FROM SATELLITES TO SAWMILLS

Thank you for such a comprehensive introduction, both for what you were kind enough to include, and for what you were discreet enough to omit! It is a deep honour for me to be here today to deliver the inaugural J. W. Hodgins Memorial lecture; and I feel especially privileged because of my close personal association with Dr. Hodgins - particularly over the period immediately following his decanal years at this institution.

Prior to our association during the Ring of Iron study, I knew Jack Hodgins as an intellectually honest, stable and ingenuous person possessing a generous measure of wisdom and insight covering a wide range of subjects including his discipline of chemical engineering, academic administration, industrial dynamics, the inner workings of the stock market and yes, of course, the game of golf. After working with him closely for over a year, I could add many more admirable traits and characteristics. Most striking was Jack's perpetual cheerfulness and strong optimism on almost any issue one could name. He had a very positive outlook for Canada's so-called high technology industries which are, in part, the subject of my lecture today, and an undying faith in the ability of young Canadian engineers to capitalize on the opportunities unfolding as Canada moves rapidly toward the "information" age.

Jack was fascinated by the challenges and anatomy of entrepreneurship, and spent the period immediately following our study on engineering education in Ontario as a visiting Fellow at Stanford University in California pursuing the subject. It resulted in a delightful little monograph entitled "Entrepreneurship in High Technology", a study of the ingredients of successful development of skill intensive industry. His conclusions are most relevant to what I want to say, and pay tribute to Jack Hodgins as a perspicacious visionary. I quote the final three paragraphs of his essay:

"In the first place there is ample evidence to demonstrate the effectiveness of the Canadian engineer and scientist in a vigorous entrepreneurial environment - our technical skills are of quite a high order. We now have a substantial concentration of industry in certain areas which should provide a population of scientists and engineers large enough to engender spin-offs if the proper environment develops. Canada is still a relatively stable nation, as yet showing less sign of national and individual violence than the United States, so there is a considerable attraction to our way of life. We have a wide distribution of good universities with some strong graduate schools. There is an adequate supply of risk capital. And we do have a keen awareness of the need to awake from our entrepreneurial torpor.

Our shortcomings are quite clear, and apparently remediable. Our governments need to learn something about small business and innovation - better learned from retained consultants from the industrial community than from civil servants. Rapport must develop among government, financial and industrial communities which at present seem to be often suspicious and frequently at cross purposes. Profit prospects must be demonstrated to entrepreneurs - a close examination of the tax write-offs in the United States would be a good place to start. In order to provide more financial management expertise, our business schools should be encouraged to consider specialization in small business management and new enterprise development. And somehow, we must develop a collective sense of optimism, without which none of the foregoing suggestions will have the slightest effect.

This is by no means an impossible list of shortcomings, but the necessary changes cannot be brought about without an understanding of the management of change, which is really what this whole discussion is about. It is time we abandoned analysis in favour of synthesis."

I could think of no better lead into my subject which deals with Canadian entrepreneurship. I want to show how simple technologies can be developed and evolved into successful businesses. In doing so, I would like to point out that in Canada, many of our high technology industries really exist to serve the resource industries - thus from satellites to sawmills.

As examples, I have chosen three companies with which I am associated that would be identified in the high tech sector - each separated in size by about an order of magnitude. They are:

1. Spar Aerospace Ltd. - which is heavily committed to space communications and mapping
2. MacDonald Dettwiler Associates - which is in the earth resources and weather satellite ground station business
3. Huntec (1970) Ltd. - which is in the underwater acoustics field

Spar Aerospace Ltd.

Spar began in 1968 as a spin-off from de Havilland Aircraft. Its roots were the Special Products Division of de Havilland and the Canadian Applied Research Division of AVRO which in 1962 became the Special Products and Applied Research Division, or SPAR for short. As a matter of interest, the Canadian Applied Research Division evolved from PSC Applied Research, the company from which Huntec also emerged.

