How to Make a Business Out of Manufacturing Linacs

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WEIFI01

Presentation Topics

- Commercial Accelerators and Applications
- AccSys' Technology and Products
- Road from Technology Transfer to Commercialization
- Words of Wisdom and Advice

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Commercial Accelerators

- **Electron accelerators**
  - Electrostatic (1-5 MeV)—Van de Graaff, ICT, Cockroft-Walton, Dynamitron
  - RF Linac (2 MeV-200 MeV)—high frequency (100 MHz) to microwave (9 GHz)
  - Microtron (10-100 MeV)—multiple pass linac
  - Betatron (1-20 MeV)—old technology, but compact
  - Rhodotron (5-10 MeV)—new cross-field device with coaxial gap
  - Synchrotron (1-3 GeV)—room temperature and superconducting
- **Ion accelerators**
  - Electrostatic (.05-10 MeV)—Van de Graaff and Cockroft-Walton
  - RF linacs (1-100 MeV)—RFQ-based (protons to heavy ions)
  - Cyclotrons (5-70 MeV & 230 MeV)—room temperature and superconducting
  - Synchrotrons (200-300 MeV)—room temperature

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Commercial Accelerator Applications

Accelerator Application	Typical Energy	Typical Beam Power	~No. of Suppliers
Electron beam welders	60-175 keV	10-50 kW	6
Radiation processing	2-10 MeV	1-200 kW	8
Ion implanters	.05-10 MeV	0.1-10 kW	8
Medical therapy	4-250 MeV	2.5-1000 W	12
Isotope production	4-70 MeV	3-30 kW	10
Material analysis	1-10 MeV	0.01-10 W	4
Non DestructiveTesting	1-20 MeV	1-2 kW	8

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Part II

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- AccSys' Technology and Products
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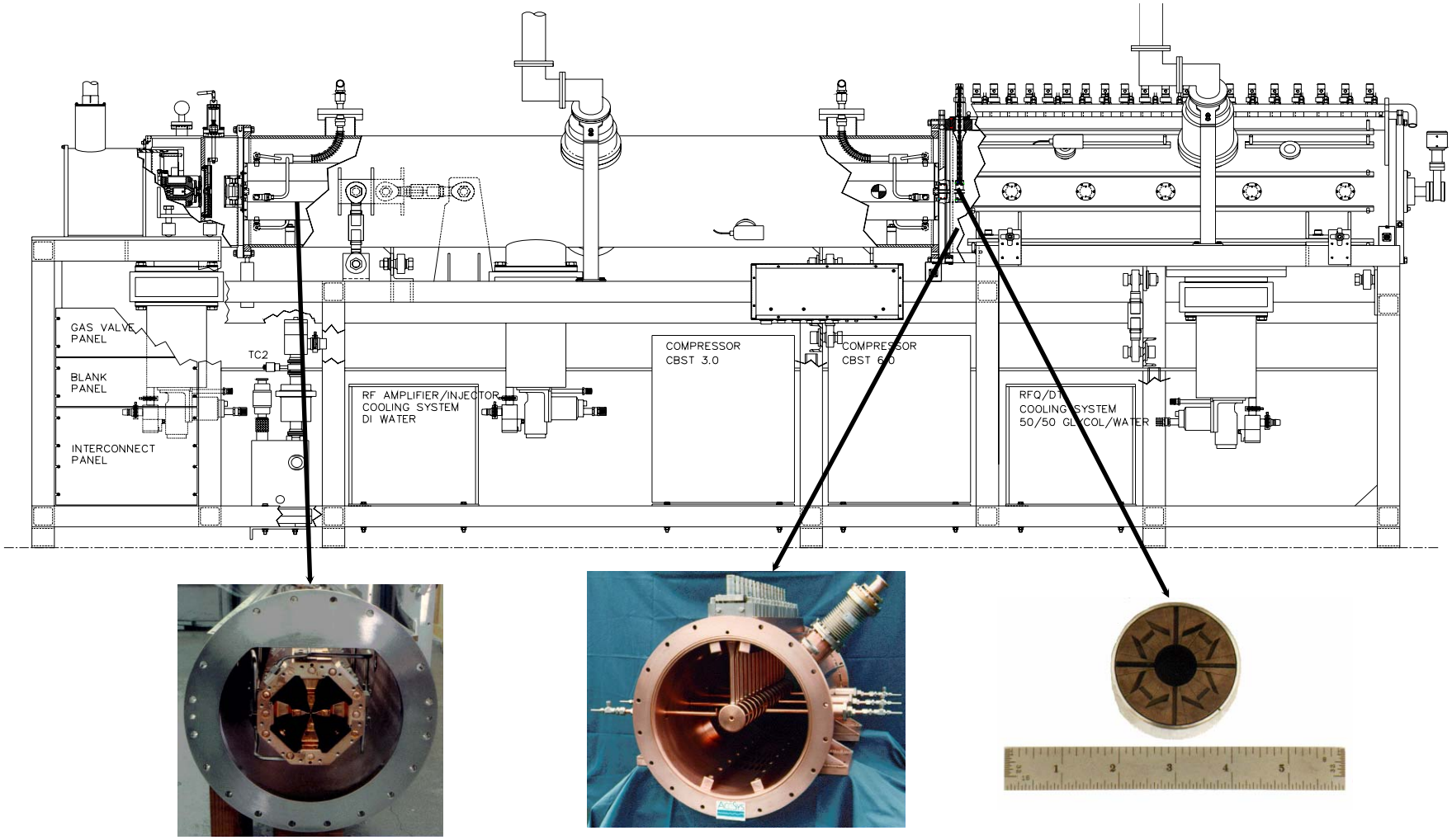
AccSys' Linac Technology



