# Business of Software (CSC454/2527)

Lecture 1

DEPARTMENT OF COMPUTER SCIENCE
University of Toronto
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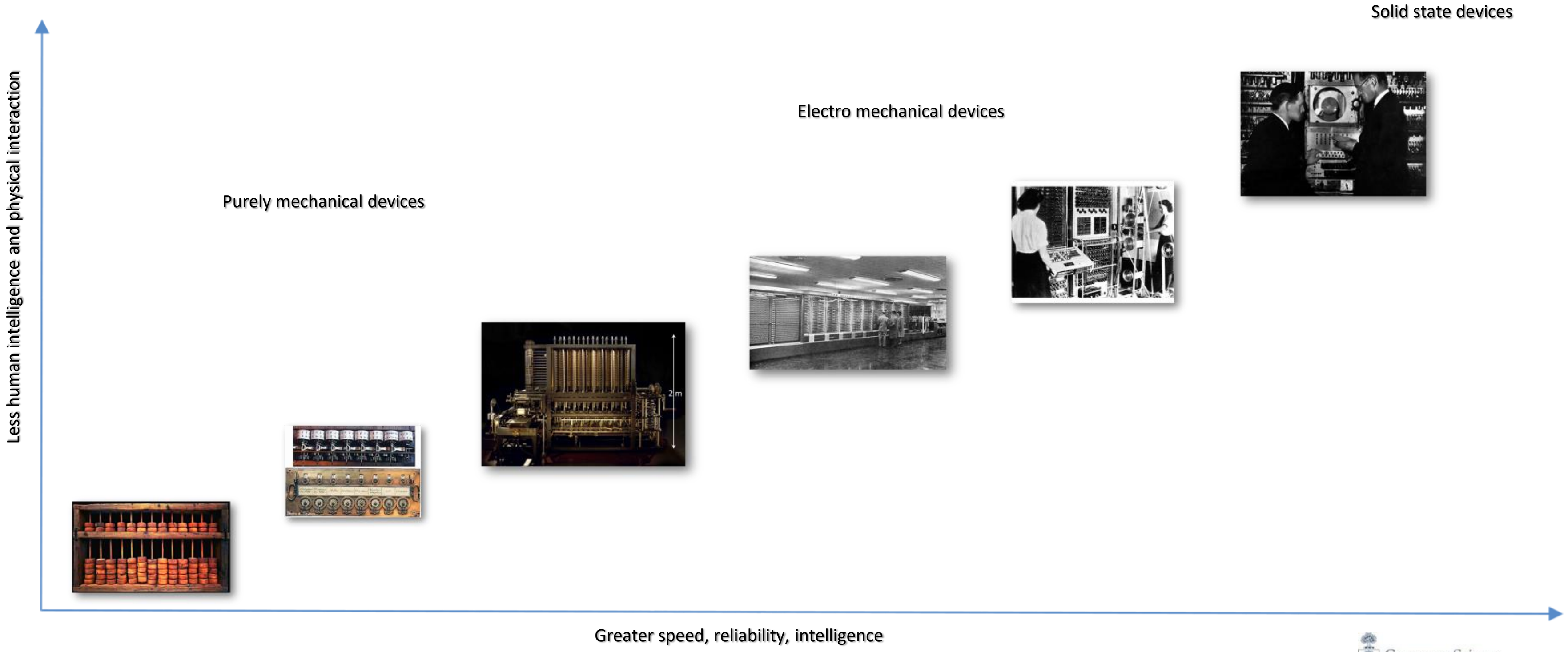
# Lecture 1 - Topics

- Tech Industry Overview
- Framing the Commercialization Problem – The Self Inflicted Wound

# Tech Industry - History

- Although computational devices have been with us for centuries the word *“software”* was coined in the mid 1950’s and started hitting the English lexicon in the 1960’s when software became commercialized sparking the *software industry*
- In the early years of the tech industry manufacturers bundled software with mainframes as a packaged deal
- Following the unbundling of software in the late 1960’s and the dawn of personal computers in the 1970’s the software industry took off as tech proliferated into the hands of individuals that created new firms entering the market with packaged applications and services
- Since then software has touched every aspect of our lives in every corner of the world and yet we have barely scratched the surface
- Software is arguably the most effective tool to humankind since the rock!

# Tech Industry – The Shift of Intelligence



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# Tech Industry – The Shift of Intelligence

Less space, heat, power, cost

First Generation

Vacuum tubes

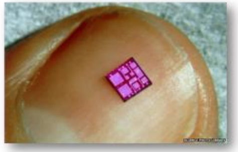
Second Generation


Transistors

Third Generation

Integrated circuits

Fourth Generation



Large scale integrated circuits

Fifth Generation

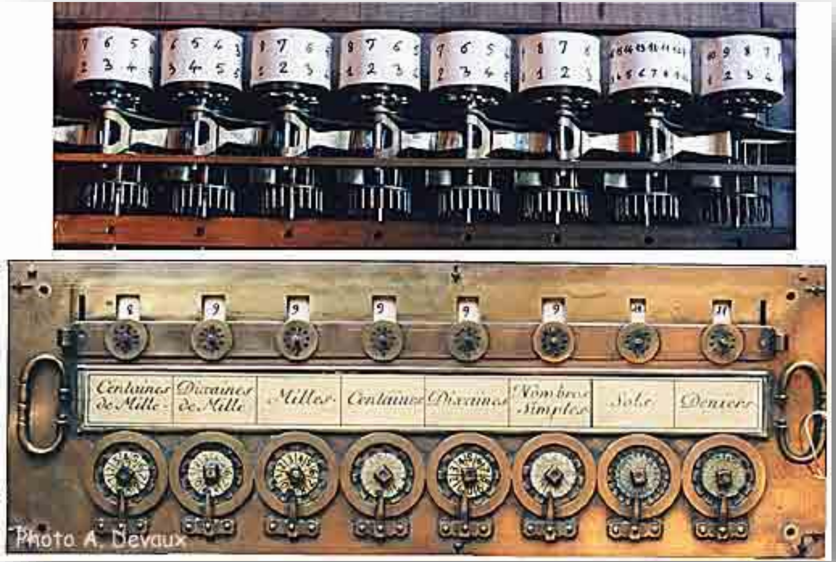
Artificial Intelligence

Greater speed, reliability, intelligence

# Tech Industry - History

One of the earliest calculating devices - the abacus. Many cultures of antiquity as far back as 5,000 years have used this method of calculation.  Archeological findings of the abacus have been discovered in many ancient hotbeds of civilization such as Greece, Rome, Egypt, Mesopotamia, Persia,  India, China, Japan and others.

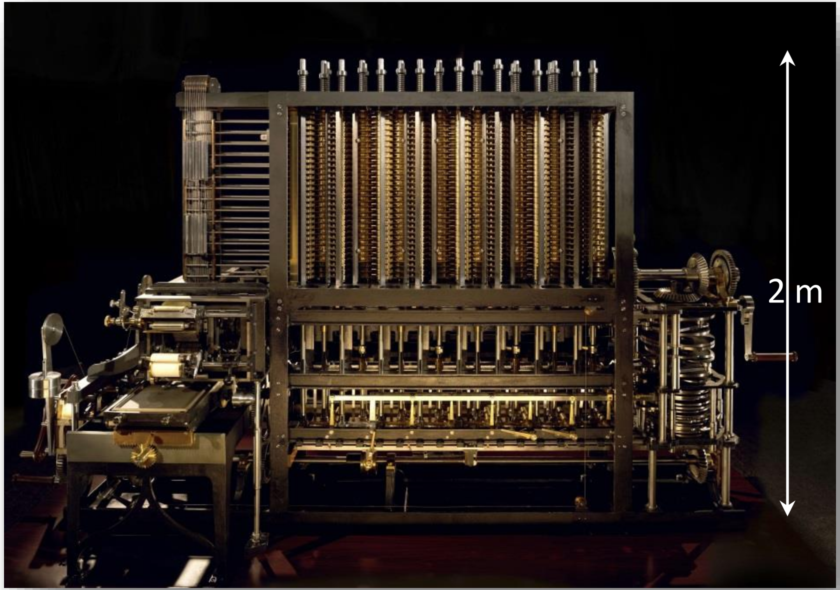
# Tech Industry - History




In 1640, Blaise Pascal conceives of the mechanical arithmetic machine.

