Hard hats and mortarboards: The industry and university working together

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ABSTRACT

University and industry goals can complement each other. There is considerable advantage to a university-industry partnership, especially in applied geophysics. This paper discusses a consortium model for the collaboration. To make the consortium work, there need to be natural advantages, ongoing demand, and demonstrated productivity. The mandate of the CREWES Project is to make better subsurface pictures to assist in resource discovery and recovery while educating students. By effective use of opportunities, CREWES has provided consistent and long-term output.

INTRODUCTION

A broad societal goal is to have a prosperous economy (providing interesting and profitable employment) that supports healthy social circumstances. Economies and societies function by supplying services and goods to their populaces. Education is naturally required to train individuals to participate in these social and economic structures. Increased educational attainment is also socially desirable because it is associated with lower rates of unemployment, higher incomes (and higher tax revenues), better health outcomes, lower social welfare spending, and reduced likelihood of following generation poverty (CalFASA, 2004). For example, the APEGGA Value of Professional Services Survey (APEGGA, 2007) indicates that, on average, each university degree adds several percent additional compensation to total cash earnings (and we trust associated value to the workplace).

The University's mandate is to create, conserve, and communicate knowledge. On the other hand, industries arise to develop and deliver products; generally, to use knowledge for the benefit of society. Some aspects of the University characteristics versus those of the industry, especially for the geosciences, are shown in Figure 1.

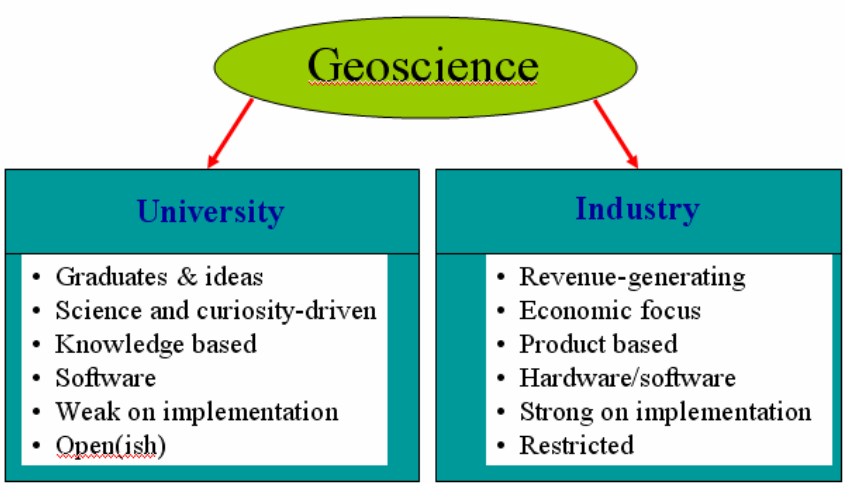


FIG. 1. Characteristics of the University versus industry in the geosciences (after Lawton, pers. comm.)

So, there are different strengths and weakness of the two sectors. However, both are dedicated to improving the state of the social enterprise. Thus, complementing collaborations between the two can be very useful. The University has certain needs: students, funding, staff, challenges and problems to work on, data, outside advice, and equipment. The industry can help in supplying these. Similarly, the University can provide well educated students to industrial endeavors as well as contribute ideas and prototypes toward specific problems (Figure 2). Creation or invention can be quite distinct from commercialization (Schrage, 2004). Often, different structures and attitudes are required for either to be successful. Major oil companies divested themselves of much of their research capability (Cope, 2001) through the 1990s. Much research is expected to come from the service industry and universities.

