



Franciscan University
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Prosperity through Good Works

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Technology Trends



Trending: new efficient pathways

- Electro-chemistries complementing fossil fuels
- Food production being enhanced: genetic and molecular engineering, sensing, robotics, machine learning & AI
- Food losses being reduced with novel chemicals, innovative packaging, improved logistics, machine learning & AI
- High-value molecules being made at lower cost, higher rates
 - Nano-structurally-engineered catalysts
 - Photo-catalysis driven by high-brightness coherent sources
 - Microbes and plants as bio-factories of valuable molecules
- Information exchanging at higher rates with less dissipation
 - Materials/structures developed with lower electrical resistance
 - Information transacted with photonics and spintronics



Trending: novel manufacturing paradigms

- Production fragmenting and diversifying
 - Bottoms up (vs. top down) enabling complex structures
 - 3D Assembling in garage shops globally
 - Product design & engineering being Uber(ed)
- Bio, nano, neural, and information disciplines are redefining the micro-world
 - DNA, RNA, and proteins entering micro sensors/devices
 - Synthetic biology yielding biologically-inspired componentry
 - Nanobots as differentiated products
- Machine Learning & AI will accelerate implementation of manufacturing innovations



Trending: information abundance

- Bandwidth: torrential information flows from enormous server farms globally
- Density: personal history on a thumb drive
- Volume: legacy in the cloud ... entire lifetime of images, sounds, messages, correspondences, actions
- Virtualized: AI will resurrect a person virtually, re-animated with steadily evolving realness
- AI growth constrained by power demands of traditional computing (CMOS devices, Von Neuman architecture)



Economic Driver: information creates wealth

- Economic value grows with information creation
- Surprises spawn information of high value
- Information mined, extracted from globally-linked data “depots” serve individual needs
- “Exponential” cost reductions of computing infrastructure and open sourcing of ML & AI
 - Spawn thousands of small enterprises (data prospectors)
 - Individuals will create and curate information ... anytime, from everywhere, about anything



Established Markets



Established Markets: technology acceleration & converging disciplines will spawn opportunities ...

- **Waste Processing & Material Extraction:**
 - Address as asset at design (front end), not as nuisance at consumption (back end.)
 - Extracting value while reducing burden to the environment.
 - Disciplines: Physics, Robotics, Chemistry, Biology, Electrochemistry, etc.
- **Water Desalinization/Purification:**
 - Trusted sources of fresh water for communities (large-scale) to consumer (portable.)
 - Disciplines: Physics, Electrochemistry, Material Science, Photonics, etc.
- **Electrical Power Generation:**
 - Fossil fuel mitigation through carbon sequestration & utilization (Physics, Thermal-mechanical engineering, Electrochemistry, Chemical Engineering, etc.)
 - Next-generation nuclear power generation (Physics, Nuclear Engineering, Thermal-mechanical engineering, Computer Science, Material Science, etc.). Smaller nuclear reactors attractive for big data. Fusion remains high-risk, high-payoff.
 - Geothermal, hydro-thermal, chemosynthesis (Physics, Thermal-mechanical engineering, Material Science, Electrochemistry, Chemical Engineering, etc.)
 - Ocean-thermal, wind, waves, hydro-electric (Physics, Material Science, Electromechanical Engineering)



Established Markets: opportunities, cont.

- **Food Production & Distribution**
 - Re-architecting, re-engineering biochemical pathways to enhance growth of edible carbohydrates and proteins
 - Micro-agriculture (robotics and data) manages materials and resources at the individual crop level
 - Reducing spoilage rates through packaging and energy-efficient refrigeration
- **National Security**
 - Detection and interdiction of WMD
 - Information security (conventional and quantum computing threats)
- **Personal Health Enhancement**
 - Physiological: Brain and body implants
 - Emotional/Psychological: Virtual coaching via smart device apps

Human Enhancement



EPIC: Hyper Human beyond Natural Evolution

- Semiconductors, sensors, AI, neural biology, big data, deep learning, high bandwidth communications are rapidly evolving and converging
 - Redefine the essential nature of the human being
 - Blur boundaries between individuals and environments
- E: enhanced, extended ...
- P: projected, protected ...
- I: immersed, integrated, interconnected ...
- C: communal, consecrated (immortalized) ...