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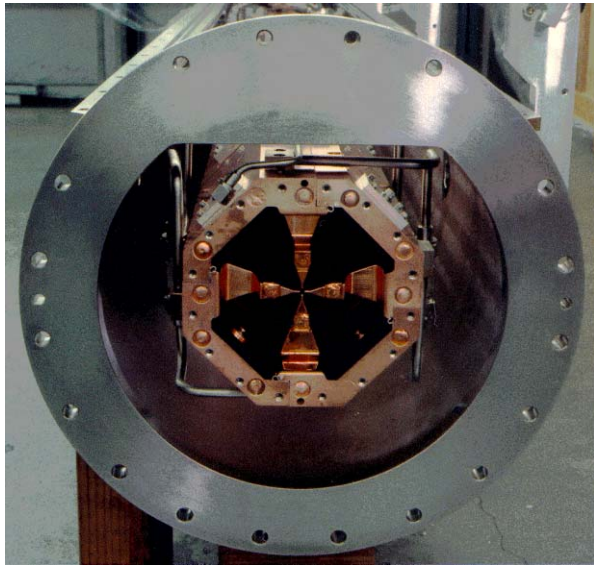
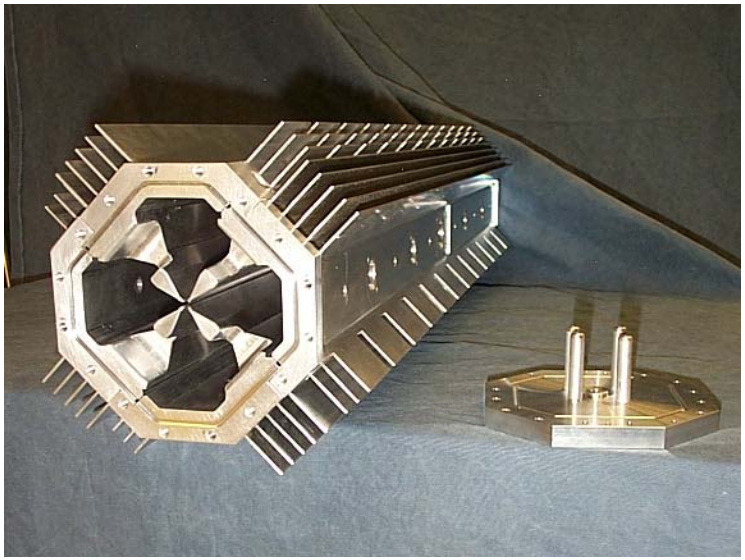
Univane RFQ



