their part, the private partners were dreaming of facilities that would facilitate applied research and production that would be strongly influenced by their respective corporate orientations.

Further complicating matters was the fact that we were soon confronted with the imperatives of confidentiality within the highly competitive nanotechnology sector. We had to take into account the demands of the three clients in terms of security requirements, their corporate policies (a university institution and two multinational enterprises), their respective internal procedures and standards, and technical specifications. This highly complex situation forced the designers and CIMA+ to create all of the telecommunication and security infrastructures in triplicate.

CIMA+ also had to manage the stakeholders. Within this extremely complex context with multiple stakeholders, we had to meet their respective objectives over a limited time span. We succeeded in this by deploying effective communication tools, including numerous weekly meetings involving the project team, the construction site team and the clients. In order to ensure comprehension by every stakeholder, CIMA+ acted as a bridge between the various committees and oversaw the transmission of knowledge and information.

Some members of the design, supervision, and management team on the day of the visit following the provisional acceptance of the works

2. MEETING OR EXCEEDING THE CLIENTS' NEEDS

2.1 CONTINUOUS MONITORING OF THE CHANGES IMPACTS

The technical complexity of the C2MI project had major consequences for management of the project. We constantly had to adapt to specific developments in this innovative industry. As a result, the calls for tenders' plans and specifications underwent numerous changes compared to the initial deliverables. In addition, the layout plans were modified to reflect the updating of the scientific equipments.

In a standard project, the influence of stakeholders declines as requirements are confirmed and as the project progresses. In this case, we had to work closely with the partners' specialists until delivery so as to build a functional centre, but changes become increasingly expensive as a project progresses.

Taking into account the very aggressive schedule that forced us to accelerate the work on the one hand, and the threat of losing the financing after the October 31, 2011 on the other; we had to define an effective strategy to prioritize requirements. In fact, it was necessary to maintain a delicate balance between respecting the schedule and the budget, the addition of changes and a work overload on the construction site. Workers' productivity would have been affected causing delays and impacting the budget.

Therefore, we defined a clear process from the very beginning of the project that was approved by all stakeholders. The roles and responsibilities of each were defined from the initial identification of a change through to its analysis, approval and implementation on the construction site. We obtained approval from the UdeS Management Committee for various persons in charge of changes, along with their level of authority in terms of scope. Every effort was made to ensure that there was no ambiguity, and that the decision-making process would be efficient.

The extensive experience of the senior resources from CIMA+, backed by risk analysis and value analysis tools, made it possible to advise and guide the client through certain difficult decisions. Therefore, the client was aware of the opportunities and risks facing the project at all times, taking into consideration the contingencies available to deal with them.

We then documented all the changes that were proposed and all the decisions that were made. CIMA+ prepared and maintained a detailed register of changes throughout the project. This allowed us to ensure that all the stakeholders shared a common understanding, and to coordinate their activities in each discipline. It also allowed us to keep the number of changes under control.

2.2 SURPASSING LIMITS WHILE ANTICIPATING FUTURE NEEDS

Right from day one, CIMA+ understood that, by virtue of the very nature of the project, no compromise would be possible in terms of the quality. The C2MI is intended to be a world leader in packaging the next generations of electronic microchips.

In light of this, it is worthwhile to highlight the technical feats that were accomplished with respect to the anti-vibration slab and the clean rooms. Not only were the experts and specialists who came to carry out the qualification and certification surprised to obtain positive results right from the first tests, but the C2MI will henceforth be cited as a pilot project and model for success throughout North America.

"We're talking about a project (…) that is unique among its kind on our territory. We can take pride in being involved in the MiQro Innovation project."

P. Audet, Regional Supervisor for Con-Test, a clean-room accreditation company.

In addition, in order to do the best possible job to meet the clients evolving needs , the emphasis was put on flexibility of laboratory spaces. They were fitted with removable partitions and a distribution services loop that allows hook-ups at the desired location for an expansion, and the electrical supply is delivered over a busduct system. This system makes possible to remove or add a branch without cutting off the voltage throughout the entire cable jacket.

