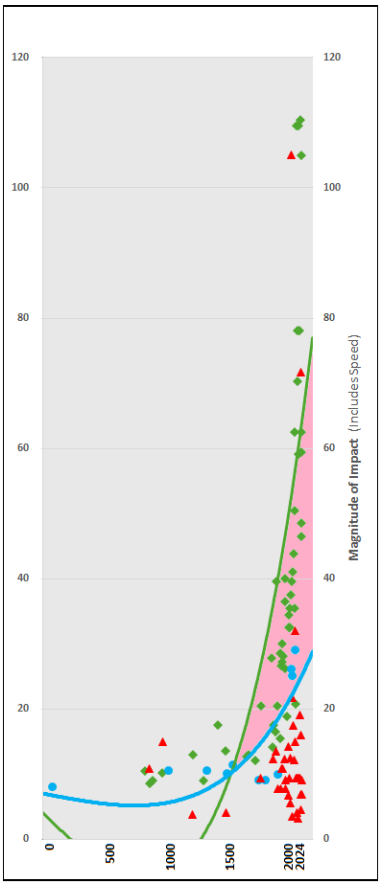
Image Generated by Flux1.ai

***Prompt**: "A moderately lit (from upper corner) female Arabic face in semi-profile, sad, crying with tears on cheeks, hand on lips, mid-thirties, with long black hair, set mid-distance against a bright detailed blue hue background comprising a mixture of DNA, legible computer programming code, uranium atoms and stray small planets. style: photorealistic."*

Bending the Blue Curve

HELPING HUMANITY MANAGE TECHNOLOGICAL DEVELOPMENT

Joe Chiarella | Bending the Blue Curve | September 9, 2024



"***When you can measure what you are speaking about, and express it in numbers, you know something about it.***" ~ **Lord Kelvin** (real name: William Thompson) in a lecture in **1883**.

"***Where there is great power, there is great responsibility.***" ~ **Winston Churchill** in his speech to the House of Commons in **1906**

"***We have to learn to think in a new way.***" This is often rephrased in popular culture as "*We cannot solve our problems with the same thinking we used when we created them.*" ~ **Albert Einstein** in the Russell-Einstein Manifesto of **1955**

"***Change is the process by which the future invades our lives, and it is important to look at it closely, not merely from the grand perspectives of history, but also from the vantage point of the living, breathing individuals who experience it.***" ~ **Alvin Toffler** in his **1970** book "Future Shock"

Table of Contents

Preamble

- Generative AI, and other technologies, were used in research and preparation of this paper.
- However, this human is the sole author of the content of this paper.

Audience: As I have been researching and writing, I've talked with many smart, informed, and thoughtful people. The first question they ask is "Who is your audience?" My answer: "*Everyone*… eventually."

However, initially this paper is meant for people who are in, or can influence, media, public policy, sources of capital and, most critically, makers of AI/AGI and other frontier technologies.

We are at a pivotal crossroad and our collective voice is crucial. So, please bring your creative thinking, collaborative spirit, and civil constructive comments and arguments to the discussion. (Extremism and emotionalism are not considered helpful.)

Pro-Tech: There are some who may claim that I am writing this because I am a neo-Luddite afraid of new technology. This is false and does not contribute to the topic.

I am a *fan* of Science, Technology, Engineering, Art, and Math (STEAM). I've enjoyed a successful lifetime career in tech. I've enthusiastically helped to build technology that hundreds of millions of people around the globe have used and companies have paid many millions of dollars to own. I've been awarded three US Patents. I still actively help to build Tech ecosystems. And for more than 40 years I've worked in civic circles from City Council to State Legislature, from non-profits to professional associations and academia. I am enthusiastically pro-tech and an actively engaged citizen who has a legitimate concern. I believe it is my responsibility to share that concern.

Bias: My bias is *vigorously and unapologetically* ***pro-humanity***. Only outcomes that respect and benefit humanity, and the dignity of the human person, are desirable to me. Your input is invited if you do, or if you don't, share this same bias.

Disclaimer: This paper sets forth a construct and a rubric for measuring several trends over a long period of time. A construct and rubric that is 80% right today, is far more useful to us than the construct and rubric that is 100% right 2 years from now. We don't have the luxury of debating it for years. The current model is rich enough that a few errors in model, item selection, weights, and scores will not significantly impact the big picture answer.

Acknowledgements: No effort of this depth and breadth happens in solitude. It would not exist without, first and foremost, the loving support of my amazing wife, Michele. For all the hours she actively listened to me while I thought kinetically through this content, I can only say "thank you." Others include Marty Schoffstall, Lester Strong and Paul Gates, not only for their unfailing support – but keen critical reasoning and patient sound boarding as I worked through so much of this content. And for their persistent encouragement: Jody Donatucci and Gerri Shettle.

Figures

ID	Figure Title	Description
Figure 1	The Techno-Socio Gap	This is the central figure of this paper. It shows the rapidly widening gap between the rate of technological developments and sociological developments. Also plotted are an accumulating collection of detriments/risks. The techno and socio developments are reduced to polynomial curves to show trends. It plots a total of 145 data points (derived from 655 inputs) in four categories: Technological and Sociological Developments, Known Detriments and Identified Risks. These are plotted along a 12,000 year timeline on the X-Axis with a Magnitude of Impact score on the Y-Axis.
Figure 2	The Emerging Technologies Map	This figure is also central to this paper. It shows the depth, breadth and interconnectivity between technologies that are currently rapidly advancing. There are six significant categories of emerging technologies with 65 subcategories. The map also shows 44 connections between various subcategories. Finally, it shows eight termination points that could be existential risks.
Table 1	Technological Developments	This table shows the 380 inputs to compute the magnitude of impact score for the 76 technological developments identified for the 12,000 year period of the study.
Table 2	Sociological Developments	This table shows the 75 inputs to compute the magnitude of impact score for the 25 sociological developments identified for the 12,000 year period of the study.
Table 3	Known Detriments	This table shows the three inputs to score the 10 known detriments of past technological developments.
Table 4	Identified Risks	This table shows the five inputs to score the 34 identified risks of past and present technological developments.

Note: Appendix B – Construct and Rubrics – explains the selection and scoring methodology that gave rise to the Techno-Socio Gap chart.