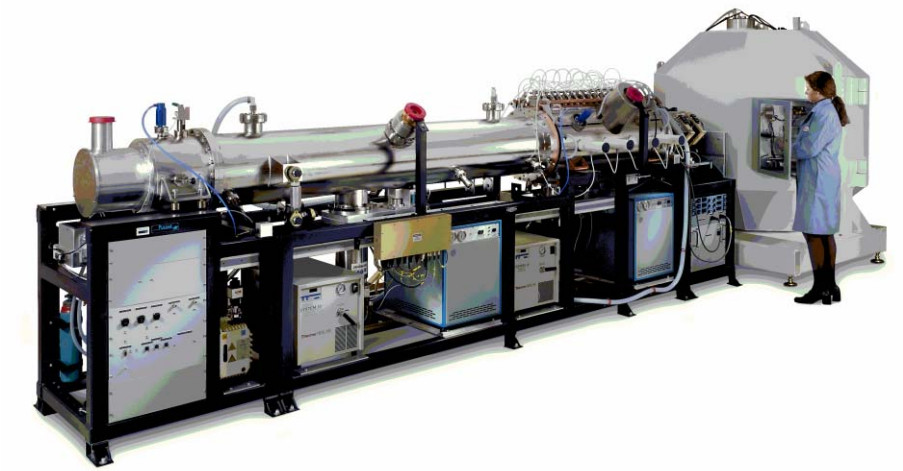


- Patented four vane geometry with water or air cooling
- Frequency range from 200 to 600 MHz
- CW capability demonstrated
- Demonstrated stability over many years

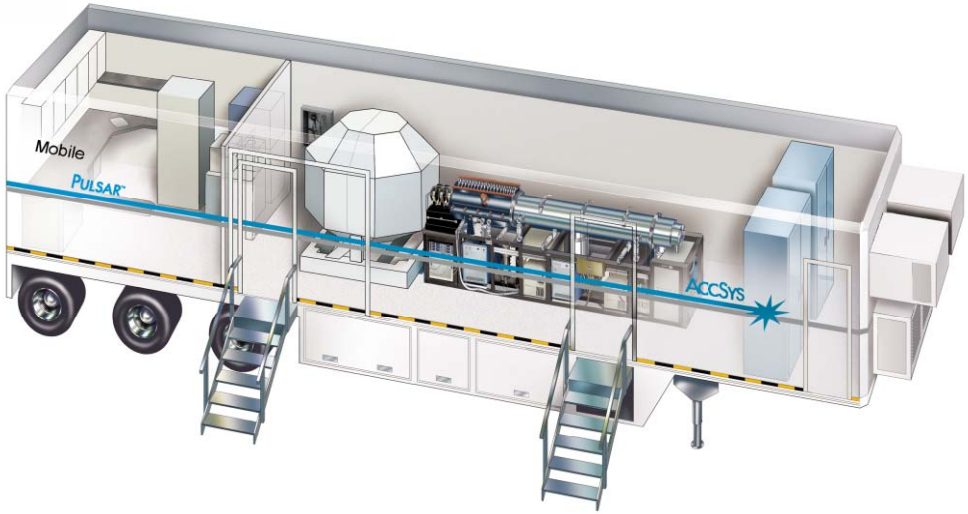
AccSys Products & Markets

- PULSAR® for nuclear medicine
  - First identified application for the technology
  - Smallest, lightest system for PET radioisotope production – only mobile unit available
  - Five units to date – demonstrated capability
- LANSAR® for industry
  - Neutron generators for NDT applications
  - Simple, reliable, low cost & mobile
  - New tool leading to new applications and markets
- LinSTAR™ for cancer therapy
  - Six systems to date in US and Japan
  - High reliability demonstrated
- Custom linacs for research
  - Contributed to standard product designs
  - Keeps company at forefront of technology

PULSAR® Systems



- **Proton energy – 7 MeV**
- **Beam current – 150 uA**
- **F-18 yield – 1000 mCi/hr**
- **C-11 yield – 600 mCi/ 40 min**
- **N-13 yield – 30 mCi/ 10 min**
- **O-15 yield – 600 mCi/ 10 min**



