Structured Settlement: From Astronauts to Space Independence

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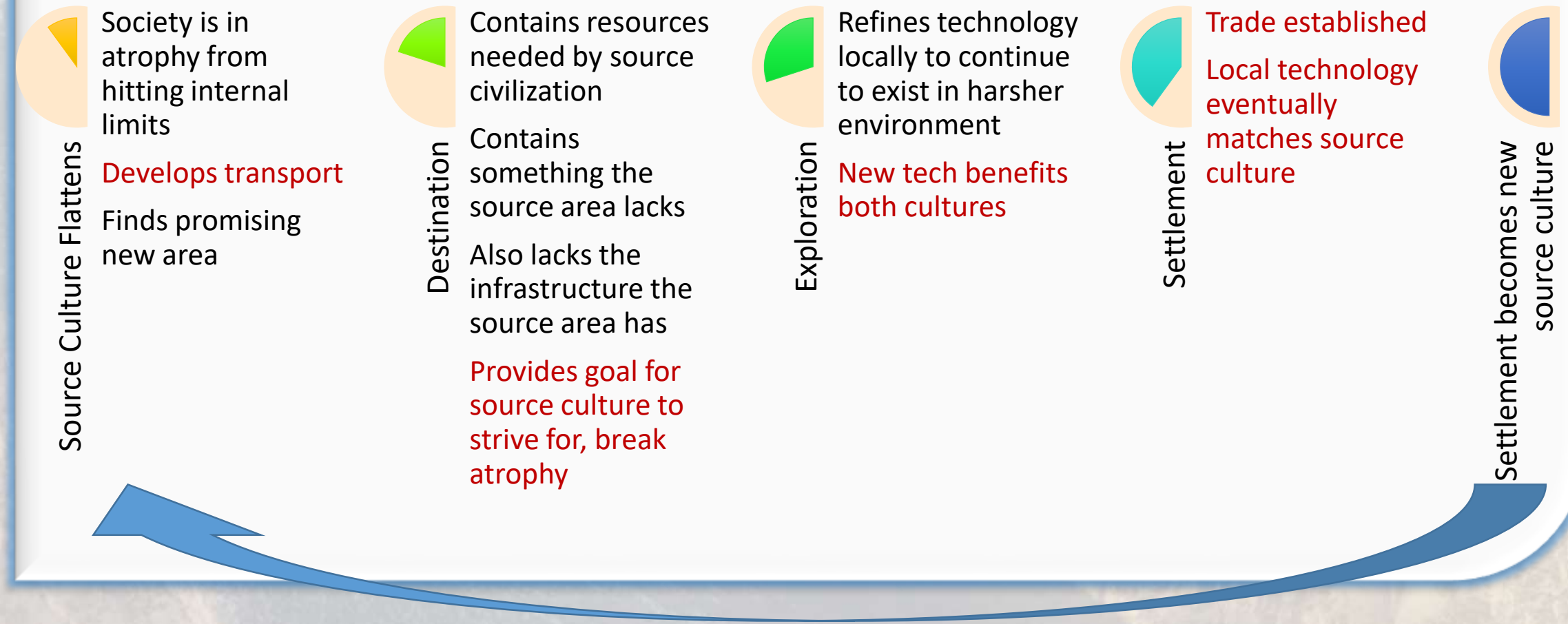
Settlement Loop

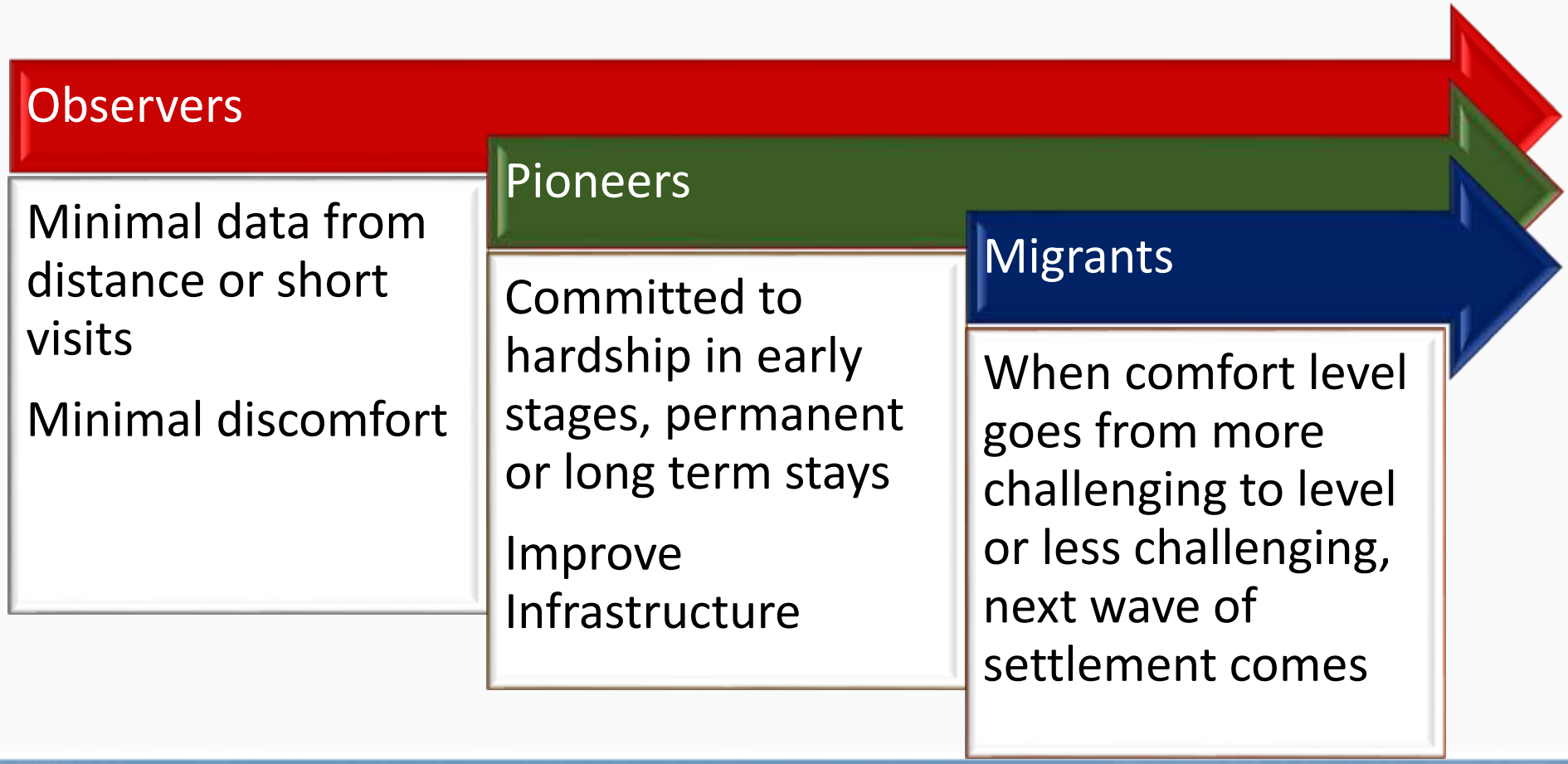


Space Settlement:

- **Space** – the harshest environment, most antithetical to life, that humans have experienced regularly and survived. Space contains almost nothing to give a living being any assistance in remaining a living being.
- **Settlement** – Moving from one habitat to another habitat, typically because of better living conditions in the new habitat.