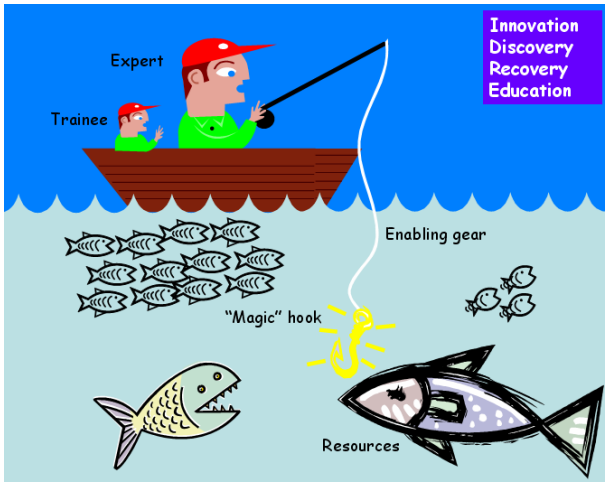


FIG. 2. Innovation in the resource industry requires experts, novices, and appropriate technology and structures as can be contributed by the University.

UNIVERSITY-INDUSTRY RELATIONSHIPS

The industry and the University are involved in a number of ways. These can range from informal, small, and short term to contractual, broad, and multi-year:

- Guest lectures, continuing education courses
- Consultancies, spin-off companies
- Sabbaticals (both ways)
- Adjunct professorships
- Senate, Advisory Boards
- Informal joint projects
- Donations
- Contracts
- Consortia

All of these arrangements can provide benefit to the University. In this paper though, I will discuss mainly the Consortium structure. We can define, "consortium" as:

- A cooperative arrangement among groups (www.thefreedictionary.com)
- An association or combination of institutions or businesses for the purpose of engaging in a joint venture
- An agreement, combination, or group formed to undertake an enterprise beyond the resources of any one member (www.m-w.com/dictionary)

To make the consortium work requires a number of factors. These include having certain natural advantages in location, personnel, or local industries. There must be faculty leadership and significant industry interest (Figure 3). This may often involve new, but unproven high-potential technology. Ultimately, the consortium must deliver some results including significant ideas, bright and well educated students, software, and data. Other requirements are outlined below (after Lawton, pers. comm.):

- Critical mass of researchers: team of full-time professors, staff scientists, and visitors
- Undergraduate/graduate program and students – B.Sc., M.Sc., Ph.D.
- Equipment and software
- Long-term administration, hardware, and software support staff
- Requisite office, lecture, and lab space
- Track record of excellence in research and highly qualified personnel (HQP)
- Regular contact with sponsors and consistent deliverables
- Supply of industry data, projects, internships

- Intense professional Society involvements
- Visibility (media, publications, meetings, courses)

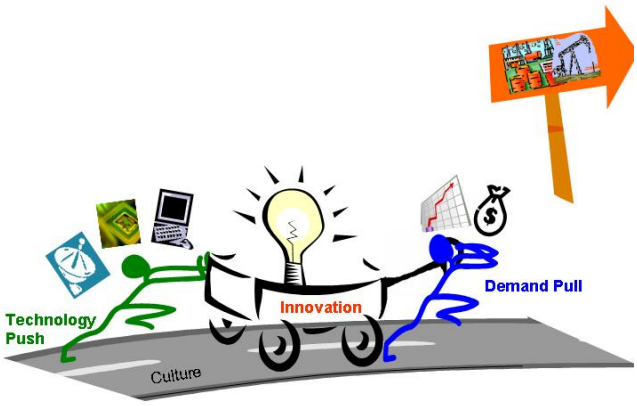


FIG. 3. Innovation in the resource sector is associated with a financial demand pull, and an outside technology push, in a culture that encourages inventiveness and application.

THE GEOPHYSICS COMMUNITY

As mentioned above, the chances of achieving a successful partnership will be increased if certain factors are present. Clearly, having the university and industry in close proximity for meetings and courses, with similar laws and language, and informal sharing of expertise is of considerable benefit. In the specific CREWES case, Calgary provides an excellent home for a geophysics consortium because of its broad and capable geophysics community. The Canadian Society of Exploration Geophysicists (CSEG) and Canadian Society of Petroleum Geologists (CSPG) are headquartered in the city. The Association of Professional Engineers, Geologists, and Geophysicists of Alberta (APEGGA) has a local office and the Tulsa-based Society of Exploration Geophysicists (SEG) has had Presidents from Calgary. There are hundreds of energy companies, numerous seismic contractors and service companies located in the city. Thus, Calgary is a vibrant centre of Canadian geophysics and one of the top geophysics cities in the world with many hundreds of professional geophysicists.