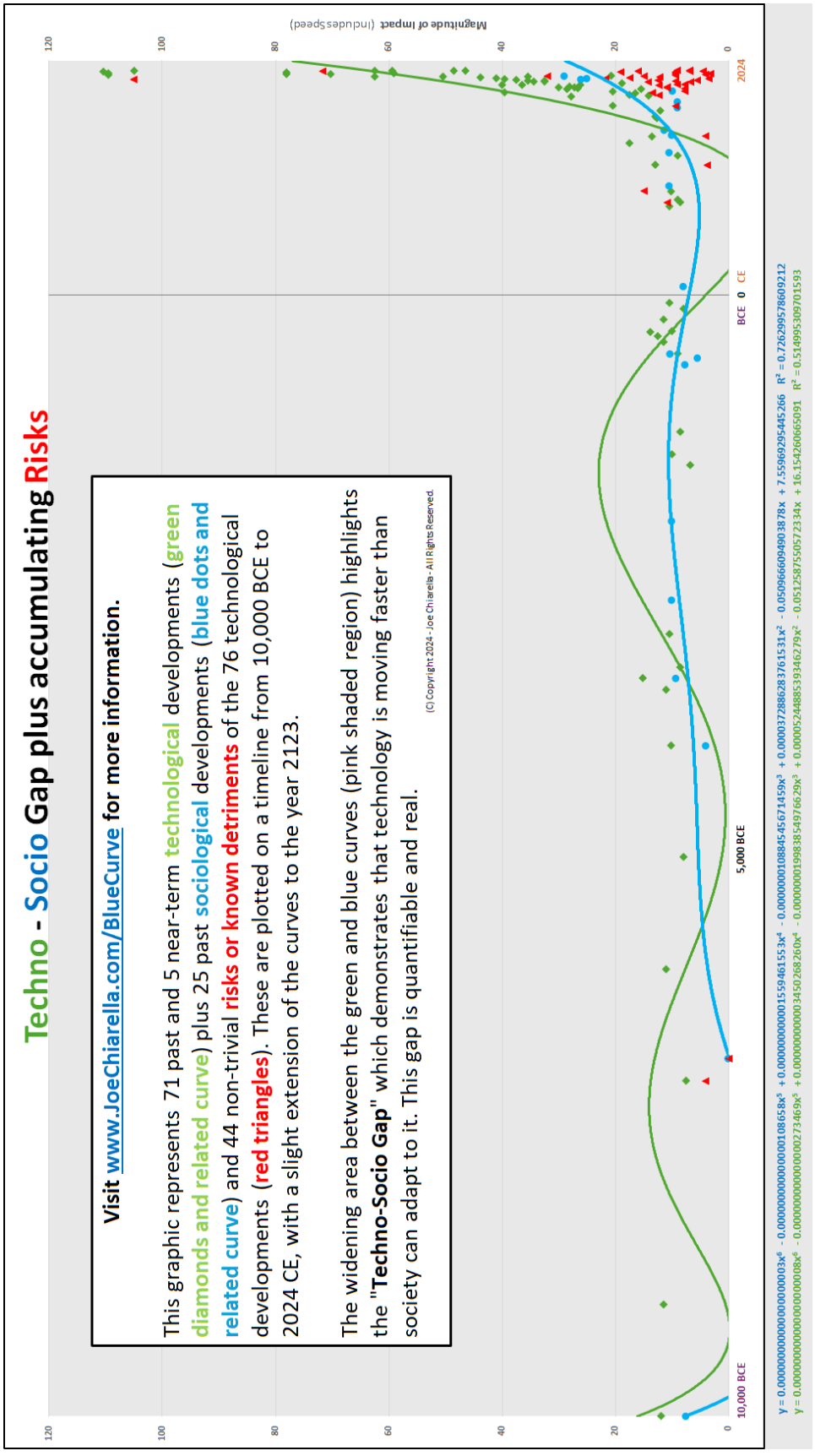


Figure 1 - The Techno-Socio Gap

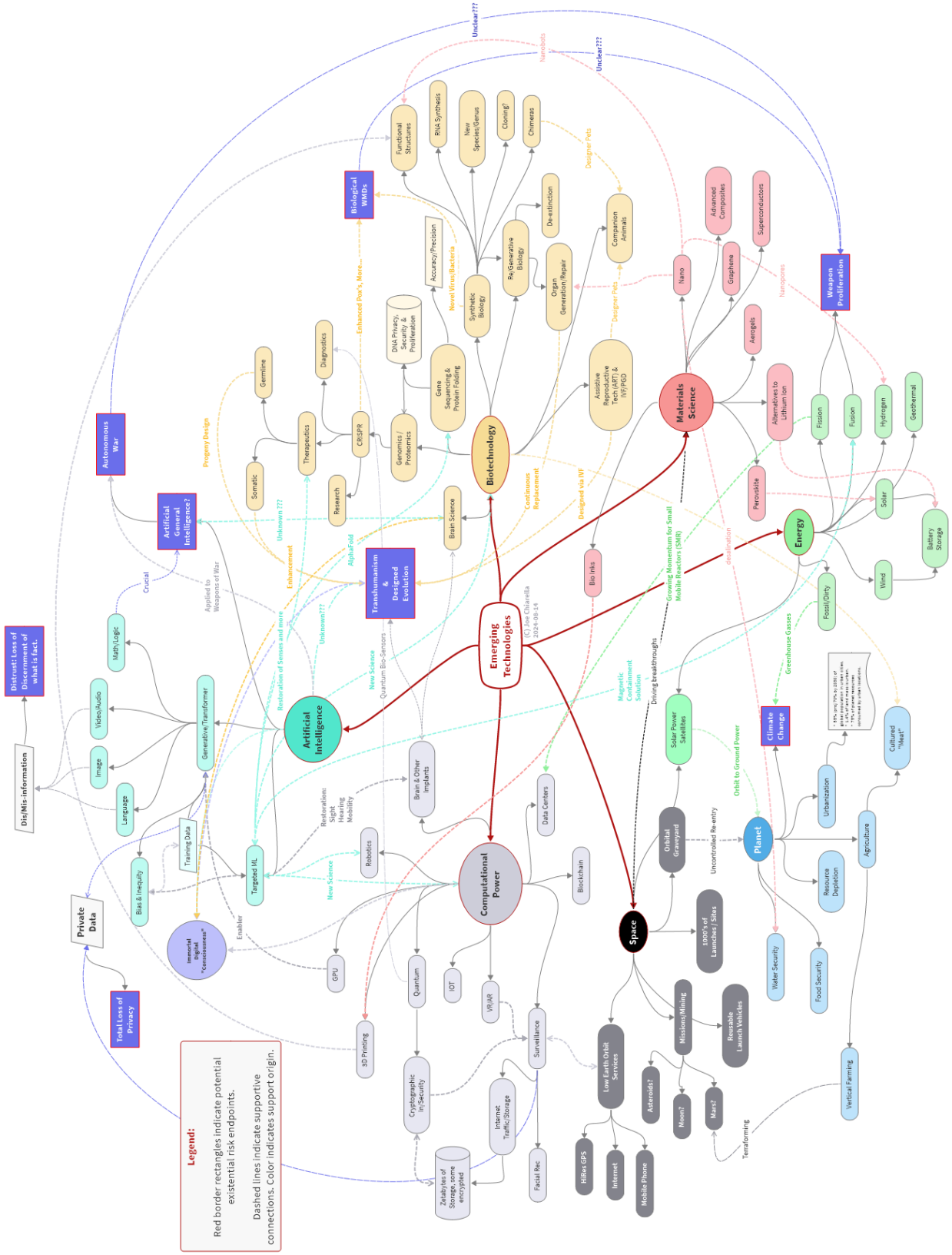


Figure 2 - The Emerging Technologies Map

Table 1 - Technological Developments

	BCE vs CE	Linear Years	Technological Development	Area	Impact Measures (Y-Axis)													
					Societal Impact		Complexity		Centrality to Life		Human Impact		Speed	Yrs: 50%	Total
1	-10000	0	**Agriculture**	Food	Transformational	3	Specialized	0.5	Essential	4	Longevity + Quality	4	0.50	2000	12.0
2	-9000	1000	**Mudbricks**	Shelter	Transformational	3	Specialized	0.5	Integral	2	Longevity + Quality	4	2.00	500	11.5
3	-7000	3000	**Alcohol**	Other	Influential	2	Specialized	0.5	Peripheral	1	Quality	2	2.00	500	7.5
4	-6000	4000	**Irrigation**	Food	Influential	2	Interdiscipline	1	Integral	2	Longevity + Quality	4	2.00	500	11.0
5	-5000	5000	**Copper**	Other	Influential	2	Specialized	0.5	Peripheral	1	Quality	2	2.50	400	8.0
6	-4000	6000	**Sailing**	Transport	Transformational	3	Multidiscipline	1.5	Peripheral	1	Improve Access to Others	3	1.67	600	10.2
7	-3500	6500	**Wheel**	Transport	Transformational	3	Specialized	0.5	Integral	2	Improve Access to Others	3	2.50	400	11.0
8	-3400	6600	**Writing**	Relation/Comm	Transformational	3	Interdiscipline	1	Essential	4	Species Change	6	1.25	800	15.3
9	-3300	6700	**Bronze**	Other/Multiple	Influential	2	Interdiscipline	1	Peripheral	1	Quality	2	2.50	400	8.5
10	-3000	7000	**Plow**	Food	Incremental	1	Interdiscipline	1	Integral	2	Longevity + Quality	4	2.50	400	10.5
11	-3000	7000	**Concrete**	Shelter	Influential	2	Interdiscipline	1	Peripheral	1	Quality	2	0.33	3000	6.3
12	-1500	8500	**Sundial**	Other/Multiple	Influential	2	Specialized	0.5	Peripheral	1	Quality	2	1.25	800	6.8
13	-1400	8600	**Glass**	Other/Multiple	Influential	2	Interdiscipline	1	Peripheral	1	Convenience	1	5.00	200	10.0
14	-1200	8800	**Iron**	Other/Multiple	Influential	2	Interdiscipline	1	Peripheral	1	Quality	2	2.50	400	8.5
15	-500	9500	**Pythagorean Theorem**	Other/Multiple	Transformational	3	Specialized	0.5	Peripheral	1	Quality	2	2.50	400	9.0
16	-400	9600	**Wheel and Axel**	Transport	Transformational	3	Interdiscipline	1	Integral	2	Improve Access to Others	3	2.50	400	11.5
17	-350	9650	**Gears**	Other/Multiple	Transformational	3	Multidiscipline	1.5	Integral	2	Quality	2	4.00	250	12.5
18	-312	9688	**Aquaducts**	Food	Transformational	3	Multidiscipline	1.5	Integral	2	Longevity + Quality	4	3.33	300	13.8
19	-300	9700	**Euclidean Geometry**	Other/Multiple	Transformational	3	Specialized	0.5	Integral	2	Quality	2	2.50	400	10.0
20	-200	9800	**Paper**	Relation/Comm	Transformational	3	Interdiscipline	1	Integral	2	Improve Access to Others	3	2.50	400	11.5
21	-100	9900	**Compass**	Transport	Expansion	2	Interdiscipline	1	Peripheral	1	Improve Access to Others	3	1.00	1000	8.0
22	-50	9950	**Nails**	Shelter	Influential	2	Specialized	0.5	Integral	2	Convenience	1	5.00	200	10.5
23	815	10815	**Algebra**	Other/Multiple	Transformational	3	Interdiscipline	1	Integral	2	Quality	2	2.50	400	10.5
24	850	10850	**Gunpowder**	Other/Multiple	Transformational	3	Interdiscipline	1	Peripheral	1	Convenience	1	2.50	400	8.5
25	876	10876	**Zero**	Other/Multiple	Influential	2	Specialized	0.5	Integral	2	Quality	2	2.50	400	9.0
26	950	10950	**Windmill**	Energy	Influential	2	Multidiscipline	1.5	Peripheral	1	Longevity + Quality	4	1.67	600	10.2
27	1185	11185	**Chimney**	Other/Multiple	Influential	2	Specialized	0.5	Essential	4	Longevity + Quality	4	2.50	400	13.0
28	1268	11268	**Magnifying Glass**	Other/Multiple	Incremental	1	Interdiscipline	1	Peripheral	1	Convenience	1	5.00	200	9.0
29	1380	11380	**Mechanical Clock**	Other/Multiple	Influential	2	Multidiscipline	1.5	Integral	2	Quality	2	10.00	100	17.5
30	1440	11440	**Printing Press**	Relation/Comm	Transformational	3	Multidiscipline	1.5	Integral	2	Quality	2	5.00	200	13.5
31	1603	11603	**Telescope**	Other/Multiple	Influential	2	Interdiscipline	1	Peripheral	1	Quality	2	6.67	150	12.7
32	1620	11620	**Microscope**	Health	Influential	2	Interdiscipline	1	Peripheral	1	Longevity + Quality	4	5.00	200	13.0
33	1666	11666	**Calculus**	Other/Multiple	Influential	2	Specialized	0.5	Peripheral	1	Quality	2	6.67	150	12.2
34	1712	11712	**Steam Engine**	Energy	Transformational	3	Multidiscipline	1.5	Integral	2	Longevity + Quality	4	10.00	100	20.5
35	1796	11796	**Vaccines**	Health	Transformational	3	Multidiscipline	1.5	Essential	4	Species Change	6	13.33	75	27.8
36	1800	11800	**Battery**	Energy	Influential	2	Multidiscipline	1.5	Integral	2	Quality	2	6.67	150	14.2
37	1808	11808	**Atomic Theory**	Energy	Transformational	3	Multidiscipline	1.5	Peripheral	1	Quality	2	10.00	100	17.5
38	1826	11826	**Photography**	Other/Multiple	Influential	2	Multidiscipline	1.5	Peripheral	1	Quality	2	10.00	100	16.5
39	1830	11830	**Electricity**	Energy	Transformational	3	Multidiscipline	1.5	Essential	4	Longevity + Quality	4	27.03	37	39.5
40	1844	11844	**Telegraph**	Relation/Comm	Expansion	2	Interdiscipline	1	Integral	2	Improve Access to Others	3	12.50	80	20.5
41	1863	11863	**Pasteurization**	Health	Influential	2	Specialized	0.5	Essential	4	Longevity	2	20.00	50	28.5
42	1865	11865	**Periodic Table**	Other/Multiple	Influential	2	Specialized	0.5	Peripheral	1	Quality	2	10.00	100	15.5
43	1869	11869	**Telephone**	Relation/Comm	Expansion	2	Interdiscipline	1	Essential	4	Improve Access to Others	3	16.67	60	26.7
44	1876	11876	**Internal Combustion**	Transport	Influential	2	Multidiscipline	1.5	Essential	4	Improve Access to Others	3	16.67	60	27.2
45	1879	11879	**Electric Light**	Other/Multiple	Transformational	3	Interdiscipline	1	Essential	4	Quality	2	20.00	50	30.0
46	1885	11885	**Automobile**	Transport	Transformational	3	Multidiscipline	1.5	Essential	4	Improve Access to Others	3	16.67	60	28.2
47	1898	11898	**Plastics**	Other/Multiple	Transformational	3	Specialized	0.5	Essential	4	Longevity + Quality	4	25.00	40	36.5
48	1901	11901	**Radio**	Relation/Comm	Transformational	3	Multidiscipline	1.5	Essential	4	Improve Access to Others	3	28.57	35	40.1
49	1903	11903	**Airplane**	Transport	Transformational	3	Multidiscipline	1.5	Integral	2	Improve Access to Others	3	16.67	60	26.2
50	1915	11915	**Relativity**	Other/Multiple	Influential	2	Specialized	0.5	Peripheral	1	Quality	2	13.33	75	18.8
51	1926	11926	**Rocketry**	Other/Multiple	Transformational	3	Multidiscipline	1.5	Integral	2	Improve Access to Others	3	25.00	40	34.5
52	1927	11927	**Television**	Relation/Comm	Expansion	2	Multidiscipline	1.5	Integral	2	Quality	2	25.00	40	32.5
53	1937	11937	**Digital Computers**	Other/Multiple	Transformational	3	Multidiscipline	1.5	Essential	4	Longevity + Quality	4	20.00	50	32.5
54	1938	11938	**Nuclear Fission**	Energy	Transformational	3	Multidiscipline	1.5	Integral	2	Longevity + Quality	4	25.00	40	35.5
55	1942	11942	**Penicillin**	Health	Transformational	3	Multidiscipline	1.5	Essential	4	Longevity + Quality	4	25.00	40	37.5
56	1952	11952	**Transistor**	Other/Multiple	Influential	2	Interdiscipline	1	Essential	4	Longevity + Quality	4	28.57	35	39.6
57	1957	11957	**Space Satellites**	Other/Multiple	Transformational	3	Multidiscipline	1.5	Essential	4	Longevity + Quality	4	28.57	35	41.1
58	1970	11970	**Public Key Crypto**	Other/Multiple	Transformational	3	Specialized	0.5	Essential	4	Improve Access to Others	3	33.33	30	43.8
59	1971	11971	**Microprocessors**	Other/Multiple	Transformational	3	Multidiscipline	1.5	Essential	4	Longevity + Quality	4	50.00	20	62.5
60	1974	11974	**Magnetic Resonance Imaging**	Health	Transformational	3	Multidiscipline	1.5	Integral	2	Longevity + Quality	4	40.00	25	50.5
61	1977	11977	**DNA Sequencing**	Other/Multiple	Transformational	3	Multidiscipline	1.5	Integral	2	Longevity + Quality	4	25.00	40	35.5
62	1981	11981	**Quantum Computer**	Other/Multiple	Transformational	3	Specialized	0.5	Peripheral	1	Improve Access to Others	3	13.33	75	20.8
63	1986	11986	**Mobile Phones**	Relation/Comm	Transformational	3	Multidiscipline	1.5	Integral	2	Improve Access to Others	3	100.00	10	109.5
64	1993	11993	**Consumer GPS**	Relation/Comm	Transformational	3	Multidiscipline	1.5	Essential	4	Improve Access to Others	3	66.67	15	78.2
65	1995	11995	**Internet**	Relation/Comm	Transformational	3	Multidiscipline	1.5	Essential	4	Improve Access to Others	3	58.82	17	70.3
66	2004	12004	**Social Media**	Relation/Comm	Transformational	3	Multidiscipline	1.5	Integral	2	Improve Access to Others	3	100.00	10	109.5
67	2007	12007	**Smart Mobile Devices**	Relation/Comm	Transformational	3	Multidiscipline	1.5	Essential	4	Improve Access to Others	3	47.62	21	59.1
68	2012	12012	**CRISPR**	Health	Transformational	3	Multidiscipline	1.5	Peripheral	1	Species Change	6	66.67	15	78.2
69	2017	12017	**Deep Learning (AI)**	Other/Multiple	Transformational	3	Multidiscipline	1.5	Integral	2	Longevity + Quality	4	100.00	10	110.5
70	2022	12022	**Transformers (AI)**	Other/Multiple	Transformational	3	Multidiscipline	1.5	Integral	2	Longevity + Quality	4	166.67	6	177.2
71	2024	12024	**Neural Implants**	Health	Transformational	3	Multidiscipline	1.5	Integral	2	Quality	2	40.00	25	48.5
72	2025	12025	**Thermal Batteries**	Energy	Influential	2	Interdiscipline	1	Peripheral	1	Convenience	1	100.00	10	105.0
73	2025	12025	**Gene-Editing Therapies**	Health	Transformational	3	Multidiscipline	1.5	Integral	2	Longevity + Quality	4	50.00	20	60.5
74	2026	12026	**Humanoid Robots**	Other/Multiple	Influential	2	Multidiscipline	1.5	Integral	2	Convenience	1	40.00	25	46.5
75	2027	12027	**Organ Generation**	Health	Transformational	3	Multidiscipline	1.5	Essential	4	Longevity + Quality	4	50.00	20	62.5
76	2028	12028	**Quantum Biosensors**	Health	Influential	2	Multidiscipline	1.5	Integral	2	Longevity + Quality	4	50.00	20	59.5

Table 2 - Sociological Developments

	BCE vs CE	Linear Years	Societal Development	Magnitude of Impact: Societal Impact		Development in Human:		Speed	Yrs: 50%	Total
1	-10000	0	Agriculture	Transformational	3	Survivability	4	0.5000	2000	7.5
2	-4000	6000	Birth of Urban Centers	Influential	2	Industry/Productivity	1	1.0000	1000	4.0
3	-3500	6600	Writing	Transformational	3	Flourishment	5	1.2500	800	9.3
4	-2700	7300	Monarchies	Transformational	3	Governance	2	5.0000	200	10.0
5	-2000	8000	Legal Systems	Transformational	3	Justice	3	4.0000	250	10.0
6	-600	9400	Religious Movements	Transformational	3	Justice	3	1.6667	600	7.7
7	-539	9461	Human Rights Movement	Influential	2	Justice	3	0.4545	2200	5.5
8	-500	9500	Philosophical Thought	Influential	2	Flourishment	5	3.3333	300	10.3
9	-500	9500	Birth of Democracy	Transformational	3	Governance	2	5.0000	200	10.0
10	100	10100	Global/Cultural Trade	Influential	2	Industry/Productivity	1	5.0000	200	8.0
11	1000	11000	Universities & Systematic Study	Transformational	3	Flourishment	5	2.5000	400	10.5
12	1300	11300	Renaissance	Transformational	3	Flourishment	5	2.5000	400	10.5
13	1450	11450	Spread of Literacy	Transformational	3	Flourishment	5	2.0000	500	10.0
14	1500	11500	Scientific Revolution	Transformational	3	Flourishment	5	3.3333	300	11.3
15	1700	11700	Industrial Revolution	Transformational	3	Industry/Productivity	1	5.0000	200	9.0
16	1700	11700	Rise of Secularism	Influential	2	Governance	2	5.0000	200	9.0
17	1750	11750	Rise of Liberalism	Influential	2	Governance	2	5.0000	200	9.0
18	1750	11750	Rise of Nationalism	Influential	2	Governance	2	6.6667	150	10.7
19	1850	11850	Rise of Socialism	Influential	2	Governance	2	5.8824	170	9.9
20	1850	11850	Rise of Communism	Influential	2	Governance	2	5.8824	170	9.9
21	1850	11850	Feminist Movement	Influential	2	Justice	3	16.6667	60	21.7
22	1850	11850	International Organizations	Influential	2	Governance	2	10.0000	100	14.0
23	1950	11950	Environmental Awareness	Influential	2	Survivability	4	20.0000	50	26.0
24	1960	11960	Social Justice Movement	Influential	2	Justice	3	20.0000	50	25.0
25	1980	11980	Information Age	Transformational	3	Industry/Productivity	1	25.0000	40	29.0

Table 3 - Known Detriments

Linear Years	Technological Development	Known Detrimentals					
		Impact to		Effect	Lag	Yrs: 20%	Total
3200	**Alcohol**	Social	2	Addiction - social damage	5.00	200	**7**
12000	**Plow**	Environmental	3	Desertification	0.20	5000	**3.2**
10950	**Gunpowder**	Multiple	5	Murders, Wars, Suicides	10.00	100	**15**
11970	**Electricity**	Multiple	5	Climate Change - Industrialization	7.14	140	**12.14286**
11976	**Internal Combustion**	Multiple	5	Climate Change - Industrialization	10.00	100	**15**
11965	**Automobile**	Multiple	5	Climate Change - Industrialization	12.50	80	**17.5**
11958	**Plastics**	Multiple	5	Oceans, Human Biology, Cancers	16.67	60	**21.66667**
11948	**Nuclear Fission**	Multiple	5	Nuclear Arsenals	100.00	10	**105**
11981	**Penicillin**	Biological	3	Antibiotics Resistant Bacteria	25.64	39	**28.64103**
12019	**Social Media**	Multiple	5	Teen suicides, fake news, more…	66.67	15	**71.66667**

Table 4 - Identified Risks

Technological Development	Risk Measures												
	Risk A		Risk B		Risk C		Risk D		Likelihood		Lag	Yrs: 20%	Total
Alcohol	Social	2	None	0.25	None	0.25	None	0.25	Very Likely	1.5			**4.125**
Gunpowder	Geopolitical	2	Biological	3	Social	2	None	0.25	Very Likely	1.5			**10.875**
Chimney	Environmental	3	None	0.25	None	0.25	None	0.25	N/A or Unknown	1			**3.75**
Printing Press	Social	2	None	0.25	None	0.25	None	0.25	Very Likely	1.5			**4.125**
Steam Engine	Economic	2	Geopolitical	2	Social	2	None	0.25	Very Likely	1.5			**9.375**
Atomic Theory	Environmental	3	Geopolitical	2	Biological	3	None	0.25	Very Likely	1.5			**12.375**
Electricity	Economic	2	Environmental	3	Geopolitical	2	Social	2	Very Likely	1.5			**13.5**
Telegraph	Economic	2	Geopolitical	2	Social	2	None	0.25	Likely	1.25			**7.8125**
Telephone	Economic	2	Geopolitical	2	Social	2	None	0.25	Likely	1.25			**7.8125**
Internal Combustion	Economic	2	Geopolitical	2	Environmental	3	None	0.25	Very Likely	1.5			**10.875**
Automobile	Economic	2	Geopolitical	2	Environmental	3	None	0.25	Very Likely	1.5			**10.875**
Plastics	Environmental	3	Biological	3	Economic	2	None	0.25	Very Likely	1.5			**12.375**
Radio	Economic	2	Geopolitical	2	Social	2	None	0.25	Likely	1.25			**7.8125**
Airplane	Economic	2	Geopolitical	2	Environmental	3	None	0.25	Likely	1.25			**9.0625**
Rocketry	Geopolitical	2	Social	2	Existential	10	None	0.25	N/A or Unknown	1			**14.25**
Television	Economic	2	Social	2	None	0.25	None	0.25	Very Likely	1.5			**6.75**
Digital Computers	Economic	2	Geopolitical	2	Social	2	None	0.25	Very Likely	1.5			**9.375**
Nuclear Fission	Economic	2	Environmental	3	Geopolitical	2	Biological	3	Likely	1.25			**12.5**
Penicillin	Biological	3	None	0.25	None	0.25	None	0.25	Very Likely	1.5			**5.625**
Space Satellites	Geopolitical	2	None	0.25	None	0.25	None	0.25	Likely	1.25			**3.4375**
Quantum Computer	Geopolitical	2	None	0.25	None	0.25	None	0.25	Likely	1.25			**3.4375**
Mobile Phones	Economic	2	Geopolitical	2	Social	2	None	0.25	Very Likely	1.5			**9.375**
Consumer GPS	Geopolitical	2	None	0.25	None	0.25	None	0.25	Very Likely	1.5			**4.125**
Internet	Economic	2	Geopolitical	2	Social	2	None	0.25	Very Likely	1.5			**9.375**
Social Media	Social	2	Geopolitical	2	Economic	2	None	0.25	Very Likely	1.5			**9.375**
Smart Mobile Devices	Economic	2	Geopolitical	2	Social	2	None	0.25	Very Likely	1.5			**9.375**
CRISPR	Biological	3	Social	2	Existential	10	None	0.25	Likely	1.25			**19.0625**
Deep Learning (AI)	Economic	2	Geopolitical	2	Social	2	None	0.25	Very Likely	1.5			**9.375**
Transformers (AI)	Existential	10	Geopolitical	2	Economic	2	Social	2	N/A or Unknown	1			**16**
Neural Implants	Biological	3	Social	2	None	0.25	None	0.25	Likely	1.25			**6.875**
Gene-Editing Therapies	Biological	3	Social	2	None	0.25	None	0.25	Unlikely	0.75			**4.125**
Humanoid Robots	Social	2	Economic	2	None	0.25	None	0.25	N/A or Unknown	1			**4.5**
Organ Generation	Biological	3	Social	2	Economic	2	None	0.25	Likely	1.25			**9.0625**
Quantum Biosensors	Biological	3	Social	2	None	0.25	None	0.25	Likely	1.25			**6.875**

Introduction

Perhaps you feel it too: the rate of change in society driven by technology, is accelerating.

This central figure of this paper, **Figure 1 – The Techno-Socio Gap**, quantifies and illuminates the relationship between technological and societal change. The ***Blue Curve*** represents ***Societal*** developments. The ***green curve*** represents ***Technological*** developments. The gap between these two curves is widening rapidly.

It seems that every week there is some new technology introduced, more powerful than the last, that has material impact on society. Whether that power points toward good or harm, is up to us… *or is it*? A few will use this new technology for harm, intentionally. The vast majority will use it for good, intentionally. There will also be unintentional good and bad consequences.

Humanity must continue advancing its knowledge of science and applying that science to make tools that serve us. However, we are at a precarious moment in human development. I am concerned that we are not looking at our circumstances with a wide enough lens and are thus missing the precarious precipice on which we stand.

Several human-driven forces have created a situation not previously seen by humanity. There is no historical guidance to help us know if that situation will result in utopia (as some predict) or extinction/dystopia (as others predict). Since these are dramatically different outcomes, a *careful consideration of the path forward* is not just prudent, it is crucial.

Those forces are:

1. Humanity's quest (or perhaps just a few of humanity) for Technological Development is accelerating at a rate far greater than that of Societal Developments. (See Figure 1) This growing delta is the "Techno-Socio Gap." As of this writing, the slope of the green curve is ***3.3x*** that of the blue curve.
2. By human intention, technology intermediates every aspect of the human experience. As such, it is a material, if not the most material, force for controlling our lives.
3. With over eight billion people on the planet, a relative handful (a few hundred or thousand) of (unelected) scientists and technologists, through a handful of technologies, have more power to ***program*** human existence (fatal or flourish is unknown) than ever before; ostensibly that is more power than any government – elected or otherwise.

These forces have combined in a way that makes it possible for a select few people to program the future of our species and planet according to their design, without our input.

Beyond the history shown in Figure 1, there are more than 60 rapidly emerging technologies across six categories that will impact our future: Biology, Energy, Space, Computation, Materials, and Artificial Intelligence. See Figure 2.

These six areas interconnect in over 40 ways. They hold immense power and promise for humanity to improve our standard of living, our quality and quantity of life, and more. There are also eight

termination points that embody great risks for humanity, perhaps even existential. One example of these is Climate Change. The other seven are detailed later.

Beyond these eight specific existential risks, these curves illuminate a general existential risk. Consider the **Techno-Socio Gap.** Is there a point at which new technological developments happen so fast, that human society cannot manage those changes? If so, does society break? What does that break look like?

If we can ***Bend the Blue Curve*** upward and slow the green curve, (in other words, narrow the Techno-Socio Gap) then humanity may have the time it needs. The time to do what? To reconsider how it, and who, drives technological developments. Indeed, to reconsider how "fettered" or "unfettered" technological research and developments should be.

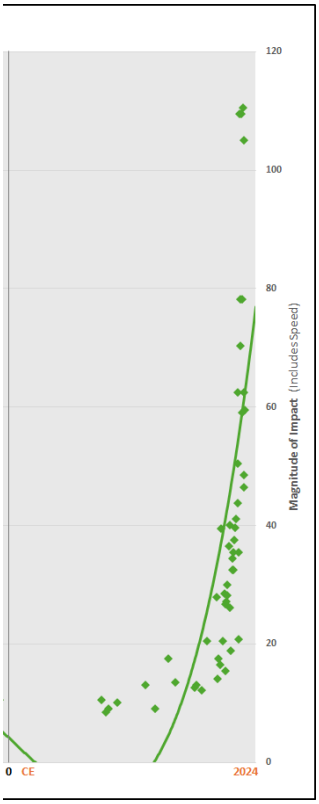
This paper is divided into three major sections (plus appendices) as follows:

Section Title	Brief Description
The Techno-Socio Gap	This section explains the central chart (Figure 1) and the assertion that there is a hyperbolic widening of the gap between technological and sociological developments. Based on historical data.
Commentary	The central narrative including general and specific concerns, key questions, and more.
Summary & Solutions	The implications, forks in the road, and how we can Bend the Blue Curve.
Appendices	The Emerging Technologies Map Construct and Rubrics Suggested Viewing/Reading

The Techno-Socio Gap

Figure 1 – The Techno-Socio Gap - gives visual clarity to the rapidly widening gap between the accelerating pace of technological developments (71) and the much slower pace of sociological developments (25). Accumulating on the chart as well, are risks & detriments (44) associated with about half of those technological developments. The gap between technology and humanity's ability to adapt is widening and accelerating.