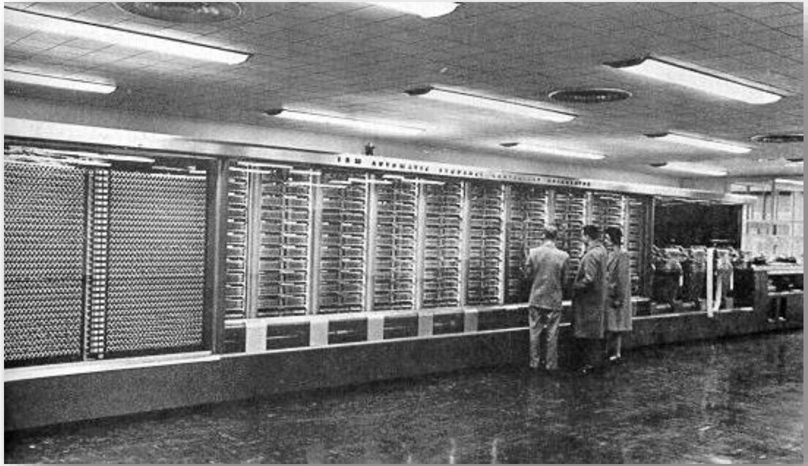
The construction of a mechanical adding machine comprised of sets of interlocking cogs and wheels.

# Tech Industry - History



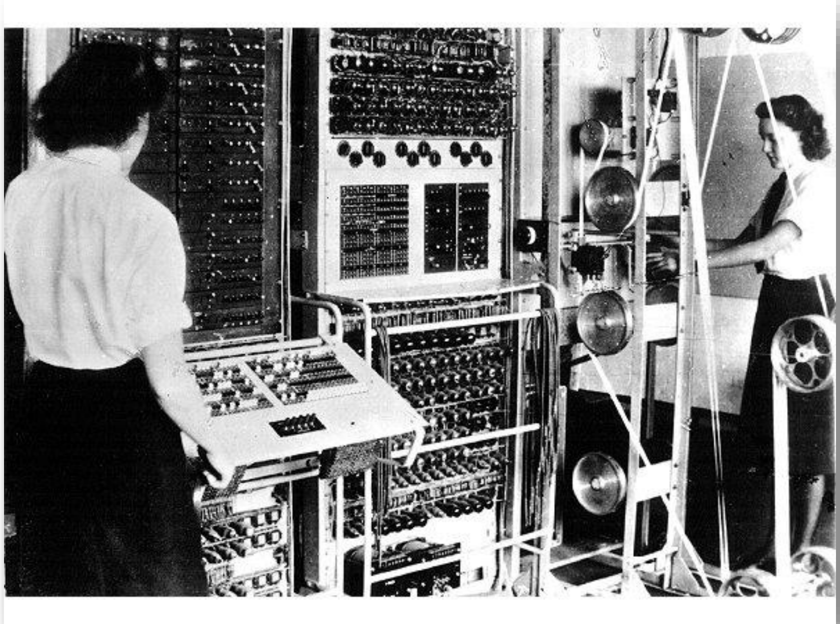

A difference and subsequent analytics engine proposed by Charles Babbage in the 1820’s is an automatic mechanical calculator designed to tabulate and interpolate polynomial functions. Most mathematical functions commonly used by engineers, scientists and navigators, including logarithmic and trigonometric functions, can be approximated by polynomials, generating various useful tables of numbers.

# Tech Industry - History



Just before World War II, Thomas Watson, head of IBM, funded Howard Aiken, a mathematics professor at Harvard, to construct an electro-mechanical equivalent of Babbage's analytical machine. Unveiled in 1944 the Mark I cost nearly one million dollars to build ($13.6M in 2016). Rather than using gears, the Mark I used electromagnetic relays that would click open and closed. The first system “bug” was a moth caught in the electromagnetic relays.

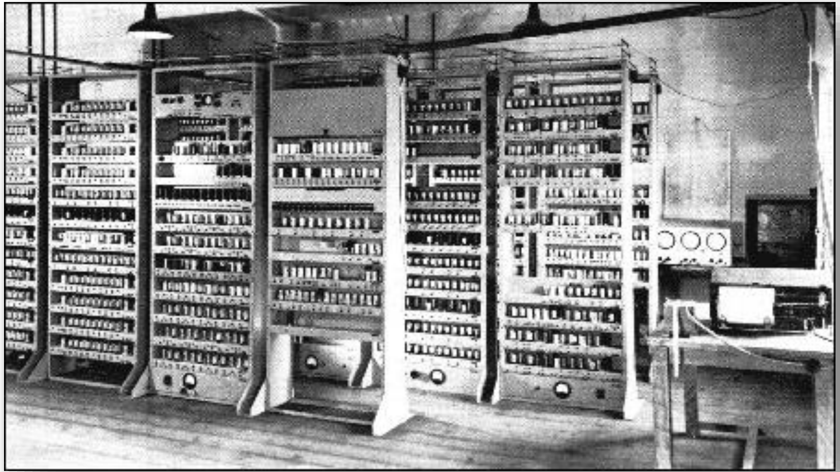
# Tech Industry - History



At the same time (1944) both the Germans and the British were developing primitive computers, driven by a mutual need for cybersecurity during World War II. The British developed a computer, known as Colossus, which was specifically designed and built to decipher supposedly secure codes within the German high command. This vulnerability in Germany's cybersecurity apparatus ultimately cost them the war.

Colossus used about 2,500 vacuum tubes, a series of pulleys that ran rolls of punched tape with possible solutions to a particular code.

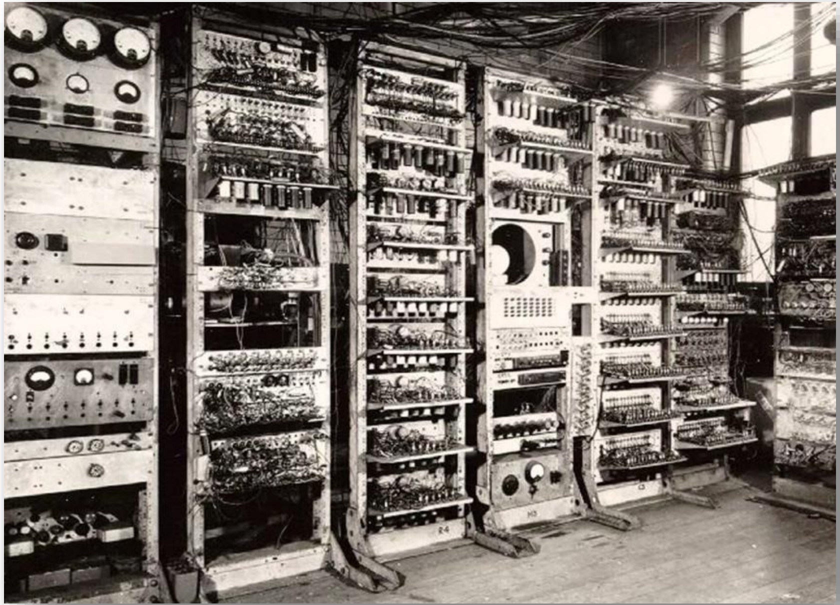
# Tech Industry - History



Electronic Numerical Integrator And Computer (ENIAC – circa 1946): was the first electronic general-purpose computer. It was digital, and capable of being reprogrammed to solve "a large class of numerical problems“.