Being close to an industry centre provides a natural job market for undergraduate and graduate students as well as staff. The ongoing education and employment of students (with continuing education after employment) is a large part of the continuity required by the consortium. The students are a critical link between the university and industry. While research is being conducted, the students are being educated, and employed.

THE CREWES CONSORTIUM

The mandate of the CREWES Project (Consortium for Research in Elastic Wave Exploration Seismology) is to conduct advanced research and education in geophysical exploration in partnership with the resource industry. We are specifically committed to developing seismic methods to understand, image, and monitor the subsurface and its fluids. The Project functions partially with a traditional structure of professors and their

individual graduate students. Critically, however, there is a group of employees comprised of administration, research, and technical support (Figure 4).

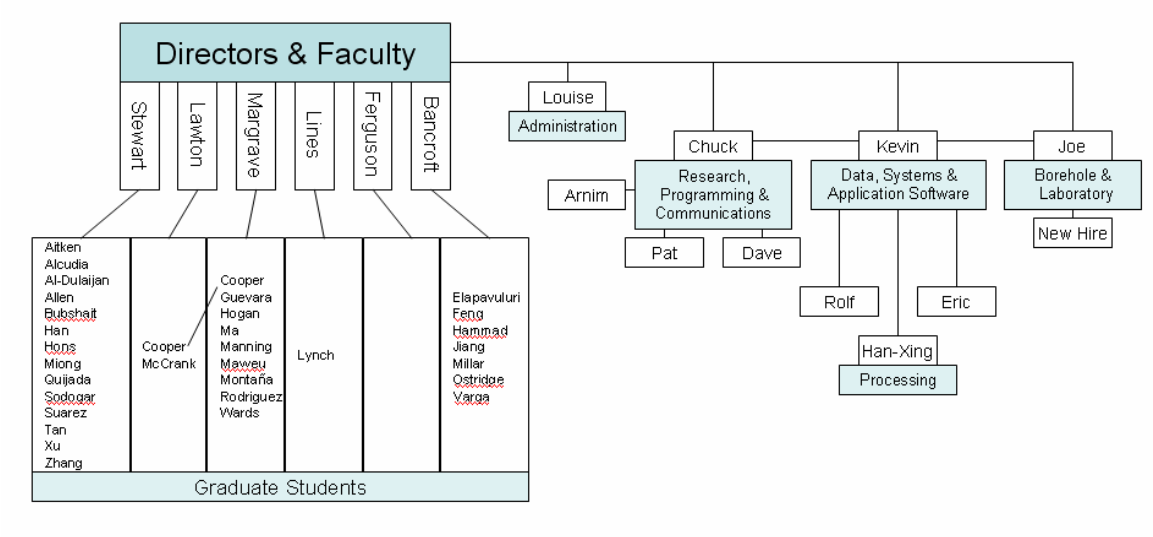


FIG. 4. The structure of the the CREWES Project. There is the traditional faculty and graduate student component as well as permanent staff support.

The Project is established inside the University with funding largely from outside of it (Figure 5). With CREWES, the majority of the funding is from our industrial sponsors (some 30 companies engaged in petroleum exploration, including national oil companies, super-majors, independents, seismic contractors, and software companies) who pay an annual sponsorship fee. This fee is renewable annually. While this is short-term for the University and provides annual stress, it makes a lower risk investment for the industry and encourages timely production. CREWES also receives significant funding from the federal government, under a Collaborative Research and Development (CRD) grant from the Natural Sciences and Engineering Research Council (NSERC). This grant provides monies that match a portion of those contributed by the industry.

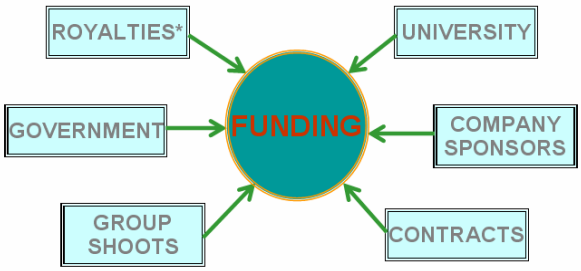


FIG. 5. Financial support comes to the University consortia from a number of sources.

