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See Appendix R&D – Research & Development Example
See Appendix TECH – Technology Progress

“Science is more than a body of knowledge, it is a way of thinking, a way of skeptically interrogating the universe.” – Carl Sagan

Research: All technology (except Existential Patents purchased during set up) begins with placing a Research Piece in the Public Space. Research Pieces are received as a result of successful Research and must be immediately placed on an unoccupied Monad in the Public Space (which becomes occupied). Research represents the theoretical and experimental aspects, it represents the accumulation of experimental data and the formulation of theoretical frameworks, organization of knowledge. Development (*ut infra*) is more representative of experimental science.¹

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- ✓ Research Pieces should not be abbreviated “RPs” as that will cause confusion with Resource Points that are already abbreviated RPs throughout the rules. There were no better options, it had to be called Research because that’s what it is and there is no other sensible substitute term, and it’s a ‘piece’ because it is placed on the Public Space, e.g., Cultural Traits Pieces, and is not a star or planet from Galactic Space.
 - ✓ The Public Space is getting crowded, eh? Government Titles, Proficiencies, Aspects, Fuzzy Groups, Pathways, Research Groups, plus many bits of Galactic Space!
 - ✓ [Interview] “These two men, Schrib and Bradbury, were in many ways very similar men, you know they were both experimental physicists, and people who haven’t been around physicists possibly don’t realize how different theoretical physicists, who are the ones who do the calculations, are from the guys who actually do the hands-on experiments on the lab bench or in the field. Experimentalist are a totally different breed as far as I’ve been able to tell, often politically more conservative strangely enough, they tend to be intensely practical people. They’ve learned to think clearly about how you manipulate objects to make a certain outcome occur, whereas theoreticians are often into literature and art, often politically quite liberal; Robert Oppenheimer was perhaps an extreme example, but he was a rather neurotic man, a chain smoker, troubled in some ways, troubled certainly about who he was, you never had a sense with Bradbury or Schrib that they ever had any doubt about who they were and what was their place was in the world and how they went about doing their work.” – Richard Rhodes (author of The Making of the Atomic Bomb (1986)), The Half-Life of Genius: Physicist Raemer Schreiber (2018).
- **Research Groups:** Two Research Pieces occupying adjacent Monads at least one of which is adjacent to a *Friendly, Naturalized or Converted Colony* with an active Epistemological Constructural Element, form a Research Group. A previously-placed Research Group that is no longer adjacent to an eligible colony with an active Epistemological Constructural Element is *disrupted* (but not removed), and will not be eligible for Development actions. Research Groups are required to develop Applications. Each Research Piece belongs to a specific Research Area (see following section), that is, it represents a specific type of research. Research Groups must consist of two Research Pieces from the same Research Area.
- ✓ A new Research Piece may be placed to form a Research Group that is automatically disrupted. The wisdom of doing so may be questionable (unless paired with Cohering), like voluntarily allowing a Government Title to fail, but the rules do not prohibit positions from doing it.

“The problem of pinning down these various entities to a nice level could imply a nice subtrope. Most Soft Sci-Fi is powered by a Large Convenient Energy Source (LCES), which in theory provides as much energy as the plot requires without refueling (‘Scotty, I need more power’). Meanwhile, since they are using magic, anti-matter, dark matter, white holes, or black holes, the theoretical power that these devices provide to our protagonists does not result in the expected megascale Dyson Spheres, ring orbitals, or space elevators. Unfortunately (or fortunately for the sake of comprehensible story telling) we relate ‘better’ to this soft Sci-Fi even though it does little to represent the actual technology needed to power replicators, transporters, shields, and artificial gravity on grand scales.”

– from TVTropes.com, “Abusing the Kardashev Scale”

Research Areas: Each Research Piece or attempt must be assigned to one of ten Research Areas, which can be conceptually divided into two groups of five each. The first group is the Universal Research Concentration which consists of the Research Areas: Energy, Matter, Information, Life, and Planets. The Universal Research Concentration is knowledge which provide the *theoretical underpinnings* for the Interstellar Research Concentration consisting of the Research Areas: Stardrive, Ships, Weapons, Defenses, and Industry. The second group consists of the *engineering knowledge* that makes interstellar culture, the sinews of the galactic empire. The following general descriptions are offered for the Research Areas.

The general descriptions below are offered for concept and edification purposes, but will become more important later during the Patent process (see Patents generally, *infra*).