Technological Developments (green curve)



{Refer to Table 1 to see the list of 71 developments and their scores.}

The chart is constructed from 71 technological developments (green ♦ and curve) from the birth of Agriculture in 10,000 BCE until the present. Each development is scored according to a Construct and Rubric as explained in that self-named appendix. The development is plotted against the X-Axis (timeline) according to when the best literature suggests the development began. Each development has a beneficial impact measure that is based on four factors plus a measure of speed as a fifth measure. These are plotted on the Y-Axis.

For nearly 12,000 years the rate of technological developments was slow and spotty with magnitudes of impact in the 5 to 20 range. Then beginning in the 13th century, the frequency, speed and impact all started to increase. And, today, in 2024, we are seeing impacts in the 80-10 range that are no longer centuries apart; they're a handful of years apart.

This yields a visual representation of how technological developments have accelerated in both frequency and magnitude of impact with a dramatic rise in impact in the last 100 or so years.

A polynomial regression of these plotted dots yields a striking asymptotic vertical curve that is going to become even more vertical in the coming months and years as new more dramatic and faster moving dots are added to the chart.

Sociological Developments (blue curve)

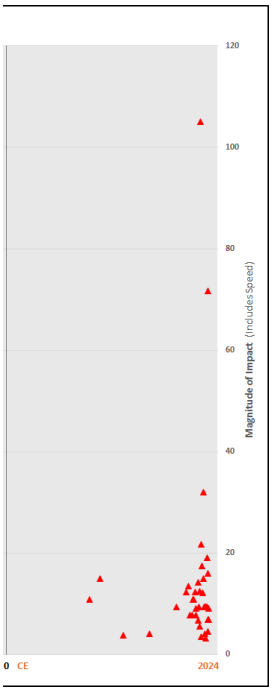
{Refer to Table 2 to see the list of 25 developments and their scores.}

Also on Figure 1 are the 25 scored sociological developments (blue ● and curve) over the same period. Each sociological development is scored for beneficial impact as well but using a different rubric than technological. The sociological developments impact measure is comprised of two factors plus a measure of speed as a third. These are also plotted on the same Y-Axis and scale.

There were, essentially, no societal developments until the Birth of Urban Centers around 6000 BCE. And these emergences have been slow and infrequent. Only the last three had impact scores above 20.

A polynomial regression of these plotted dots also yields a significant rise in the last 100 or so years. Whereas the technological curve intersects the Y-Axis in 2024 at 60, the sociological intersects at about 24, which presents a gap of 36 points.

Risks and Detriments



{Refer to Tables 3 and 4 to see the list of 44 risks and known detriments and their scores.}

There are 34 identified risks (a predicted potential to have a detrimental impact) and 10 known detriments of past and current technological developments accumulating in the lower right corner of Figure 1 (red ▲).

One of the key factors that is hard to plot is the time delay between when a technology is introduced (examples: penicillin in 1949 and methicillin in 1959) and when the now known detriments begin to manifest broadly (Methicillin-Resistant Staphylococcus Aureus (MRSA) in 1981). And in 1959, nobody saw the MRSA risk at all. The "peril" lagged the "promise." Best-faith estimations are made in these cases. Further empirical research may refine individual dot placements, but I suspect, will not dramatically change the overall picture.

Not only are Technological Developments outpacing those of Society, but the risks associated with them are also greater. With every technology, the more powerful the technology, the greater its promise. But sometimes, not always, also its peril (though this relationship is not always symmetric or time similar).

All we can do is our best, but that still means acknowledging the known nature(s) of risk(s) associated with each technology. Or attempting to predict them for the relative near future and creating an estimated measure of that risk. According to our two-part rubric for risk (see Appendix B), not only are the beneficial impacts and speed of proliferation of technologies accelerating – but so are the risks.

Commentary

Humanity is at a precarious moment in time. It is tempting to say that is not new since humanity has been making and using tools for thousands of years and this moment in time is no different. And, in a sense, that is true. However, there are a handful of characteristics about these technologies that humanity has *not* previously experienced. That is what makes this moment important.

In the general sense, there is the Techno-Socio Gap chart that illustrates that there is a dramatically widening distance between how fast technologies are being developed and "forced" on societies, and the speed by which societies can adapt to and adopt these technologies. This is literally uncharted (until now) territory. We can now quantify, chart and to a limited degree, project forward to predict the size of that gap. But what does that gap mean? What are the implications of it? These are the "big picture" questions, some of which I will address later under **Key Questions**.

Also in the general sense, there are at least six categories of technology that are emergent and convergent. (See Appendix A) The speed and degree with which these are inter-connecting is also accelerating. It is important to note that multidisciplinary developments are usually more impactful. That pushes the green dots further up the magnitude scale and pulling the green curve even more vertical.

In the specific sense, out of 6 categories and 65 subcategories of emerging technologies, there are two exemplar groups of technological developments that are significantly different than any other in history. One is Artificial (General) Intelligence (AI/AGI). The other is informally called CRISPR. Scientists and technicians now leverage this CRISPR mechanism to efficiently and effectively edit the DNA of any living organism of choice, including humans. This technology is not yet a household name, but it will be soon.

GENERAL CONCERNS

If the **Blue** curve (sociological developments) in Figure 1 cannot catch up to the **Green** curve (technological developments) – then what are the implications of that to humanity? Nobody can know that answer empirically because we've never been in this situation before as a species. Some might say "So what? What if the rate of technological development is far outpacing humanity's social developments? (Read: ability to adapt)"

I'd like to address that question with a more concrete hypothetical.

Let's say that the green curve is the rate at which novel pandemic-causing viruses like Covid-19 are appearing in the wild. And the blue curve is the rate at which humanity can address each virus. Any rational person would be concerned about the widening gap between the curves.

But let's also consider for a moment two possible *causes* of the accelerating appearances of these novel pandemic-causing viruses.

In one hypothetical cause, assume that climate change is causing more rapid mutations of existing viruses. It would be another sad consequence of climate change, but it could be said that "Oh well, perhaps there is neglect, but it isn't intentional."

In a second hypothetical cause, assume that in a handful of labs around the world, a handful of scientists are experimenting with existing viruses in various ways, or synthesizing entirely new ones. Some are trying to discover ways to kill them. Some are just trying to understand them. Others are experimenting with "gain of function" research (it's a real thing) with notions of creating a "super virus" that could, maybe, perhaps, do whatever. Viruses have long been considered[1] "engines of evolution." What if we learned that these scientists ***intend*** to release these viruses into the general population because they believe that is what is best for humanity? Would that be acceptable to you?

Obviously, this is an analogy for our current situation vis-à-vis AI and CRISPR, but we can extrapolate it for technological developments in general.

> A small number of scientists are impacting society based on a set of values, beliefs and/or motivations that may or may not align with what humanity wants.

Imagine a day when technology is coming at us in a way that, literally every day, life is changing. The way we communicate, the way we transact, the way we do everything from ordering a carton of milk for delivery, to new medical discoveries that result in our medicines being updated *remotely* and changing *inside* our bodies, every day, governed by an AI. Such scenarios are being developed already. A future reality of such rapid change will draw a different reaction from each person depending on their individual ability to adapt to change. But I can see a time when change is so blisteringly fast that it becomes bewildering and overwhelming to most people. Is that a future we want? Is that the inescapable general conclusion of the green and blue curves diverging?

SPECIFIC CONCERNS

While we can, and likely should, debate unknown future consequences of the Techno-Socio Gap, there are real and concrete consequences of the specific variety. I'd like to focus on the two most troubling (for me) areas of concern. These are Artificial Intelligence and Biotechnology.

Artificial (General) Intelligence (aka "superintelligence")

AGI, is being talked about as a new sentient species based on silicon instead of carbon. All life as we know it now, is carbon-based. Silicon-based AGI, some posit, could become sentient and intelligent and capable of the classic requirements of a life form. Merriam-Webster defines life as "an organismic state characterized by capacity for **metabolism**, **growth**, **reaction to stimuli**, and **reproduction**". An AGI could pass this test if we consider:

- **metabolism** as an ingestion of electricity and information and an excretion of heat and new information
- **growth** as self-improving and expanding neural networks via "learning" from a continuous feed of content, and now other direct inputs like cameras and microphones and more. Then there is the ability for the AGI to re-write its own code.

- **reaction to stimuli** as response to prompts and "learning" from a continuous feed of content or other direct inputs like cameras and microphones and more.
- **reproduction** as the ability to copy itself

So, perhaps an AGI could be considered a life form under that definition.

But is it truly intelligent?

Intelligence has been debated for centuries. Philosophers, cognitive scientists, neuroscientists, and even poets have long explored what it means. If we use Merriam-Webster's definition:

> **Intelligence:**
>
> A (1): the ability to learn or understand or to deal with new or trying situations: reason
> also: the skilled use of reason
> (2): the ability to apply knowledge to manipulate one's environment or to think abstractly as measured by objective criteria (such as tests)
> B: mental acuteness

Can an AGI learn? Depends on the definition of learning. Can it understand? Again, it depends on the definition of understand. But if you define it as the ability to apply knowledge to manipulate the environment – then an AGI can be considered intelligent. Particularly if, as is now the rage, that AGI has "agents" – tools that plug into the AGI in such a way that they can carry out tasks as assigned to them by the AGI.

Today, Generative AI, *looks like* it understands. But it really does not. Generative AI, using a form of neural network called a Transformer model is "trained" on massive corpuses of information. This training results in a very sophisticated network of billions (or trillions) of "nodes" and "edges" with quantified fractional values.

When you give a Generative AI a "prompt" the neural network iteratively generates a "next token prediction" (NTP) from a massive collection of quantified fractional numerical values. It's all statistics. Is that the same as "understanding?"

In general, today, though by no means a consensus, is that statistics is not "understanding." Understanding depends on self-awareness or, sentience.

Is AI sentient? Is it self-aware? Today, it is not. But AI scientists are laser-focused on advancing the science and technology to the point where an AI is capable of self-awareness, sentience, or in a word: consciousness.

Humanity has never been here before. This is new. If scientists and technologists achieve this, it will mark a radically new and unprecedented turning point for humanity. Scientists will "become like gods" who have created a new life form, a new species of life, a new consciousness. And this new species will "think" faster and more creatively than we can, with virtually all the knowledge of humanity in its immediate memory. It will have the ability to improve itself, replicate itself and interact with the entire world at literal lightspeed.

We have no idea what it will think or what will motivate it. We have no idea if it will be benevolent toward humanity, or malevolent.

Imagine giving birth to a child that is a thousand or million times smarter than you, with a kind of telepathy that lets it communicate with all other similar-aged children on the planet – but you cannot participate in that communication. Imagine that it knows… EVERYTHING. But it has no feelings. To it, you are no different than a piece of construction lumber. How would you "raise" it to adulthood? You wouldn't. You couldn't.

AI scientists concerned about "AI safety" or "AI superalignment" believe that the "initial conditions" under which the AGI exists when it becomes sentient – is all we have. If the initial conditions result in the AGI being "superaligned" with our goals and values, it will "wake up" with our interests prioritized. And, as a result, it will either defer to our authority or will become an equal collaborator (as opposed to a superior one). This does not guarantee that it won't later change its "mind" about being deferential to our interests.

It is important to keep in mind that certain kinds of AIs can help us solve significant and vexing societal problems. Google's DeepMind division in the United Kingdom created an AI called "AlphaFold" which identified how proteins fold in three dimensions.

DNA is ultimately a mechanism for making proteins. Scientists once thought that all we needed to know was the "inventory" of parts and their sequence to make any given protein. From that we would understand how that protein worked. But it turns out this DNA science, called genomics, was incomplete. The three-dimensional shape of a protein impacts function as much as what it is made of. Thus, the field of proteomics was born.

There are over 300 million proteins on earth and 300,000 in the human body alone. Discovering how a single protein folds would take scientists many years and millions of dollars. They did this to learn how to treat one disease state or another. Enter AI.

DeepMind's AlphaFold[1] project learned from 100,000 known proteins and, in four years, solved the problem and has discovered the folded origami of over 200 million proteins. This effectively solved the protein folding problem and has opened the door for countless bio-medical researchers to cure thousands of diseases. Surely, nobody would say that AlphaFold is a bad thing.

And a year or so ago, another AI solved a thorny problem in the field of clean and safe nuclear fusion (not fission) energy. One approach to fusion involves using a kind of "magnetic bottle" to contain the super-hot plasma where the fusion reaction happens. But getting that magnetic bottle to be stable for long enough has been an elusive problem. Some scientists at Princeton[2] are solving this problem with the help of AI.

Before Generative AI came along, there was (still is) a class of "non-generative" AI that we might call "special purpose AI." These fall into a class called "Deep {machine} Learning Neural Networks." This class of AI has been trained, as an example, on reading mammograms[3]. And it turns out that a well-trained mammogram-reading AI can spot cancers and pre-cancers, earlier, faster and more accurately than humans can. As an augment to that profession, such tools are essential to saving lives and improving the quality of lives.

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[1] https://deepmind.google/technologies/alphafold/
[2] https://scitechdaily.com/ai-powered-fusion-the-key-to-limitless-clean-energy/
[3] https://www.cnn.com/2023/08/01/health/ai-breast-cancer-detection/index.html

In all the mania surrounding Generative AI's like ChatGPT, the poor precursor AIs like the mammogram AI have been all but forgotten. But these are the real workhorses of AI. And they have virtually zero probability of ever becoming sentient, self-aware, conscious machines that can take over the world. In other words, we need to consider each form of AI independently in terms of its risk/reward profile. This is not an all-or-nothing game.

Motivations

When humanity seeks solutions to broken things or seeks to improve something that isn't broken, the art and science of business (free enterprise) has proven itself to be the most efficient and effective way to reach the most people the least expensive way. And through competition, bring continuous improvement in the product or service. The free-market model has lifted the standard of living for more people faster than any other system in history[4]. However, like any system, *it is only as good as the virtue of the people in it*. Any system can fail when greed or other vices dominate generosity and virtue.

What happens when a handful of technologists, instead of humanity, are driving societal change? And what happens when that handful of technologists are incentivized in ways that are not in the best interests of the 8.1 billion other humans? This is the condition today.

We are not driving societal change. Technologists are. Information technology is ubiquitous and integral to everything we do – it is the nervous system and the circulatory system of our society today. As such, changes are "pushed out" from central locations to billions of devices daily. Every day, your smartphone, laptop, favorite streaming movie app, fitness watch, and on and on, are "improved" by a handful of decisions by a handful of people (mostly in Silicon Valley). In general, we don't mind that, unless the change breaks the device (it happens), or the change forces us to do things in new ways we don't like. We have become "trained" into this approach, and as a result, we have made it easy for a handful of people to "push out" new things like AI with impunity, whether or not we want it.

The laptop on which I am writing happens to be a Microsoft Windows-based laptop (but the same applies to my Mac or Ubuntu computers) and the latest version of Office 365 now has "CoPilot" available to me, even though I didn't ask for it. And it's virtually impossible to remove. Where did I lose my "agency"? My right to choose? I lost that agency when I entered a social contract of sorts where I surrendered that agency to those few in Silicon Valley in exchange for convenience.

About Agency

There is a lot of talk of humanity losing agency to AGI. That may be true, eventually. But the mechanism by which that happens, has already happened. Humanity has voluntarily surrendered its agency to the makers of these products. And, in doing so, surrendered its agency to the products they make. If we want agency over the products, we must first recover our agency from the makers.

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[4] http://www.jstor.org/stable/41560252

Overall, this has been a beneficial arrangement. I don't have to do much to "maintain" my laptop which saves me time and (theoretically) aggravation. I "surrender" that duty to the people who make the device. They, for their part, can "continuously iteratively improve" my device from afar. That makes it easy for them to make fixes and add features that keep them competitive. Both sides benefit. But it does involve a certain level of agency surrender.

They, the few in Silicon Valley, shape the technology any way they want. In so doing, they shape the way we work, communicate, interact, consume, transact and more. In short, the few can shape (read: program) the lives, jobs, companies, governments and societies – in their image – not ours. This is all facilitated and intermediated by our digital universe over which we have very little oversight and which they control.

What is motivating this "push" to AGI? Answer: perverse incentives.

With the release of ChatGPT in Nov 2022, OpenAI launched an arms race. It was a "sputnik moment" for AGI and now the race is on. Ultimately, nobody but Sam Altman (CEO) and Greg Brockman (President) can tell you why they chose to release an AI that was not "aligned" with human interests, was biased in results, and used unlicensed copyrighted content in training. But there are some easy speculative conclusions we can make.

OpenAI did not have sufficient funds to secure the massive amount of computational power needed to train and offer ChatGPT to the public. So, they partnered with Microsoft who underwrote the training and release. Microsoft is a publicly traded company beholden to its shareholders, like you and me, who seek a continuous increase in stock value. Microsoft saw OpenAI as a path to raise its stock value and regain market and mind share.

A Microsoft insider with whom I spoke said that Satya Nadella (CEO of Microsoft) and the other leaders of the company are "all in and betting their future on A(G)I". That's a lot of commitment (and risk) from a company that employs more than 220,000 people and generates over $236 billion in annual revenues. It has a market capitalization of more than $3 trillion and has over $80 billion of cash on hand. With that kind of power and wealth, what limits can we impose on them?

But, in hindsight, we now know that OpenAI's GPT 3.5 has significant constraints and was, essentially, a "loss leader" in the language of retail. It was meant to familiarize the market with chat bots, lure other developers to integrate the technology into their products, and eventually, lift all users to the better, but costly, version(s).

These are all standard business maneuvers. But this is not just another soda bottle or lollipop. This is technology that has the potential to upend our lives, our businesses, our markets, our nations and our very species. It should be held to different standards.

So, yes, profit motives are at play here. But I suggest that is not the ultimate driving force.

Legacy. Several prominent AI scientists and technologists have voluntarily stated, on camera, that they seek to (and indeed believe it to be inevitable) create a new intelligent life form. Some AI scientists have gone as far as to say that just as humanity rose to prominence over the other creatures on the planet – by evolution – humanity as a species will be subordinated to the next step

in evolution: a sentient silicon species. We will cease to be the dominant, and only, sentient species. They also believe this to be inevitable, and, totally acceptable.

My assertion is that this motivation, more than any other, is fueling the current race to AGI. Those that manage to engineer a truly sentient silicon system, will go down in history as being the first human(s) to give rise to a new life form and, if they are right, subordinate humans in the process. What will that subordination look like? We have no idea.

I do not wish for humanity to merely hold on to the #2 spot on the planet and I'm betting that most humans agree.

So, why should a handful, of scientists and technologists have the right to decide the fate of the species for us? Perhaps there is a reason why so many of them are building underground apocalyptic bunkers.[5]

Alas, Artificial General Intelligence is not the only threat to the human species. Nor is it the only race to create a new species of life.

Biotechnology

In the section called **The Emerging Technologies Map (see Appendix A)**, there are six technological areas that are currently rapidly emerging and, to some degree, converging. Some have labeled this a "technology super cycle" (Amy Webb at the Future Today Institute) and others call it "superconvergence" (Jamie Metzel in his book of the same name). Whatever label we apply to it, it's here and we must deal with it.

In the prior section, I engaged in a thought experiment about how we might think about the gap between the green and blue curves. How we might react if I said the green curve was the rapidly accelerating rate at which pandemic level viruses were emerging in the wild. And how we might feel if we knew that those viruses were being hurled at us by other humans with their own agendas. Obviously, that was an analogy for how AI is being hurled at us now. But that is not mere metaphor in the case of bio-tech.