The full CREWES group (Figure 6) consists of some 50 individuals including six geophysics professors in the Department of Geoscience at the University of Calgary, their associated graduate students (approximately 35), and ten staff members. The group meets once a week to receive a technical presentation from its ranks and/or visitors. Students are involved in CREWES goals as well as their graduate M.Sc. and Ph.D. programs. The

project personnel are heavily involved in our professional organizations (CSEG, SEG, APEGGA, Australian SEG, and European Association of Engineers and Geoscientists).

FIG. 6. The CREWES group consists of graduate students, professors, and staff.

Additionally, CREWES has developed a unique model for forging partnerships between industry and the university. Annually, these sponsors receive research reports, software, data, and an invitation to an annual Sponsors Meeting (typically attended by more than 60 geophysicists from around the world). The meeting gives representatives from sponsoring companies the chance to attend presentations describing recent research results, update their technical skills at courses taught by faculty, interact with senior researchers, and meet the next generation of geophysicists (CREWES has graduated some 70 Ph.D.'s and M.Sc.'s, most of whom were subsequently employed by sponsoring companies). A list of contributions from CREWES to its sponsors (the "deliverables") is given in Appendix I.

The Project and university attempt to provide a number of opportunities for all personnel and have certain expectations for their outcomes:

- Interesting classes and courses, excellent staff, facilities, data, meetings, conferences, presentations, publications → *tools & techniques*
- Conscientious research in geophysical problems → *creative & useful output*
- Professional development and deportment → *personal growth & respect*

CREWES is also involved in international development projects (Figure 7). Examples include technology transfers to ONGC (The Indian national oil company) and associated universities, and assistance by CREWES faculty in setting up Thailand's first graduate school in geophysics. Currently, CREWES non-confidential research results (data, software, reports and teaching materials) are distributed publicly via the SEG.

More specifically, CREWES is involved in understanding the geology and petrophysics of resource targets while developing characterization, recovery, and monitoring methods associated with the resources (Figure 8).

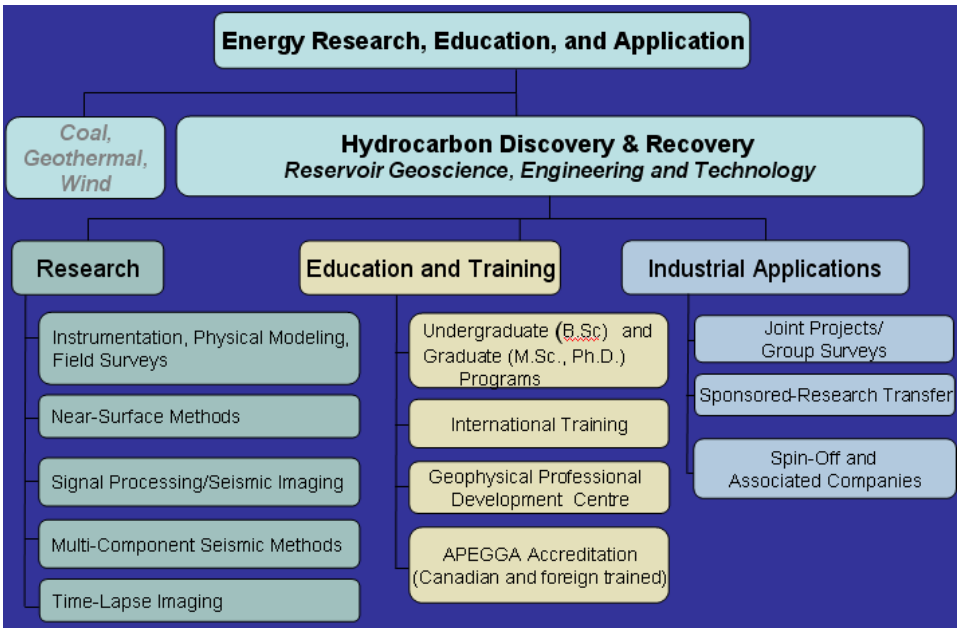


FIG. 7. CREWES conducts research enquiries primarily directed toward the energy industry. A great part of the CREWES effort entails education and training as well as applications in the industrial geophysics community.