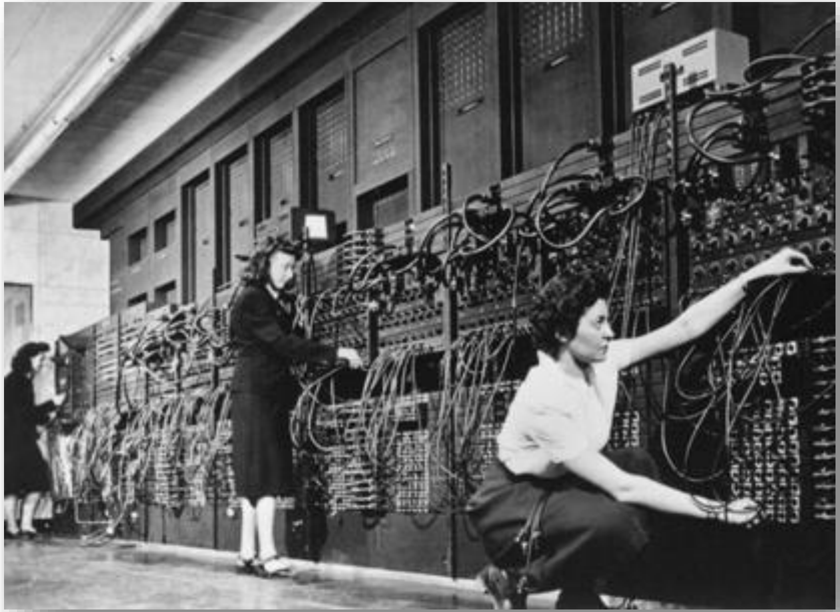
Though ENIAC was designed and primarily used to calculate artillery firing tables for the United States Army's Ballistic Research Laboratory, its first programs included a study of the feasibility of the hydrogen bomb.

# Tech Industry - History



When ENIAC was announced in 1946, it was hyped in the press as a "Giant Brain". It had a speed of one thousand times that of electro-mechanical machines. This level of computational power, was a major breakthrough. ENIAC used panel-to-panel wiring and switches for programming, occupied more than 1,000 square feet, used about 18,000 vacuum tubes and weighed 30 tons.

# Tech Industry - History



The limitations of the ENIAC became obvious very quickly, particularly the fact that to change its function required rewiring a substantial part of the machine, which was a slow process.



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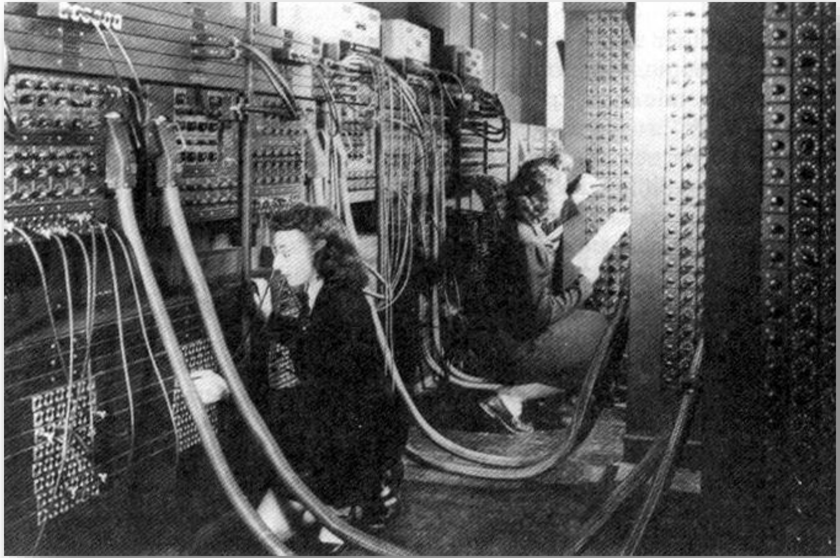
# Tech Industry - History



The solution to this problem necessitated the development of the "stored-program" concept, in which the sequence of instructions to be performed (called a program) could be entered in much the same way as data stored in the computer to be used when needed. Being able to do this made rewiring the computer each time unnecessary.

At this point the tide shifts toward the software as the driver to advancing the hardware.



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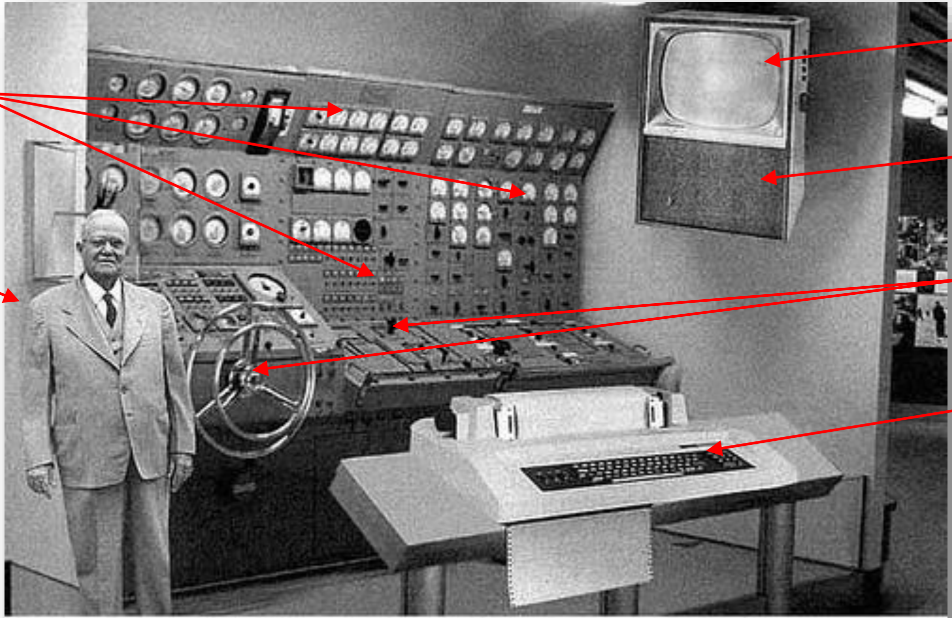
# Tech Industry - History

University of Manchester researchers Frederic Williams, Tom Kilburn, and Geoff Toothill develop the Small-Scale Experimental Machine (SSEM). It was built to test a new memory technology developed by the researchers which was the first electronic random access memory for computers. The first program, consisting of seventeen instructions and written by Kilburn, ran in 1948. This was the first program to ever run on an electronic stored-program computer.

# Tech Industry - History




*Scientists from the RAND Corporation have created this model to illustrate how a "home computer" could look like in the year 2004. However the needed technology will not be economically feasible for the average home. Also the scientists readily admit that the computer will require not yet invented technology to actually work, but 50 years from now scientific progress is expected to solve these problems. With teletype interface and the Fortran language, the computer will be easy to use.*