Starting with sales of $6 million, in 1983 Spar's sales totalled $218 million and now employs over 2000 persons. It has facilities in Toronto, Ottawa, Montreal, Calgary, Dartmouth, Denver and Santa Barbara.

During its evolution, Spar grew both internally, and through acquisition. At the beginning, the assets of Spar centered around its early space achievements and its capabilities in infrared detection. As some of you will recall, the STEM device invented by NRC was perfected by Spar and used in the Alouette ionospheric research satellites:

(Show Stem)

Slide 1 Alouette 1
Slide 2 ISIS 1
Slide 3 Stem device

The Stem product led to the development of large-power flexible solar arrays.

Slide 4 - CTS array in lab - 13 kw, flexible, Stem erected

Slide 5 - CTS in orbit - fully extended dimension ft.

Slide 6 - L-Sat or Olympus in orbit 3.5 - 8 kw, 50 m.

Slide 7 - Astromast - used to erect L-Sat array

Another outgrowth of the earlier Stem technology is the famous Canadarm - shuttle remote manipulator system.

Slide 8 - EM Arm under test at Spar's facility

Slide 9 - End effector

Slide 10 - Canadarm being installed in the shuttle bay.

Slide 11 - Canadarm in space

Slide 12 - Canadarm holding the European SPAS package.

Slide 13 - Medical application of Canadarm technology.

Slide 14 - Remote Manipulator Control System, Ontario Hydro

Slide 15 - Space Station

The arm technology is also to be used by Ontario Hydro. Known as the remote manipulator control system, it will be used to replace pressure tubes in the CANDU reactor.

After Spar acquired the space and communications division of RCA in Montreal, it achieved the ability to be a private contractor for complete spacecraft. Its first prime contract was for Anik D shown here.

Slide 16 - Anik D

Slide 17 - David Florida Laboratory - where Canadian spacecraft are integrated and tested

Slide 18 - Teleglobe receiving station at Lake Cowichan, B.C. built by Spar

Slide 19 - IRST for Canadian and U.S. Navies

In 1980, Spar acquired the assets of Northway Gestalt, a mapping company that had its roots in the Photographic Survey Corporation, the original parent company of AVRO's Applied Research Division, the "AR" of Spar. Its main product is the Gestalt Photo Mapper which automatically draws contours from stereo photograph pairs, and can produce orthophotographs

Slide 20 - GPM - 4

Slide 21 - Orthophotograph

Northway is also in the digital mapping field, and uses interactive graphics to digitize maps and thematic attributes for municipal governments.

Slide 22 - Interactive graphics
This technology is leading to a Spar initiative in the Computer Aided Design field.

Spar can no longer be considered an entrepreneurial enterprise as it was in the beginning. Today its stock trades on exchanges across Canada, and is viewed by many stock analysts as a senior high tech industrial alongside Northern Telecom and Canadian Marconi. Spar itself has become an incubator company. Within the past few years, two or three groups have spun off Spar as separate enterprises, one in the industrial robotics area using know-how obtained from participation in the Canadarm program.

Spar contributes to Canada's resource industries directly through its mapping subsidiary, and indirectly through the provision of communication facilities via satellite and microwave to Canada's remote communities. Space and Canada were made for each other. Did you know that more than half of all Canadians live within 10 miles of the 401! As the second largest nation in the world, with the lowest population density of any - 3 persons per square kilometer on average - Canada would be hard pressed to meet its communication needs by land-based means alone.

Turning to my second example - MacDonald Dettwiler and Associates - this company, located in Vancouver, emerged from UBC in 1969 where John MacDonald was a professor of Electrical Engineering, and Vern Dettwiler ran UBC's computer centre. MDA is dedicated to the field of remote sensing and early on developed a ground station to receive data from the Landsat earth resources satellite which has been sold to a number of other countries in addition to Canada.

Slide 23 - MDA's objective

Slide 24 - Monitoring earth from air and space

Slide 25 - Geometric resolution

MDA's principal product has been Landsat satellite receiving stations.