2.3 ON BUDGET AND ON SCHEDULE

As expected, the C2MI was delivered to the project partners at the end of October 2011, in full compliance with the schedule and budget. All the invoices were submitted to the funding agencies within the KIP framework. The construction budget was $82.03 M, and we delivered the project at a cost of $76.47 M, including all changes. Thanks to our collective expertise and to the customized solutions we adopted, we can take pride in having delivered a research and development centre designed and built in 26 months, at a cost 7% below the initial budget.

This undisputed success would not have been possible without sound and effective management, the exceptional commitment of all stakeholders to push the project forward and continuous clear communications throughout the the project life cycle . The client, the partners, the other stakeholders, and even the funding agencies, IQ[3], and all of the specialists were surprised by the success of the project.

CIMA+ earned the heartfelt thanks of its clients for the quality of the management of this exceptional project. We demonstrated that using the right tools and applying best practices in project management can allow us to meet all the objectives. The dedicated project management team worked unceasingly to ensure that a balanced approach was used at all levels, and that nothing was overlooked.

On November 7, 2011, only 7 days after signing the provisional acceptance certificate of works, one of the partners was already moving in , and starting to hook up its equipment. There is also a long waiting list for future partners who would like to become part of the new centre. The C2MI was designed to allow expansion into three new zones, and we have already completed the earthworks and levelling on these lands.

[3] Infrastructure Québec

© Photo - Marc Cramer

3. ENVIRONMENTAL IMPACTS

The UdeS is very conscious about sustainable development, and seeks to incorporate green building solutions into all its projects. It has committed itself to a reflection and action process in the area of sustainable development that meets the needs of the present without compromising the ability of future generations to meet their needs. This project was no exception, and CIMA+ assisted the UdeS in promoting sustainable development throughout the project.

3.1 FEATURES OF THE MANUFACTURING BUILDING

Although the clients initially wished to obtain a LEED certification for the centre, we soon realized that the very nature of the project would not allow it. In fact, the LEED Canada NC 1.0 rating system for new buildings compares the performance of the building to a standard one. The constraints imposed by the clean rooms are, for the most part, not comparable to a conventional building. However, the manufacturing building was designed in accordance with sustainable development principles. We should also note that certain LEED certification criteria would have compromised the very function of the building.

3.2 AN OFFICE BUILDING DESIGNED IN ACCORDANCE WITH LEED PRINCIPLES

For its part, the office building design would have led to a silver LEED certification. Efforts were undertaken in various areas covered by this certification.

Water in the building is managed as efficiently as possible. Potable water use has been rationalized, thanks to innovative systems for toilets and landscaping, with savings of up to 40%. In addition, wastewater is treated before being discharged from the site.

Energy savings were also a consideration in the design of this building. Insulation and energy recovery measures have resulted in energy cost reductions of at least 30% compared to the reference model.

Great importance was given to local sourcing for materials and resources. Preference was given to materials containing over 15% of recycled materials, as required for a LEED certification.

Finally, as requested by the UdeS, a waste management policy was developed. Everywhere on the construction site, this approach aimed at reducing the quantity of materials required, and therefore, the wastes generated. In addition, a strict policy about recycle and management of organic waste was introduced, and is still applied since the building occupancy.

FOR EXAMPLE

LEED criterion development density:

Concentrating development in urban zones.

Incompatibility: A class 10 clean room cannot be built in an urban zone because of the air particle count concentration.

LEED criterion natural light and views:

Providing a connection between interior and exterior spaces for building occupants.

Incompatibility: The resins used in the industrial processes cannot be exposed to natural light.

4. NEW APPLICATION OF EXISTING TECHNIQUES, ORIGINALITY AND INNOVATION

The C2MI construction project is unique on various aspects. This research and development centre will propel the Bromont Technoparc into the highly exclusive circle of centres of excellence in commercialization and research (CECR). To ensure the delivery of such a highly complex project from a technical perspective within the tightly regulated context of a public project with a rather unusual financial scenario, CIMA+ had to implement some very original solutions.