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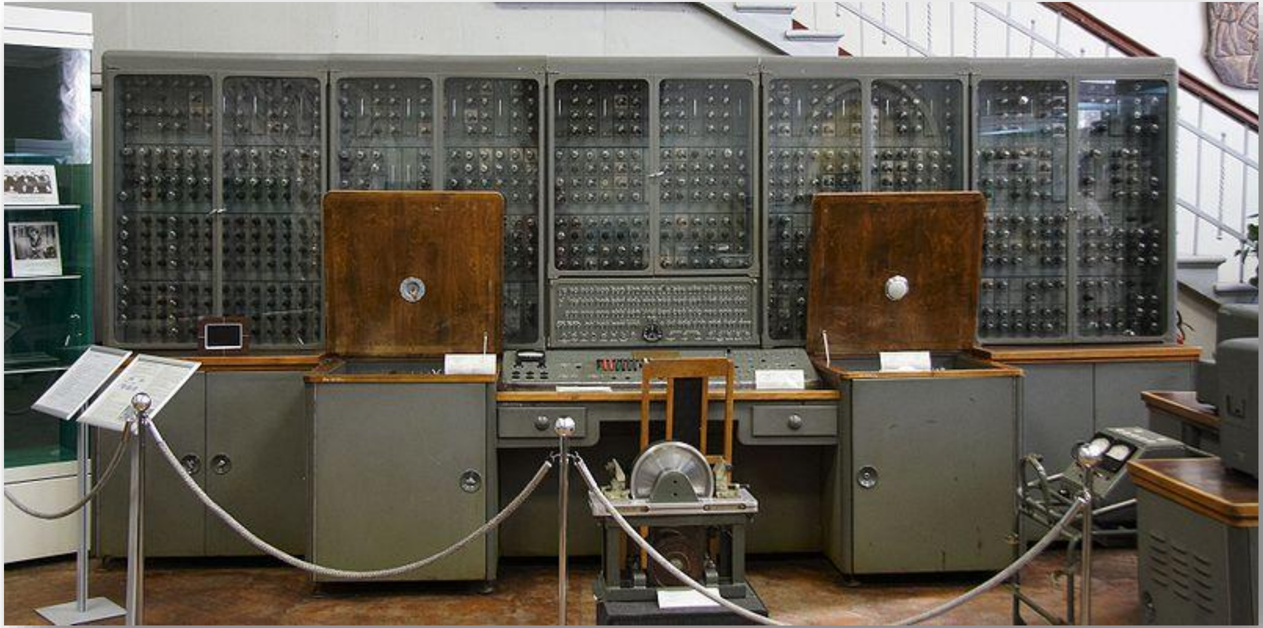
# Tech Industry - History



Ural 1 Mainframe 1959 (Soviet Union): The Ural 1 could perform 12,000 floating point operation per second and occupied 1000 sq ft of floor space. Today, you would need to occupy almost all of the Empire State building (1.7million sq ft) with Ural 1s to have the same computing power as an iPhone.



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# First Generation Computers (1951-1959)

Walter Cronkite (right) listens as Dr. J. Presper Eckert (center) describes the functions of the UNIVAC I computer he helped develop in the early 1950s.
*AP*

The UNIVAC 1 was the first of what have come to be called first-generation machines. These are typified by using vacuum tubes, by performing slowly (about 1,000 instruction per second),and having a memory capacity of about 16,000 characters of data (the equivalent of about four single-spaced typed pages)

# Second Generation Computers (1959-1964)


The era of the first-generation computers ended with the replacement of vacuum tubes by transistors by Bell Laboratories scientists. The transistor accomplishes everything a vacuum tube does, uses far less power, and occupies approximately 1/100th of the space. It is also far more reliable and requires no warm-up time. Second-generation computers used transistors rather than tubes, which increased their reliability, computational speed, and reduced their volume, cost, and power consumption.



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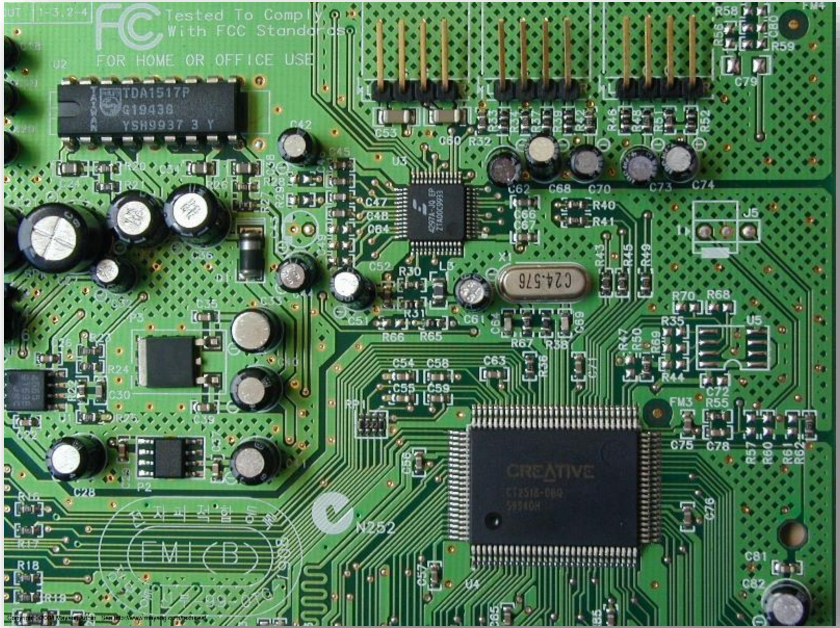
# Third Generation Computers (1964-1971)



Third-generation computers are attributed to the invention of the integrated circuit, or IC. Integrated circuits allow many components (transistors) to exist on a single small chip. Thus, what had previously been a box full of transistors and other electronic parts making up the "brain" of the computer could now be packed into an area about 1/4-inch square, known as a chip. IC's are even more reliable than transistors, are cheap to produce, are compact, and use virtually no power at all compared to previous technologies.



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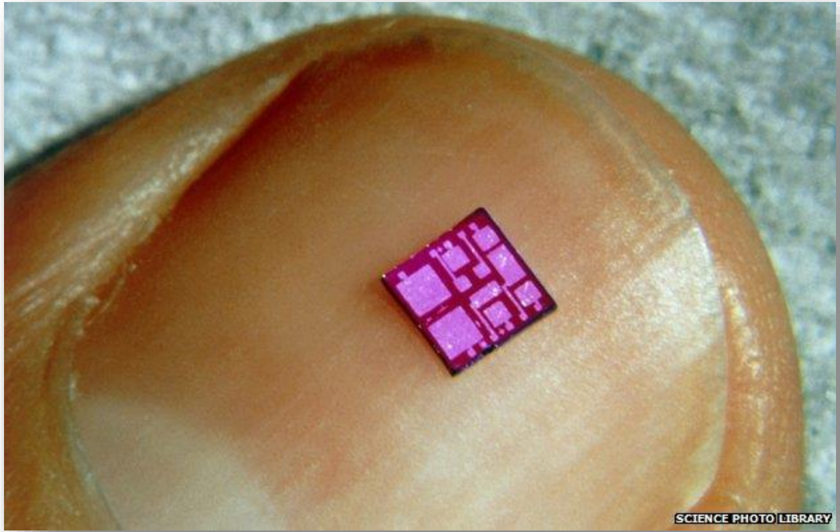
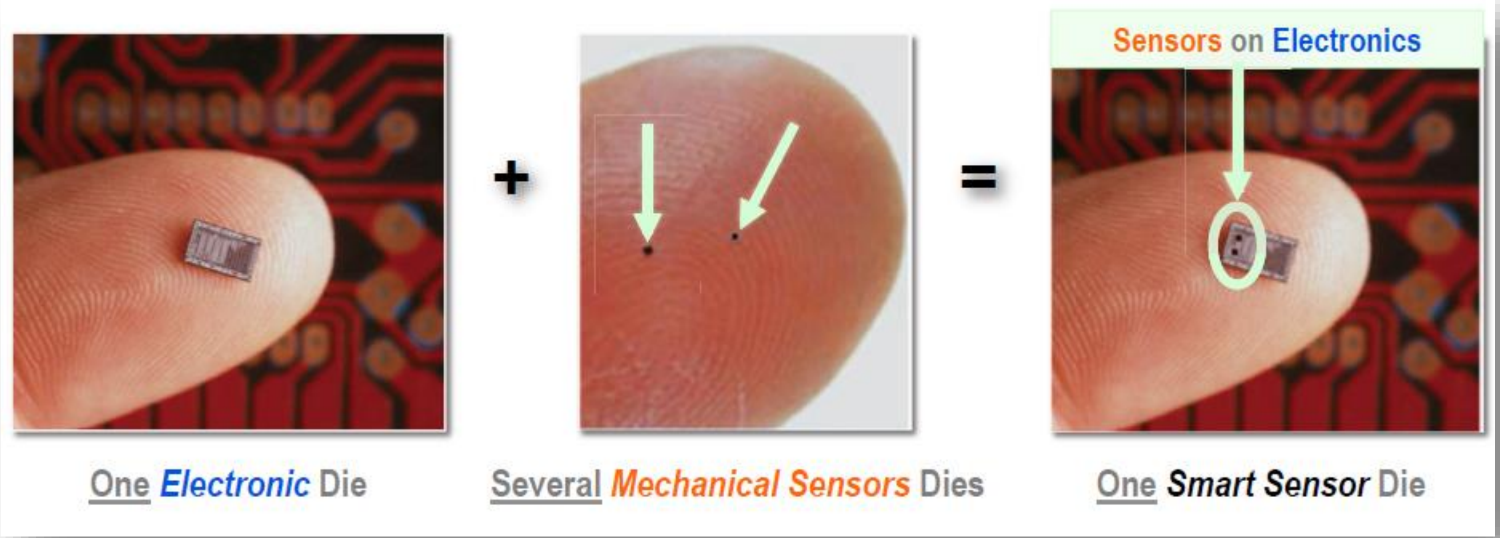
# Fourth Generation Computers (1971-Present)