Smart devices become brilliant human complements

- Enablers propelling humanity's cultural-informational ascendancy:
 - Smart phones/tablets already complement and enhance our abilities: alert, track, guide, inform, entertain, and organize. Features and apps quickly evolving.
 - Data volume, bandwidth, and Deep Learning growing exponentially.
 - AI permeating products and networks.
 - Robotics advances are accelerating in sensing, dexterity, locomotion, autonomy.
 - Human-machine interfaces ex-vivo and implantable being pursued globally.
- Human Complements:
 - Technologies: Intelligent, adaptive micro-sensors, safe, dense power sources, secure communications, and affective and/or intuitive interfaces
 - Features: interfaces body-worn, miniature, intelligent, informative; integrated with sensing-communication networks ubiquitous in the environment.
 - Networks are evolving to realize hyper-human existence.

Aspects of My Career

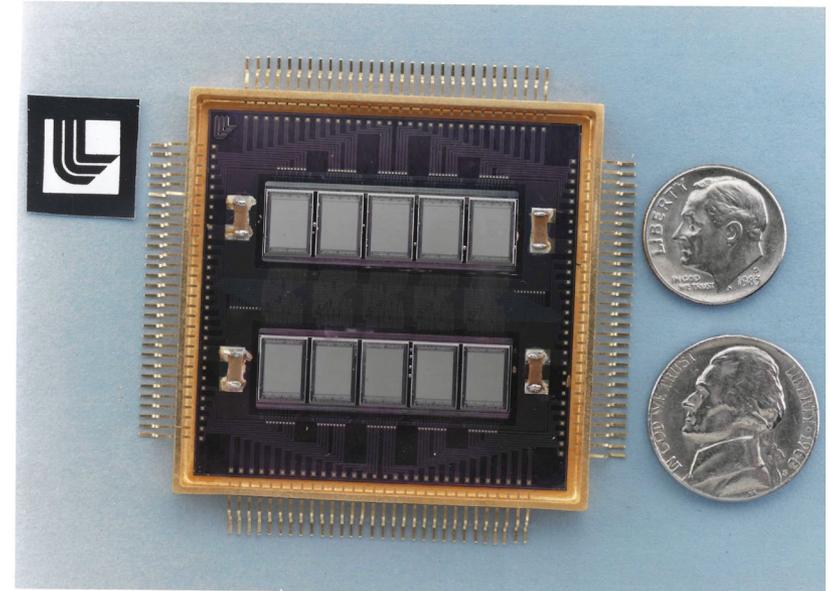
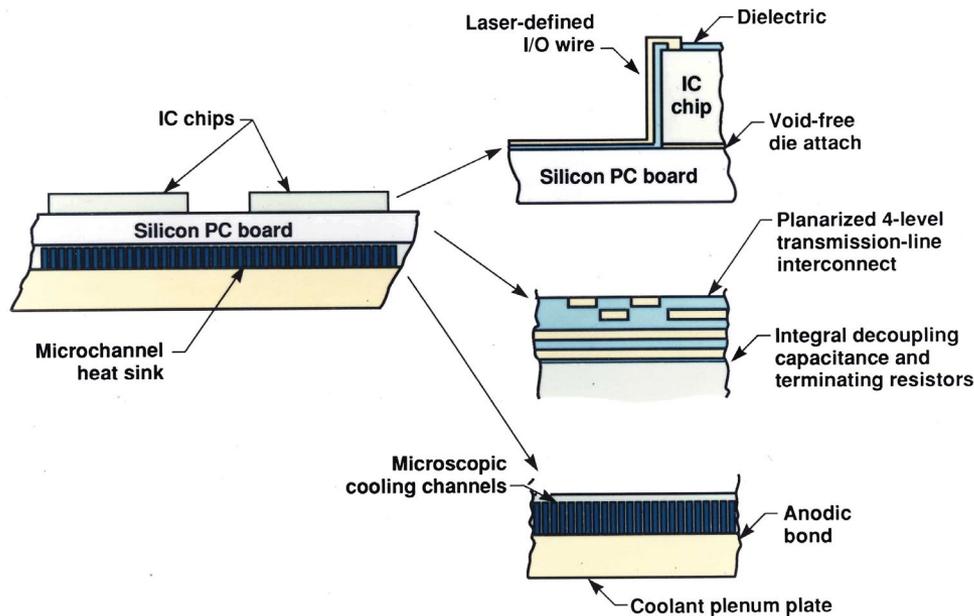


My Early Years ...