The project management approach used by CIMA+ is inspired by the best practices in the industry. We ensure the success of projects entrusted to us through rigorous and efficient management of scope, schedules, costs and quality. We were able to meet all the challenges encountered during the C2MI construction project.

To provide a framework for all the actions and to organize everything, CIMA+ proposed to establish a project management plan, in which the definition of roles and responsibilities, constraints, organization rules and control and management procedures discussed with the partners were clearly specified.

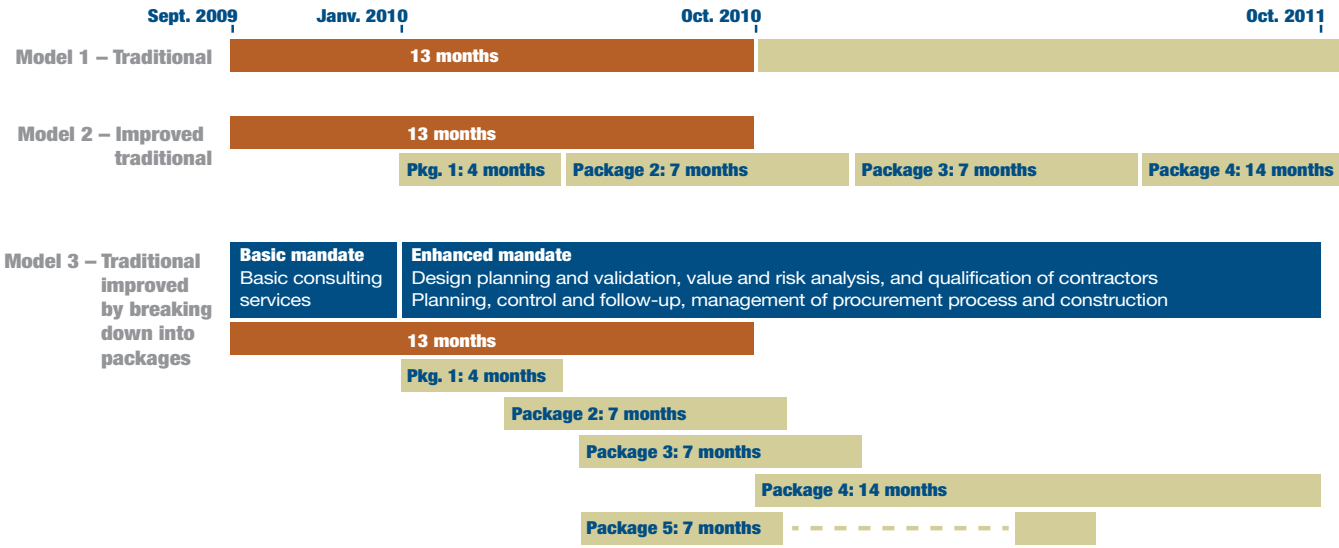
4.1 NO COMPROMISE ON SCHEDULE

In the ultra-competitive world of high technology, it was obvious that every minute counted. We knew that every minute not used for research and development was a minute lost for C2MI's industrial partners. It was regularly reminded by our client and its partners. We also had to deal with the constraints imposed by public financing, which required that all expenditure had to be approved and invoiced by October 31, 2011. Therefore, CIMA+ put all of its ingenuity and resourcefulness into this project, and came up with solutions that were perfectly suited to this context.

In fact, we did our best to reduce the lead times for processing, approval and delivery wherever possible.

Exceptional situations call for exceptional measures. We obtained client approval of pre-authorized amounts in order to issue letters of intent immediately after opening the tenders. We could then request that the selected contractor mobilize without delay. We also required and obtained that the UdeS Executive Committee held extraordinary meetings in order to make decisions on certain major changes.

The regulatory framework subjected us to some very heavy procedures, and CIMA+ worked toward making the work of the other stakeholders as efficient as possible throughout the project. We favoured a parallel approach of the work rather



Diagrams comparing the execution models and their impacts on the timeline

than a sequential one, and we got more closely involved in the coordination process at all levels than in any traditional project.