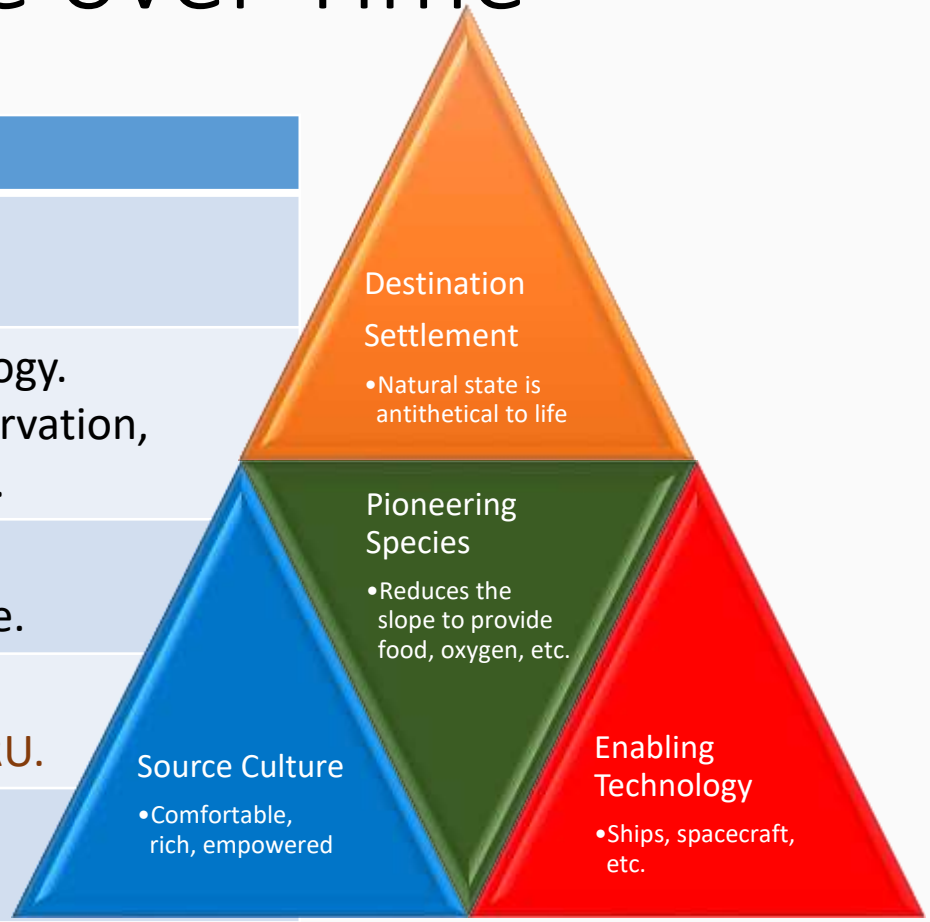
SEE THE PROBLEM???

The Hardship Bell Curve



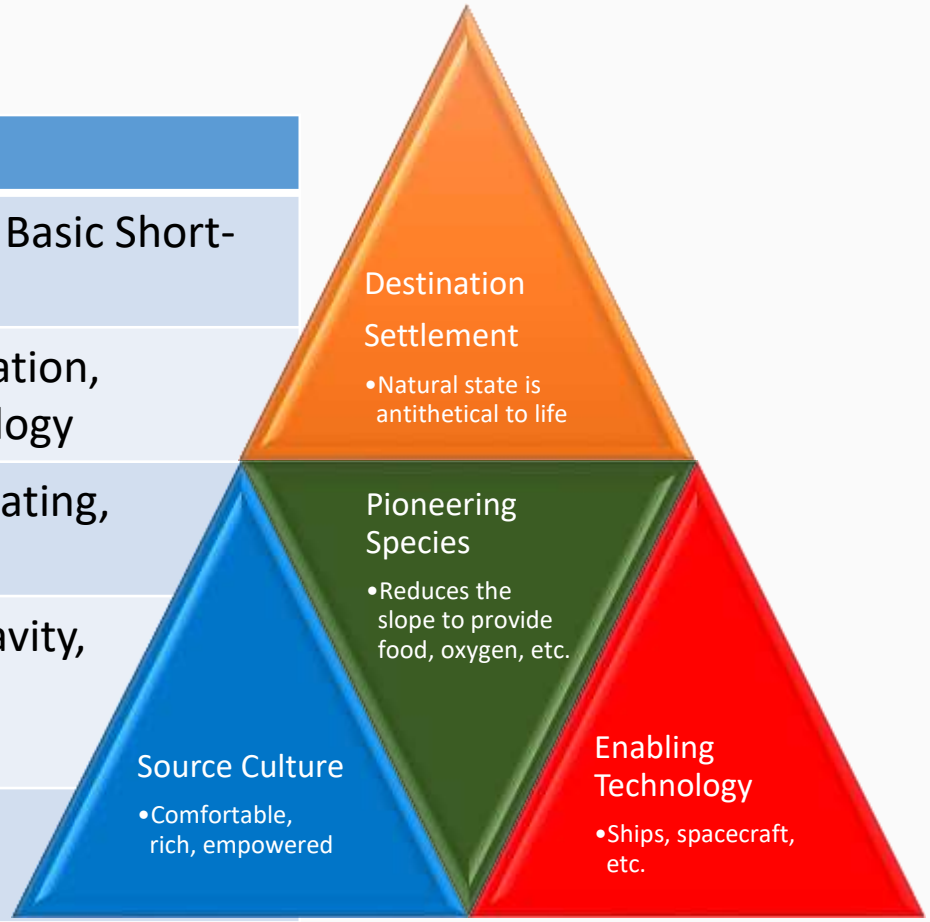
Settlement Slopes Increase over Time

Migration	Obstacles to Settlement
Africa > Eurasia	Colder temperatures, growing seasons. Invention of agriculture.
Europe > Americas	Thousands of miles of ocean, no technology. Expansion of ship technology, food preservation, technology trade and localized invention.
Polar Exploration	Lack of pioneering species, sunlight, etc. Expansion of hunting, greenhouses, trade.
Space Settlement	Lack of life, distance, energy. Affordable launch, local oxygen/food, ISRU.
Outer Planets	Lack of solar energy. Fission/fusion power, propulsion.