Universal Research Concentration (Research Areas)

- **Energy (EGY):** Research into the production, manipulation, storage, and transmission of energy. More than any other research area, Energy output is the defining reality of advanced technological civilization.
- **Matter (MTR):** Research into the material sciences, physics, chemistry, metallurgy, and engineering, the technology for turning theory into product, channeling the Energy.
- **Information (INF):** Research into the ability to collect, process and store, and communicate information, including sensors, computers, and all of the forms of media. Information is the third major component of the universe: Matter, Energy, Information.
- **Life (LIF):** Research into the biological and medical sciences, organic chemistry, and the understanding of the basic building blocks of life and evolution. Matter, energy and information combine to make life.
 - ✓ “The secrets of evolution are time and death. Time for the slow accumulation of favorable mutations and death to make room for new species.” – Carl Sagan, *Cosmos*, Episode 2.
- **Planets (PLN):** Research into the formation and conditions of planets, including geology, satellites, orbital mechanics, tidal forces, solar forces, meteorology, erosion, planet aging, atmospheres, and biospheres, all of the knowledge required to colonize distant planets.
 - ✓ “On whim, to pass a slow half-hour, she can command more energy than the entire nation of Portugal can spend today, and use it to launch a weekend satellite or remold a crater on the Moon.” – Frederik Pohl, “Day Million” (1966).²

Interstellar Research Concentration (Research Areas)

- **Stardrive** (SDR): The knowledge that allows ships to travel interstellar distances, probably at faster-than-light (FTL) speed, and also in-system propulsion systems. Stardrive is the technology that makes interstellar culture possible; a civilization may have high levels in all Research Areas, but if Stardrive has not been invented yet, they aren't going anywhere.
- **Ships** (SHP): Knowledge of starships, construction, naval architecture, orbital shipyards, ship systems, especially life support, design, and the ship as a whole unit, also Fighters, System Boats and Bases.
- **Weapons** (WEP): The design, production, and use of all weapons, including ship weapons, bombardment weapons, and planetary defense weapons to defeat enemy defenses efficiently.
 - ✓ [Interview] “The plane took off alright and the drop on was made on Hiroshima. We were so remote from the actual explosion that it was a little hard to realize the tragic loss of life which actually occurred...” – Dr. Schreiber (audio recording), 1993 Voices of the Manhattan Project by Richard Rhodes.
- **Defenses** (DEF): Development of ways in which ships and planets can be protected from opposing forces' weapons and bombardment and natural hazards.
- **Industry** (IND): Development of new manufacturing processes, new products and demands to keep Industry vital, and engineering and construction techniques.

“He traveled in interstellar spaceships. In order to make a spaceship go really fast about thirty-one male and seven genetically female human beings had to do certain things, and Don was one of the thirty-one. Actually he contemplated options. This involved a lot of exposure to radiation flux – not so much from his own station in the propulsive system as in the spillover from the next stage, where a genetic female preferred selections and the subnuclear particles making the selections she preferred demolished themselves in a shower of quanta.” – Frederik Pohl, “Day Million” (1966) ³

Research Action: Research requires the activation of the Technology Power for that purpose with the use of one Act and no Scenes. Research consists of the following steps:

1. Choose Research Area (i.e. ‘select the target’),
 2. Dedicate Resources (i.e. ‘pay the money’),
 3. Resolve Research (i.e. ‘roll the dice’),
 4. Place Research Piece (if successful, do the Hokey Pokey).
- **Black Hole:** When the Technology Power is activated for the purposes of Research, the Actions sent to the Concierge must include a designation of the Research Area and a commitment of a specific amount of RPs for the Research Attempt. A position may not commit more RPs to research than they have available in the Treasury at that time. Because one Act is required to activate the Technology Power for Research, Research Attempts will be resolved before other Power Activations in the same turn that require more than one Act.
 - **Schrödinger’s Cat:** The basic chance of a successful Research Attempt is 50%. The chance of a successful Research Attempt may be influenced by many factors, chief among them being the sufficiency of the resource commitment. Prior to resolving the Research Attempt, the

Concierge will first determine if the Research Attempt is sufficiently funded via two die rolls using ten sided dice (results 0-9). For the purposes of resolving Research Attempts, “0” die roll results are zero, not 10. Enlightenment may (wisely!) be assigned to Research Attempts.

The first die roll will determine if the Research Attempt is overfunded or underfunded. The resource commitment is divided by three (fractions rounded down), and a ten-sided die is rolled. If the die roll is *less than or equal to* the resource commitment divided by three (fractions rounded down), the research is overfunded, if it is *greater than* the resource commitment divided by three (fractions rounded down), the research is considered underfunded.

The second die roll determines the extent to which the Research Attempt is over- or underfunded. The second roll on a ten sided die, is multiplied by 5% to determine the extent of the over- or underfunding.

- ✓ For example, a position commits 9 RPs to a Research Attempt. The amount is divided by three, for a result of 3. The die is rolled and the result is a “5.” Since the die roll of 5 is greater than 3, the Research Attempt is considered underfunded. A second die is rolled and the result is a “1” which is multiplied by 5%, meaning the research is underfunded by 5%. Only a “0” result on the second roll produces no effect from over/under funding.

It is irrelevant whether the Concierge shares the results of the die rolls with the position players or not; it is up to the Concierge. The die rolls are what they are (aka, the Law of Identity). The Concierge could even use an Intervention with a Special Bulletin.