We advised our client to carry out the works in several construction packages. This allowed us **to break down the design work into segments and overlap it with the construction works.**

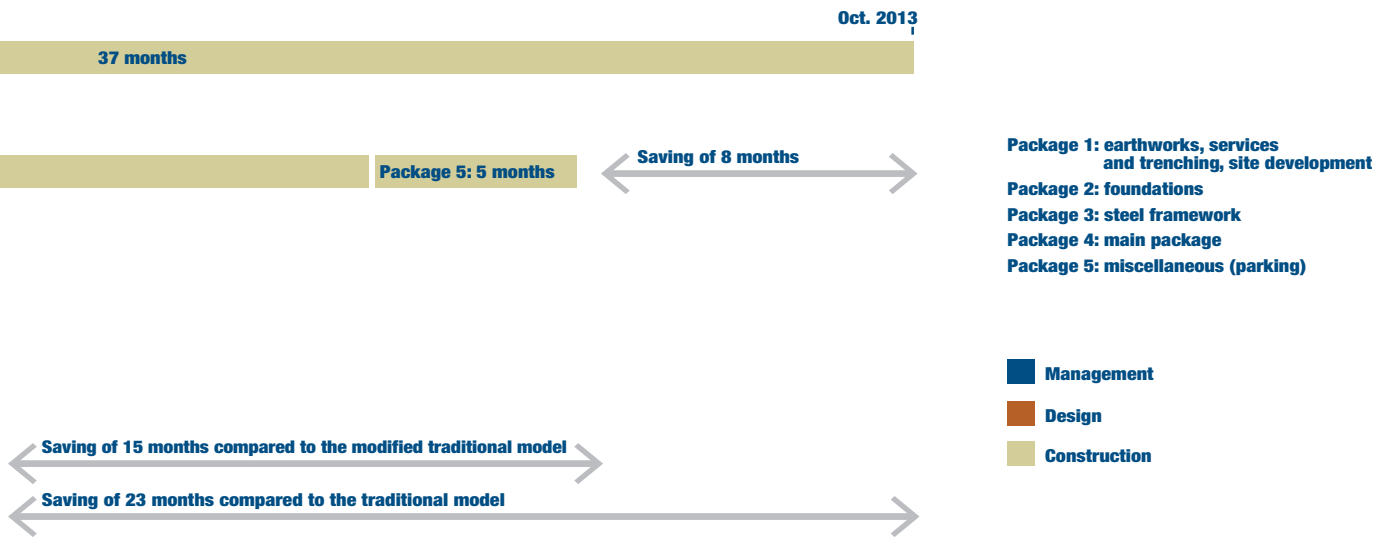
Using this approach, we were able to start the earthmoving works in winter 2010, while work was still going on for the plans and specifications of foundations, structure, mechanics, electricity and finishing. Completed before spring thaw, this initiative resulted into savings of time and money, as we were not subject to load restrictions on material transportation during the thaw period.

Then, as soon as the foundation plans were sufficiently advanced, we started the process of public call for tenders for these works. This allowed the professionals to have more time to complete the plans and specifications of theremaining works.

In terms of construction, we dedicated a resource to follow up deficiencies with the contractor eight months before the completion date. This action proved to be beneficial, because some deficiencies were corrected while works were progressins. Thus, the number of deficiencies that had to be corrected at the end of the project was considerably reduced.

We also organized a gradual taking possession of the main premises, beginning four months before provisional acceptance, allowing the qualification of the laboratories by the external controllers in parallel with finalization of the works.

With all these solutions, we estimate that we delivered the project almost two years earlier than what would have been possible following the traditional model (strictly sequential single-package approach).



4.2 NO COMPROMISE ON QUALITY

To carry out such a technically complex project, it was necessary to find qualified bidders within a context where contracts were awarded to the lowest price compliant bid. CIMA+ proposed some innovative and imaginative ideas which allowed to deal with this delicate situation. We opted for an action plan, which included the following:

- Optimization of the breakdown into construction packages;
- Reminders to local contractors;
- Support to the client in the call for tenders process and the documents preparation;
- A qualification process for certain construction packages in order to meet the quality criteria;
- A pre-purchasing process.