Settlement Benefits

Migration	Drive to Improve Technology
Africa > Eurasia	Clothing, Agriculture, Food Preservation, Basic Short-Range Trade, Cities.
Europe > Americas	Ships, Food Preservation, Printing, Navigation, Mathematics, Astronomy, Education, Biology
Polar Exploration	Power, Advanced Ships, Early Aircraft, Heating, Shelter, building in permafrost.
Space Settlement	Solar Power, Affordable Launch, Microgravity, Local technology, Food Preservation, Radiation shielding
Outer Planets	Fission/fusion power, propulsion, Advanced local sourcing of technology.



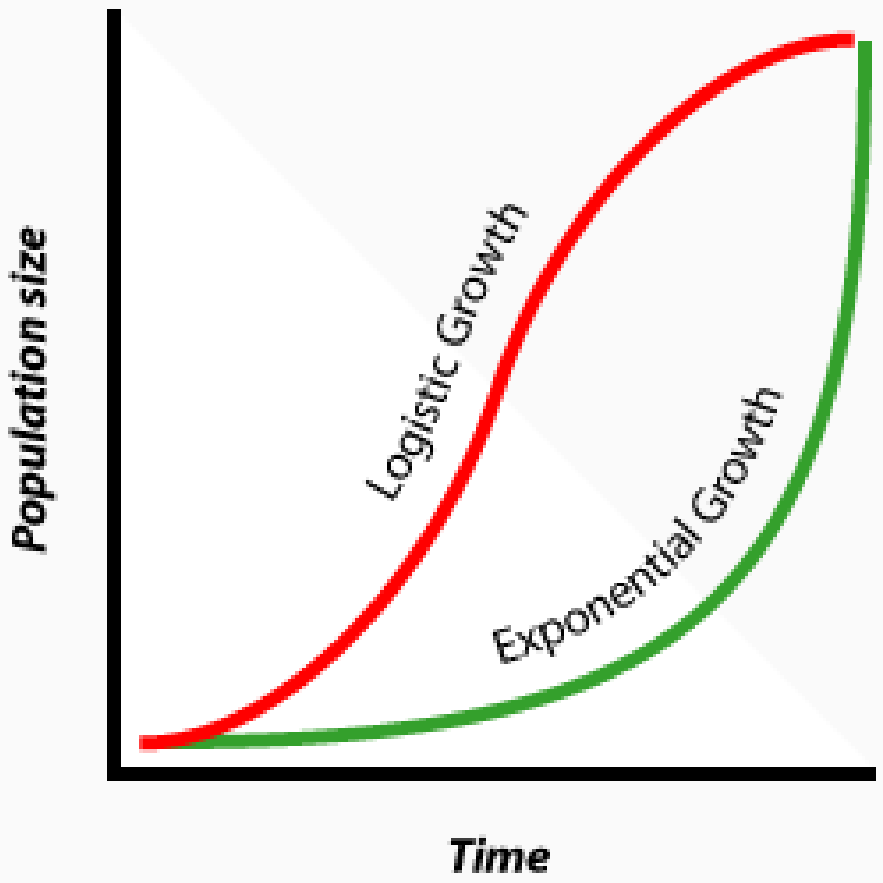
Technology Growth and History

Technology Revolutions

Time	Revolution	Enabling Technologies, People, and Transitions
1770-1830	Industrial Age	Hand made -> Machine made, Stationary steam power, Wood -> Coal Textiles, Iron, Metallurgy, Basic Chemistry, Machine tools, Gas lighting, Railroads
1829	Rail/Steam Age	Railroads, steam ships, heavy logistics.
1887-1914	Steel/Gas Age	Transitions from Iron -> Steel, Alloys, Gasoline, electricity, mechanized construction Telegraph, telephone, radio, automobile
1942-	Atomic Age	Scientists -> Government -> Industrial -> Medical
1944 -	Jet Age	Inventors -> Government -> Commercial-> Corporate/Private
1957 -	Space Age	Clubs -> Government -> Old Space -> New Space -> Cubesats
1970's -	Information Age	Mathematicians -> Government -> Corporate -> Personal -> Portable -> Cellular
Now	"Maker Age"	3D printing, Internet education/Sales/Collaboration/Finance
Starting	New Space Age	IT Successes -> Space tourism -> Space Stations -> Moon/Mars missions