- Boyhood: delivered newspapers, mowed lawns, shoveled snow, split firewood & serviced trees.
- Teenager: attended Big Beaver Falls HS, worked at an industrial foundry, steel tube furnace, road work
- Studio musician dream: trombone lessons (Duquesne University), music theory (Geneva College) ... my first broken dream!
- College not even imagined ... lucky recommendation (admonishment) by a high school counselor to attend college
- Temple University: scientific awakening; learned commitment; blessed with advice and opportunities; mentored by Prof. Kenneth McFarlane.
- Carnegie Mellon: physics (MS, PhD); met Bruce McWilliams & began a multi-decade friendship; corporate research (MI Fellow); steel industry collapsed => impetus to create jobs

LLNL: HWSI/nChip, my first spinout (co-founder)

Hybrid Wafer-Scale Integration Technologies



PT-530-U-1094-1A

- Inventors: Bruce McWilliams, David Tuckerman, Jim Kaschmitter
- My role established state-of-the-art multi-chip modules with commercial SRAM could survive LEO space environment (heretic). Led major radiation effects testing program
- 10-chip SRAM module flown on Fairchild Space P87-2 Mission
- Commercial electronics plus advanced electronics “packaging” established feasibility of Brilliant Pebbles

LLNL: RAPTOR/TALON, a boost-phase defense

Flight Testing Of The RAPTOR Demonstrator



TMD-1293-00010-NJC
HC.096.02

Public Display Of RAPTOR Pathfinder



TMD-1293-00092-NJC
HC.062-06/NJC

- High-altitude, long-endurance “robotic minefield” for boost-phase interception of TBM’s
- Demonstrator (Scaled Composites) was the interceptor platform: 65 Kft altitude, 48-hour endurance
 - Six miniature KKV’s, miniature pumped propulsion system
 - Mesh communications network
 - Anti-missile coverage reconfigurable
- Pathfinder (AeroVironment) was to be a tireless sentry for e-signal detection

National Robotics Engineering Center, Carnegie Mellon

- I took a sabbatical from LLNL to work at Carnegie Mellon's Field Robotics Center
 - Led by Prof William "Red" Whittaker; a pioneer of autonomous vehicles
 - Red and I had shared interests in launching robotics companies.
 - Red wanted to build a lunar robotics group
 - My BP/Clementine experiences would be helpful.
- Red had conceived of a Robotics Engineering Center in Pittsburgh.
 - State of Pennsylvania committed development funds
 - City of Pittsburgh donated an abandoned factory
 - NASA funding was needed for first projects
- I helped launch the center, secure its federal funding (NASA), and was chair of its Advisory Board during its early years.



The Pathfinder, a solar-rechargeable unmanned aircraft, would put Jules Verne to shame. It can go around the world in 20 days without a stop at an average airspeed of 90 m.p.h.

Great minds, new ideas come to Pittsburgh as a result of Lawrenceville NASA facility



My career opportunities ...

- Founder (nChip, Angel Technology, AEMS Corp)
- Executive Officer (Angle, Polystor, Tessera, Intermolecular, AEMS)
- Corporate Board (Grandis, Ultracell, Protein Fluidics, AEMS)
- Advisory Board (Zyvex, Greystripe, mBio, Aurrion, Protein Fluidics, Photon Pharma)



Thoughts guiding my growth ...

- My time is my most important investment
- Today's invention, tomorrow's commodity
- Failures => surprises => learning => growth
- Joy accelerates learning; anxiety inhibits it
- Learning is a lifetime journey
- Choose and perform good works
- Lead by example, truthfully and honorably
- Every individual is a fellow pilgrim worthy of dignity, respect, empathy, and love
- *Make me prudent in planning, courageous in taking risks, Make me patient in suffering, unassuming in prosperity. Pope Clement XI*



Consumers Mindset



Consumers want and expect ...