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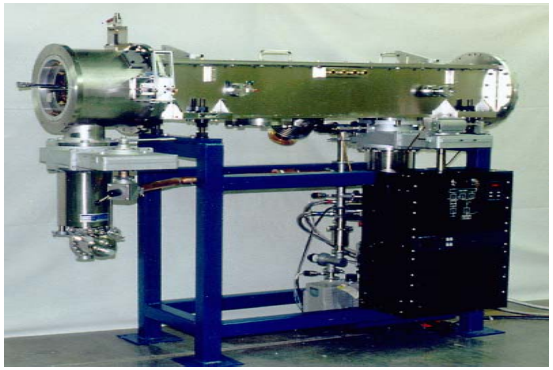
LANSAR® Systems

- Reliable neutron sources for non-destructive testing (NDT) in mineral assay, explosive detection, nuclear waste assay & neutron radiography
- Fills void between radioactive sources and reactors
- The solution for ***mobile*** NDT with neutrons
- Same technology as used in PULSAR

Linear Accelerator Neutron Sources for Applications of Radiation

LinSTAR™ Systems

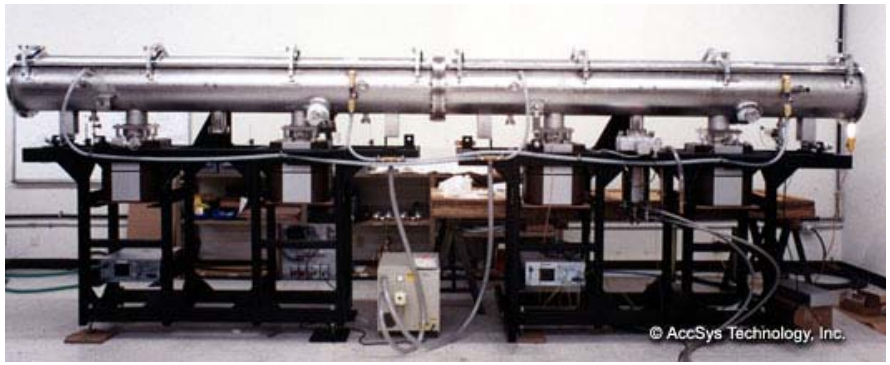
- Injectors for proton synchrotrons
  - 2-70 MeV protons
  - H^+ or H^- (can be polarized)
  - Research (IUCF & SSC)
  - Proton Therapy
    - ✓Loma Linda (California)
    - ✓Shizuoka (Japan)
    - ✓Tsukuba (Japan)
    - ✓MD Anderson (Texas)
    - ✓South Tohoku (Japan)
    - ✓IUCF (Indiana)



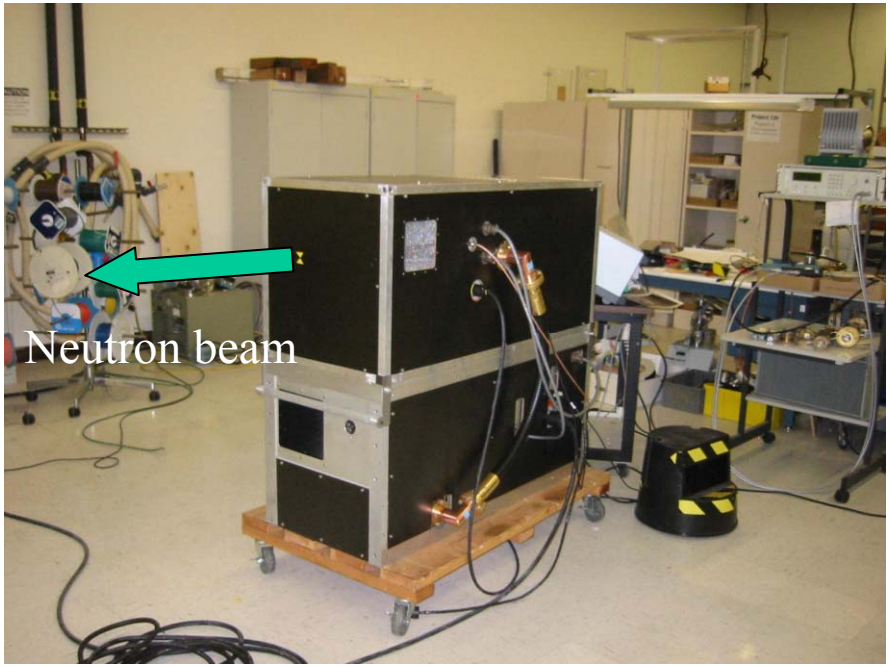
Linac Injectors of Synchrotrons for Therapy and Research