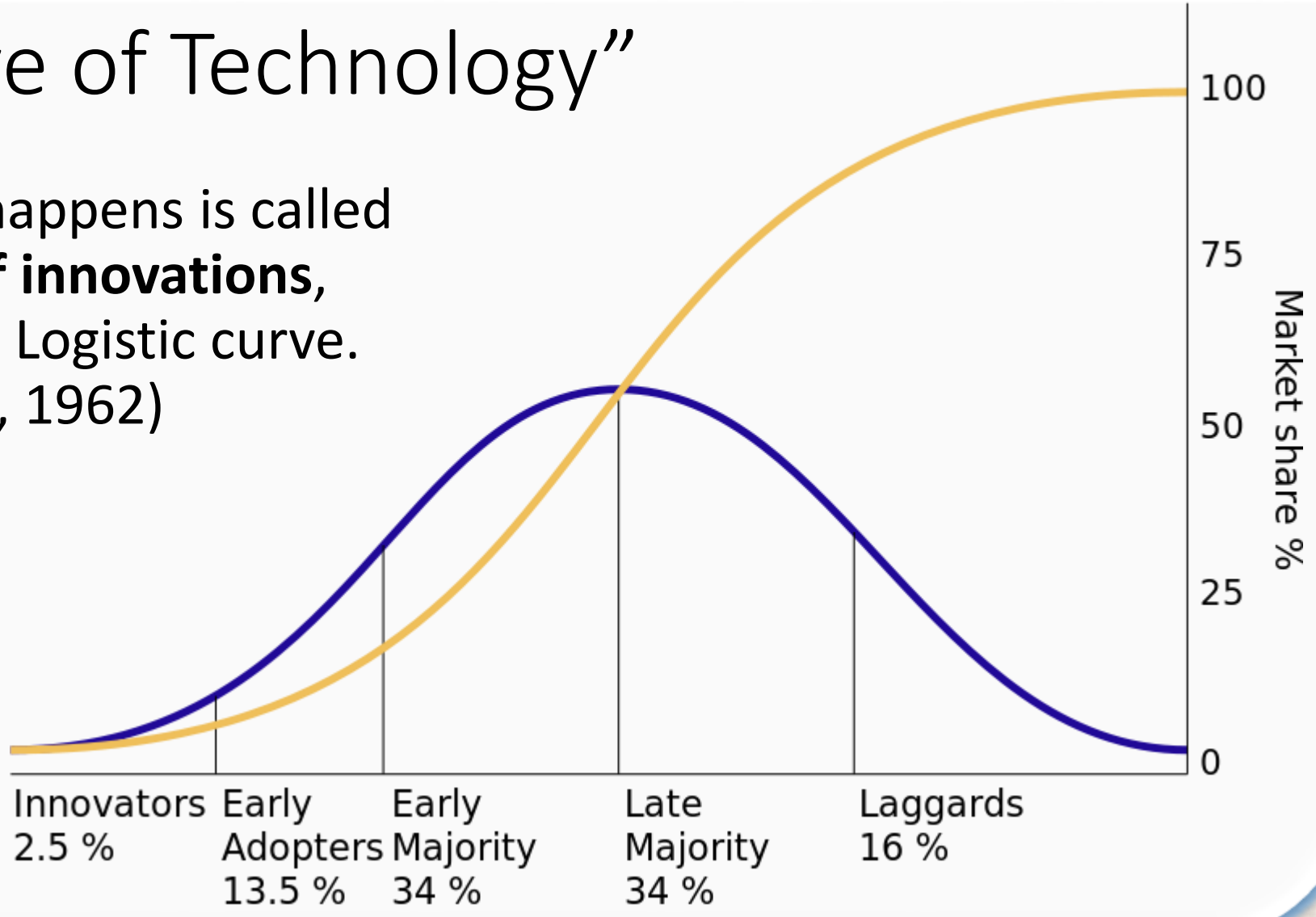
The “S Curve of Technology”

- The aerospace and early electronics revolutions were thought to be exponential.
- During the early space age, this lead to hope of fast solar system settlement.
- Had the curve continued, we would have hit light speed by the year 2010.



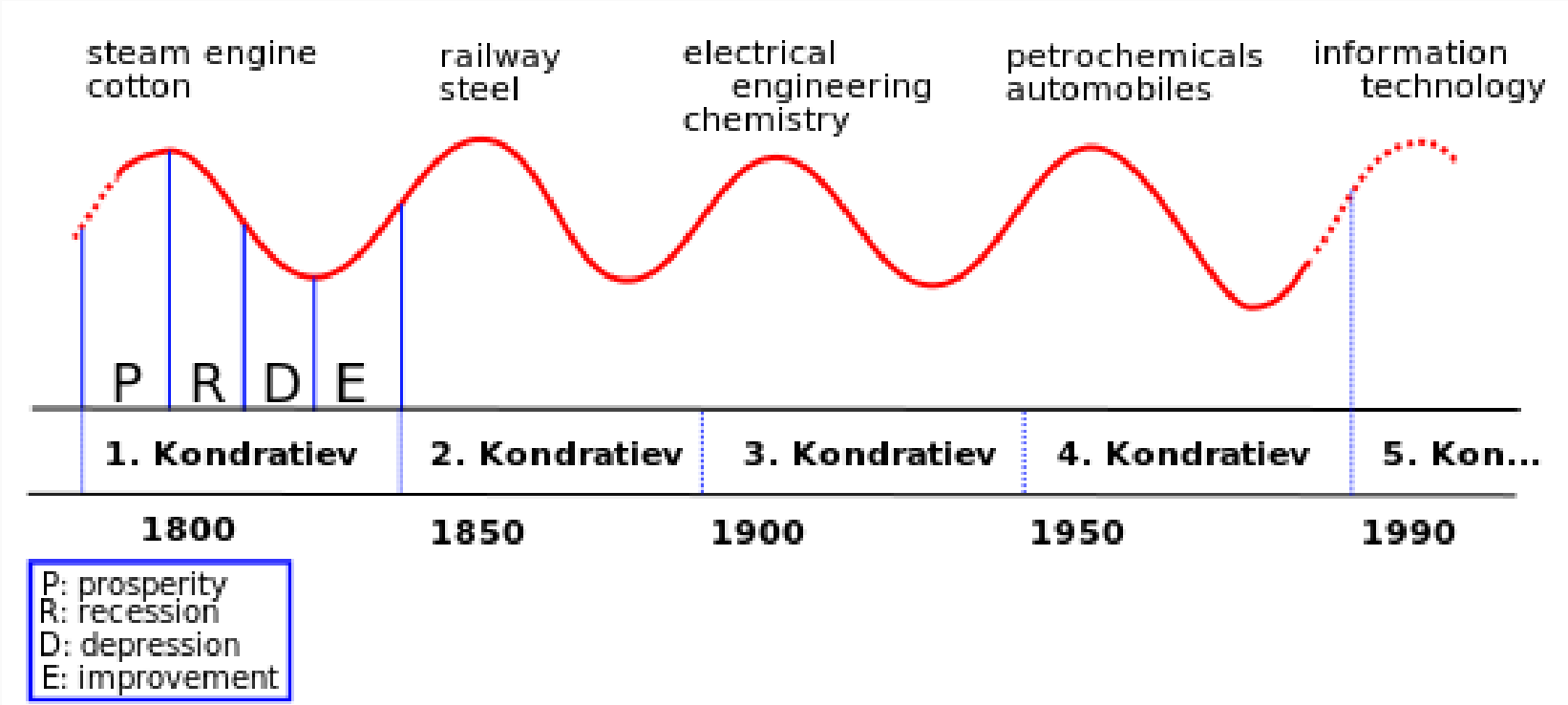
The “S Curve of Technology”

- What actually happens is called the **diffusion of innovations**, which follows a Logistic curve. (Everett Rogers, 1962)



The “S Curve of Technology”

- This was also predicted in 1925 by Nikolai Kondratiev, and are called Kondratieff Waves or K-Waves. Two Dutch economists proposed a similar effect in 1913.
- Next wave would be 2015-2035 if true