Slide 26 - Canada's Landsat station at Prince Albert, Sask.

Slide 27 - MDA-built station at Bangkok, Thailand

Slide 23 - Inside Thai station

Slide 29 - Electromagnetic spectrum - optical

Slide 30 - Electromagnetic spectrum - optical and radar

Slide 31 - Spectral reflectance curve

Slide 32 - Landsat-2 MSS false colour enhancement image of Vancouver (80m)

Slide 33 - NOAA-5 AVHRR image of the Beaufort Sea (600 Km)

Slide 34 - Seasat SAR image of Trois Rivieres (25 m)

Slide 35 - Solar radiation components

Slides 36, 37, 38 Earth from Meteosat

Slide 39 - Multispectral Electronic Imaging System - MEIS concept

Slide 40 - MEIS hardware

Slide 41 - MEIS imagery from 5000 ft. (1.2 m)

Slide 42 - MDA Total System Concept

Slide 43 - Geometric Image Correction System - GICS

Slide 44 - Image Analysis system - interactive graphics

As you can see, MDA develops products and systems needed for the more efficient management of resources, and for monitoring the environment. Company sales will be in excess of $20 million this year, but it is still entrepreneurial in nature and spirit.

My third and last example is Huntec which specializes in the geophysical market - in support of discovering new resources. Primarily it has specialized in underwater acoustics, although it still supports a product line in induced polarization equipment for the land geophysics market. Huntec is a small company, less than 50 employees, doing about $2-3 million per year - but it specializes in unique products relating to the seismic exploration of the seabed, so-called sub-bottom profiling. These systems are characterized by the depths of water in which they operate, and the type of seabeds they can penetrate. Huntec specializes in high energy boomers that can penetrate the hard rock structures off Canada's east coast.

Slide 45 - Deep Tow System profiler diagram

Slide 46 - 500m DTS towfish, in operational use at various locations throughout the world.

Huntec's most recent development is known as SeaBed II. Supported by the federal government, it is designed for water depths of 2000 m.

Slide 47 - Seabed II layout

There are some very advanced technologies in the Seabed systems. To begin with, there is the seismic sound source or boomer. It is designed to create a very high pressure peak with no following rarefaction wave (1 acoustic joule per sq. metre). The seismic system, consisting of the source and receiving hydrophones and other sensors, is mounted in a towfish as shown in:

Slide 48 - Towed body arrangement

The seismic system measures the reflected sound waves from the various stratified layers under the seabed and the scattering properties of the bottom which can be characterized as to roughness, shape and hardness. A side scan sonar is also included to measure roughness from back-scatter intensities out ± 2 1/2 kilometers either side of the track to yield roughness and large objects through the shadows they cast.

Perhaps one of the more sophisticated parts of the system is the cable which tows the system at a speed of 3 knots. It must take the stress of towing, it transmits 4 kw of power to the towfish, it transmits digital data at 1 Mbs back up the cable using TDMA, and yet it must have a minimal drag cross section. It is 6000 metres long and operates at depths of 2000 metres.

In the towfish, power is converted to a 6000 volt pulse at 2500 amperes peak to yield 1000 joules of energy for the boomer using SCR crowbar switching. There is an angular motion compensator system in the towed package and a navigation system to recover the track of the towfish. Obviously motion of the geophone between transmission and reception must be accounted for in reducing the data. All in all, it is a very sophisticated piece of technology.

Seabed II went through its first sea trials last summer, and the following views were taken at that time:

Slide 49 - Seabed II on jetty
Slide 50 - Hudson from rear with Seabed on deck
Slide 51 - Seabed being lowered by deck winch
Slide 52 - Seabed being immersed
Slide 53 - Seabed electronics console on ship

As you can see, Huntec is another high technology company focussed on resources, in this case, their discovery. In the context of corporate development, it is still a very young company about an order of magnitude smaller than MDA which, in turn, is an order of magnitude smaller than Spar.