Custom Linacs

- Major R&D contracts
  - Designs & prototypes for aerospace industry for Strategic Defense Initiative (“Star Wars”)
  - Detector calibration linac for L3 experiment (CERN)
  - H^- ion source (DESY)
  - SCRFQ development with ANL
  - Tandem booster RFQ at SNL (390 MeV Au beam)
  - Tritium AMS system with LLNL (CRADA)
  - Linacs for Homeland Security applications



Portable RFQ-based Neutron Source



Three control cables and RF coax cable connect the two units. Total AC input power is 2 kW at 220 Volts.

All linac operation is controlled from a small panel on top covered by Lexan.

Courtesy of W.Stoeffl LLNL

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Part III

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- Words of Wisdom and Advice

Formation of AccSys

- **1975-1980** – Development at Los Alamos National Laboratory (LANL) on Radio Frequency Quadrupole (RFQ) structure and PIGMI linac.
- **1980 –** Lab management rejects author's proposal for private company to develop linacs for commercial companies.
- **1981 –** Idea for linac for PET isotopes comes to author during LANL tech transfer meeting with commercial companies.
- **1981** – R. Hamm leaves Lab to pursue PET linac as VP of R&D at Cyclotron Corp (TCC); M. Hamm starts Technical Programming Services (TPS) for custom accelerator control & communication software.
- **1983 –** TCC declares bankruptcy and R. Hamm goes to Varian Medical as R&D Manager; learns of new U.S. government Small Business Innovative Research (SBIR) program; applies for grant for PET linac through TPS.
- **1984** – TPS wins grant; R. Hamm, J. Potter, K. Crandall and L. Hansborough (LANL) are consultants; TPS gets Tech Transfer agreement from LANL.
- **1985 –** AccSys is born; Hamms, Potter and (later) Crandall are founders.

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Start-Up Funding Sources

- **Venture Capital – >$5M**
  - Requires large market, explosive growth, quick IPO or acquisition
  - Loss of control
- **Angels, "Patient" Capital – $0.25M to $5M**
  - Available mainly in high-tech areas
  - Retain some control
- **Bank and government-backed loans**
  - Limited $ not suitable for high-tech needs
- **Do It Yourself – "Bootstrap" method**
  - Seed money from founders, family, friends, associated "angels"
  - Retain control at personal financial risk
- **Corporate sponsor – Joint Venture, partnership, strategic alliance**
  - Proprietary or patented technology required
  - Good fit with corporate interests and markets necessary
  - Limited control