But Technology Itself Doesn't Cycle

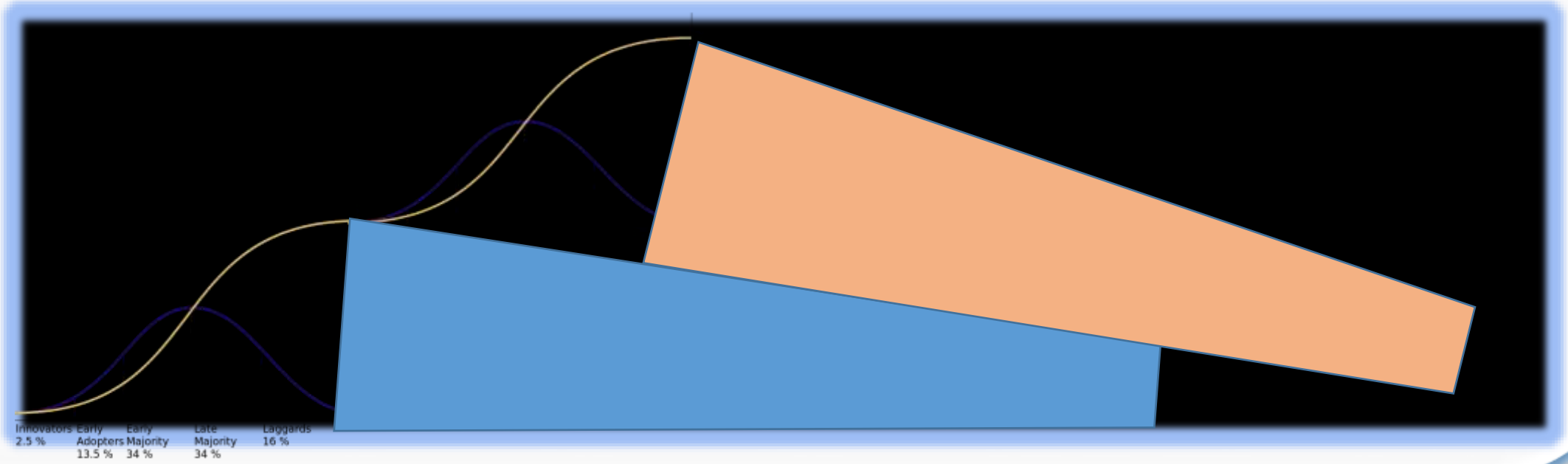
After the S Curve…

- Downward effect as old methods fall from common practice
  - Fewer people can ride a horse, make a vacuum tube, etc.
  - Risk of "technology trap" if knowledge not preserved.
- Upward effect as new methods applied to old technology
  - Advanced manufacturing for engines, etc.
- "Ubiquitous Vector" as prices drop, particularly with digital tech
  - Self-driving cars, 3D printers are what happens when $1000 computers become $10 computers (Secondary long frequency wave).
  - Technology still advances slowly in "Maker space" by hobbyists.

Curves become “wedges”, not cycles

The cumulative effect is new technology is stacked with older waves.

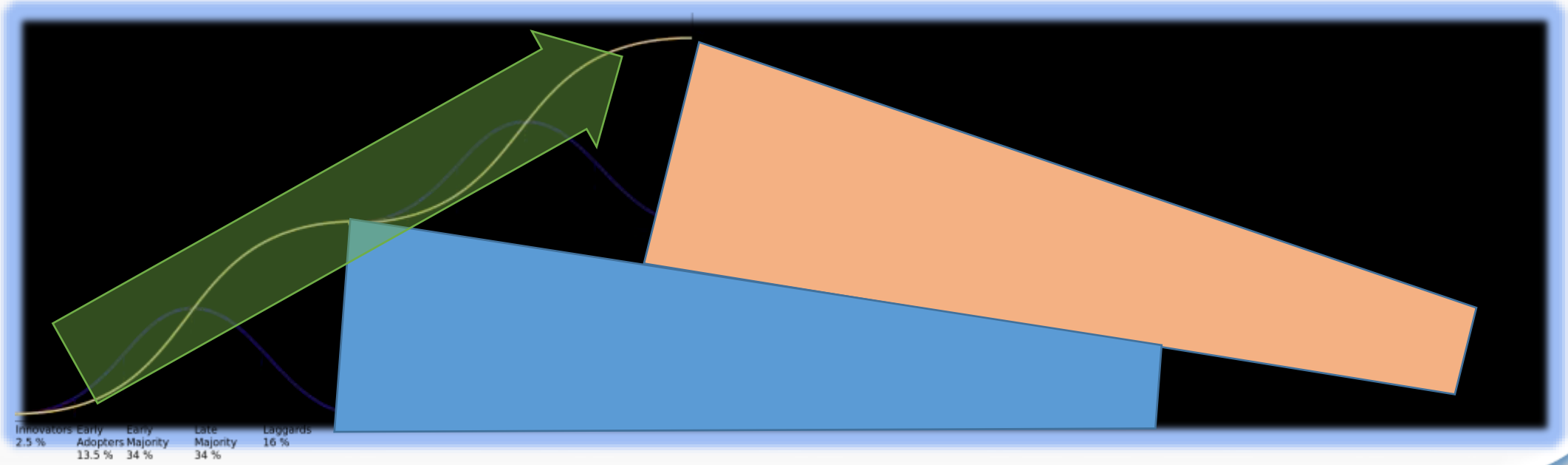
Older technologies slowly flatten until entirely replaced (steam engines, etc.) and enter collector/hobby space.



Investment Seeks Path of Least Resistance

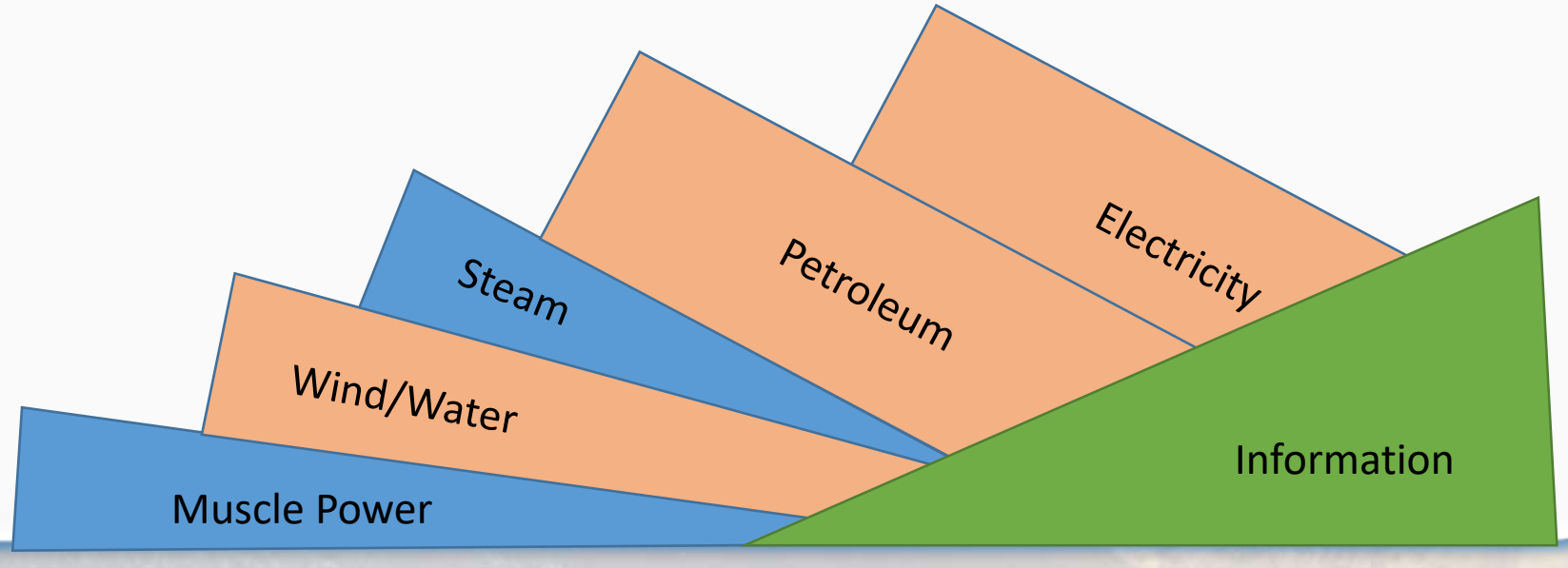
For investment to grow, needs to be focused on areas where invention is making new wealth out of ideas rather than commodities.