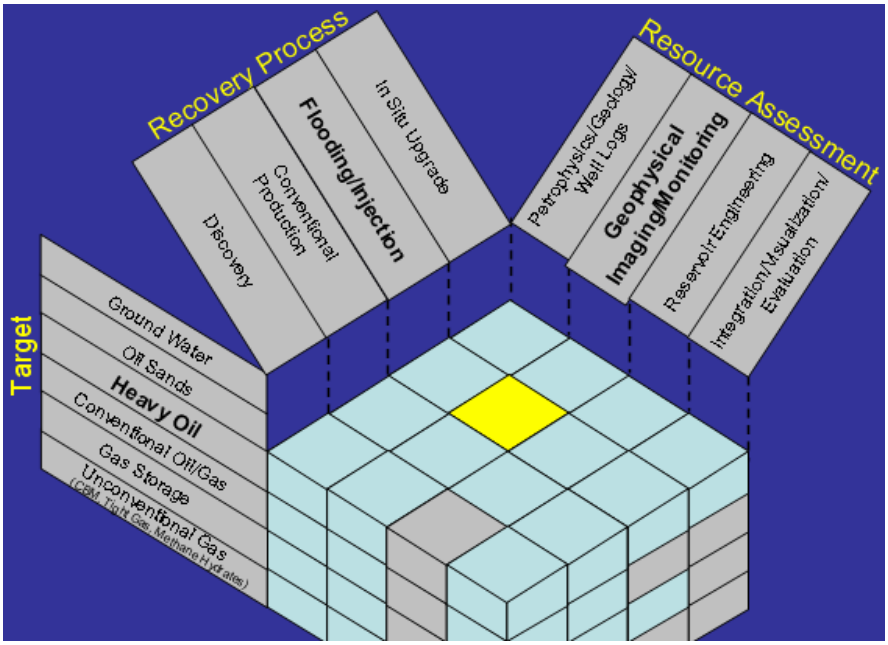
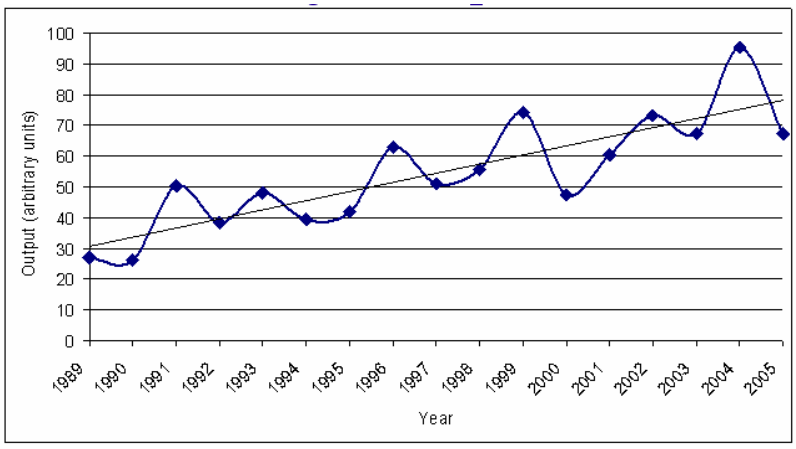


FIG. 8. The energy and resource communities have a number of targets, recovery processes, and methods to assess the resource.

In further detail, the technical goals of the Project are to:

- Provide better structural images of the subsurface
- Determine lithologic information (rock type)
- Describe rock properties (poro., fracs, perm.)
- Estimate fluid content
- Monitor reservoir changes
- Find & recover underground resources!
- Design & test geophysical instrument
- Acquisition field and lab data
- Investigate the mathematics of wave propagation & imaging
- Conduct computer programming & modeling
- Perform seismic data processing
- Undertake wellbore (logs & VSP) geophysics
- Interpret geophysical data & synthesize case histories

It is important to review the accomplishments of any ongoing structure. We attempt to do this in CREWES via a number of indicators. One simple indicator is sponsorship renewal, itself. However, we find that this may be more tied to the state of the industry (merger and acquisition activity and the price of commodities) than our productivity. So, we've developed another indicator composed of awards, publications, surveys, patents, data, student graduations, and software released. We've plotted this summary productivity and recognition indicator versus time in Figure 9. We find an overall increase in output.