CIMA+ provided support to the client in the optimization of the breakdown into construction packages in order to promote competition. By concentrating the works by specialty, we sought to encourage some specialized contractors to tender directly under their general contractor's licence, therefore eliminating the administrative fees and profits of an additional intermediary. Moreover, by capitalizing on our extensive experience with the local qualified contractors, we ensured their interest in the C2MI project from the beginning of 2010. We wanted them to take the project into account in their medium-term planning, and to ensure that they had qualified resources available if required.

Besides, we were aware of the long delivery delays of some specialized equipment and industrial process parts that were designed to meet the needs of the C2MI. Working in close collaboration with the project architects and engineers, we offered our expertise to the UdeS to support it in a major public pre-purchasing process, in order to remove these equipments from the critical path. In addition to the 7 construction packages and sub-packages, we managed the supply of 4 pre-purchasing packages, ranging from $600K to $1.4 million.

4.3 CONTROL AND DOCUMENTATION TOOLS

CIMA+ was able to deal efficiently with all the challenges of this project by setting up control tools and follow-up registers, and by documenting every major decision.

These control tools included performance index based on the earned value method. We ensured that plans were adjusted based on actual project performance, and required the professional staff to revise the cost estimates for each new defined package. Every construction package has been broken down into smaller deliverables, each of which was given its own target date. This made the work more tangible for contractors, who could better control it.

We used follow-up registers in the form of dedicated tables (follow-up for questions & answers, shop drawing issuing, change instructions/directives, construction site change orders, project completion documents, etc.) which not only made it possible to ensure the efficiency of communication and the handling of outstanding issues at all times, but also to make up for shortcomings in the organization of some stakeholders. We systematically ensured a proper fit between a specific action, a person in charge, a target delivery date, the context in which the order was given and the impacts on the project budget/schedule. This rigorous follow-up, which was documented in monthly status reports given to the client, allowed us to uncover divergences in the understanding of some subjects upstream of the process on numerous occasions, and to quickly correct these situations.

We were convinced that, in order to succeed in delivering a product that entailed such drastic and specific quality criteria, we had to implement a communications plan just as rigorous as flawless. We wanted to be the fabric that held all stakeholders together.

"[…] communication is very often seen as both the cause of all the troubles and the remedy that can bring a solution to any problem."

(Cabin, 1998 : 240).

In practice, we implemented a highly effective communication process, ensuring that the Project Manager would take part in all discussion tables. He could then transfer the information to the project team, which in turn processed the information, digested it, and passed its substantial content on to the appropriate stakeholders for purposes of coordination and action planning.

4.4 CHANGE MANAGEMENT

We identified key individuals who had the authority to approve changes, depending on their scope.

Increasing the level of accountability of the decision-making bodies in dealing with changes translated into a marked reduction in the number and scope of changes. We also constantly analyzed and monitored the impacts of changes on the budget. This exercise required us to maintain perfect mastery of the project situation at all times, and to achieve this, we implemented a meticulous document management process, which included real-time monitoring of the following:

- Communications between the professional staff and the clients;
- Communications between the professional staff and the contractors;
- The number of workers on the construction site by trade;
- The approval of shop drawings;
- Schedules and cost control.

Finally, we are convinced that the approach used by CIMA+ and the customized solutions we developed throughout this project were essential to ensuring its success on every level, **leading to the on-time delivery of a functional research and development centre within the baseline budget.**