When a tech curve flattens, investment jumps to the next tech curve.



Types of Technology Waves/Wedges

- **Kinetic wedges** are power sources (energy or information)
  - Base wedges can go “extinct” if a new technology fully fills the niche.
- **Utilization wedges** are implementations (car, plane, rocket) of the power wedges
- Any kinetic wedge that does not go extinct can launch another Utilization wave.
  - A technology that continues to drop in price is not done innovating yet.

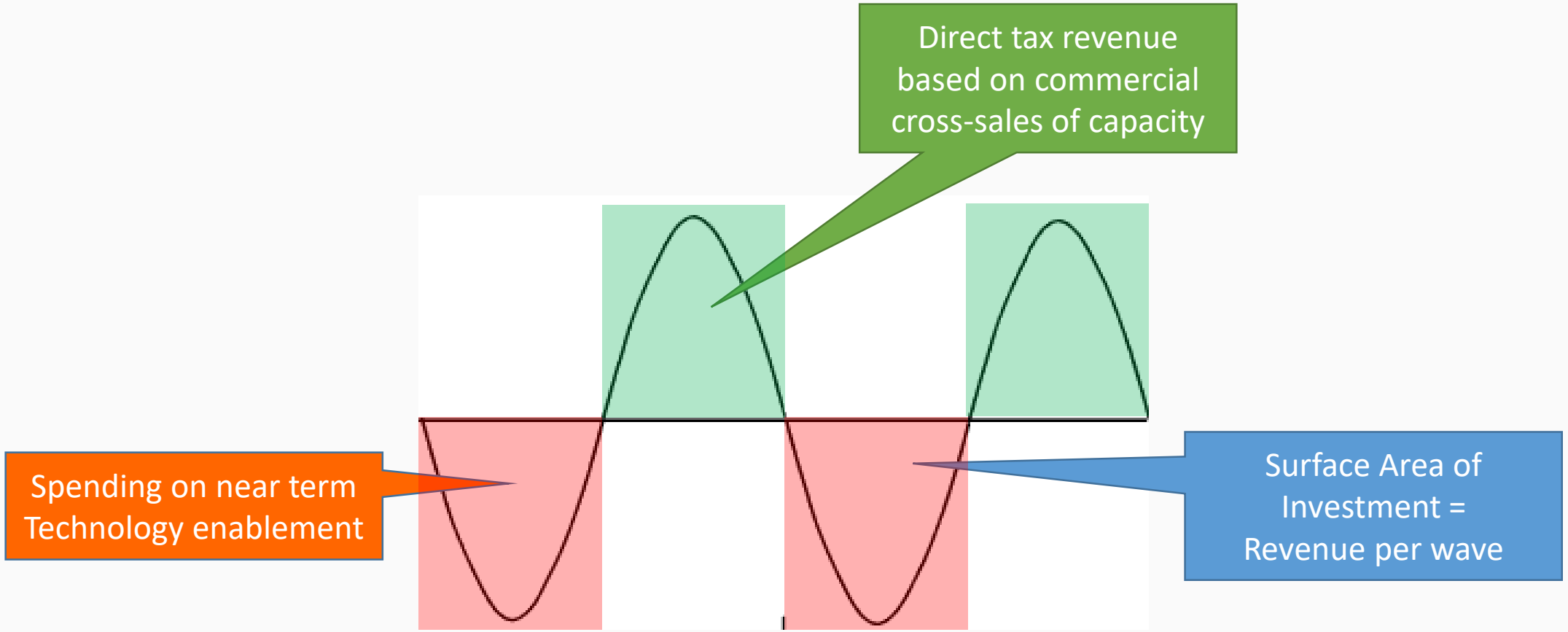


Energy Density Drives Technology

Energy Wedges	Utilization Wedges	Information
Human Power	Hunting, Gathering, Migration, Villages, Basic Farming, Textiles	Language
Animal Power	Farming, Roads, Cities, Travel, Mass Warfare, Writing, Trade	Math
Fire	Metallurgy, Basic Chemistry	Metallurgy
Wind Power	Ocean going vessels, Navigation	Navigation
Steam (Wood)	Fast transport on rail/oceans. Paddle-wheels/wood boats.	Telegraph
Steam (Coal)	Ironclad ships with screw propellers. Steel and other alloys.	Fast News
Petroleum (Kerosene)	Indoor lighting, advanced industrial chemistry of petroleum.	[Radio]
Electricity	Indoor lighting, Distributed mechanical/heat power.	Telephone
Petroleum (Gasoline)	Internal combustion, Cars, Aircraft, early rockets.	[Television]
Chemical Rockets	Moon landings, Solar system exploration, etc.	Satellites
Nuclear Power	Nuclear power plant, Submarines/Aircraft carriers, NERVA.	[Computers]