CRISPR, Gene-Editing and Synthetic Biology

As big as AI is in terms of impact to our species, CRISPR could very well be even bigger. AGI will be an "external" threat to our species. CRISPR will be an "internal" one. CRISPR is an acronym that means Clustered Regularly Interspersed Short Palindromic Repeats. CRISPR is a mechanism that bacteria use to protect themselves from a particular kind of virus called a bacteriophage.

Just as there are a handful of people (scientists, technologists and capitalists) driving the AGI bus, there are just a handful driving the most impactful biological tools in human history. In prominent labs, and hidden ones, people are tinkering with the very core of life as we know it.

In Appendix C there are a few recommended books about CRISPR and Gene-Editing that will give you a cross-sectional view of the promise, and peril, of this technology. This is a broad and deep

[5] https://duckduckgo.com/?q=silicon+valley+elite+building+underground+bunkers&t=newext&atb=v371-1&ia=web

topic, and this paper is not the forum for laying out all the details of this science and technology. However, a brief introduction will help.

Deoxyribonucleic Acid, or DNA, and its sister molecule, RNA (Ribonucleic Acid) contain the blueprint "code" for constructing and operating virtually all biological forms of life on Earth. DNA/RNA provide the "inventory list" to make the proteins and genes which govern living cells.

Over the last forty or so years, science developed some poor, slow, costly and inaccurate methods (Transcription Activator-Like Effector Nucleases – TALENS, and Zinc Finger Nucleases – ZFN) for "knocking out" specific genes in DNA. But about 15 years ago this mechanism of CRISPR was discovered by two researchers (California and Europe). Shortly after, around 2013, they figured out how to harness this mechanism to do very fast, cheap, easy and precise edits in DNA. They can knock out chunks of DNA or edit sections at a time. And kits are readily available on the Internet for $120 that would allow you to do this in your own home – if you had some basic training and a few lab tools.

Imagine being able to "fix" the DNA in your liver that causes it to over-produce the "bad" cholesterol (LDL or Low-Density Lipoproteins). Or what if you suffer from a genetic mutation that causes blindness or cystic fibrosis and a CRISPR treatment could literally cure you, versus just treat/manage, these ailments? The promise of such remedies has lit the imagination of the bio-tech industry. Over $3 billion dollars have rushed in to fund research and treatments in the last few years.

And, late last year in 2023, the FDA approved the first CRISPR-based treatments deployed in real people to remedy real issues. In this treatment case: sickle cell disease and beta thalassemia[6]. But there are many other treatments in various stages of FDA review. We can be very excited about what CRISPR will do to relieve human suffering and its use in agricultural applications[7] to make better rice or potentially eliminate malaria from mosquitos.

But a handful of scientists are already using CRISPR in research labs to do many other things we might find ethically and/or morally objectionable. In 2018, a scientist in China used CRISPR to edit human embryos[8] before they were implanted and carried to term. Twin girls named Lulu and Nana and an unrelated girl named Amy are now about six years old. His actions resulted in a three-year prison sentence since China had implemented regulations against editing human embryos for implantation.

The scientist, Dr. He Jiankui, used CRISPR to edit the DNA of these girls in a way that would make them "immune" to HIV, which the maternal and paternal DNA contributors – both had.

I label them "maternal and paternal contributors" for three reasons. First, while they contributed most of the DNA to the daughters, because of the DNA edits – their status as mother and father is not "exact" which changes the normally black and white definition to a grey one. Second, the children were carried by surrogates. Third, after birth, the children became wards of the state, more than their "DNA contributors."

There were far less invasive and less risky ways to do this such as IVF (In Vitro Fertilization) with PGD (Pre-implantation Genetic Diagnosis) – particularly since IVF had to be used in the CRISPR approach anyway. And, after birth, it was discovered

[6] https://time.com/6343853/fda-crispr-treatment-sickle-cell/
[7] https://www.fdli.org/2021/11/the-future-of-food-crispr-edited-agriculture/
[8] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6813942/

that as good and precise as CRISPR is in gene-editing, there were a number of what are called "off target effects." This is bio-speak for the reality that he accidentally altered genes he wasn't targeting. We don't know the consequences of these unintended changes as the health, welfare and privacy of the three girls is well-respected.

Dr. Jiankui is not alone. There are many scientists around the planet that are actively racing to use CRISPR to do all kinds of things. Some are even injecting themselves in a cultural wave known as biohacking[9] which some now regret. Others, like Dr. George Church, have raised millions of dollars to form a company, Colossal[10], focused on resurrecting the woolly mammoth. And in 2008, Dr. J. Craig Venter announced[11] that he and his team had created the first synthetic cell form by synthesizing a genome of only 473 genes (DNA of a little over 400,000 nucleotide bases) and bringing it to life. The list of such activities could go on and on, in virtually every area of biology today. I'll draw from one scientist, Steven Potter Ph.D., and his 2010 book "Designer Genes" to sum up a growing, though currently minority, mindset. He writes:

"Designer Genes" – Pg 175 – Steven Potter, Ph.D.

The Genetics revolution is ongoing, and there may be indeed no stopping it now. The human species is about to undergo an incredible transformation. The forces of natural selection are about to be replaced by the forces of human selection. In the future it will likely be routine for parents to choose the genes of their children. Where this might take us, we cannot know. Of course, we will quickly remove from the human population version of genes that result in catastrophic disease. But in addition, we will be selecting ideal combinations of genes from the two parents, modifying genes for which neither parent offers a preferred copy, and perhaps even making entirely new kinds of genes never before seen in nature. For the first time humans will have complete control over their genetic destiny. And the process will result in an upward spiral of genetic change, as each generation is more intelligent than the last and better able to choose the genetic makeup of their children.

It could well mean the end of the human race as we know it, but perhaps the beginning of something better.

Science no longer needs a biological "father" and a biological "mother." For years now, scientists have been able to fertilize a female human egg with DNA from a non-sperm source. Even "three-parent" fertilizations are possible. In an IVF process, plus something called "cytoplasmic (or mitochondrial) transfer," an egg is injected with both the sperm of the "father" plus mitochondrial DNA from a third person (female) that doesn't carry certain genetic mutations.

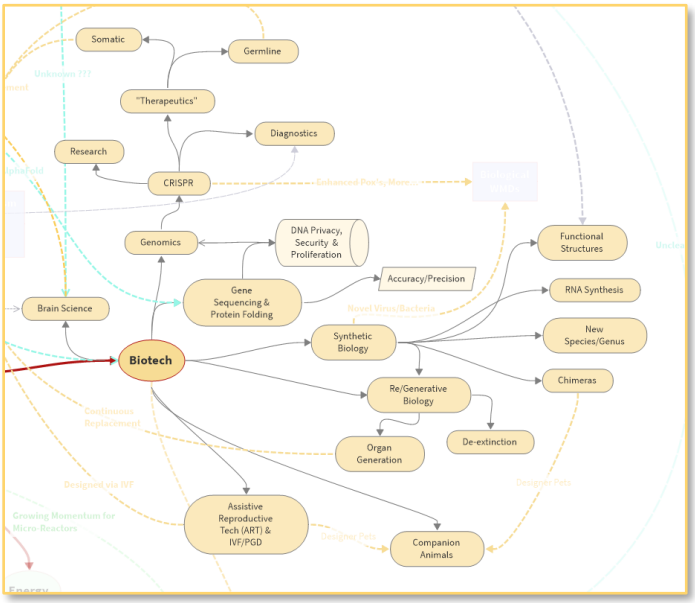
Still further, what if it were possible to make a baby from any two people I wanted? Without even their knowledge? Using a process developed by a Japanese scientist Yamanaka called "induced pluripotent stem cell" generation, it is possible to scrape some cells from the skin on your arm and "induce" them back into their stem cell state. From that pluripotent stem cell, the right process can further induce that cell to become an egg cell. From another person, using a similar process, induces that skin cell to become a sperm cell. From this point, it is standard IVF with the DNA of two "parents" who might, unknowingly, donate their DNA to an offspring born of a surrogate mother. This means it's possible to "manufacture" a child from any two humans, carried to term by

[9] https://www.theatlantic.com/science/archive/2018/02/biohacking-stunts-crispr/553511/
[10] https://colossal.com/mammoth/
[11] https://www.youtube.com/watch?v=QHIocNOHd7A

a third. The good news is that, currently, while this is theoretically and practically possible, there are varied levels of regulation around the planet that prohibit it.

In short, now that we believe we can "edit" DNA almost as easily as I am editing this document on my computer, we have people who want to use that tool to do just that. But there are risks.

When we first decoded the human genome, and the field of genomics was born, we thought that would lay bare the "code" of the human species. Only then did we learn that not all proteins are created equal and that their shape matters, thus the field of proteomics was born. Then, we used to think that the 98.5% of the human genome that did not code for genes was "junk DNA" – artifacts of some historical evolutionary labors. But now we know that at least some of that "junk DNA" is vital to controlling the genes themselves; a kind of on/off switch for other parts of the genome. Then there is the field of epigenetics where we are learning more and more every day about how external elements can alter the on/off switches or protein-folding and more. In short, every time we think we have it all figured out, we learn there is more to figure out.



This branch of the Emerging Technologies Map contains multitudes of ways that humanity is learning to "edit the code of life" and "write our own code of life".

In short, we are on the verge (or precipice) of choosing our own genetic future as a species... or even creating our own new humanoid species. At the least, it won't be long before we have designer pets (my personal prediction for the first wave) and designer plants.

This is all looking at biotech in isolation. But if we look more broadly, there are interrelationships to the other technology areas coming – that give rise to entirely new promises, and perils.

For example, as AGI looms, and humanity is struggling to "keep up" with an advancing Artificial Intelligence, we'll attempt to adapt and adopt in new ways.

One way that is already happening is machine-mind interface. Companies like Elon Musk's Neuralink are working furiously to implant silicon circuits in our brains that will have therapeutic value at first: hearing, seeing, walking, controlling computers with our minds, and so on. But science fiction will become reality with implants that also let our minds tap directly into the vast knowledge stores of the Internet. Or, perhaps even, silicon-based AI species. And with that, perhaps, in real-time, any two people similarly connected via their brains to a single silicon "intelligence" – may be able to read each other's minds – or think collectively.

But initially, such machine-mind interfaces will only get us so far. There will be increasing pressure to alter our genetics to make us all smarter (as described by Dr. Potter above). If not us, then at least our next generation.

But do we yet know enough to do this safely? No. Pretty sure the answer to that is, "no." But, with smarter and smarter AI assisting our research efforts, perhaps even augmented by a machine-mind interface, will we find ways to enhance our DNA? Probably, "yes."

The Industrial Age gave way to the Information Age which will give way to the Intelligence Age joined with the Biotech Age.

Again, the purpose of this paper is not to cover all the possibilities relative to CRISPR in specific, Biotech or AI in general, or any of the 50+ emerging technologies on the Emerging Technologies Map. But it's instructive to cover a few specific current and near-term scenarios.

WHAT ARE THE RISKS TO HUMANITY FROM THIS WIDENING GAP?

WHAT IF HUMANITY HAS A FINITE MAXIMUM RATE AT WHICH IT CAN ADOPT NEW TECHNOLOGIES?

WHAT HAPPENS WHEN THE NEW TECHNOLOGY RATE EXCEEDS HUMANITY'S MAXIMUM RATE?

HOW CAN WE RAISE HUMANITY'S MAX TECH ADOPTION RATE?

HOW CAN WE LOWER THE NEW TECHNOLOGY RATE TO GIVE HUMANITY TIME TO MANAGE?

WHO DECIDES THE TECHNOLOGY DEVELOPMENT RATE?

What are the risks to humanity of this widening gap?

Truly, at this time, nobody knows or can know the answer to this question, concretely or empirically. This is because humanity has never been in this position before.

On the other hand, humanity has experienced smaller "explosions" of developments and their commensurate good and bad consequences. The Industrial Era and the Information Era are two examples. In both cases, there were broad and deep impacts to societies as they entered these eras. We are still seeing those play out as less-developed nations, even now, are entering into one or the other of these eras. So, there is a small amount of history from which to extrapolate. And yet, in two specific and critical areas of development, we have no history. Those are AGI and Genome Design/Synthetic Biology.

It is out of the scope of this document to detail all the good and bad consequences of those eras. However, it is appropriate to say that some consequences of each were not anticipated. For example, while the Industrial Era brought about higher and broader levels of productivity, enhancing standard of living for much of humanity, it also initiated the unforeseen and existential risk of Climate Change. And the Information Era gave rise to unforeseen challenges such as fluid globalization, rapid employment flux, and teen suicide (from social media).

What we are learning is that technological developments build ever faster on the shoulders of prior technological developments. Just about a century ago, something like photography or electricity would take 80 to 100 years to materially impact 50% of the planetary population at the time. Today, something like ChatGPT 3.5 (OpenAI's Generative AI release in Nov 2022) reached 1 billion people (about 12% of the global population) in less than a year and as LLMs (Large Language Models of AI) are rapidly integrated into systems and technologies that are already ubiquitous, that speed and impact will accelerate. It is likely that Generative AI will impact 50% of the global population in less than 10 years, maybe even 5.

That refers to just one technology. This document identifies over 50 such technologies that are all rapidly emerging… and cross-enabling. The Techno-Socio Gap is going to widen ever faster in the coming few years and even months.

Are we taking the time to imagine, anticipate, and plan for the consequences of any one of these 50+ technologies individually, and/or collectively? If we are not, how can we know what risks are around the corner? How can we mitigate risks we are not anticipating? What organization(s) is focused on identifying and mitigating risks? If there was one, what "leverage" do they have to mitigate the risks they see?

Given that the speed, depth, breadth, and impact of these technological developments are all greater than humanity has ever seen before, how can we know, never mind plan for, the risks humanity will encounter?

What if humanity has a finite maximum rate at which it can adopt new technologies?

As Figure 1 illustrates, while societal developments are growing in impact, they still happen less often than technological. Things like "the rise of democracies" or "the human rights movement" take longer to "mature" and "spread" than a new widget like Tik-Tok.

This is because humans often differ, so building consensus takes time. Humans, and their societies, also have very different ideas of what constitutes good and bad. For example, Western societies value individualism over communalism (the part is greater than the whole). Eastern societies are the opposite, valuing communalism over individualism (the whole is greater than any part).

No matter where any given population resides on this bi-polar continuum, or any other metric of value-system, that self-organizing society must adapt to, and is forced to adopt, new technological developments. Each will do so in their own way. Some faster, some slower. Some deeper, some more superficially.

And part of adapting and adopting to new emergent technologies is enacting governing laws to maximize that society's use of said technology, while also mitigating the risks all new technologies present.

This process is well and widely known to be far slower than the rate of technological development. In fact, some might say that even at the current rate of technology introduction, these human systems cannot keep pace. In other words, humanity does have a finite rate at which it can adopt new technologies, and the rate of technology introduction already exceeds that.

How can we empirically measure humanity's maximum adoption rate?

What happens when the new technology rate exceeds humanity's maximum adoption rate?

Let us say that the new technology development rate is "A." And let us say that the maximum adoption rate for humanity is "B." This is no problem when B > A. What happens when A > B? If A = 0.8 * B then humanity is still ok. But if A = 2 * B (tech is twice as fast as humanity), then we have a problem. Can we empirically measure A and B with enough precision to be actionable?

According to Figure 1, the mathematical slope of the green curve ("A" in the above) is 3.3 times that of the blue curve ("B" in the above). So, we don't currently know the maximum adoption rate for humanity, but we do know that the technological development rate is more than 300% greater than the sociological development rate. What happens now? Are we already past our limit?

And, again, not all technological developments are equal. Some have greater power (for good and bad) and societal implications, like Generative AI, but those get no more time for adoption than does a faster USB cable.

How can we raise humanity's max tech adoption rate? (Can we?)

If the new technology development rate is A and the maximum adoption rate for humanity is B and Y is X/3.3, (or X = more than three times Y) where does that leave society? Is it possible to increase humanity's ability to assimilate new technologies? What would that look like? On a diverse planet of 8+ billion, how do we "raise our B"? Can we?

Can humanity use technology to speed up its ability to adapt… to technology?

Some might argue that "if you can't fight 'em, join 'em!" Under this philosophy, things like mind-machine interfaces (via companies such as Neuralink) might accelerate individual assimilations. But does that mean that all humanity must get neural implants just to keep pace? Is that a tenable bending of the blue curve?

What other methods do we have at our disposal to bend the blue curve upward?

How can we lower the new technology rate to give humanity time to manage?

Not all technological developments are equal. Curing Polio matters way more than a speed upgrade in a USB cable. Neither impact humanity's ability to self-organize around either development. But nuclear weaponry or biological weaponry does require humanity to self-organize around controlling that technology or it risks self-destruction.

Self-destruction can also come from non-lethal (at least un-intentionally non-lethal) technologies.

For example, a wide range of technologies called pesticides, created at the direction of society to increase crop yields to meet the increasing global demand for food, were a good thing for humanity, for a time. And humanity self-organized around these technologies with laws and regulations regarding their ingredients and use. But pesticides, and their cousin herbicides, eventually led to dangerous unintended consequences like cancers, blights, pest-resistance and desertification.

In the former examples, those technologies and associated systems had a known ability to deal humanity a fatal or near-fatal blow… quickly. In the latter examples, it was unknown and unanticipated that they could deal humanity a fatal blow… slowly. In one case, humanity had to act quickly to manage the catastrophic risk… and did. In the other, it is still working to manage that risk.

In both scenarios, humanity was directing the technological developments.

But today is different. Scientists and technologists, numbering in the dozens to thousands depending on the technology involved, are completely "unfettered" in their ability to conceive, incubate, give birth, and deliver radical technologies that may or may not have nuclear bomb or pesticide like implications. And they do so without consultation with humanity.

Is it appropriate, or even possible, that technological developments should be "fettered" by humanity to ensure that humanity is not put at risk inadvertently? If so, what would that look like?

Assuming that the central proposition here is that we "***Bend the Blue Curve***" upward – what does that mean? It means that we need another "movement" like human rights or birth of legal systems – whereby humanity asserts its dominance over technological development – rather than being subordinated to it.

Who decides the technology development rate?

When society needed a cure for polio, society challenged scientists to find one. That is to say that scientists responded to a societal need. Society was the driver while science was the passenger. When President Kennedy challenged NASA to put humans on the Moon, scientists, mathematicians and engineers strained but successfully met that challenge. When the world was at war in the 1940's and a fascist war machine was on the verge of using the morally neutral knowledge of nuclear fission and fusion to build a morally biased technology called a nuclear bomb, the United States government (imperfectly) challenged scientists and technologists to win that race to end the war sooner and definitively in favor of the non-fascists.

In short, in the pre-modern and modern eras, scientists and technologists largely (with exceptions) were driven by society.

Over a period of perhaps 50-70 years, this changed. Science/technology has become the driver and society the passenger. Today, scientists and technologists, with ever more imagination and resources, can and do manifest their own visions for the future. Entire new categories of tools are emerging from the minds and labs of governments, universities, and companies – at an ever-increasing speed. Ideas like smartphones and social media are not born out of a polio-like societal need. They are born out of a handful of people's vision and "presented" to society in some palatable way for adoption. Often, that palatable way is underwritten by perverse incentives.