Output = (Awards + Surveys shot) x 1.5 + students graduated + Refereed publications + (Research Reports + Software Released + Conference Presentations + Unrefereed Publications)/3

FIG. 9. CREWES output since inception has generally risen (with some oscillations).

It is also interesting to assess our output using normalization with financial support and number of personnel. Again, the output per dollar of support and per person has been fairly constant (Figure 10).

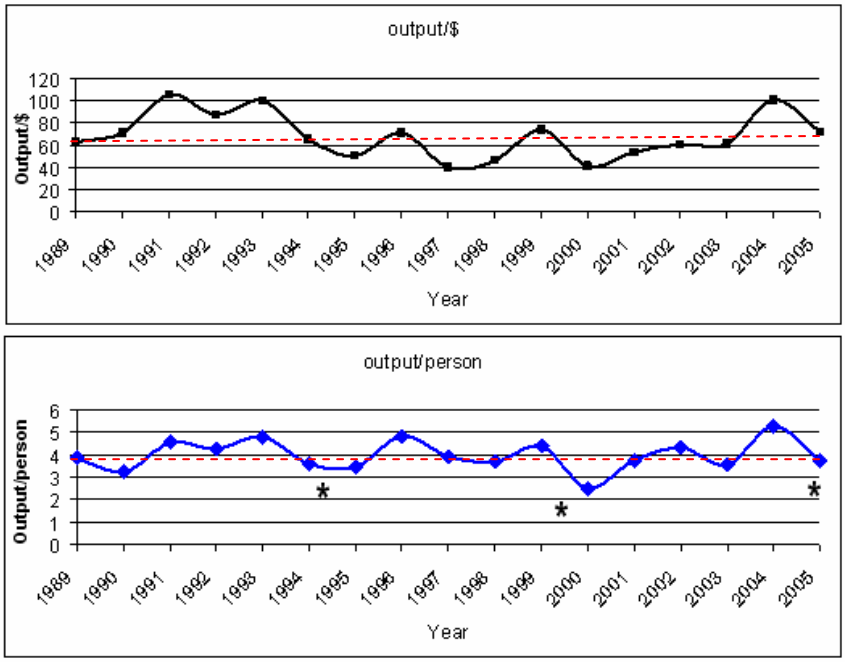


FIG. 10. Productivity over time. The normalized output of CREWES has been fairly consistent. Asterisks in the lower plot indicate Director Sabbatical Leave periods.

We were curious to understand whether the Project has varied in output according to size. Figure 10 indicates probably not. We also plotted the output/person versus the total number of people in the Project. Again, output/person was largely independent of the Project's total number of personnel. So, bigger is not better on a per person basis; but, neither is smaller. However, total output has increased substantially. So, overall it's likely better to have a larger project which could give a greater chance of some research results or innovations providing a major contribution.

We can also try to use outside statistics to assess the impact of CREWES. The number of citations by other authors is one indicator of impact. Figure 11 shows a citation index from one database and suggests that CREWES' impact is increasing and of similar value to other consortia.

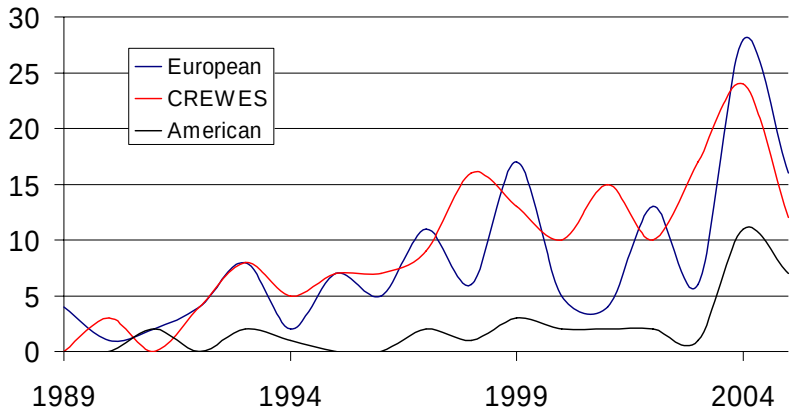


FIG. 11. An indication of impact can be gleaned from referencing in refereed journals. Comparative statistics are provided for leading European and American consortia.