Once the integrated circuit became a reality, the story of further developments centers around how many circuits could be packed on a single silicon chip. Large-scale integration (LSI), for example, made possible the smartphone. Advances in microprocessor technology were paralleled by the development of memory chips and storage capacity.

# Miniaturization and Integration Futures



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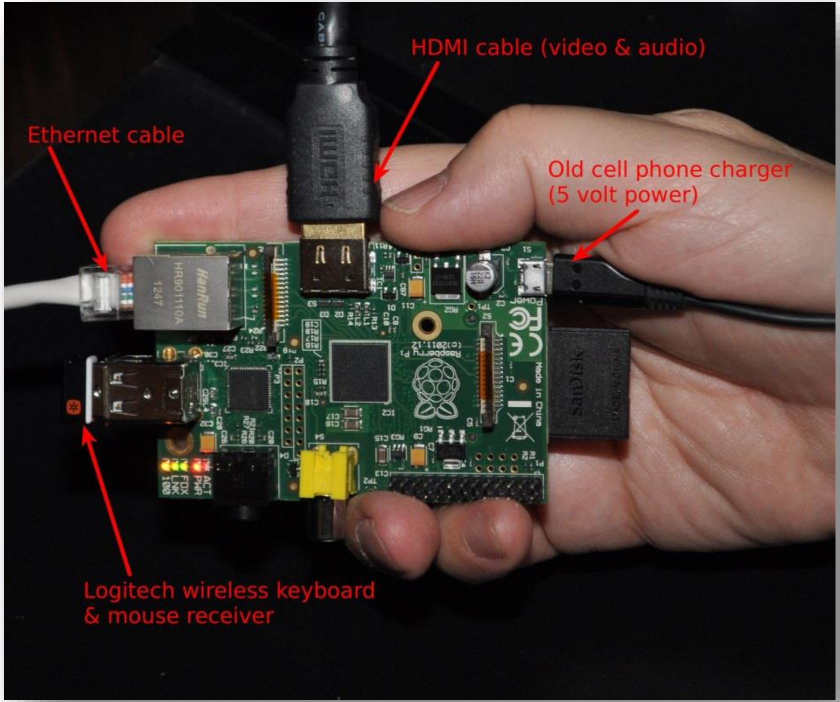
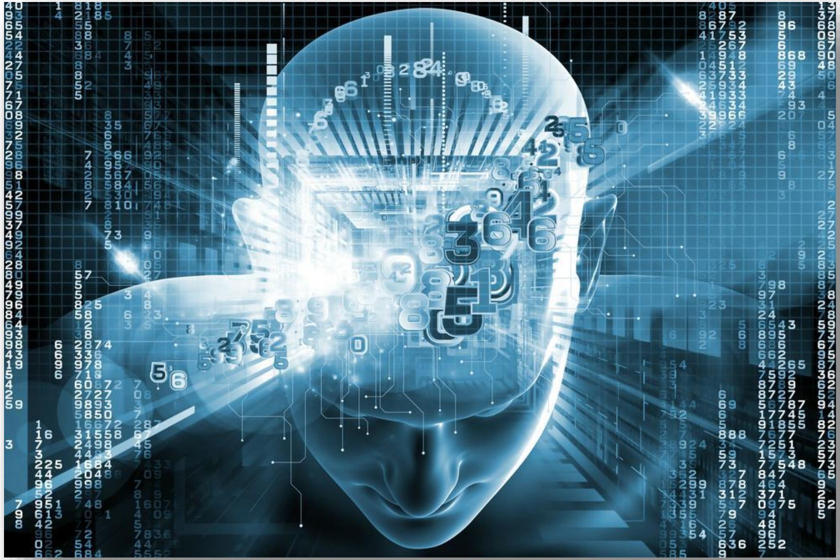
# Shrink Wrapped Computing




Advancements in the miniaturization has enabled a series of credit card-sized single-board computers developed in the UK by the Raspberry Pi Foundation with the intention of promoting the teaching of basic computer science in schools.

# Fifth Generation Computers (Present –Future)



Fifth generation computing devices, based on artificial intelligence, are still in development, though there are some applications, such as voice recognition, that are being used today. The use of parallel processing and superconductors is helping to make AI a reality. Quantum computation and molecular and nanotechnology will radically change the face of computers. The goal of fifth-generation computing is to develop devices that respond to natural language input and are capable of learning and self-organization.

# Influence of Commoditization

1. Chip manufacturers have been roughly doubling the performance on an affordable integrated circuit every 18-24 months at the same price point (example: 1971 Intel 4004, a 740 kHz processor produced 92,000 instructions per second. 2016 processors are multi-core GHz processors processes over 100 billion instructions per second – an increase of 1 million times) – GAGR of 36%

2. Miniaturization and multi-core integrated circuits, drives the advancement of infrastructure, software development tools enabling startups to speed up the proliferation of innovation.

3. Successful small software ventures that can develop into successful large software companies can often be started with almost no capital investment

4. Acquisition of startups and small companies are credited for catalyzing significant incremental volumes of revenue through the larger companies that acquired them (i.e.: Android)

# Tech Industry - Facts & Figures

- Globally the consumer (B2C) and business (B2B) 2016 expenditure on software, hardware and services was \$3.4 trillion – (2017 forecast  \$3.5 trillion up 2.9%) out of the \$76 trillion of all commercial activity worldwide (4.6%)

- Globally software and services make up about two-thirds of this expenditure
  - Software grew 6% in 2016 and forecasted at 7.2% in 2017
  - Services grew 3.9% in 2016 and forecasted at 4.8% in 2017

- The tech sector accounts for an estimated 8 percent – more than \$1.3 trillion – of total activity in the U.S economy

- US is largest software market (45-50%) however more than half of the software market lies around the world

- Employs over 7 million people in US - average salary \$85,000+ , roughly 190% of national average

# Tech Industry - Facts & Figures

- Overall spending on tech acquisitions topped $313 billion in 2015, up 82% from the previous year and nearly quadrupled the amount spent in 2010. http://venturebeat.com/2016/02/15/2015-saw-all-time-high-with-313b-in-announced-technology-acquistions/
  - Google alone has spent more than $200 billion acquiring companies since 2001 https://www.cbinsights.com/research-google-acquisitions
  - Google's most well-known products, including Android, YouTube, Maps, Docs and Analytics, have originated from acquisitions
  - Recently Deep Neural Networks, Nest, DeepMind, Boston Robotics……