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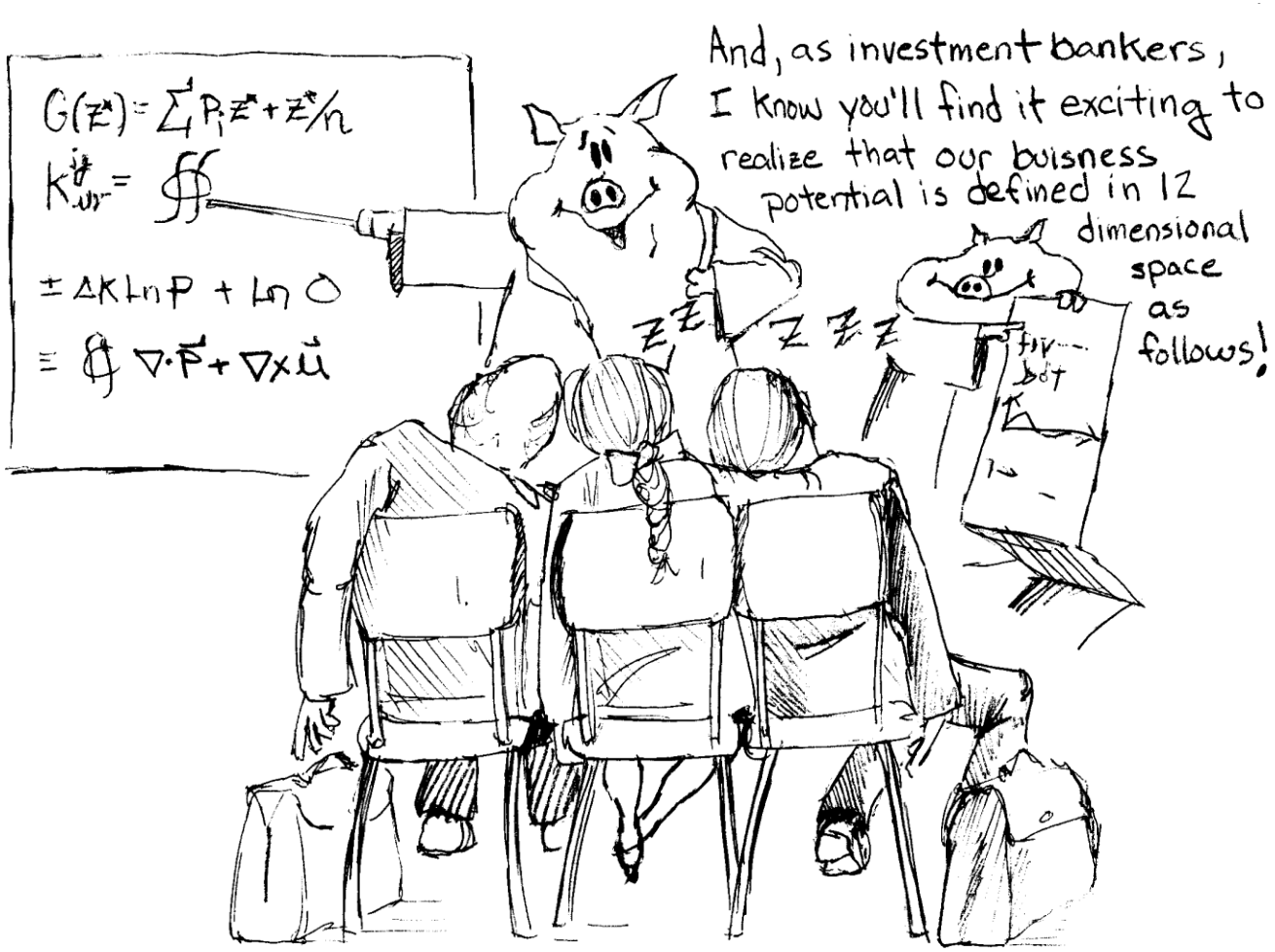
Technology vs. Business



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Early Funding

- Phase II SBIR grant from National Cancer Institute => immediate revenue
- Technology transfer from LANL and Fermilab => core technology
- No venture capital or corporate interest to be found => “Do it yourself” method only choice
- Personal savings from four founders => $60k plus TPS assets
- Small bank loans and leases => computers, furnishings & small shop
- Small bank operating line of credit => Hamms’ personal guarantees
- Demand for technical expertise => steady income and cash-flow
  - Engineering design studies for “Star Wars” technology
  - Custom systems => customers pay for technology & product development
- Small private placement (friends, family and associates) => $600k

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Bootstrap Growth Strategy

- Develop & build custom systems
  - SBIRs to provide major funding ($6.5M over first 10 years)
  - CRADAs to utilize lab expertise not available in-house
  - Customers pay for NRE
  - Uses core technology => benefits product development
  - Helps identify new markets
  - Generates revenues and profits
- Stock options to attract and retain key employees
- Bank and lease financing for additional equipment
- Purchase furnishings and test equipment at auctions
- Larger operating line of credit to smooth out cash flow
- Reinvest profits
- Negotiate aggressive progress or milestone payments

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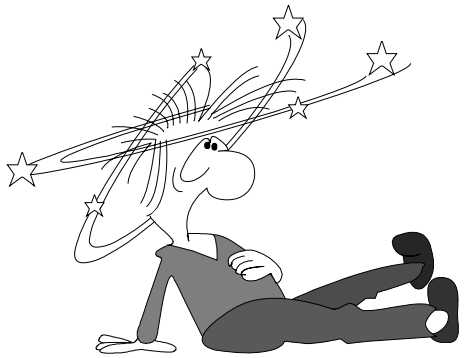
Just when things are going great...