Government Investment

Investment Sine Wave Concept

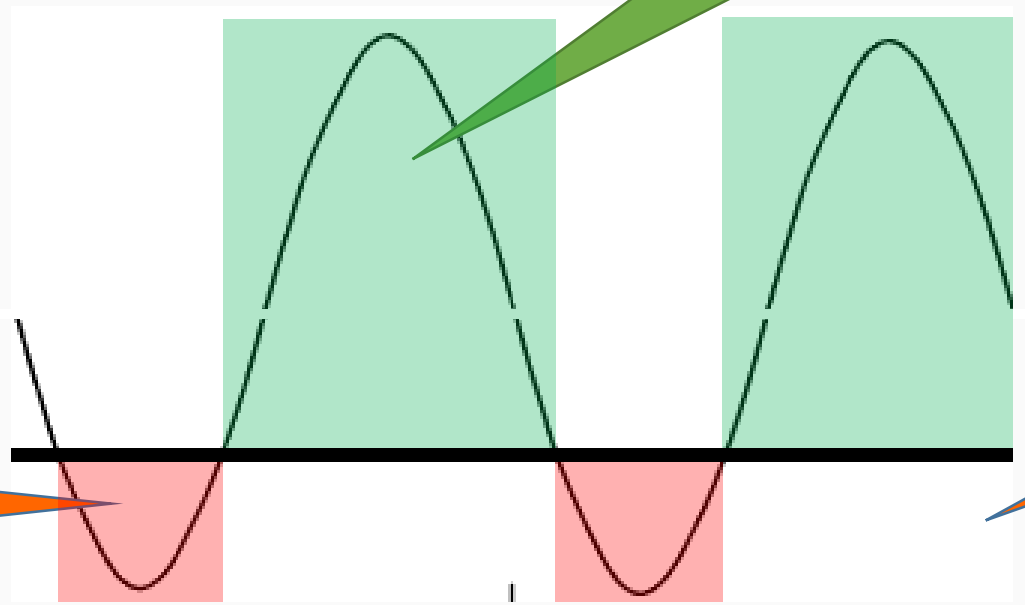


High Efficiency Wave

Revenue is much larger and lasts much longer than each spend

THIS is the financial and technological crossover of space independence

Spending can be eliminated once the industry is self-funded

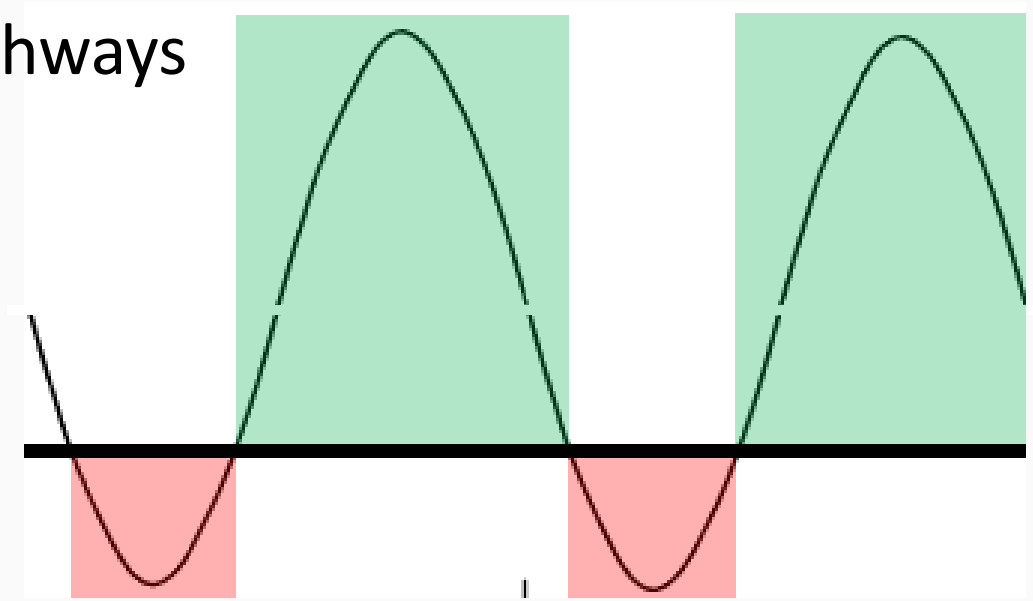


Spending is limited in time and volume

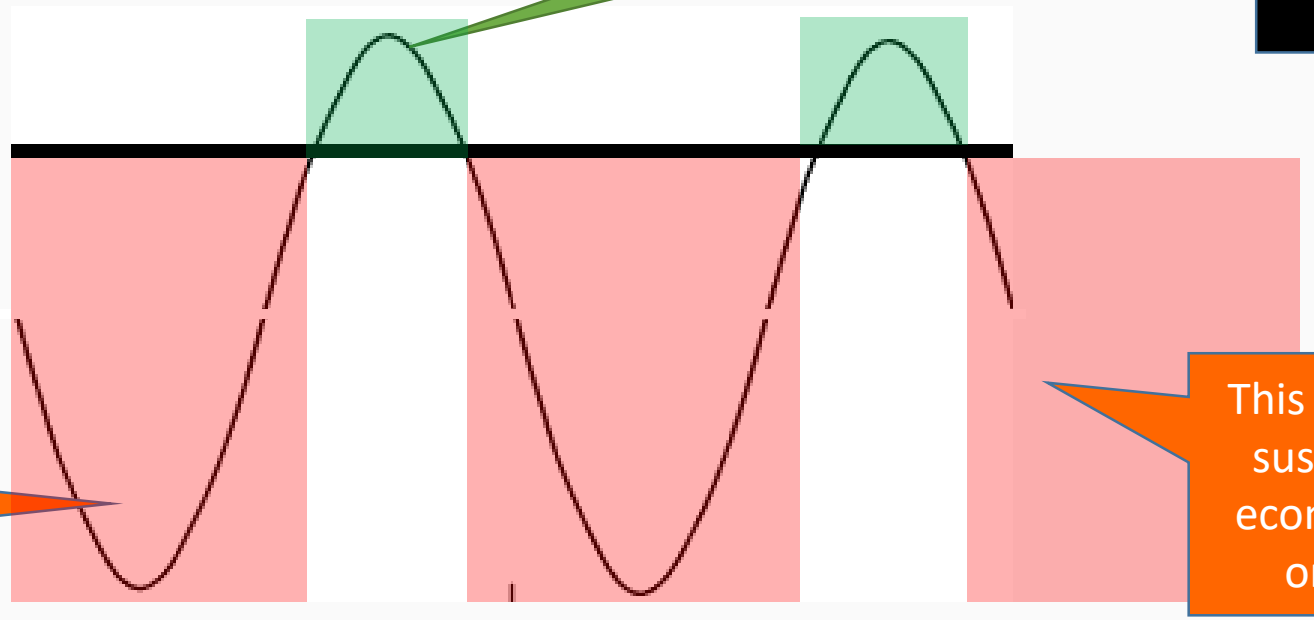
High Efficiency Wave

Where it has worked:

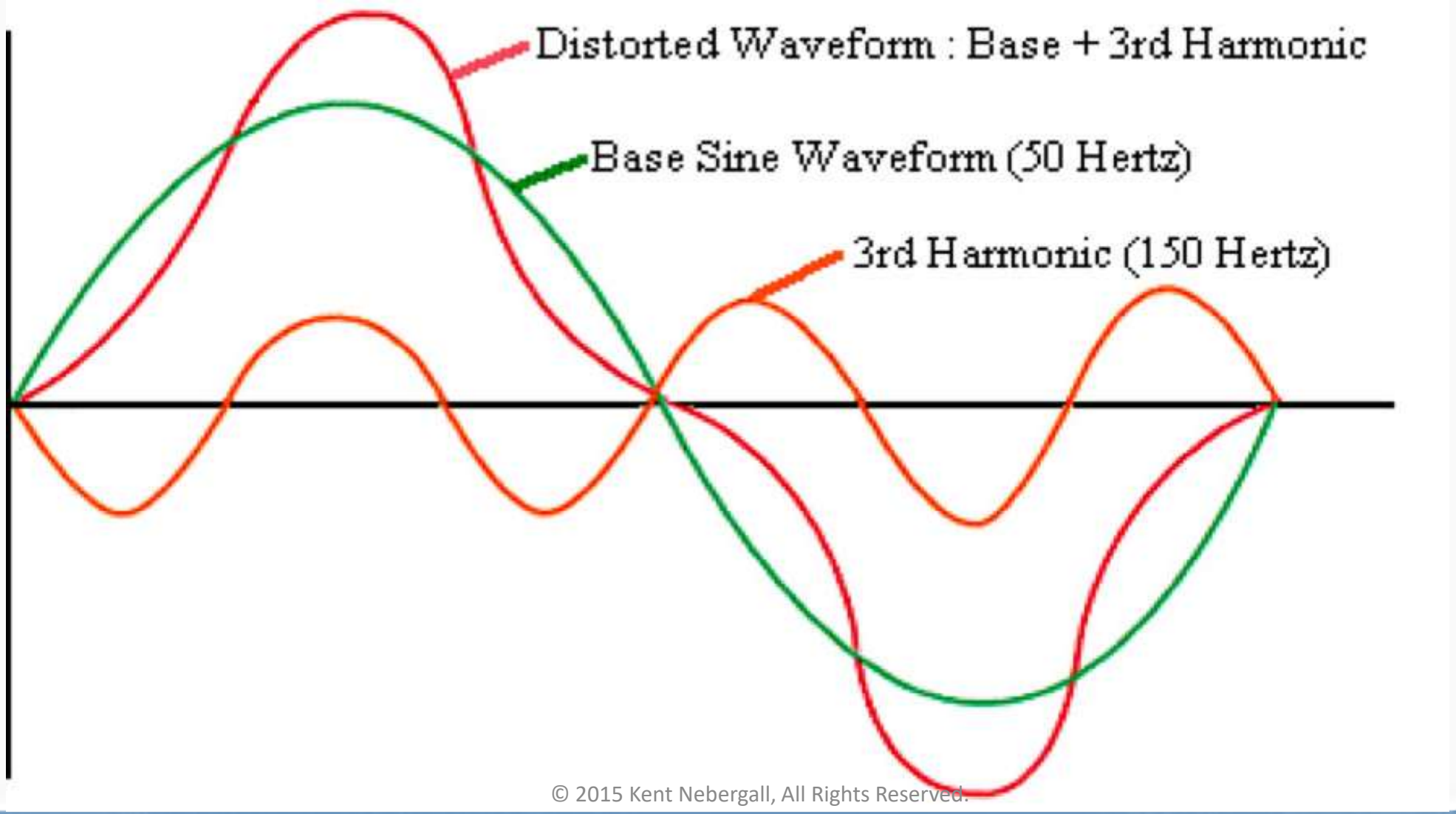
- NACA
- NASA (Apollo)
- Interstate Highways
- DARPA



Low Efficiency Wave (Cronyism/Mercantilism)



Dual Cycle Waves (Economic, Tech Investment)



Where Cronyism Comes From

Government (Source)	Crony/Political Actors	Object Response
Needs a new technical capacity for a goal	Receives massive investment to develop that technology	Public celebrates and is inspired by the new innovation.
Needs increased capacity in same range	Receives continued funding to push technical envelope	Rival governments build similar systems using similar methods.
Programs become self-driving constituencies	In 2-4 iterations, structure grows large enough to "create it's own weather"	System becomes a goal, not a means to a goal.
Public begins to notice the system is overpriced	Products end up overpriced to support the bloat (cost plus), not the mission.	Competitors realize they can make better systems for less money.
Vested political interests continue funding overpriced systems	Political actors use clout to lobby for regulation to cut out competition, arguing that it will "lower costs".	Corporate competitors cut costs and scale systems for efficiency, and move B list payload.

Killing the Feedback, Boosting the Volume

Government Role	Action	Restriction
Primary Research	Expand the definition of Feasible	Do not spend more than ~10 percent total
Needs a new technical capacity	Invest in new technology that is in the proper affordable/feasible zone. • Just beyond commercially self-funded • Just within fully-doable driven by primary research	Projects must have… • Beginning, middle, and end • Measurable results • Enable next wave technologies • Fixed price contracts or competitive "fly off" contracts to winners
Commercialize the last wave	• Use to expand information, trade, science, education. • Offer lab space to new competitors	• Demonstrate GAAP measurable value from previous wave • Tax revenue from commercialization of previous wave.
Seed for Next Wave	• Invest in engineering education, basic research prior to wave. • Repeat the loop.	• Restrict spending to match revenue. • As more waves come in, more investment possible.

Examples, Present and Possible

Government Role	Action	Restriction
Cargo to ISS	Fixed price per delivery (not launch)	Two active vendors
Crew to ISS	Fixed price per crew	Two active vendors.
BEAM to ISS	Simple short attached mission with crew access	Single mission, under 1 year, no follow-up.
Asteroid Sample Return	Planetary Resources and NASA discussed this.	Fixed budget eventually.
Red Dragon/ "Gray" Dragon/ Falcon Heavy	NASA could be broker to deliver instruments and power to moon/Mars	Limited by fixed budget, successful delivery, insurance, planetary protection.
Space Nuclear Power	Should commission/deliver self-contained reactors for deep space.	Bid on output. Use for ISPP, advanced probes, deep space work.
Deep Space Research Platform (Post-ISS)	Primary research on radiation, gravity, asteroid sample/geology, etc.	Commercial research on asteroid mining, microgravity manufacturing.

Questions?

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