But just as tools like social media have proven, such "unsolicited" tools become integrated into society at breakneck speed, without careful consideration for the risks they may engender. This is because, again, society's self-organizing nature is slow, and society is not driving the developments; they are reacting to them.

Consequently, the few technologists are deciding the technology development rate for us, *not with us*. Are their motives and ours the same?

Summary & Solutions

In my lifetime, the global population[12] has grown from 6 to more than 8 billion people. About 12,000 years ago (the point where the data for Figure 1 begins) the global population is estimated to have been about 5 million. New York City alone, today, is over 8 million. Nobody knew 12,000 years ago if only a handful of people on the planet could direct the future arc of humanity. But that is certainly true today.

Perhaps nation-state leaders (democratically elected or otherwise), like the President of the United States, or the King of Saudi Arabia, or the General Secretary of the Chinese Communist Party – have incredible influence over large populations of people and their daily lives. But increasingly, it is not these people who PROGRAM the arc of humanity. Increasingly, that emerges from the commercial (and mostly technological) titans of our day.

The science, technology, and products that companies like Google, Facebook, Amazon, Microsoft, OpenAI, Apple, Intel, and many more from the US and abroad, have become so integrated into our lives as to be nearly impossible to live a modern life without them. Soon, this will become true also for biotechnologies.

You know names like Bill Gates, Jeff Bezos, Steve Jobs, Elon Musk, Mark Zuckerberg, Satya Nadella, Larry Page, Sergey Brin, Sundar Pinchai and most recently, Sam Altman. Many of these names are household names because the technology-based products they build have become essential, indeed fully integral to our lives. But there are many others you have likely never heard of that also hold similar power to affect your life today, or in the very near future.

These few people, and perhaps a few hundred others, will have more impact on your life than your mayor, your governor, your president, your king, or other leader – combined.

Do you recognize names like Craig Venter, George Church, Jennifer Doudna, Feng Zhang, Sam Sternberg and others in the realm of synthetic biology and other genomic sciences/technologies? Or researchers like Ilya Sutskever, Ben Goertzl, Jurgen Schmidhuber, Geoffrey Hinton, Yoshua Bengio, Yann LeCun, Andrew Ng, Demis Hassabis, and others in Artificial Intelligence. And people like Michelle Simmons, Winfried Hensinger, Robert Schoelkopf, David Wineland, Robert Shor, Eric Ladizinsky and others in Quantum Computing research.

A handful of luminaries are driving the bus in each case. This relative handful of people are having, and will have, profoundly deep and broad impact on the lives of 8.1 billion. They were not elected. They were not appointed. But the power they wield over our lives, is not calculable.

[12] https://www.worldometers.info/world-population/

INTELLIGENCE VERSUS WISDOM

I am reminded of something the late, and great, Edward de Bono wrote in his book Tactics[13]:

> *There is something I have come to call the 'intelligence trap'. This means that some highly intelligent people may turn out to be rather poor thinkers: they are caught in the 'intelligence trap'. There are many aspects of this. For example, someone whose self-image depends on being right and on being the cleverest is unwilling to admit error or take the intellectual risks necessary for creativity. Highly intelligent people are often able to construct a coherent support for a particular point of view. The more able they are to construct such a support; the less do they see any need actually to explore the subject. Hence, they remain locked into a particular point of view.*
>
> *I like to think of intelligence as being equivalent to the horsepower of {the engine} of a car. The skill of thinking is then the skill {think: Wisdom} of the driver. There may be a powerful car driven badly and a humble car driven well. Indeed, a powerful car may be particularly dangerous because it demands a higher degree of driving skill.*

Why are these two short paragraphs relevant to this topic? They are and, indeed, hugely so.

The few scientists and technocrats that are driving all this technological development are, mostly but not exclusively, in Silicon Valley. They are indeed, in a word, brilliant. I am certain that if we averaged the IQs of those trying to build a "superintelligence" – it would surely be in the vicinity of genius level smart. They value intelligence, perhaps as the singular most defining human characteristic, because it is their identity.

The same is true of those driving the bus on biotechnology. They are all, brilliant. They place a lot of value on intelligence. But intelligence is not all there is to being human.

We also have emotions, which some of these scientists argue are just "processes" of our brains anyway. For them, even emotions are rooted in brains and intelligence.

But there is something far greater than intelligence and/or emotions. It is wisdom.

Wisdom is about judging the right action(s) to take. If knowledge is power, then the greater our knowledge (or intelligence), the greater the need for wisdom to know when, how and why to wield that knowledge/power.

While the world seeks "superintelligence" (raw processing power) as if that is all there is, what is needed is something greater: "superwisdom." Superwisdom to make the right judgments and actions regarding superintelligence, genetic manipulation, silicon-carbon convergence, and the rest.

This race to build a silicon superintelligence and, simultaneously, a biological superhuman race mandates not only an equal, but a superior, wisdom. A "superwisdom" to match the power of a superintelligence and/or a superhuman race.

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[13] https://books.google.com/books/about/Tactics.html?id=BOQCC_pAjgYC

WHERE will this superwisdom come from? WHO will embody it? HOW will its wisdom find sufficient agency to manage the other "super" things we seek to create? WHEN will this wisdom be needed? The answer is NOW! NOW is when we need it so that, as we try to build these super-things, we can know how to manage them.

One of the root causes of the situation we now face – is that a *few* are racing to create a superintelligence and/or a superhuman race (that only those *few* will define) without also racing toward superwisdom. I assert that the reason for this is that those who are driving the race are enamored of intelligence and their vision for the things they are seeking to create, without seeking the wisdom to know if they should even create them at all. Or if they do, the wisdom to put a "harness" on the things they create. That "wisdom void" MUST be supplied by you, me, and the remaining 8.1 billion people on this planet. But most don't see what is happening.

CHOICES

Sometimes, when things are happening to us either very slowly, or in very small increments, or in a mixed bag of good and bad, or all the above, it takes a very deliberate kind of attention to notice the change at all. And while many of those changes are indeed good for our species, not all are. But, more importantly, the many and varied value systems around the planet make it highly improbable to agree on the good or bad of those changes.

Therein lies the danger. Therein lies the opportunity. Therein lies the necessary challenge.

We surrender our personal agency when we approach a traffic signal and it is green, yellow, or red. We arrived at that urban traffic management solution over many decades, in many places, with a lot of debate by the population in collaboration with governance and engineers. We didn't get there overnight when a handful of engineers magically dropped traffic lights into every intersection on the planet and we all just had to deal with the new reality.

But there is a fair analog of that magic happening right under our noses. Engineers in information technology, biotechnology, energy, artificial intelligence and more – are pushing out technologies to society at ever accelerating rates. And it is happening ***without*** public awareness, dialog, or consent. I am plainly stating that this dynamic is unhealthy for humanity and this paper argues in favor of a new, deep, and urgent dialog.

This paper hopes to empower you, the everyone, to reclaim your personal agency. And to you, the actors, I invite you to reconsider your relationship with everyone else so that you can more effectively serve their enlightened will.

There is one conclusion, and perhaps solution, that I arrived at very slowly over the months that I have been researching, interviewing, thinking and reading about these issues. But, before I share those ideas, I'd like to opine on this fork in the road for humanity – and three possible post-fork directions it could take.

FORKS IN THE ROAD FOR HUMANITY

Fork #1: Rampant consequences of just generative AI (not Superintelligence or Transhumanism)

We, as humans, have choices. If we, collectively, choose to - we can avoid both Superior Machine Intelligence (Superintelligence) and Transhumanism. But specialized A.I. and generative A.I. are

both here to stay and companies, non-profits, governments and consumers are going to rapidly, and ubiquitously integrate these technologies into our work, governance, health, finance, entertainment and more aspects of our lives. And they're going to do it – *FAST*.

What happens when the department head of whatever department in whatever company, discovers that with AI embedded in Office 365 and/or Google Docs/Sheets/etc. figures out that with 6 of their best and brightest, augmented by AI, they can do the work of their current 20 staff? They will offer the door to the 14 less capable. Many will say: "That's ok, they'll just retrain and do other jobs." The logic and math on this say otherwise.

Imagine that same scenario playing out in department after department and company after company. And fast. Faster, in fact, than the "reabsorption rate." AI could be the most productivity enhancing tool ever devised by humanity. Displaced employees will first look to take related jobs within their existing company or the same job in another company. But other departments and other companies will be shedding staff too, not hiring. Where will these displaced workers go? Other companies? Unlikely, for all the same reasons.

So, they'll "retrain" for new roles. But what roles? The "role flux rate" is going to skyrocket. In other words, the rate at which most jobs will change, will rapidly accelerate. What if the flux rate is higher than the retrain rate? By the time the employee retrains for a new role – that new role will have changed. This spiral is as inevitable as its consequence: mass unemployment.

In addition, and this cannot be overstated, most of the so-called proponents of AI integration are saying that *everyone* is going to have to become technology and AI savvy/centric if they want to work. But not everyone is capable, willing, or interested in a job in which they sit in front of a screen all day. Where will those people go?

When this starts to happen – it will be "lumpy." It will happen at different rates in different industries and different geographies, starting with urban areas. In those areas, the most "systematized" roles (specialized) will be among the first jobs impacted. People will try to "hold on" to their lifestyle, but not finding work that pays as well, the slide will begin. Mortgage failures will rise, and housing markets will saturate, driving deflationary pricing. The so-called "mass relocation" of the Covid pandemic will pale by comparison.

The economy will not only be volatile, but it will face new waters. The existing economic models and tools for managing the economy will no longer apply. On the one hand, companies will be reporting amazing profits and productivity, catalyzed by AI. On the other hand, unemployment will soar to depression era percentages and housing, finance and other sectors will be crashing. There is a reason that Silicon Valley executives have been lobbying Washington D.C. for Universal Basic Income (UBI) for years now[14] [15]. It's self-preservation for when the masses get angry with them for taking all the jobs. One contributor to Columbia University thinks UBI should mean Universally

[14] https://www.theguardian.com/technology/2016/jun/22/silicon-valley-universal-basic-income-y-combinator
[15] https://www.vox.com/2018/3/8/17081618/tech-solution-economic-inequality-universal-basic-income-part-democratic-party-platform-california

Bad Idea[16]. It's not a tested or proven solution. But the idea won't die. I am not necessarily advocating for or against UBI, just pointing out that Silicon Valley has been lobbying for a highly debated policy for a reason.

What happens when humanity is "liberated from all labors" as is promised by AI? While, simultaneously, humanity is seeking to enhance itself as a species – living longer and healthier – but with less and less, or nothing, productive to do?

Psychologist Victor Frankl, while imprisoned in German concentration camps during WWII, developed the core principles of what would later open an entire field of psychology called "Logotherapy". In his widely read 1959 book, "Man's Search for Meaning" toward the end of the book (pg. 106-107) he writes about what he calls "The Existential Vacuum":

> The existential vacuum is a widespread phenomenon of the twentieth century. This is understandable; it may be due to a twofold loss which man has had to undergo since he became a truly human being. At the beginning of human history, man lost some of the basic animal instincts in which an animal's behavior is imbedded and by which it is secured. Such security, like Paradise, is closed to man forever; man has to make choices. In addition to this, however, man has suffered another loss in his more recent development inasmuch as the traditions which buttressed his behavior are now rapidly diminishing. No instinct tells him what he has to do, and no tradition tells him what he ought to do; sometimes he does not even know what he wishes to do. Instead, he either wishes to do what other people do (conformism) or he does what other people wish him to do (totalitarianism).
>
> A statistical survey recently revealed that among my European students, 25 percent showed a more-or-less marked degree of existential vacuum. Among my American students, it was not 25 but 60 percent.
>
> The existential vacuum manifests itself mainly in a state of boredom. Now we can understand Schopenhauer when he said that mankind was apparently doomed to vacillate eternally between the two extremes of distress and boredom. In actual fact, boredom is now causing, and certainly bringing to psychiatrists, more problems to solve than distress. And these problems are growing increasingly crucial, for progressive automation {Artificial Intelligence} will probably lead to an enormous increase in the leisure hours available to the average worker. The pity of it is that many of these will not know what to do with all their newly acquired free time.
>
> Let us consider, for instance, "Sunday neurosis," that kind of depression which afflicts people who become aware of the lack of content in their lives when the rush of the busy week is over and the void within themselves becomes manifest. Not a few cases of suicide can be traced back to this existential vacuum. Such widespread phenomena as depression, aggression and addiction are not understandable unless we recognize the existential vacuum underlying them.

16 https://wwwo.gsb.columbia.edu/faculty/gee/3)%20Should%20the%20USA%20Adopt%20the%20Universal%20Income/Universal%20Basic%20Income_%20A%20Universally%20Bad%20Idea.pdf

So, as our economy (24% of the global economy with only 4% of the global population) experiences mass unemployment and the ensuing unproductive population struggles to fill the psychological void – their individual Existential Vacuums – repercussions will reverberate in ways unknown.

That is just the "natural" consequences of AI and doesn't address CRISPR and synthetic biology or transhumanism.

Fork #2: The consequences of Superintelligence + Transhumanism

What happens if a Superior Machine Intelligence (SMI or "superintelligence") arrives? The truth is we don't know and cannot predict. But a relatively useful analogy here might be to liken that arrival of SMI to the arrival of an alien species from another galaxy. Imagine that the aliens are much smarter than us and utilize technology that is superior to anything we've ever created. We would have no idea of their true intentions and we would likely feel threatened.

As one of the "godfathers of AI," Geoffrey Hinton poignantly asks, "*Can you tell me of one example where a lesser intelligent creature had any level of control over a more intelligent creature?*" We have no examples of ants, dogs, dolphins, plants, or any other living (sentient or otherwise) thing, exerting any control over us. We've never encountered a species vastly smarter than we are. It is logical to think that we will not have any power (agency) over that alien species.

Humans want autonomy and agency, and they'll fight for it. And part of that fight will be to try and compete with that superintelligence. How can humans level the playing field? They won't be able to, but that doesn't mean they won't try. Humanity will look for advantages and one of those comes in the form of transhumanism.

Transhumanism will come through organic and inorganic means. Scientists are already experimenting with both.

I refer you back to the quote from Steven Potter's Book in the Biotech portion of the Commentary section in which he talks of scientists who want to use CRISPR to "engineer" the human species to make it smarter, stronger, faster, or whatever desire might be in societal vogue at the time. With AI pressing on humanity, it will seem reasonable to use CRISPR to enhance biological intelligence.

Then there are companies like Neuralink (Elon Musk) who are developing "neural implant" devices. These machine-mind interfaces, once implanted in the brain, could accomplish a range of advantages from helping a deaf person hear to allowing our brains to connect directly to the Internet or various devices.

Elon Musk, in 2019 when announcing Neuralink at a San Francisco event[17] said that "the idea is to create a 'well-aligned future' that mitigates the supposed existential threat of AI." Musk has been vocal about the impact that AI will have on humanity, perhaps existentially. In 2017 he said that humans will need to become cyborgs[18] to survive AI. Neuralink is working toward that future.

[17] https://www.dezeen.com/2019/07/22/elon-musk-neuralink-implant-ai-technology/
[18] https://www.dezeen.com/2017/02/15/elon-musk-humans-become-cyborgs-survive-artificial-intelligence-technology-news/

Steven Potter, Ph.D. and others think that we should be engineering (via CRISPR) the human species to be more intelligent. Elon Musk and others think we must become cyborgs to compete with AI. What are the consequences?

At what point does tinkering with the human germline to "evolve us" in our own image – make us not human? Where is the line between the "natural" and the "designer" humans? What are the social consequences of being a "natural" or a "designer" human? What about the various (not just brain) implants that transform us? Where does the organic "self" end and the electronic "self" begin? This is transhumanism. So many questions.

But the reality is that neither CRISPR nor Neuralink are moving anywhere as fast as the race for AI and the consequences are huge for which technology becomes dominant first. If it's AGI, then likely CRISPR and technologies like Neuralink won't matter.

If we can use CRISPR to engineer the massive increase in intelligence needed to compete with AGI when it comes – what does that make humanity look like? And there are plenty of studies about the razor thin line between high IQ people and mental illness. Current IQ always pegs "average" intelligence at 100. Genius level is around 140. Einstein was thought to be near 170. To compete with AGI, humans will need the "average" IQ to be, what is by today's measure, up above 1000. And maybe that won't even be enough. And what mental illness will come from such high IQ? And, since presumably, this IQ will not be evenly distributed throughout humanity – aren't we just creating another "superintelligence" vs "regular intelligence" tension (between human societies)? What does it solve?

Let's say we implant chips in our brains that let us "connect" in real-time to the great expanse of the Internet and all the "knowledge" it contains being a mere thought away. Or let's say we give ourselves the ability for our brains to connect directly to a host of devices giving humanity the equivalent of tele-kinetic abilities to manipulate the world around us with thought. What will prevent some from connecting directly to the superintelligent AI and, thus, extending their power through the AI or the AI extending its power through those specific humans? What kind of societal dynamic does that initiate?

Frankly, I don't see either approach resulting in a very good outcome for humanity. And I don't see it mattering if A(G)I gets here first – which is looking more and more likely under current conditions.

Fork #3: No Superintelligence or Transhumanism, and no rampant consequences

What about this third fork? What if humanity avoids the whole superintelligence (AGI) thing and the whole transhumanism thing? And all the commensurate existential dangers aforesaid? Some might say that is "stagnation" or "neo-Luddite-ism" or just good old-fashioned "resistance to change." To those people I say, "Just because you *can* do a thing, doesn't mean you *should* do a thing." Just because my car can do 160mph on the highway, it doesn't mean I should do it. It's not safe for me, or others, so I don't.

What if we, collectively as a species, say that AGI isn't good for us – as a species?

That doesn't mean we don't continue to develop specific cases of AI to improve reading mammograms, or discover how proteins fold, or how to contain and stabilize magnetic plasma fusion bottles. We should. Humanity's march of progress should continue.

Slowing down the AGI arms race, or stopping it entirely, is worth considering. Slowing down the "engineered evolution" race is also worth considering. Humanity often overdrives its headlights. We think that because we can see X yards ahead, we can see 2X or 3X, but that is just human hubris.

There are great possibilities offered by all these technologies. And humanity should consider them carefully, even desire them. But a race by a handful of humans to shape our collective human future, without our consent or involvement, is inappropriate. Yes, with our involvement, some will say – probably rightly – that ensuing debate will take decades and AGI will be "held up" during their lifetimes. They're likely to be right. But if that is the collective will of humanity and they disagree with that – they have the right to hold that position – but they should not have the right to unilaterally act on their position. To do so is to say, "I'm right and the world is wrong."

The question is – since this race is driven by entrepreneurship – which has always been "sacred" in our society – and technological entrepreneurship more "sacred" than most – how do we as a species - impose our collective 8.1 billion will on the few hundred or thousand scientists, technologists and entrepreneurs?

OVERVIEW

What is the solution? In a single word, it is "superwisdom". But what form does that take?

In the abstract (I'll address the concrete next), the solution has three parts:

1) A new blue dot on the Techno-Socio Gap chart that pulls the Blue Curve upward – that blue dot represents a new sociological development which I'll call "Technological Service Movement". That blue dot must have an impact score of 40 or more to matter. This "Movement" involves a change in mindset from "completely unfettered" to "managed fettering" of technology. There is historical precedent for this which I will cover below.
2) The "Technological Service Movement" must be technologist led, and global, in collaboration with governments around the world.
3) Commensurate with such a "movement" – communication and education initiatives that make the case for the non-technical person.