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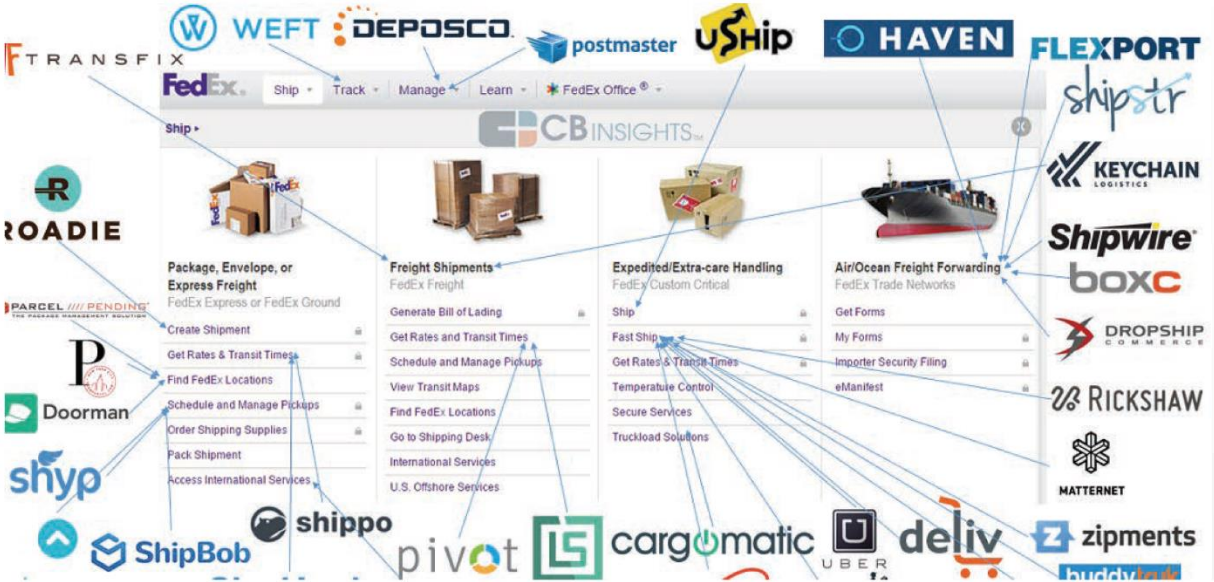
# Innovation Today

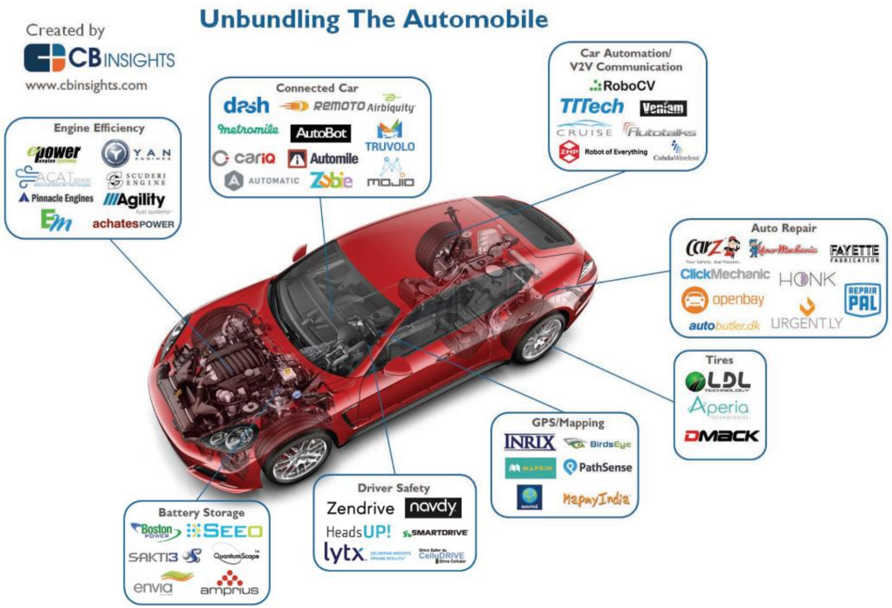
- Innovation can come from anyone and any corner of the world
- It can come from startups, small-medium enterprises, industry and academia
- Innovation has to solve a clear and defined significant problem – the bigger the better
- It's a numbers game and it always has been – investors and companies are looking for a ten fold return on their investment and it has to address a market of greater than a billion dollars or frankly no one cares.
- Businesses and startups fail because of lack of customers usually attributed to incorrectly forecasting the market size and who the target customer(s) is/are.

# Innovation Disrupting Industries




Source: https://www.cbinsights.com/blog/startups-disrupting-fedex-ups/

# Innovation Disrupting Industries




Source: https://www.cbinsights.com/blog/startups-drive-auto-industry-disruption



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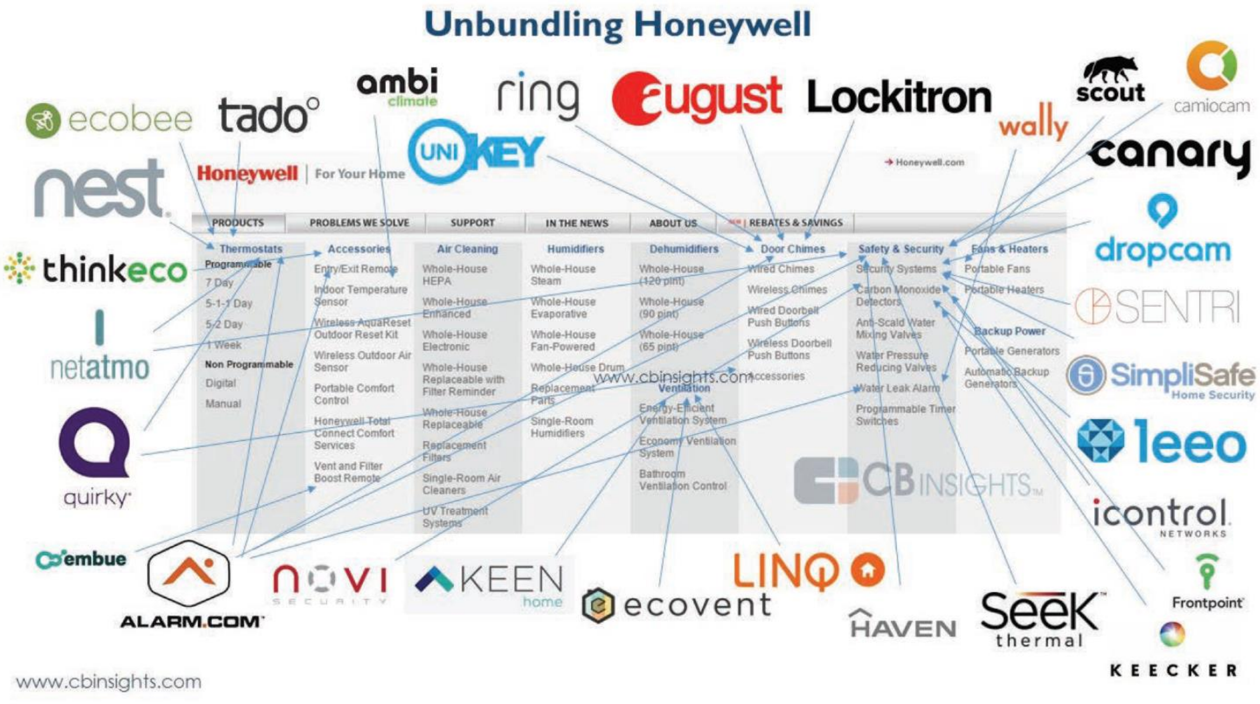
# Innovation Disrupting Industries




Source: https://www.cbinsights.com/blog/disrupting-honeywell-startups

# Tech Space Changing at Warp Speed

- "Exponential" technologies including robotics, virtual and augmented reality (VR) (AR), 3-D printing, and artificial intelligence (AI) are opening up significant areas of opportunity.
- Cognitive technologies such as machine learning, natural language processing, and speech and pattern recognition are being embedded in software applications, imbuing big data with superior capabilities.
- Blockchain, the foundation for the digital currency bitcoin, has enormous implications not only for the financial services industry, but for any company that manages a large amount of transaction data.