- Steady growth from 1986-1993
- Made *INC 500 List* twice (1991 and 1992)
- Other kudos
  - SDIO Technology Spin-off Award
  - Boeing President's Award
- $6M prestigious contract for SSC project (1991)
  - Doubled size to 45 people and 20,000 sq ft
- ***Major pothole - Contract was canceled in 1993***
  - Backlog of work cut by 60% "over night"
  - Laid off 2/3 of the company over next year
  - Told by bank to "get lost"
  - Suffered a corporate "divorce" - two of original four founders left
  - Took more than 1 year for final settlement - almost didn't survive



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Maintain a Sense of Humor...

Cartoon by Glenn James

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On to Commercialization…

- Post SSC disaster – active pursuit of standard products for medical and industrial applications.
- Back to 25 employees by 1995.
- Sign major deal in 1997 with Japanese company for purchase of 6 PET linacs plus large equity investment.
- *Another Pothole!* Japanese company defaults in 1998.
- Back to 7 employees by 1999
- Bank again says “get lost”; Hamms sell California home to provide working capital.
- Begin serious search for corporate partner to assist in getting out of high-tech business “valley of death”.

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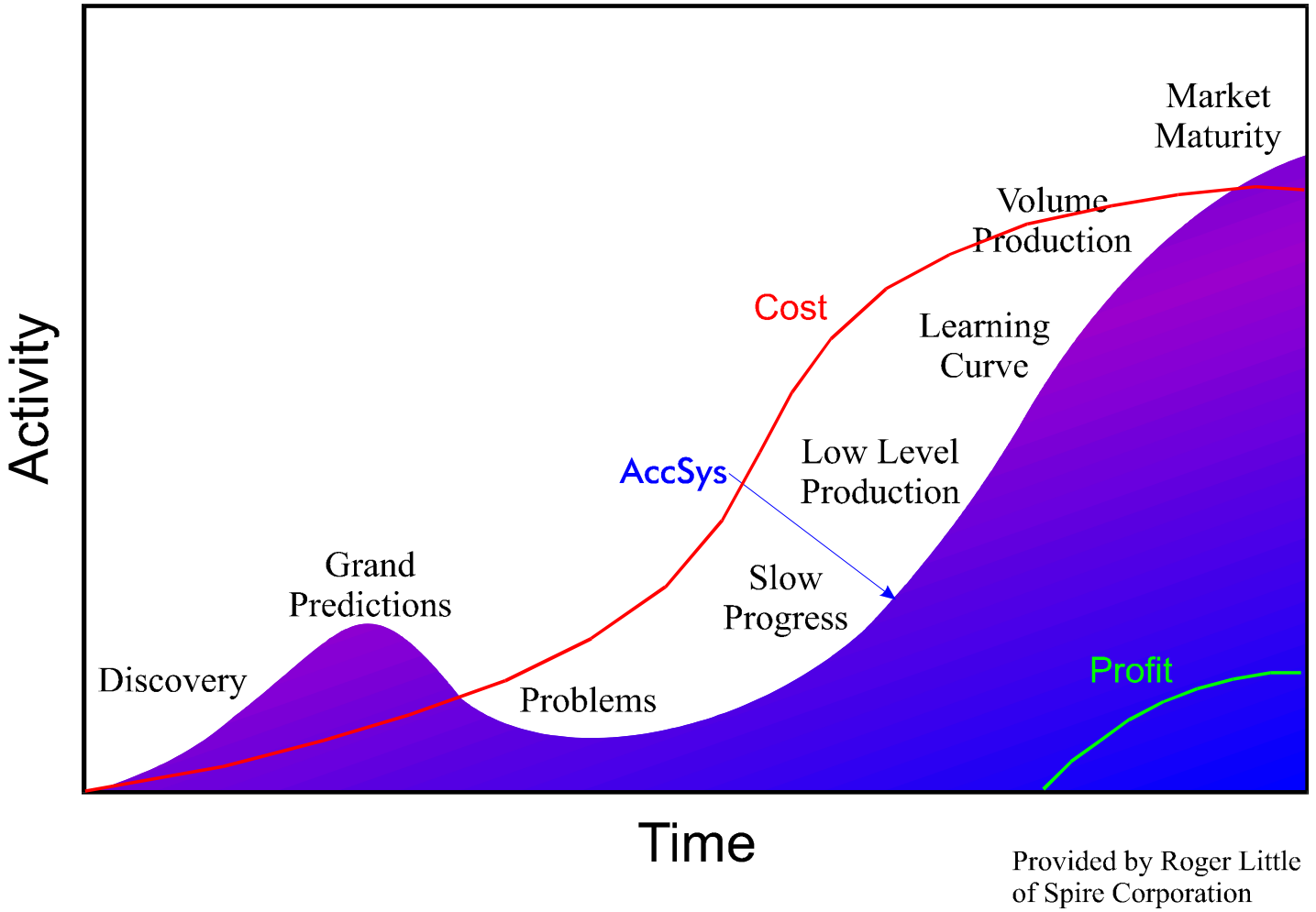
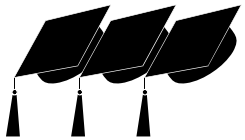
High Tech Business Path