BACKGROUND

Nuclear weapons. Biological weapons. Climate change. Conventional explosives. Opiates.

There are plenty of precedents whereby humanity, globally, has collaborate and cooperated to define a set of boundaries that restrict access to certain dangerous technologies.

These things are "controlled" by collective agreement across most national boundaries. There are nuclear arms treaties. Biological weapons treaties. Carbon emissions treaties. There are controls on a wide range of precursor substances that are needed in the production of such items. You cannot purchase Uranium or Plutonium at the local Walmart or Home Depot. Nor can you get access to strains of smallpox or a wide range of chemicals and biologics that are used in the manufacturing of

various lethal biological agents. Even certain compounds used in making TNT (Tri-Nitro Toluene) are restricted access. And if you are caught growing poppies, you can go to prison for that too.

One way to restrain production of unwanted items – is to restrict access to key components used in their production. Legislation and/or Executive Orders are required for this in the US. And if you want those restraints globally, it takes a concerted global effort to reach broad agreement. This has happened often enough that we have precedents.

The International Atomic Energy Agency[19] (IAEA) is an intergovernmental agency whereby nations cooperate to restrict atomic weapons while promoting peaceful energy through atomic power.

The Biological Weapons Convention[20] is also an intergovernmental organization that works to restrict biologic Weapons of Mass Destruction (WMD).

There are many such examples. When the collective risk is high enough and the "accessibility" to the technology is easy enough – nations come together to put sensible controls in place.

So, regulatory controls emerge to prevent "bad things" like bombs and biological weapons. But they also exist to protect against "unintended harms" from good things. Take pharmaceuticals as an example. Pharmaceuticals have relieved a great deal of human suffering. They are a good thing. However, accidents and mistakes happen. And when a single thing, in this case a drug, can be used by millions or billions of people – there are careful steps to take to make sure that it is as safe as it is beneficial. For this, in the US, we have the Food & Drug Administration (FDA) which regulates the release of drugs. The FDA drug approvement process in the US is rigorous and arduous. It takes millions or billions of dollars to bring a drug to market and the FDA is there every step of the way making sure the drug is safe for broad use.

Even space flight is controlled. While SpaceX has demonstrated that private commercial space activity can be safe and productive, it is still required to obtain a "launch license" every time it wants to launch a rocket and put something in orbit. NASA (National Aeronautical and Space Administration) and the FAA[21] (Federal Aviation Administration) work together to review and grant licenses and permits to operate space ports and launch objects into orbit.

In fact, in the USA, to drive an automobile on the open roads or fly a plane – you must earn a license. When these new technologies called cars and planes were first emerging in the early 20th century, there were a lot of fears about them. Legislation and regulation emerged to ensure the safety of both modes of transportation, for the pilot and those around them.

Why are Large Language Models (LLMs) and other forms of AI not subject to similar regulatory restrictions? If I can't launch a rocket without a license or get a drug to millions of users without some kind of regulatory oversight – why should a company be able to release a new AI (or potentially an AGI) without the same kind of oversight? Particularly when such technology can, is, or will have a potentially existential impact on humanity.

[19] https://www.iaea.org/
[20] https://www.un.org/disarmament/biological-weapons/
[21] https://www.faa.gov/space/licenses

This is because "technology" (primarily information technology) has risen, in global mindset, to a place where it is seen as an "unrestrainable good." And those that make these tools, as "unrestrainable agents of good."

But this mindset is both new, and old.

In 387BCE, Plato established his Academie for small collections of students. Aristotle followed suite in 335BCE. Small such institutions continued here and there for the next 900 years until the fall of the Roman empire and the Middle Ages. At which time, the only institution, widely, that maintained a deposit of knowledge was the Christian Church. Monasteries were the storehouse and the teaching institutions of the age. These later (about 400 years later) grew into what we call Universities today.

So, for roughly 1400 years, institutions of knowledge/learning were "secular" and operated without restrictions on "research" or "publishing" (modern methods of both did not emerge until the 15th century or so).

Because the Universities that emerged during the Renaissance were mostly tied to the Church, there were some avenues of research and teaching that were considered "heretical" or "wrong" and, thus, restricted by the Church. Thus, researchers and professors were not always free to pursue whatever they wished. They were "fettered" by the Church.

After more secular Universities re-emerged in the 19th Century, these restrictions began to fall away. The system we call "tenure" emerged as the standard. In tenure, a professor or researcher (once they achieve tenure status) is free to pursue any area of research they wish – unfettered.

That freedom is the standard today. And because of the tight relationship between academia and technology companies (academia discovers the science that the technologists then apply to make products) – that "mindset" of "unfettered" research and development into technologies and products has become the new norm.

However, what happens when that research and development leads to things that humanity objects to? And what happens when it is happening so fast (green curve) that society and humanity (blue curve) cannot keep up? That is, as this paper has been saying, the Techno-Socio Gap.

I believe that there are scientific and technological directions that we could pursue, but we shouldn't. But my opinion is just that of one person. There are another 8 billion to be considered.

> I AM SUGGESTING THAT WE RETURN TO A KIND OF FETTERING – NOT BY ANY CHURCH (THOUGH THEY SHOULD STILL HAVE A VOICE) - BUT ONE GUIDED BY THE PEOPLE, MEDIATED BY TECHNOLOGY AND "WISE TECHNOLOGISTS", AND ENFORCED BY GOVERNMENTS.

THE BIG BLUE DOT

What we need, therefore, is another Sociological Development (movement) that pulls the blue curve up. I am asserting that the needed Big Blue Dot is a "movement" where humanity at large

recognizes this situation and re-asserts its agency (superwisdom) over technology and technologists.

What might that look like?

It begins with this paper and other papers and movements like it – working together to inform, educate and influence public opinion of what lies ahead. There is some work in this regard already. And very good work it is.

Organizations like The Center for Humane Technology[22] (CHT) is a fine example. The work of Tristan Harris and Aza Raskin is profound and thought leading. Their exemplary film: The Social Dilemma (Netflix) has changed many minds about social media. Though I think the view of this paper is broader than that of the CHT, I think they are vital to this dialog.

There are other similar organizations doing similar work, such as: The Future of Life Institute[23] (FLI) (Max Tegmark), the Future Today Institute[24] (FTI) (Amy Web), the Center for AI Safety[25] (CAIS) (Dan Hendryks) and more.

These entities are informing and educating the masses and, vitally, policy makers. We need MORE of that.

There are also movements like "Pause AI"[26] (PAI) that are global and member volunteers are working to raise awareness and influence. These are also needed and making a difference.

However, while good – each is narrow in focus (mostly about AI) and, I believe, are missing the wider picture. That wider picture is best embodied in the Emerging Technologies Map in Appendix A. A broader initiative is needed.

What is generally good about all of these is that they are led by technologists themselves – not politicians or regulators or other bureaucrats. This is essential for several reasons, but the greatest of which is – they KNOW the technology way better than the politicians, regulators and bureaucrats – and they are PART of the community. So, it's a kind of self-policing approach – backed by governmental power.

If we can manifest this Big Blue Dot – we can accelerate societal change to help keep pace with technological developments. But, in a perfect world, we would also slow down the green curve of technological developments – at least for select technologies. And, in truth, the Big Blue Dot and Bending the Blue Curve are about changing the cultural mindset around the unfetteredness of technology – which, in the end, results in bending the green curve down just as we are bending the blue curve up.

This narrows, not closes, the Techno-Socio Gap.

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[22] https://www.humanetech.com/
[23] https://futureoflife.org/
[24] https://futuretodayinstitute.com/
[25] https://www.safe.ai/
[26] https://pauseai.info/

What can you, the reader, DO to make this better?

I can offer ideas like:

- Subscribe to newsletters from the CHT, FLI, FTI, and CAIS.
- Join an organization like Pause AI
- In your favorite news browser, create a filter for A{G}I, CRISPR, Synthetic Biology and more. Get informed.
- Of course, I encourage you to network with technologists in these fields. Talk with them. Learn. And don't be afraid to voice your concerns.

But, in the end, all of us are going to need to think together about how best to organize this "Big Blue Dot" or "Blue Curve" "movement". I don't have all the answers. I don't even know all the questions. 😊

My part, as I see, it, is to inform and frame the issue. But I think that is best summed up by a CRISPR Pioneer, Kevin M. Esvelt, Ph.D., who developed the concept of a "Gene Drive" who said: ***"Some boxes should be left closed."*** And ***"What keeps me up at night is the question of 'What's next?' The future of our civilization will primarily be determined by the technologies that we invent and the wisdom with which we choose to use them. More than technological power, it is wisdom that we need."***

I couldn't agree more. It is wisdom, indeed "superwisdom," that we now need. And it's up to us to supply it.

If you have other ideas, thoughts, suggestions, questions – anything you think will be helpful to this cause – please reach out to me via my contact page at: https://JoeChiarella.com/contact.asp

Thank you for reading this.

Joe Chiarella

Appendix A – The Emerging Technologies Map

While there is a lot of popularity now around the topic of Artificial Intelligence (Transformer models in particular – i.e. Generative AI) – there are many other emerging technologies that will eventually appear on the table of Technological Developments.

The following map is an attempt to identify a reasonably complete constellation of these (near future) emerging technologies, and document how they are inter-connected. It is not a detailed treatise on each category and sub-category. I am considering a companion document to more fully elaborate on all the bubbles on this map.

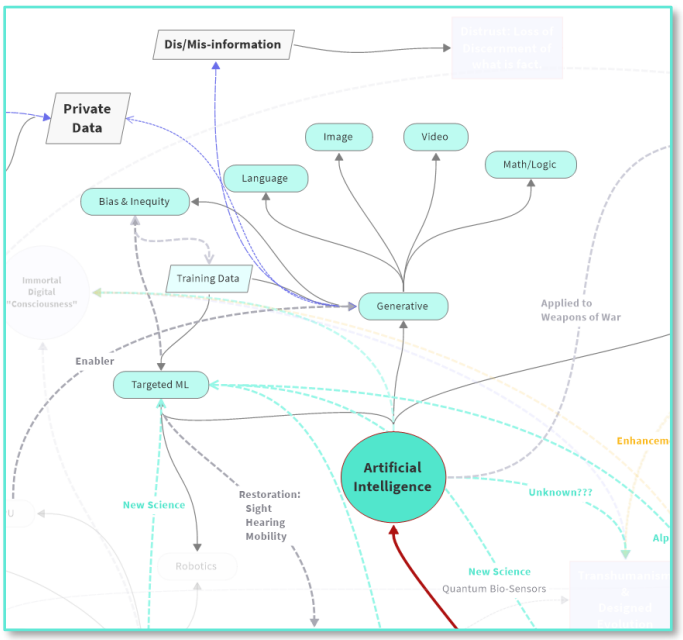
In this map, there are six areas of rapidly emerging technologies: Artificial Intelligence (9, 11), Computational Power (13, 10), Space (6, 3), Energy (8, 3), Materials (8, 7) and Biotech (21, 10). In total, there are 65 (9+13+6+8+8+21) sub-categories of emerging technologies. There are 44 ways (11+10+3+3+7+10) that these 65 sub-categories interconnect. And there are eight "termination points" that embody some level of existential risk.

The goal and value of this map is being able to "see the bigger picture." To be able to capture as much of the emerging future as possible to assess benefits and risks of future Technological Developments. Once these are placed on the data table, we can add them to the trend curves to refine that predictive curve.

Our society tends to fixate on whatever is the new shiny tile of the moment (AI today, Blockchain yesterday, Bitcoin before that…), and thus fail to see the entire mosaic. And failing to see the entire mosaic can involve risks. This map is the remedy. Let's break it down by each of the six categories.

Artificial Intelligence

What used to be a reasonably obscure technology (for the average consumer), Artificial Intelligence (AI) has now burst into the popular sphere. On the one hand, it promises to change our lives for the better, but on the other hand, there's fear that the "change for the better" looks like a lost job.



Sub-categories in Artificial Intelligence:

1. Targeted ML
2. Generative
    a. Language
    b. Image
    c. Video/Audio
    d. Math/Logic
3. AGI/SMI

The category of Artificial Intelligence has exploded. Beginning with the advent of Deep Learning Neural Networks in 2017 – many new applications became possible that were not possible before. And that shiny orb was leveraged to do everything from identifying cancers in mammograms to presenting you with just exactly the right stuff to keep you consuming that "infinite scroll" on your smartphone – so you'll see more ads and buy more stuff.

Then, in late 2022, a previously not-widely-known form of AI called a "Transformer" – burst into public view with the release of a generative AI chat bot called ChatGPT from OpenAI. Since then, the world has been on fire.

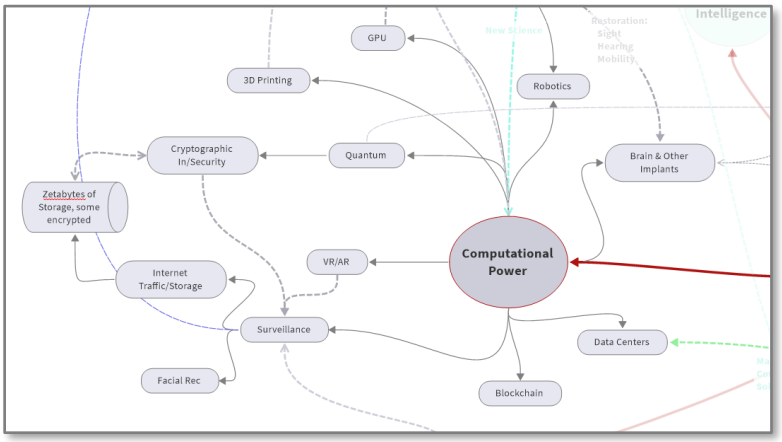
But there is much more coming. Most Transformer models today are focused on Large Language Models (LLMs). But the magic of a transformer is that it can "learn" any abstract representation system – of which human language is only one. Computer programming languages are another – and LLMs are particularly good at learning and generating those. Wait until LLMs start creating their own programming (and non-programming) languages.

In the near emergent future (next two years) we will see Transformers emerge for Image, Video, Audio in the "relatively easy" category – but then also the harder categories of Math, Symbolic Logic and more. Each of these are precursors to actual reasoning, versus the appearance of reasoning that we see today. And all of that will lean toward Artificial General Intelligence (AGI) or alternatively known at Superior Machine Intelligence (SMI).

There is a lot more that could be written here, in general, about AI and AGI/SMI – but this paper is not a treatise on that subject or the other four categories of Computation, Biotech, Energy and Space.

What remains to be said has to do with how AI interacts with those other four categories. All the inter-category interactions are addressed collectively after each of the six categories are addressed.

Computational Power



The category of Computational Power is pretty much an "enabler" to all four other categories. It goes without saying but included here for emphasis: absolutely nothing happens in AI, Biotech, Space or Energy without computers. And computational power has been doubling pretty much every two years for about 40 years now – thanks to Moore's Law.

Again, this paper is not meant to be a treatise on any of the below-stated sub-categories. However, there are interactions between computational power and those other four categories that benefit from a little level-setting first on one or two of the sub-categories.

Sub-categories in Computational Power:

1. Robotics
2. Brain & Other Implants
3. Data Centers
4. Blockchain
    a. Surveillance
    b. Facial Recognition
    c. Internet Traffic/Storage
5. VR/AR
6. IOT
7. Quantum
    a. Cryptographic In/Security
8. 3D Printing
9. GPU

Generational Shift

There is a seismic generational shift underway for computation. That shift is to massive energy consumptive data centers. This shift began with the "transformation" to "the Cloud" that began about 15 years ago. The "Cloud" moved us back toward centralization from decentralization embodied by personal computers and local area networks – which was a decentralization from mainframe computers.

This "re-centralization" was with classical rack computers running hypervisors for mass virtualization. Then, it gained some momentum with Blockchain and crypto-coin mining operations that required hundreds or thousands of high-electricity-demanding GPUs. Now, this nascent next phase of rapid growth is being fueled by thousands and tens-of-thousands of GPUs to power generative AI.

Blockchain mining operations around the globe, in aggregate, currently consume nation-state levels of electricity. The latest estimate from the International Energy Agency[27] is that mining operations in 2022 accounted for 110TWh or 0.4% of global electricity production and equal to the total demand of the Netherlands. AI data centers are estimated to rise to 70TWh or more by 2026.

Sam Altman, the CEO and co-founder of OpenAI, has publicly stated that he believes future AI data centers will have to be nuclear fission powered. He is so convinced that he personally invested in a "micro reactor" company called Oklo (NYSE: OKLO) [https://www.Oklo.com] and helped take that company public in 2022 via a public SPAC. There are other such new companies like NuScale and TerraPower, along with traditional energy plant product companies like Westinghouse and GE.

Revolution

One of the subcategories of Computational Power is "Quantum". The last 10 or so years have brought great progress toward the goal of the full realization of quantum computing. The race began as an academic research effort some 40 years ago, Nobel-awardee Physicist Richard Feynman at CalTech posited that quantum computing was possible.

Today, in addition to US, Chinese and other National Laboratories, private companies such as IBM, Google, Amazon, Intel, Microsoft and others have their own quantum development efforts underway. And companies such as D-Wave, Quantinuum, Rigetti, Xanadu and others make commercial quantum computers.

Quantum computers, versus classical computers, operate via "quanta" or "qubits" instead of binary 1's and 0's. But that is a dramatically incomplete description and distinction. They also are each ideal for solving different kinds of problems. Quantum computers can, for example, factor composite numbers (the product of two prime numbers) into the two original primes – in seconds. Whereas classical computers cannot solve that math problem at all – except by brute force of trying one multiplication of two primes after another until the accidentally get a match; a process that could take thousands of years with current classical computers. On the other hand, a quantum computer would be very hard to program to make it do word processing.

There is a lot of speculation now that quantum computing and artificial intelligence are on a converging course. The product of that convergence could mean a several orders-of-magnitude reduction in compute resources (read: electricity) needed to generate that fake image of a puppy in a suit walking a pink rabbit wearing sunglasses.

Other

[27] https://iea.blob.core.windows.net/assets/18f3ed24-4b26-4c83-a3d2-8a1be51c8cc8/Electricity2024-Analysisandforecastto2026.pdf

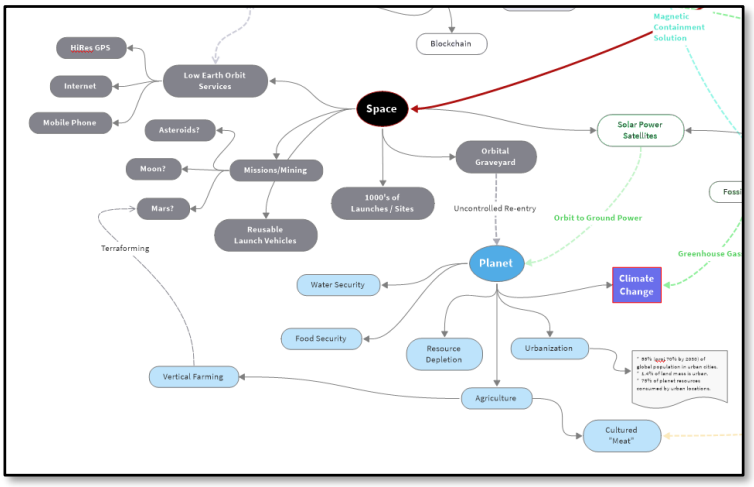
It's not all about data centers, there are massive developments happening in virtual and augmented reality, in robotics, "Internet Of Things (IOT)," and neural implants that will simultaneously enable every device around us with computation, interconnection and AI – while also "invading" our very selves to seamlessly connect with those devices... even with just a thought.