Companies like Spar, MDA and Huntec in one way or another support the resource sector - Spar through communications and mapping, MDA through remote sensing in support of resource management and environmental monitoring, and Huntec through the application of geophysical methods for the discovery of soil and minerals. (Incidentally, the forestry sector is one of the largest users of satellite remote sensing which led me to the title "from satellites to sawmills").

In today's terms, entrepreneurship is indeed the successful and profitable marketing of new technology. It follows that this country has had to create a "warmer" climate for innovation (recalling the 1971 Science Council study "Innovation in a Cold Climate"). In his monograph, Jack Hodgins concluded that there are five ingredients for successful technological entrepreneurship:

1. Proximity of what he called an "incubator" industry where new businesses could be spun-off.
2. Proximity of a university with a dynamic graduate school.
3. A community setting where entrepreneurship is understood and welcomed by the governmental and financial organizations.
4. An economic policy which makes entrepreneurial activity financially attractive.
5. Availability of an adequate number of financial managers.

I would suggest that on most of these counts 12 years later the climate in Canada is considerably warmer. Industries from which new companies can spin off exist in major centres such as the Ontario golden horseshore, Ottawa, Montreal and Vancouver. Canada has a network of universities with strong graduate schools in all major centres. Most important, however, is the rapidly maturing attitude and understanding of our governmental and financial organizations which has caused the climate to warm up considerably in recent years. Today there is a growing pool of venture capital and merchant banking facilities available to new Canadian enterprises. I believe we have reached the point where the ability to finance outstrips the number of commercially sound ventures looking for capital. Economic policies also have moved in favour of the entrepreneur, and I site the Scientific Research Tax Credits as a recent example of a policy shift supporting high technology industries in this country that rely on R and D for their survival.

In Canada, we still fall short in the availability of adequate numbers of financial managers, at least those who also have an understanding of technology. This shortcoming can and has been very damaging to the evolution of the high tech sector.

It is no news to this audience that there is an urgent need for more engineers trained in business, and indeed more businessmen knowledgeable about technology. You recognize this at McMaster by the establishment of your Engineering and Management programs. It is also no news to you that the university component of our post-secondary education system has been under considerable financial stress for some time. It is clear that education is caught between the overwhelming costs of health care in this province and upper limits on social development spending. Hard decisions are coming, and I would hope that the Bovey Commission, which is charged with the task of proposing new structures for our university system, will recognize the needs of the wealth-producing sectors of our economy.

Jack Hodgins identified the proximity of a university with a dynamic graduate school as one condition that favours successful technological entrepreneurship. It is worth noting that MDA emerged from UBC. There are many examples like MDA across Canada - SED Systems in Saskatoon and Sinclair Radio Labs in Toronto are two that come to mind. It would be ironic indeed if penury in the university system stultified in any way those components that support or enhance the wealth-producing sectors of our economy.

Canada traditionally has gained its wealth from a trading base in forestry, agriculture and minerals. Output and productivity in our resource industries is being enhanced by the application of new technology, and it follows there is a symbiotic relationship between our resource and high tech sectors - they do not compete.

In future our wealth will depend more and more on how we deploy our brainpower. Technology, particularly computers and robotics, is altering the traditional employment patterns in all sectors of the economy. In order to remain competitive, companies have had to cut costs by improving productivity resulting in a permanent loss of jobs. For example, General Motors cut staff from 800,000 to 531,000 employees world-wide over the past four years, while actually increasing output; Caterpillar Tractor cut from 90,000 to 60,000 over roughly the same period.

Such major structural changes in employment are being experienced in Canada as well as in the USA and Europe. Economists have concluded that the answer to the unemployment problem lies in the development of small entrepreneurial enterprises that become nuclei for future job creation, which is why governments are now developing policies that favour the small business sector. In future, new entrants to the labour force will increasingly have to rely on creating their own employment, rather than on finding an existing job. Whether it is satellites or sawmills, I am sure Jack Hodgins would join me in urging any of you with the spirit of enterprise to take advantage of the opportunities that surround us.

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Philip A. Lapp.