Provided by Roger Little of Spire Corporation

Back on the Road...

- Successes to date:
  - Survived 21 years with some profits to show for it
  - Developed technology into commercial products
  - Parlayed $60,000 initial investment into multi-million dollar company
  - Sold majority share of company to Hitachi Ltd. in a successful 2001 tender offer to all of AccSys shareholders.



- What's ahead:
  - Sales, Sales, Sales! (Hitachi has worldwide sales agreement)
  - Ramp up manufacturing capability
  - Fine-tune Marketing Plan for rapidly-changing markets
  - Explore additional markets for products and potential spin-offs

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Schonberg Research Corporation

- **1950- 1955** - Development work at Livermore National Laboratory on linac structures and rf power systems by Russ Schonberg.
- **1970** – Formed company with wife for NDT applications.
- **1978 –** Idea for compact electron linac for NDT at nuclear power plants funded by Electric Power Research Institute.
- **1984** – Additional orders for Minac.
- **1989** – Collaboration to develop “X-ray surgery” version.
- **1991** – Spin-off company AccuRay formed for medical system.
- **1994** – Second spin-off company IntraOp formed for irradiations during cancer surgery.
- **1998** – X-band linac technology and underlying patents sold to American Science & Engineering (AS&E) for security applications.
- **2006** – AccuRay has delivered 110 linacs, IntraOp has delivered 12 linacs and AS&E has delivered numerous security systems.

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Conclusion

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- AccSys' Technology and Products
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- Words of Wisdom and Advice

Are We Having Fun Yet?

- You know you're successful when you:
  - **Make your first profit**
  - **Make your first sales**
  - **Convince somebody to invest in your company**
  - **Convince somebody to loan you money**
  - **Sign first multi-million dollar deal**
  - **Go public, sell the company, license the products**
  - ***Survive against all odds***

- The Flip Side
  - **You have to keep doing it**
  - **Can you deliver?**
  - **Funny thing about investors - they expect something in return**
  - **You have to make enough sales and profits to pay it back**
  - **You have to deliver the goods**
  - **Did you get the best possible deal?**
  - **You're exhausted and battle-scarred**

Concluding Advice

- Must believe in technology & product. (Tenacity, stubbornness and luck)
- Necessary ingredients for success no matter what the path
  - Good invention or technology
  - Good business plan
  - Enough capital – Borrow it, generate it and/or use OPM ("Other People's Money")
  - Cash flow – "Cash is King"
  - Business savvy – If you don't have it, better hire someone who does!
  - Proximity to support and service businesses – Cannot do everything "in-house"
  - Access to skilled labor pool
  - Good legal advisors and accountants

- Not essential, but when the going gets tough...
  - Ready supply of headache and heartburn tablets
  - A good therapist!