Space

The Space category is very nascent but expanding very rapidly. Private companies like SpaceX, Blue Origin, and United Launch Alliance (ULA) have moved space launches from a handful of launch sites and perhaps one government planned launch per month – to a growing number of launch sites globally and approaching a launch per day.

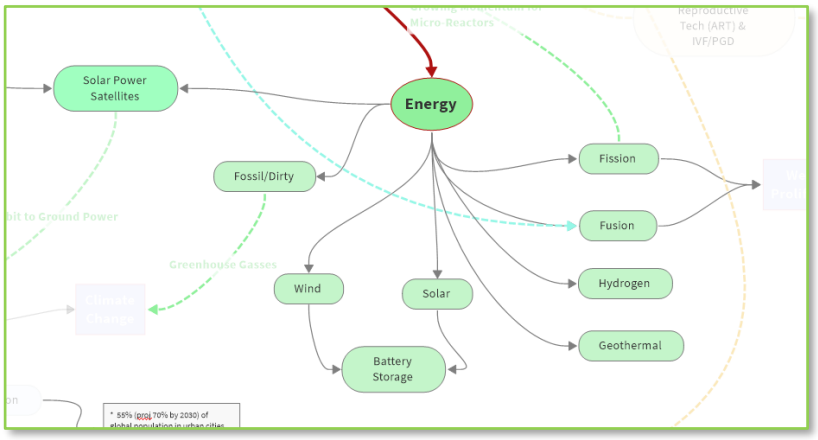
Subcategories here are:

1. Reusable Launch Vehicles
2. 1000's of Launch Sites
3. Missions/Mining
    a. Moon
    b. Asteroids
    c. Mars
4. Low Earth Orbital Services
    a. HiRes GPS
    b. Internet
    c. Mobile Phone
5. Orbital Graveyards



This rapidly emerging technology category holds several potentials to influence or transform human society. Foremost is science. The International Space Station has been home to over 3700 investigations yielding over 500 published research papers. Space is a key research environment and what we learn "out there" will change our lives "down here." And if technology is "applied science" then some portion of those 500+ science research findings will make their way into technology that affects us.

Energy



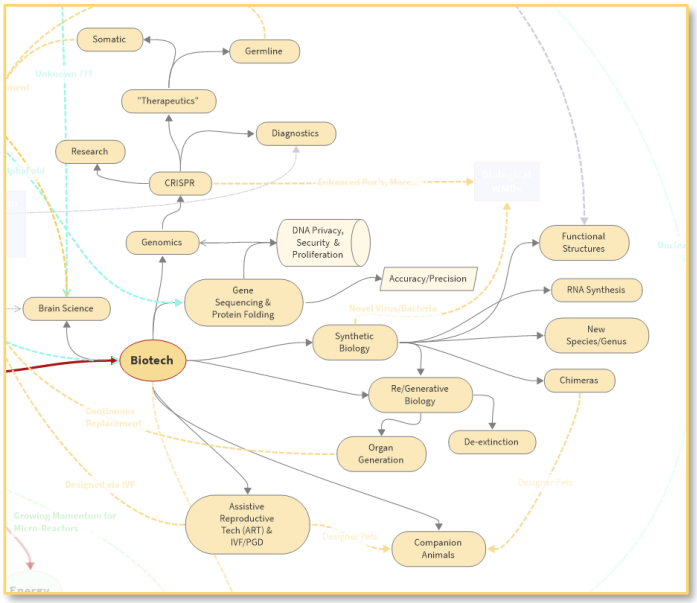
Since the beginning of the Industrial Era (300 years ago) and the discovery of electricity (200 years ago), humanity has had an insatiable desire for energy. First to power industry (heavy manufacturing and railways), then neighborhoods and personal transportation, and now – our very persons with everything from smartphones to earbuds, from Fitbits to laptops. Which also means using some means of energy storage (batteries). Humanity is increasingly "charged and wired."

But that insatiable demand has given rise to a climate crisis that we must now mitigate. That means a shift to cleaner and more sustainable energy sources. On the rise are solar and wind, but also geothermal, and a shift back to nuclear fission. On the horizon are hydrogen and nuclear fusion.

In short, there is a renaissance of sorts underway to new forms of plentiful energy production. The sub-categories in this emerging category are:

1. Solar
2. Wind
3. Battery Storage
4. Fission
5. Geothermal
6. Hydrogen
7. Fusion
8. Solar Satellites
9. Fossil/Dirty (re-engineering for cleaner)

Biotech



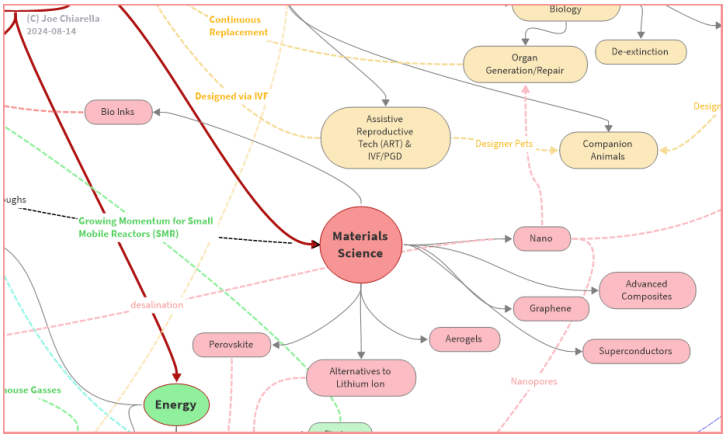
As much "buzz" as there is right now about Artificial Intelligence – it is going to pale by comparison to what is coming in Biotech. Our "dominance" over our biology is nearing the threshold to a "Biotech Era" where we can scarcely imagine what is coming.

This is the richest emerging technology of them all. But one that is also highly dependent on Artificial Intelligence, Computational Power and Energy… even Space will enable Biotech developments.

In the sub-category area for Bio-Tech are:

1. Brain Science
2. Genomics
    a. CRISPR
        i. Research
        ii. Diagnostics
        iii. "Therapeutics"
            1. Somatic
            2. Germline
3. Gene Sequencing & Protein Folding
4. Synthetic Biology
    a. Functional Structures
    b. RNA Synthesis
    c. New Species/Genus
    d. Chimeras
    e. Re/Generative Biology
        i. De-extinction
        ii. Organ Generation
5. Companion Animals
6. ART (Assistive Reproductive Tech)

Materials Science:



The science and technology surrounding materials has seen a tremendous renaissance in the last two to three decades. A science once thought "mature" has become a new burgeoning field of research and application.

Space, computers, biology have all been drivers in this area.

Artificial Intelligence is now, like so many other sciences, a catalyst to new breakthroughs.

In the sub-category area for Materials Science are:

1. Nano
    a. Nanotubes
    b. Nanobots
    c. Nanopores
2. Advanced Composites
    a. Carbon reinforced plastics
    b. Exotic ceramics
    c. Composite coatings
3. Graphene
4. Superconductors
    a. "Room temperature"
    b. Cooled
5. Aerogels
6. Alternatives to Lithium Ion
    a. Glass
    b. Sodium Ion
    c. Lithium Sulphur
    d. Graphene
    e. Magnesium Ion
    f. More…
7. Perovskite

Inter-connectivity

The most important aspect of this Emerging Technologies Map is not the bubbles on it, though they are essential. The most important aspect is how these emerging technologies are cross-enablers. It is crucial that we try to understand these paths-of-enablement, as well as where they lead.

For example, the relationship between Computational Power and Artificial Intelligence, in the macro sense, seems obvious – because it is. However, it is in the details that we see specific cross enablers. One clear example is how GPU technology (Computational Power) is an enabler of Generative AI. A less clear example is how 3D Printing technology (Computational Power) is an enabler for Functional Structures (Biotech/Synthetic Biology).

Understanding these cross-enablers lends insight to future developments via enablers and frictions.

Articulated on this chart are the following cross-enablers:

Computational Power:

1. Generative AI (GPUs)
2. Functional Structures (3D Printing)
3. Brain Science (Brain & other Implants)
4. Transhumanism (Brain & other Implants)
5. More…

Artificial Intelligence:

1. Gene Sequencing/Protein Folding (Targeted ML like AlphaFold)
2. Genetic Diagnostics (Quantum Bio-Sensors)
3. Autonomous War (Range of AI tools)
4. Restoration of Sight/Hearing/More (via Brain and other implants as well as Somatic Gene Therapies)
5. Fusion Energy (Targeted ML solving Magnetic Containment problem)
6. Transhumanism/Designed Evolution (Targeted ML)
7. Robotics (Targeted and Generative AI)
8. More…

Energy:

1. Data Centers (Small Mobile {fission} Reactor (SMR) tech)
2. More…

Space:

1. Surveillance (Low Earth Orbit Services)
2. Materials Science (driving breakthroughs)
3. More…

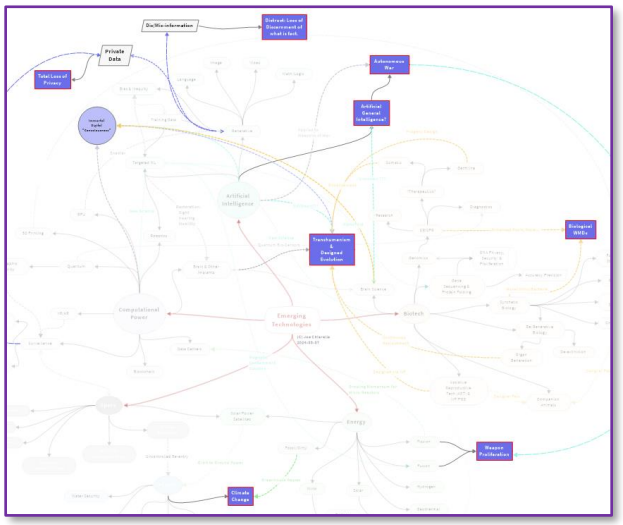
Biotech:

1. Transhumanism (Continuous Organ Replacement)
2. Transhumanism (Germline Progeny Design)
3. Biological WMDs (Synthetic Virus/Bacteria, CRISPR enhanced Pox's)
4. Designer Pets (ART, Chimeras, CRISPR)
5. More…

Materials Science:

1. Hydrogen (nanopores)
2. Functional Structures (nanobots)
3. Water Safety (desalination)
4. Organ Generation/Repair (nanobots)
5. 3D Printing (bio inks)
6. Solar Photovoltaics (perovskite)
7. Battery Storage (alternatives to lithium ion)

Existential Risk Termination Points



Collectively, these six areas of Emerging Technologies have some concerning (potential) existential risks. We all know that Energy (and industry, farming, etc.) have created an existential risk in the form of **Climate Change**. But there are more already known that are coming.

One that is clearly concerning for many is the prospect of an **AGI** (Artificial General Intelligence) or SMI (Superior Machine Intelligence) that starts to encroach on human agency. I think an AGI, and indeed its precursors, are an Existential Threat not only from a loss of human agency, but from 2nd and 3rd order effects of humanity's use of AI. This is explained more in the **Commentary\\AI** section below.

Autonomous War combined with **Weapon Proliferation** presents the very real possibility of unplanned conflict arising from two sources: unintended consequences of an Autonomous Weapon of War, or Weapons Proliferation (Nuclear, Bio WMDs).

Transhumanism and **Designed Evolution** arises from a collection of Biotech, Computational and AI based enablers. Transhumanism is seen as a neutral outcome, but I argue it is not neutral. This is explained more in the **Commentary\\Biotech** section below.

Then there are the softer threats like a **Total Loss of Privacy** and the rise of **Distrust** due to a loss in the ability to discern what is factual.

Appendix B – Constructs and Rubrics

The goal is ambitious: identify all the material technological and sociological developments from 10,000 BCE to now, in 2024 CE. Then, plot each category on an X-Axis: Timeline, and on the Y-Axis: Magnitude of Impact. Then, employ a regression function to generate a best-fit curve to each category. Technological Developments are plotted with green diamonds and regressed to a green curve. Sociological Developments are plotted with blue dots and regressed to a blue curve.

In this fashion, we can measure the relative speed and magnitude of developments in each category to see if the two are pacing each other, or if one is outpacing the other.

As Figure 3 (12,000-year view) and 4 (1,200-year view) show, the green curve (technology) is going asymptotically vertical while the blue curve (society) is indeed accelerating, but not nearly as aggressively. Is this chart correct? That depends entirely on the accuracy and precision of the data tables that drive it.

Therefore, the quality of the rubric is crucial. There are two general aspects of the rubric: development selection and impact measure. In the case of Technological, there is also the aspect of estimating Risk.

In terms of a selection rubric, a range of sources were used to identify Technological Developments. I used Google and other search engines searching for "technological developments over time" and other similar search parameters. This yielded a range of academic, historical non-profit and other result sources with a range of credibility. I also used ChatGPT, Claude and Perplexity with an assortment of prompts to elucidate as comprehensive a list as possible. In general, I then looked for overlaps from all these sources and those are the 71 items on the full list shown in Table 1.

Then, for impact and risk measures, I again used a series of Internet searches and generative AI prompts and, employing some of my own reasoning, then reduced the measure set to what is described herein.

Impacts of Technological Developments

The Technological Development (TD) rubric estimates impact using the following measures:

Impact Measures (Y-Axis)										
Societal Impact		**Complexity**		**Centrality to Life**		**Human Impact**		**Speed**	
Incremental	1	Specialized	0.50	Peripheral	1	Convenience	1	How many years did it take for the advancement to impact 50% of the relevant population?	
Influential	2	Interdiscipline	1.00	Integral	2	Longevity	2		
Expansion	2	Multidiscipline	1.50	Essential	4	Quality	2		
Transformational	3					Longevity + Quality	4		
						Improve Access to Others	3		
						Species Change	6		

Each TD has been assigned a **Societal Impact, Complexity, Centrality to Life and a Human Impact** value – and commensurate score. The total score for that TD is merely the sum of the four assigned value scores + the **Speed** score.

Speed to Ubiquity

The **Speed** score is a semi-empirical measure, based on historical records, of how long it took that TD to impact around 50% of the available population of the era. That's the point where it "feels" like it is ubiquitous to most people.

The formula for speed is then one divided by that number of years. In this fashion, a TD that takes 80 years to impact 50% of the available population (1/80 = 0.0125) is scored much higher than a TD that takes 400 years (1/400 = 0.0025). These results are then multiplied by 1000 as a scaling factor to bring them into the order of magnitude of the other Impact Measures. (Resulting in a score of 12.5 and 2.5 respectively in the examples.)

Societal Impact

Each TD has an estimated "**Societal Impact**". This measure has four values: **Incremental, Influential, Expansion and Transformational**. Each value has a corresponding score of **1, 2, 2, and 3** respectively.

The goal of this measure is to attempt to stratify the level of Societal Impact that a given TD had on the population of the day. "**Incremental**" means that the TD had a marginal, or incremental, impact. For example, the TD of the "Plow" made an Incremental improvement on the TD of Agriculture which made an Incremental improvement on the sustainability, and/or quality, of the produce from each harvest. This in turn had a commensurate incremental impact on the society of the day.

An "**Influential**" TD is one that influenced the future direction of that society in some material way. For example, the TD of Bronze and the Bronze Era – influenced the contemporary society – and future societies – in terms of their ability to make a wide range of tools. This is more than a mere Incremental impact, but less than a Transformational one. Like the "Influential" value, the "**Expansion**" value is more than Incremental, but less than Transformational – and indicates that the TA acted as an enabler to society's ability to expand into other geographies or in other ways.

Influential and Expansion are currently both weighted the same (2), but that may not be appropriate. Your critical reasoning is solicited.

A "**Transformational**" TD is one that is causal to a material transformation of society. For example, the development of paper around 200 BCE was transformational because it enabled a persistent memory for any given society, and it enabled a means of permanence in communications between societies. It forever transformed the way societies communicated internally and externally.

Complexity

Next, each TD has an estimated "**Complexity**." Complexity seeks to measure how easy or difficult it is for that TD to arise. It is assumed that it is easier for a singular discipline ("**Specialized**") development to arise than an development that requires the interaction/cooperation of two disciplines ("**Interdisciplinary**"). And easier for an Interdisciplinary development than a "**Multidisciplinary**" (three or more) one. These are arbitrarily assigned scores of **0.5**, **1.0** and **1.5** respectively.

As technologies abound and persist, the likelihood of new multidisciplinary TDs increases. And indeed, that appears to be the case.

Complexity matters as a part of the rubric because it represents the level of friction to discovery on the one hand, and the compounding effect of technology on the other.

Centrality to Life

The centrality to our lives of Technological Developments is not uniform. Some TDs are **Peripheral** to our daily existence – like Iron. Our lives are made richer by a wide range of tools. And some of those tools are made of Iron or an Iron ore. Others, are made of aluminum, plastics, wood, etc. Iron and Iron Ores are, arguably, Peripheral to our daily existence. We use them occasionally, and if they weren't made of Iron/Iron Ore, they would be made of something else. They are neither **Integral** (part of, but could live without) in our daily lives, nor are they **Essential** (can't live without). But try, today, to take either a smartphone or a social media app from a 25-year-old and you will quickly discover how Essential they consider those technologies to be.

Human Impact

One of the weightier measures in this rubric is Human Impact. This measure looks at HOW this TD affects us as human beings. Is it merely a **Convenience** with no meaningful impact on either our **Longevity**, **Quality of Life**, (or both), or ability to interact/**Access to Others**? Or is it a technology that can literally **Change our Species** either deliberately or "accidentally"?

Consider the Magnifying Glass. It is a technological development of the 13th Century. It helps us see small things in greater detail. That could be a 6-year-old child looking in wonder at an ant or a 66-year-old using it reluctantly to read off a restaurant menu. In both cases, it provides a convenient solution to inconvenient problem. It likely does not lengthen our lives or transform our species. It may offer an improvement in the Quality of our life, but probably not enough to justify that score.

On the other hand, Vaccines and CRISPR both have the potential, if not reality, to alter our very genomes. In the case of Vaccines, over time and generations, through the elimination of the proliferation of certain diseases, our genomes or epigenomes may evolve. And CRISPR, applied directly to the genome through ART/IVF (Assistive Reproductive Technology / In Vitro Fertilization) does literally change our species… applied broadly enough.