# Tech Space Changing at Warp Speed

- Technology enterprise customers are requesting solutions using a pay-per-use or consumption-based models.
- In order to maintain the competitive pace of innovation, companies find themselves engaged in a global war for talent.
- Well established players will want to be aware of competitive threats and how new companies might disrupt their business models and at the same time considering how they can beat them to the punch by disrupting themselves first.

# Tech Space Changing at Warp Speed

- The transformation of an enterprise is a complex undertaking, and the digital solutions need by companies don’t come neatly bundled out of the box giving startups whitespace to exploit.

- In order to gain a leg up, technology companies are partnering together for the purpose of advancing a particular field or building end-to-end customer solutions that harness the best of each of their assets and capabilities.

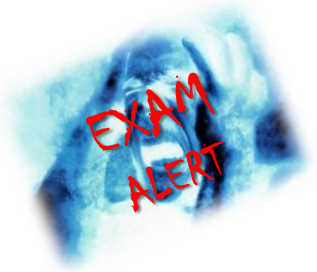
- Courtesy of Paul Sallomi, Deloitte LLP

Paul is vice chairman and the Global Technology, Media, and Telecommunications Industry leader for Deloitte LLP. He also serves as the US and Global Technology Sector leader

# Startups & Founders by the Numbers

- In 2016 there were over 16,000 startups in Silicon Valley
- Startup Founders age profile
  - 20 (<1%), 20-29 (34%), 30-39 (40%), 40-49 (20%), 50+ (5%)
- Average funding per startup $1.5 million, average value of a funded company $22 million (YC)
  - Hottest investment sectors today, Internet (27%), healthcare (27%), mobile/telecom (14%)
  - 75% of all startups fail
- 68% of entrepreneurs believe the odds of business succeeding are better than others in their sector. Only 5% believe their odds are worse – entrepreneurs are optimists

# Anatomy of an Investable Venture




Thinking outrageously big is a must to play in the big leagues

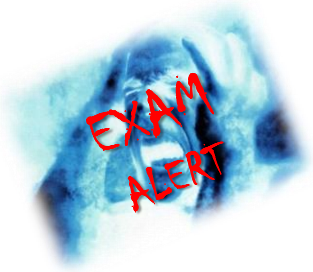
- Industry disruptive or creating a whole new industry with a solution that addresses a massive perceived or yet to be perceived need (Example: search, music, social)

- Today the rule of thumb is that you should be looking at a market worth in excess of $1 billion along with adjacent markets to expand into

- Investors will be looking for a return of 5-10 times what they originally invested

- There should be an order of magnitude in improvement in relation to your closest direct or indirect competitor

# Anatomy of an Investable Venture




Other major considerations include

- Strength of the business model
- Distinct competitive advantages (proprietary IP)
- Viability of founding team (dedication, background, track record, chemistry)

# Investors & Investment Portfolios

An investor is a person who allocates capital with the expectation of a financial return.

Generally, the types of investments include: equity, debt securities, real estate, currency, commodity, and derivatives (call/put options). Someone who provides a business with capital and someone who buys a stock are both investors. An investor who owns a stock is known as a shareholder.

<u>For this course and startups, we focus on equity (stock) and possibly debt financing (convertible notes)</u>

# What You Get – What You Give Up

This form of raising capital is popular among new companies or ventures with limited operating history, which cannot raise funds by issuing straight up debt because there is little to no assets to collateralize the debt in case of a default.

The trade-offs for entrepreneurs is that venture capitalists usually get a say in company decisions, in addition to a portion of the equity (your co-owners). This is a good thing if you get “smart money” (more on this later).

# Venture Capitalists Fund Supply Chain

*Venture Capitalists are money managers providing a financial service in the high risk investment space*

Most venture capital comes from large institutions hoarding cash such as;

1. Charitable foundations
2. Insurance funds
3. Pension funds
4. Investment banks
5. Wealthy family offices
6. Corporations
7. High net worth individuals that pool or partner
8. Endowments (hospitals, museums, universities)

Some institutions invest directly in VC funds others use intermediaries such as;

1. Funds of Funds
2. Advisory Firms

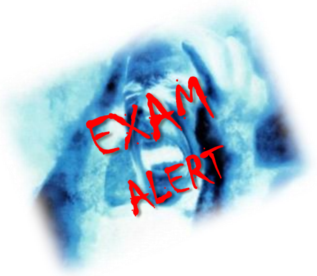
Why?

1. Staff constraint – lack in-house vetting capabilities
2. Lack network of relationships to the high quality funds
3. Institution governance mandates intermediaries
4. Scale and diversification into multiple VC funds

# Typical Institutional Portfolio

Portfolio

- EQUITY
  - DOMESTIC
  - INTERNATIONAL
- FIXED INCOME
- ALTERNATIVES
  - HEDGE FUNDS
  - REAL ESTATE
  - PRIVATE EQUITY
    - VENTURE CAPITAL
    - LEVERAGED BUYOUT FUNDS
  - ENERGY & NATURAL RESOURCES
- CASH EQUIVALENTS




# Framing the Commercialization Problem

# The Self Inflicted Wound

*Build it and they will come.*

# Product Development Model – Framing the Problem

Concept → Product Development → Alpha/Beta Test → Launch/First Ship

When a venture stringently follows the traditional Product Development Model and the idea of getting big fast its on its way to major trouble - regardless of how well funded or managed. When startups use this model solely as a roadmap for finding customers and time their sales launch and revenue plan to it, it becomes a recipe for disaster.

# Decomposing the Problem – Stage 1

Concept

- Founders capture vision, set of key ideas, business plan
- Product or service need is defined along with features, benefits
- Customer assessment through - stats, market research, customer polls
- Product distribution and pricing/cost determined
- Competitive differentiation, positioning, financial modeling
- Funding pitch

# Decomposing the Problem – Stage 2

Product Development

- Engineering designs first release product and hires staff
- Waterfall development , critical path charts, milestones, costs, delivery
- Market focus groups to create requirements doc (MRD) for engineering
- Marketing promo, generate sales demo/collateral, presentations, brand development, hires PR firm
- Hires VP of Sales

# Decomposing the Problem – Stage 3

Alpha/Beta
Test

- Engineering works with small group of outside users to debug system
- Marketing communications plan, sales material complete,
- PR agency starts positioning and contacting press
- Sales group staffs/scales ups, signs up first beta prospects and partners with distribution channels
- Investors start measuring progress by order count in place by first customer ship
- CEO forecasts the need for greater capital and launches a “growth round” investment campaign

# Decomposing the Problem – Stage 4

Launch/First Ship

- Cash burning activities to scale goes into overdrive – more fund raising is required
- Initial Public Offering is contemplated
- Sales kicks into high gear staffing a national organization with sales goals and quotas
- Marketing spends large on elaborate press events and a series of demand generating programs (trade shows, seminars, advertising)

# What could possibly go wrong?

The Product Development model is not a marketing, sales hiring, customer acquisition, or even a financing model.

Yet startup companies have traditionally used a Product Development mindset to manage and pace all of these non-engineering activities.

# 1. Where Are the Customers?


The greatest risk and cause of failure in startups is not the development of new product but in the development of customers and market. Startups don't fail because they lack a product; they fail because they lack customers and a validated business model.

# 2. The Focus on First Customer Ship Date

The flaw in this thinking is that “first customer ship” is only the date when Product Development thinks they are finished building the product. The first customer ship  date does not mean the company understands its customers or how to market or sell to them.  It ignores the Customer Discovery element. In doomed startups, sales and marketing and even worse the investors are managing their financial expectations by this date.

# 3. Emphasis on Execution Instead of Discovery

Sales and Marketing heads believe they need to take the lead because they assume their prior experience is relevant to the new venture. They assume they know the customer problem and were hired for what they know and not what they can learn. These are faulty assumptions .

Before building or selling a product ask the basics: What do we solve? Do the customers see these as important or <u>must haves enough to pay you</u>? How big is the problem?