- Want to live healthier, better and longer
 - Youthful mental abilities over extended lifetime
 - Dexterity of musicians, muscles of athletes
 - High vitality until final hours
 - Assortment of delicious prepared food delivered to the door
- Expect access to information anytime, from everywhere, about anything
 - Delivered instantly
 - Sourced globally
 - No language barrier to content
 - Curated, annotated, and presented in preferred language

Good Works



Serving regional markets ...

- Small, private businesses launched with friends, family, small business financing; tailored to local needs
- Personal Services for Seniors:
 - Transportation, nutrition, lawn maintenance, snow removal
 - Emotional, social, and physical wellbeing
- Senior Living Support Technologies:
 - Exoskeletal mobility: lightweight, low-power exoskeletal walkers
 - Health (metabolic) coaching via smart apps (nutrition, exercise, ...)
 - Health assessment via smart mirrors and other devices
 - Robotic assistive systems
- Distributed manufacturing consortium (Father William Cunningham story)

Starting Your Venture

An entrepreneur's first steps ...

- Start with the market story ...
 - State value proposition (unsatisfied need?)
 - Specify market entry
 - Identify first customers (the finer the details, the better!)
 - Make an objectives-based market plan
- Develop a simple, provable business model ...
 - Diagrams depicting cash flow, revenue, cost, profit.
 - A map of critical actions with quantifiable “sobriety checkpoints.”
- Write a top-level summary of your new venture:
 - Market, First Customers, Key Competitive Factors
 - Leadership Team
 - Investment Required, Use of Cash
- Access experts and mentors. Invite criticism and challenges.
- Afterwards, then ... Start writing your Business Plan.



Build your business as a prototype ...

- Architect your business from a systems perspective:
 - emphasize “value creation” throughout
 - specify best use of resources (money, brains, time)
- Benefits of the systems approach:
 - Test/verify market assumptions => evolve market strategy
 - Fine tune value proposition => narrow and improve product features (evolve minimum set of features most valued by customers)
 - Determine best approach to operate business
 - Stay capital efficient to optimize ROI

Build your business as a prototype ...

- Expose market assumptions requiring validation.
 - Talk to customers to discover and refine value proposition (many iterations)
 - Seek opinion leaders and influencers to improve your market story
 - Apply best data mining tools to discover market friction, needs, underserved segments
- Capture “user experience” from early adopters for building valuable IP:
 - Gain insights from early customers and opinion leaders
 - Evolve understanding of desirable product features and offerings
- Make market-desired changes to product’s design
 - Improve understanding of market positioning and building
 - Increase value of product to customers; expand customer base

Traits & Behaviors Fostering Success



Leadership traits that will serve all well

- Healthy body and mind; and discipline to stay healthy.
- A mind that accepts crises as opportunities and is graceful at learning from failures.
- Superb manager of tasks, time, and finances.
- Skilled, respectful communicator and a great listener.
- Ethical, fair, dignified and honorable.
- Ability to inspire *esprit de corps* and collaboration.
- A demeanor that promotes calm and objectivity.
- A warm heart that embraces people with divergent opinions.



Behaviors of a healthy business culture

- Treat people with dignity and respect.
- Value others' motivations.
- Recognize decisions and behaviors impact others' lives.
- Share credit and rewards.
- Be conscientious with each hiring/firing decision.
- Be trustworthy with money.
- Commit to growing the value of each investment.
- Commit to excellence.
- Expect excellence.

“When you deal with fellow human beings, behave as one.” Marcus Aurelius

Take Away Messages



First time entrepreneur's take home messages ...

- *“Do what you love and what you can do well,”* Mike Rowe
- Be driven by passion and relentlessly build your skills
- Talk to “customers” before writing your B-Plan
- Prepare well before seeking investment
- Pursue smart money in right amounts
- Emphasize value creation and be sensible with cash
- Prototype your business to improve it steadily
- Learn from surprises and adapt
- Be humble for success requires commitment, vision, courage, adaptation, stamina, and ... luck