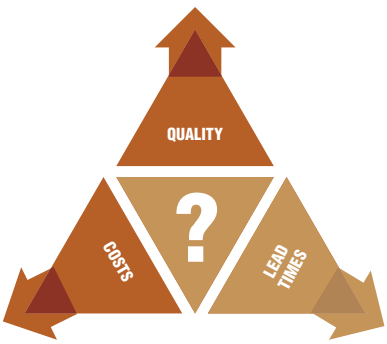
INITIAL SITUATION

RESEARCH AND DEVELOPMENT LABORATORY

Cutting-edge technology, technical complexity

Rapidly changing needs

Coordination of multiple packages



BUDGET A MOVING TARGET

Rigid and highly regulated call for tenders process

Multiple changes

DELIVER ON TIME OR LOSE GRANTS

Availability of budget dependent on delivery date

Multiple changes

Divergent needs of stakeholders

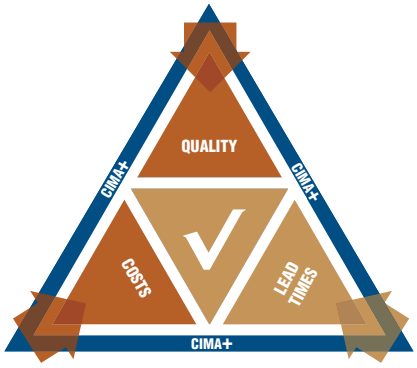
FINAL SITUATION

C2MI: A FUNCTIONAL CENTRE

Certification of clean rooms on first attempt

Qualification of systems on first attempt

Anti-vibration slab, a technological feat in North America



BUDGET MET!

Final cost of construction project below initial reference budget

TIMELINE MET!

Provisional acceptance on October 31, 2011, cut-off date

Situation before and after CIMA+ intervention

5. SOCIAL AND ECONOMIC BENEFITS

5.1 DIRECT BENEFITS

This project carries some very significant scientific and economic benefits for the economies of Québec and Canada. The MiQro Innovation Collaborative Centre is at the heart of the creation of a Québec microelectronics cluster that is strategically integrated into the continent's northeastern microelectronics corridor. This corporate-university partnership has the potential to position Québec as a world leader in packaging of electronic microchips and manufacturing of MEMS[4] devices. Among other things, this project represents:

- 250 world-class scientific jobs;
- 1,000 jobs per year related to the construction of the centre;
- the preservation of 400 jobs at Teledyne Dalsa and 2,800 jobs at IBM;
- the training of a highly qualified workforce;
- the attraction of foreign resources and researchers.

[4] Microelectromechanical systems

$218 million microelectronics project in Bromont

"(…) 250 researchers will be located here, and 3,000 microelectronics jobs in Québec will be saved. (…) if this government investment had not been made, these future-oriented jobs would quite simply have been created elsewhere than in Québec."

Source: La Presse – September 1, 2009

Jean Charest - Photo: Gesca

© Photo - Marc Cramer

5.2 ENSURING THE SAFETY OF SKILLED TRADESMEN OF THIS PROJECT

The CSST[5] designated Université de Sherbrooke as the prime contractor for this project. In order to fulfil this role, the UdeS had to ensure compliance with the Health and Safety standards applicable in the province of Québec at all times. Since it could not perform this function on its own, the University delegated this role to CIMA+. In the end, despite the presence of more than 250 workers on the construction site simultaneously at peak, and a total of 364,706 hours worked, we did not receive a single CSST violation notice, and most importantly, we had zero accidents involving loss time, which we consider to be an extraordinary performance.

[5] Commission de la Santé et de la Sécurité du Travail

5.3 INDIRECT BENEFITS

Throughout the project, CIMA+ did its best to demonstrate to all its collaborators the substantial added value that comes with a dedicated project manager who manages the project on a full-time basis, and whose main function is to ensure the success of the project. Whether by proposing original and customized solutions, providing proven decision-support tools, or recommending best practices in project management, the CIMA+ team clearly demonstrated its undeniable effectiveness in the rather specific and unique situations that were encountered in the C2MI construction project. CIMA+ ensured that every effort was put to meet the needs on schedules, budget, and with the required quality.

As a result, thanks to the involvement of qualified project managers like those of CIMA+, we here in Canada are able to deliver large complex infrastructure projects within budget and schedule baselines. We are convinced that the C2MI project will be cited throughout North America as an example of success and exceptional technical feats. We also plan to present it in various forums: within CIMA+, at the ACEC, at the PMI, and at some university conferences related to project management.

In addition, the client extended our professional services contract to realise the project management of partners' scientific equipments' hook up. This project is valued at $138 millions.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