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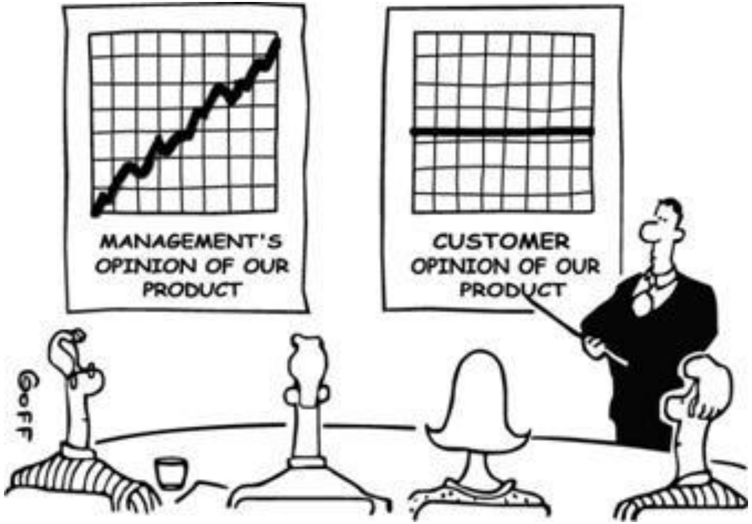
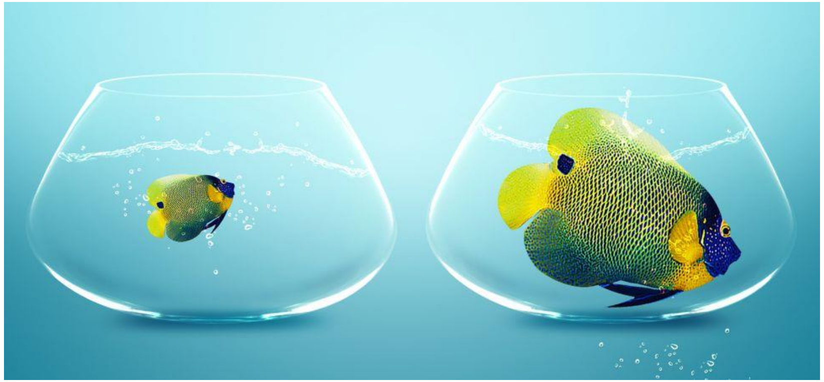
# 4. Lack of Meaningful Sales, Marketing, & Bus Dev Milestones




Product Development model alone distorts objectives and priorities and results in the collection of "feel good metrics" as related to sales/customers sales team headcount, "lighthouse" customers. The marketing equivalent is the level of buzz and getting on the cover of magazine covers.

<u>Simply put, a startup's focus should be on a deep understanding of its customer journey, value proposition, product-market-fit, and repeatable sales roadmap</u>

# 5. Premature Scaling



Occurs when a venture begins to escalate cash consuming activities before they have a clear understanding of their business model. The cash burning excesses occur as mistimed expansion of demand and revenue generating resources (salaries & programs, facilities, infrastructure, travel costs, overhead). If the increased “burn rate” of the venture is not counterbalanced by a recurring, escalating  and profitable revenue stream or a capital infusion from investors the venture will “run out of runway” and fail

# 6. Not All Startups Are Alike

Startups have different customer adoption and acceptance rates so sales /marketing strategies and resource consumptions differ

- Bring new product into a new market
- Bring a new product into an existing market
- Bring a new product into an existing market and trying to resegment the market as a low-cost entrant
- Bring a new product into an existing market and trying to resegment the market as a niche entrant

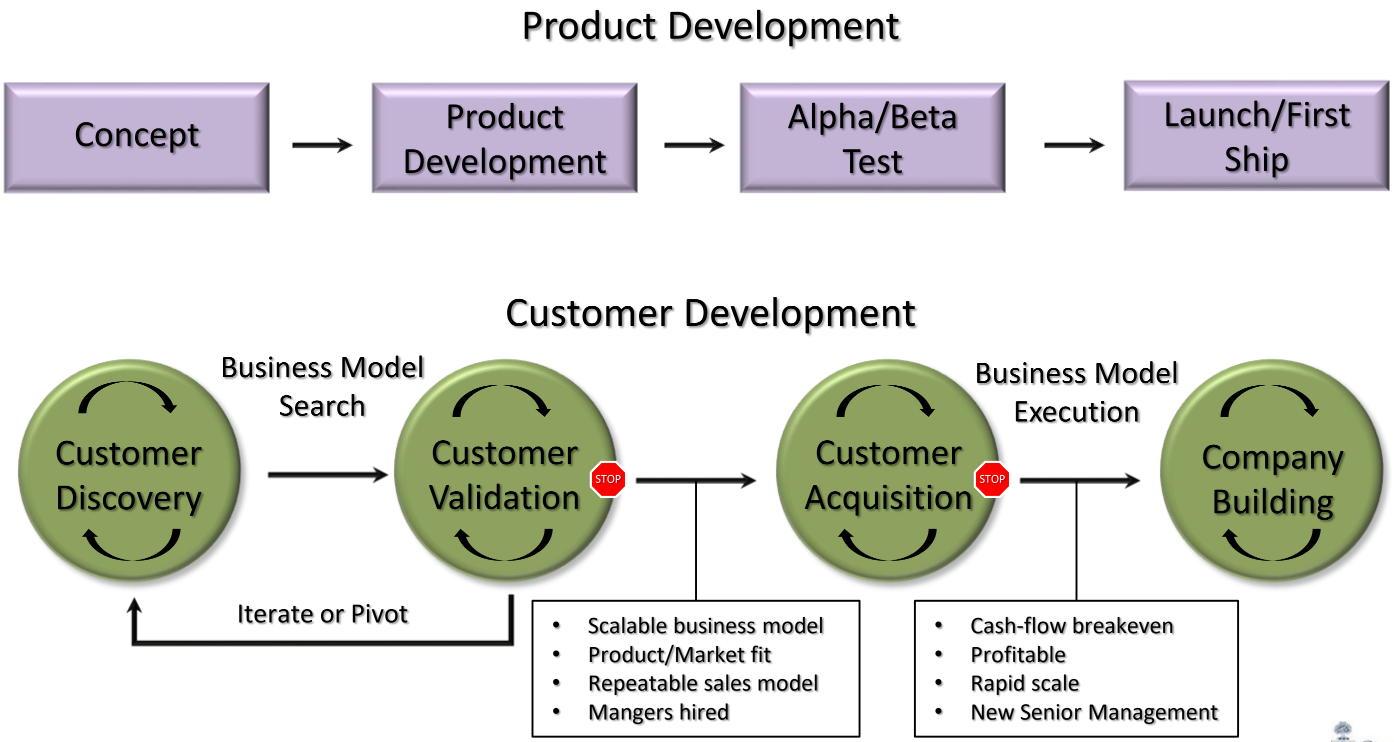
# The Set-up of Unrealistic Expectations

- The Product Development model can be relied upon to guide activities like finding customers, a market and viable business model.
- Customer Development will move on the same schedule as Product Development.
- All types of startups and new products will achieve acceptance and deployment at the same rate, namely at First Customer Ship.
- Succumbing to investor pressure for profitability leading the founders to make unrealistic financial and market size assumptions.

# Fast Forward - Here's How it Ends


- Customer profile has not been nailed down
- Sales & marketing fully staffed
- Sales misses numbers, Board gets concerned
- VP beats on the field troops to work harder
- Field troops improvise so the thrash factor increases escalating the “burn rate”
- Marketing makes up a new story to further confuse the sales force
- Morale plummets sales believes product can’t be sold – “No one wants to buy it!”
- VP Sales gets fired at next Board meeting
- New VP Sales in and Board fires VP Marketing
- Executive “death spiral” commenced as situation does not improve
- Board and investors start looking at replacing the CEO

# How it Should Work



# QUESTIONS

# ASSIGNMENT 2

# THANK YOU