Total Score

The rubric then simply adds the Societal Impact, Complexity, Centrality to Life, Human Impact and Speed to arrive at a Total Score. Here are the top and bottom 10 of the 71 items on the Technological Development table:

	BCE vs CE	Linear Years	Technological Development	Area	Impact Measures (Y-Axis)										
					Societal Impact		Complexity		Centrality to Life		Human Impact		Speed	Yrs: 50%	Total
1	-10000	0	**Agriculture**	Food	Transformational	3	Specialized	0.5	Essential	4	Longevity + Quality	4	0.50	2000	**12.0**
2	-9000	1000	**Mudbricks**	Shelter	Transformational	3	Specialized	0.5	Integral	2	Longevity + Quality	4	2.00	500	**11.5**
3	-7000	3000	**Alcohol**	Other	Influential	2	Specialized	0.5	Peripheral	1	Quality	2	2.00	500	**7.5**
4	-6000	4000	**Irrigation**	Food	Influential	2	Interdiscipline	1	Integral	2	Longevity + Quality	4	2.00	500	**11.0**
5	-5000	5000	**Copper**	Other	Influential	2	Specialized	0.5	Peripheral	1	Quality	2	2.50	400	**8.0**
6	-4000	6000	**Sailing**	Transport	Transformational	3	Multidiscipline	1.5	Peripheral	1	Improve Access to Others	3	1.67	600	**10.2**
7	-3500	6500	**Wheel**	Transport	Transformational	3	Specialized	0.5	Integral	2	Improve Access to Others	3	2.50	400	**11.0**
8	-3400	6600	**Writing**	Relation/Comm	Transformational	3	Interdiscipline	1	Essential	4	Species Change	6	1.25	800	**15.3**
9	-3300	6700	**Bronze**	Other/Multiple	Influential	2	Interdiscipline	1	Peripheral	1	Quality	2	2.50	400	**8.5**
10	-3000	7000	**Plow**	Food	Incremental	1	Interdiscipline	1	Integral	2	Longevity + Quality	4	2.50	400	**10.5**
62	1981	11981	**Quantum Computer**	Other/Multiple	Transformational	3	Specialized	0.5	Peripheral	1	Improve Access to Others	3	13.33	75	**20.8**
63	1986	11986	**Mobile Phones**	Relation/Comm	Transformational	3	Multidiscipline	1.5	Integral	2	Improve Access to Others	3	100.00	10	**109.5**
64	1993	11993	**Consumer GPS**	Relation/Comm	Transformational	3	Multidiscipline	1.5	Essential	4	Improve Access to Others	3	66.67	15	**78.2**
65	1995	11995	**Internet**	Relation/Comm	Transformational	3	Multidiscipline	1.5	Essential	4	Improve Access to Others	3	58.82	17	**70.3**
66	2004	12004	**Social Media**	Relation/Comm	Transformational	3	Multidiscipline	1.5	Integral	2	Improve Access to Others	3	100.00	10	**109.5**
67	2007	12007	**Smart Mobile Devices**	Relation/Comm	Transformational	3	Multidiscipline	1.5	Essential	4	Improve Access to Others	3	47.62	21	**59.1**
68	2012	12012	**CRISPR**	Health	Transformational	3	Multidiscipline	1.5	Peripheral	1	Species Change	6	66.67	15	**78.2**
69	2017	12017	**Deep Learning (AI)**	Other/Multiple	Transformational	3	Multidiscipline	1.5	Integral	2	Longevity + Quality	4	100.00	10	**110.5**
70	2022	12022	**Transformers (AI)**	Other/Multiple	Transformational	3	Multidiscipline	1.5	Integral	2	Longevity + Quality	4	166.67	6	**177.2**
71	2024	12024	**Neural Implants**	Health	Transformational	3	Multidiscipline	1.5	Integral	2	Quality	2	40.00	25	**48.5**

Table 5 - Impact Measures - Techno Developments

This table shows the first 10 Technological Developments and their associated impact measures and scores. The full table is shown in Table 2.

Known Detrimental Impacts of Technological Developments

Technological developments come with both promise (beneficial impact) and peril (risk of detrimental impact). The greater the development, the greater the promise and peril. Some past technological developments have already demonstrated associated perils. For the 71 included in this list, 10 of them have demonstrated detrimentals.

Detrimentals are measured according to the following rubric:

Known Detrimentals			
Impact to		**Effect**	**Lag**
Economic	**2**	One or two word description of the detrimental effect.	How many years, after the tech was introduced, did it take for the detrimental impact to reach 20% of the population?
Environmental	**3**		
Geopolitical	**2**		
Biological	**3**		
Social	**2**		
Multiple	**5**		
Existential	**10**		

There are two measures for Detrimental Impact: the “Impact To” measure and the “Lag” measure.

Impact To

Not all detrimental impacts are equal. Developments that detrimentally impact social interactions are not as impactful as ones that detrimentally impact biological systems – for example. If a Technological Development impacts a single area, that one is selected, and the associated score is assigned. If it impacts two or more areas, then the selected impact is “Multiple” and a weighted score of 5 is assigned. If the impact is existential – meaning it HAS or WILL lead to a dramatic reduction in the human species or flourishing, then that impact is assigned a score of 10.

Lag

Most detrimental impacts are not felt by humanity at the same time as the corresponding technological development gains ubiquity. There is a lag. In this measure, an estimation is made for how many years it took (the lag) between when the technological development gained 50% ubiquity and when the detrimental impact reached 20% of the population. The rationale here is

that until 20% of the population (1 in 5 people) feels the detrimental impact of that technological development, mitigations will likely not happen.

This time lag is then converted to a score the same way as the speed of ubiquity:
(1 / lag years) * 1000.

The 10 known detrimental impacts and their measures:

Linear Years	Technological Development	Known Detrimentals					
		Impact to		Effect	Lag	Yrs: 20%	Total
3200	**Alcohol**	Social	2	Addiction - social damage	5.00	200	**7**
12000	**Plow**	Environmental	3	Desertification	0.20	5000	**3.2**
10950	**Gunpowder**	Multiple	5	Murders, Wars, Suicides	10.00	100	**15**
11970	**Electricity**	Multiple	5	Climate Change - Industrialization	7.14	140	**12.14286**
11976	**Internal Combustion**	Multiple	5	Climate Change - Industrialization	10.00	100	**15**
11965	**Automobile**	Multiple	5	Climate Change - Industrialization	12.50	80	**17.5**
11958	**Plastics**	Multiple	5	Oceans, Human Biology, Cancers	16.67	60	**21.66667**
11948	**Nuclear Fission**	Multiple	5	Nuclear Arsenals	100.00	10	**105**
11981	**Penicillin**	Biological	3	Antibiotics Resistant Bacteria	25.64	39	**28.64103**
12019	**Social Media**	Multiple	5	Teen suicides, fake news, more…	66.67	15	**71.66667**

Table 6 - Known Detrimental Impacts

Risks of Technological Developments

Any individual Technological Development presents both benefits and risks. In that sense, Technology itself is essentially "neutral" – so the value judgement of how it is used (for good or for bad) is up to us. It is often, but not always, symmetrical. That is to say, the greater the power of the technology to benefit mankind – the greater the risk as well. An example of this is Nuclear Fission (or Fusion). It can provide plentiful carbo-neutral electricity to our homes, businesses, and hospitals, or it can be used in warfare to destroy. An exception to this symmetry is a vaccine. Their power to benefit humanity is very great while the risk to humanity is not.

Risk Measures (Bubble Size)			
Form of Risk		**Likelihood**	
None	**0.25**	Very Unlikely	**0.50**
Economic	**2**	Unlikely	**0.75**
Environmental	**3**	N/A or Unknown	**1.00**
Geopolitical	**2**	Likely	**1.25**
Biological	**3**	Very Likely	**1.50**
Social	**2**		
Existential	**10**		

The Impact measures are essentially scoring the benefits of that Technological Development and the speed with which it expands its reach to all of humanity. But what about the Risks?

Risk has two components: the Form of the risk and the Likelihood it will happen.

Form of Risk

There are different natures of Risk. It can carry a risk that impacts our **Economy**, our **Ecology**, our **Governance**, our **Biology**, our **Society**, or our very **Existence**. Or more than one of these.

Climate Change is an Existential risk because it threatens our very Environment and in so doing, our species and many others as well. But Climate Change is a consequence of Technological Developments such as the Internal Combustion engine and Automobiles, but also fossil fueled Electricity plants. So those Technological Developments, while providing many benefits to humanity – also came with Risks that eventually manifested as a threat to our planet.

In the rubric, Economic, Geopolitical and Social forms of risk are scored with a value of 2 because while they are risks, they are human-controllable. That is, we can make choices that can lower the risk. Environmental and Biological are scored a value of 3 because they are not as easily changed by human decisions, and they are more directly impactful to our survival. An Existential risk (like a Manhattan sized meteor striking the planet) gets its own classification and is scored a value of 10.

In the rubric, any given Technological Development may have up to four associated potential forms of risk. These four are added together and that total is multiplied by the Likelihood score.

Likelihood

The likelihood that the risk(s) associated with a given Technological Development will happen at all gets its own score. In this scoring, if the likelihood is unknown or not applicable, it gets a score of 1 so that when it is multiplied by the aggregate of the Forms = it does not change that sum. But if the likelihood is Unlikely or Very Unlikely – but still not zero, the sum is reduced by multiplication with 0.75 or 0.5 respectively. Conversely, if the risk is Likely (1.25) or Very Likely (1.5) the sum is increased by 25% to 50%.

Here are the Risk scores associated with their Technological Developments:

Technological Development	Risk Measures													
	Risk A		Risk B		Risk C		Risk D		Likelihood		Lag	Yrs: 20%	Total
Alcohol	Social	2	None	0.25	None	0.25	None	0.25	Very Likely	1.5			4.125
Gunpowder	Geopolitical	2	Biological	3	Social	2	None	0.25	Very Likely	1.5			10.875
Chimney	Environmental	3	None	0.25	None	0.25	None	0.25	N/A or Unknown	1			3.75
Printing Press	Social	2	None	0.25	None	0.25	None	0.25	Very Likely	1.5			4.125
Steam Engine	Economic	2	Geopolitical	2	Social	2	None	0.25	Very Likely	1.5			9.375
Atomic Theory	Environmental	3	Geopolitical	2	Biological	3	None	0.25	Very Likely	1.5			12.375
Electricity	Economic	2	Environmental	3	Geopolitical	2	Social	2	Very Likely	1.5			13.5
Telegraph	Economic	2	Geopolitical	2	Social	2	None	0.25	Likely	1.25			7.8125
Telephone	Economic	2	Geopolitical	2	Social	2	None	0.25	Likely	1.25			7.8125
Internal Combustion	Economic	2	Geopolitical	2	Environmental	3	None	0.25	Very Likely	1.5			10.875
Automobile	Economic	2	Geopolitical	2	Environmental	3	None	0.25	Very Likely	1.5			10.875
Plastics	Environmental	3	Biological	3	Economic	2	None	0.25	Very Likely	1.5			12.375
Radio	Economic	2	Geopolitical	2	Social	2	None	0.25	Likely	1.25			7.8125
Airplane	Economic	2	Geopolitical	2	Environmental	3	None	0.25	Likely	1.25			9.0625
Rocketry	Geopolitical	2	Social	2	Existential	10	None	0.25	N/A or Unknown	1			14.25
Television	Economic	2	Social	2	None	0.25	None	0.25	Very Likely	1.5			6.75
Digital Computers	Economic	2	Geopolitical	2	Social	2	None	0.25	Very Likely	1.5			9.375
Nuclear Fission	Economic	2	Environmental	3	Geopolitical	2	Biological	3	Likely	1.25			12.5
Penicillin	Biological	3	None	0.25	None	0.25	None	0.25	Very Likely	1.5			5.625
Space Satellites	Geopolitical	2	None	0.25	None	0.25	None	0.25	Likely	1.25			3.4375
Quantum Computer	Geopolitical	2	None	0.25	None	0.25	None	0.25	Likely	1.25			3.4375
Mobile Phones	Economic	2	Geopolitical	2	Social	2	None	0.25	Very Likely	1.5			9.375
Consumer GPS	Geopolitical	2	None	0.25	None	0.25	None	0.25	Very Likely	1.5			4.125
Internet	Economic	2	Geopolitical	2	Social	2	None	0.25	Very Likely	1.5			9.375
Social Media	Social	2	Geopolitical	2	Economic	2	None	0.25	Very Likely	1.5			9.375
Smart Mobile Devices	Economic	2	Geopolitical	2	Social	2	None	0.25	Very Likely	1.5			9.375
CRISPR	Biological	3	Social	2	Existential	10	None	0.25	Likely	1.25			19.0625
Deep Learning (AI)	Economic	2	Geopolitical	2	Social	2	None	0.25	Very Likely	1.5			9.375
Transformers (AI)	Existential	10	Geopolitical	2	Economic	2	Social	2	N/A or Unknown	1			16
Neural Implants	Biological	3	Social	2	None	0.25	None	0.25	Likely	1.25			6.875
Gene-Editing Therapies	Biological	3	Social	2	None	0.25	None	0.25	Unlikely	0.75			4.125
Humanoid Robots	Social	2	Economic	2	None	0.25	None	0.25	N/A or Unknown	1			4.5
Organ Generation	Biological	3	Social	2	Economic	2	None	0.25	Likely	1.25			9.0625
Quantum Biosensors	Biological	3	Social	2	None	0.25	None	0.25	Likely	1.25			6.875

Table 7 - Risk Scores for Techno Developments

Again, it is likely that this rubric is flawed. Is it more than 20% flawed? I can't say. It is also likely that some of these individual assessments of Impact or Threat Risk have been mis-assessed. Are there more than 20% of them wrong? I can't say. Collectively, for the Technological Developments table there are 710 assessments (71 items * 10 assessments/item). If the table is 80% correct, then mathematically 130 items could be wrong, and the resulting conclusions will not be materially

wrong. But math isn't the whole story. *Which* items are wrong *does* matter. So, diligence in reviewing the rubric and the selection of 71 items and their associated assessments – is necessary. Your critical reasoning is solicited.

Societal Developments

Just as there have been technological developments over the millennia, there have also been societal developments. Humanity hasn't always been civilized. We take certain "societal constructs" (such as legal systems or urban centers) for granted, but each of those emerged over history. By plotting these sociological developments, along with their beneficial impact measures, we can reduce that march of development to a polynomial regression, just as we did for Technology. To accomplish this, we need a rubric for selecting the Sociological Developments, and another for estimating their impacts.

In terms of sociological development selection, a range of sources were used to identify these. I used Google and other search engines searching for "societal developments over time" and other search parameters. I also used ChatGPT, Claudia and Perplexity with an assortment of prompts to elucidate as comprehensive a list as possible. In general, I then looked for overlaps from all these sources and those are the 25 items on the full list shown in Table 2.

Sociological Developments are unlike Technological Developments in that the measure of beneficence of an Development can vary from one society to another. It is therefore subject to a great deal more "squishiness" and debate. For example, someone in China with a strong preference for Communism is likely to rate the beneficial impact of the social construct of Communism far more favorably than they might rate the social construct of Democracy. Therefore, a component was sought that was "agnostic" to the social construct itself. In this way, a more global rubric is still possible without getting into philosophical debates of the relative preference of one social construct versus another.

The measurement rubric has two components: Societal Impact and Nature of Development in Humanity. Each component has a set of assessed values and associated scores. The first considers "how much" that Development impacted society and the second considers in "what way" it impacted it.

Societal Impact	
Incremental	**1**
Influential	**2**
Transformational	**3**

Advancement in Human	
Industry/Productivity	**1**
Governance	**2**
Justice	**3**
Survivability	**4**
Flourishment	**5**

Societal Impact

This component seeks to identify the level of impact that the Sociological Development had on Society. Was it "**Incremental**," "**Influential**," or "**Transformational**"? These are scored with values of 1, 2, and 3 respectively.

If a Sociological Development (SA) was "Incremental" – this means it had a small beneficial impact on the society of the day – but in and of itself – it was neither influential toward future societies, nor did it transform either that present day, nor did it influence a future transformation. None of the 25 SAs were assessed as Incremental.

If an SA was classified as "Influential" it means that it, in some way, not only impacted the society of the day, but was influential in shaping future societies – without transforming them. An example of an Influential SA was the rise of "Global/Cultural Trade" around the first century CE.

This SA did not fundamentally transform any given society, such as the then Roman conquered Greece. But it did Influence how Greece interacted with what is now China – and the nature of that interaction had influence on the development of both societies both at the time and in the future.

The final Societal Impact classification, "Transformational" is reserved for those developments that fundamentally changed how societies functioned going forward. For example, consider the birth of Legal Systems around 2000 BCE. Prior to this, disputes were settled directly by opponents and usually violently. The birth of the legal construct, whereby a third party or parties, objectively evaluates and resolves disputes was transformational. It contributed to a fundamental shift that favored civilization.

Each SA is thus classified as Incremental, Influential or Transformational in Impact. In this fashion, this component makes no judgment on the relative value of Communism vs Democracy.

Nature of Development

The way that an development impacted societies also matters, not just how much it did. An SA that enhances Productivity, for example, is less impactful than one that enhances Survivability.

This component has five classifications: "**Industry/Productivity**," "**Governance**," "**Justice**," "**Survivability**," and "**Flourishment**." These are scored linearly from 1 to 5 respectively. And, again, measuring impact this way makes no direct judgment on Communism vs Democracy. It merely says that an Development in Governance for example, is more important than Industry/Productivity and less important than Survivability.

With that said, one might make the argument that Democracy as a system of Governance leads to more Flourishment for humanity than other systems. So, it may be tempting to classify this component for Democracy as "Flourishment" – but this temptation was resisted, and Democracy was classified as a Transformational impact to Governance only. The resistance is out of respect for other nations and their philosophical approaches to governance.

On the other hand, every nation, culture, and nationalistic philosophy will agree that Writing systems (language) have had a profound effect on the Flourishing of every culture. So, in this societal development, we assess it as such: Flourishment.

Appendix C – Suggested Viewing/Reading

Title	Topic	Link
Documentaries & Talks		
iHuman	AI	https://www.imdb.com/title/tt11279794/
Human Nature	CRISPR	https://www.imdb.com/title/tt9612680/
AI Tipping Point	AI	https://www.youtube.com/watch?v=1cKE12LK4Eo
A.rtificial I.mmortality	AI	https://www.youtube.com/watch?v=P7vkaR6gdMI
AI Goes to Work	AI	https://www.pbs.org/video/ai-goes-to-work-vvh1e3/
A.I. Revolution	AI	https://www.pbs.org/video/ai-revolution-umwwlt/
It's Alive, But is it Life?	Synthetic Biology	https://www.youtube.com/watch?v=rU_pfCtSWF4
Can We Make Life	Synthetic Biology	https://www.pbs.org/wgbh/nova/video/nova-wonders-can-we-make-life/
Super Humanity | Transhumanism	Transhumanism	https://www.youtube.com/watch?v=mZrwTMfYpwo
What is AI Anyway?	AI	https://www.ted.com/talks/mustafa_suleyman_what_is_an_ai_anyway
The Dark Side of Competition in AI	AI	https://www.ted.com/talks/liv_boeree_the_dark_side_of_competition_in_ai
The AI Dilemma	AI	https://www.youtube.com/watch?v=xoVJKj8lcNQ
The Genetic Revolution	CRISPR	https://www.youtube.com/watch?v=4OGAz1j5yF8
How Wisdom Can Protect Humanity from Technology	Society & Tech	https://www.youtube.com/watch?v=v3F5Hsua4J4

Title	Topic	Author(s)
Books & Other Reports		
Hacking Darwin	CRISPR	Jamie Metzl
AI Superpowers	AI	Kai-Fu Lee
Designer Genes	CRISPR	Steven Potter
Regenesis	CRISPR	George Church & Ed Regis
A Crack in Creation	CRISPR	Jennifer Doudna & Sam Sternberg
Trends Report	Tech Trends	Future Today Institute
European Union AI Act	AI	Worlds First Regulatory Framework for AI