Challenges

There are some challenges presented by the creation of a consortium. Naturally, the financial supporters must receive some direct benefit from their funding. This requires considerable time, on the part of university faculty and staff, to organize and deliver. Part of the specific industry benefit comes from having access to information that is not available otherwise. This requires that CREWES documents themselves remain confidential for a period (three years). This does not include theses and abstracts. However, the Project strives to provide abstracts to the sponsorship first, then releases them to the public. On the industry's part, its support will often be maximized through greater involvement of its personnel (e.g., in joint projects, internships, technology tests). This will take some time and resource commitment from the company as well as it representatives. For the most part, though, we believe that the advantages of the consortium in applied geophysics far outweigh any disadvantages.

CONCLUSIONS

The industry and university have much to gain by working collaboratively. Our field of geophysics, the education of students, and the application of technology to industrial problems can all be improved by a university-industry partnership. The CREWES Project aspires to make better pictures of the subsurface via advanced seismic methods. Success in this undertaking is ameliorated by natural advantages of a local industry, numerous professionals, and a dedicated staff and faculty. Using these advantages has given rise to a consistently productive group in applied geophysics.

ACKNOWLEDGEMENTS

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REFERENCES AND READING

APEGGA, 2007, http://www.apegga.org/pdf/SalarySurvey/VPS2007.pdf

Anderson, H., 2004, Why big companies can't invent: Technology Review, **107**, 4, 56-59.

CalFASA, 2004, Post-secondary education and the government's return on investment: CalFASA (Calgary Faculty and Student Alliance): Academic Views, **36**, 1.

Durham, L.S., 2004, Wall Street has its own rules and, oil stocks have their own personality: AAPG Explorer, **25**, 10, 24-26.

Cope, G., 2001, How did M&A's impact R&D in geophysics?: CSEG Recorder, 3, 42-46.

ESS, 2002, Earth sciences sector – Business Plan 2002/2005: Natural Resources Canada.

Pike, W., 2004, Ed., Service sector committed to stable investment, industry's 'pure' R & D falls short: Research & Development, E&P: Hart Energy Publishing.

Selim, J., 2004, Lord's advice: Let your students go (Interview with Lord Robert May): Discover, **25**, 11, 23-24.

Schrage, M., 2004, Much ado about invention: Technology Review, **107**, 4, 17.

APPENDIX I - Deliverables

Each sponsor of the CREWES Project:

i) has immediate access to the CREWES Research Collection (876 research reports and 89 student graduate theses), software, and CREWES News through the web site (www.crewes.org).

ii) receives the yearly, Research Report on CREWES research activities (approximately 70 chapters and 900 pages) and bi-monthly CREWES Newsletter;

iii) receives regular releases of software developed by the Project;

iv) has access to detailed seismic field surveys acquired by the Project including a 3C-3D survey and a broad-band set of 3-C lines from the Blackfoot field near Strathmore, Alberta, a high-resolution 3-C survey, a vertical hydrophone cable line, and a 3C-3D near-surface survey.

v) has access to physical modelling data (acoustic and elastic);

vi) is invited to continuing education courses on areas of recent technical development;

vii) is invited to the annual Sponsors Meeting where CREWES-generated research results are presented;

viii) receives graduate-student theses, presentation abstracts, and publication reprints;

ix) receives copies of lecture notes and CREWES-authored SEG publications as well as PowerPoint presentations;

x) has the opportunity to develop joint projects of mutual interest; and

xi) has a chance to become acquainted with graduate students as potential future employees.