- ✓ Application of Enlightenment to over- or under-funding of Research Attempts – whether it is a ‘failed die roll’ is governed by the rules in Harsh Mistress, 2 Colleges, p. 478, *supra*. Enlightenment application could make it worse on the reroll, but that’s a chance to take, and over- or under-funding rolls can exhaust Enlightenment.
- Cure for the Common Cold: The base chance of successful Research Attempt is adjusted by the previously-determined percentage by which the research is over- or underfunded. If the research is overfunded, the base chance of a successful Research Attempt is increased by that percentage; if it is underfunded, the base chance of a successful Research Attempt is decreased by that percentage. After adjustments, two ten sided dice are rolled to determine the final results of the research as a percentile. If the result is *less than or equal to* the adjusted base chance, the attempt was successful and a Research Piece is added to the Public Space.
 - ✓ Continued Example: The underfunding result of 5% means that 5% is subtracted from the base 50% chance of success for an adjusted 45% chance of success. Two ten-sided dice (2d10%) are rolled for a percentile, and the final die roll is 43%, which is less than 45%, thus the Research Attempt was successful. A Research Piece is then added to the Public Space as a result of successful Research.

The adjusted base chance of successful research is never greater than 90% or less than 5%.

- ✓ “Most business meetings involve one party elaborately suppressing a wish to shout at the other: ‘just give us the money.’” – Alain de Botton.
- Lab Assistants: Faculties may be committed to any roll related to a Technology Power activation increasing the odds of a favorable result. It may also be possible through Writs fo-

cused on the Technology Power to alter the results of Technology Power activations in various, creative ways. But all of this is added cost to get more bang for the buck (e.g., Faculties, Fuzzy Groups expended).

- ✓ The only tungsten-fast rule is that no modification should make the chance of success of any Technology Power Activation 100%; modern researchers and those who fund research know this is simply not the way nature works (within any time scale less than, say, a million years...). Any approach to 100% chance success in GGDM should be like approaching the speed of light – the universe narrows to a point and an exponentially increasing amount of effort is required to continue acceleration. And you can never quite reach it, falling just a miniscule percentage short.

Zero divided by three is still zero, so a Research Attempt with zero RPs committed, is underfunded on any result of “1” or greater on the first die roll. The second die roll determines how much, to a maximum of 45%. Thus a zero RP commitment Research Attempt might still have a minimum 5% chance to succeed (and a maximum of 50%).

- **Big Money:** Finally, the resources expended during the Research are subtracted from the position’s Treasury, *regardless of whether the research was successful or not*. The only remaining issue is to determine the amount that was expended. If the research was overfunded, the amount of the committed Resources will be reduced accordingly; if the research was underfunded, the amount of committed Resources will be increased accordingly (all fractions rounded up), and the final amount will be removed from the Treasury, even if this means that insufficient resources will be available during subsequent Power Activations in the same turn (i.e. a ‘budget shortfall’).
 - ✓ **Continued Example:** Since the previous rolls determined that the Research Attempt was underfunded by 5%, that 5% is added to the 9 RPs research commitment, for a result of 9.45 RPs. The final cost is rounded up to 10 RPs. Research in GGDM is an expensive process, balancing expediency and cost management.

If there are insufficient funds in the Treasury, half of the amount will be taken, or whatever is currently available from the Treasury, whichever is lesser, *and the remaining amount will be taken from the Treasury the next time the Technology Power is activated for any purpose*, before any further Research, Development, or Patents are processed. If the research was successful, but there are insufficient resources to pay for it, the Research will not be received until the research is fully funded (i.e. ‘paid for,’ stamped Paid in Full!).

Note that this ‘research deficit’ situation can create some interesting game situations; e.g. a position has to pay off the previous research before doing anything else. A position might activate the Technology Power after Taxation just to pour RPs into the black hole (i.e. ‘black hole research’ ☺) and/or to release previously completed Research Pieces.

- **Big Nothing:** Zero RPs commitment to a Research Attempt will never cost any RPs because adding a percentage to zero (see previous section discussion) will always be zero. So, yes, it is possible for a position to proceed through the game not paying anything for Research, but depending on the luck of the die (95% of the time the Research Attempt will be underfunded, by up to 45%) for an occasional success. Each attempt still costs an Act and a Power Activation however. Thus, astute players will never waste a Power Activation due to *lack of RPs*

and zero RP commitment to Research Attempts will never risk disturbing later Power Activations. This may be a necessity in some cases to pass Conflict Checks. There are dynamics.

- ✓ There is an interesting point for debate as to whether by ‘thinking out loud’ I am depriving the players of the ‘joy’ of the learning curve of the game; there is a certain joy of learning the complexities and discovering subtleties, efficiencies, exploitations and understanding of game rules through thinking and play experience.⁴ But GGDM is a simulation game that exists at the limits of human complexity and the ‘joy’ of playing is equally in the holism of the game, position management and the story arc.
 - I might also, while we are on the subject, be accused of being verbose.
- **Space Race:** New fully-paid Research Pieces must be immediately placed on an unoccupied Monad in the Public Space (which is then occupied) and the positions’ Actions must contain information as to the desired placement of the Research Piece should research be successful. If this information is not provided, the Concierge will do whatever looks right and move on.
 - ✓ Research Pieces may be placed either singly or added to another Research Piece to form a Research Group; there is *no requirement* that a Research Group be formed.

More than two Research Pieces of the same type may be placed adjacent on the Public Space, there is no limit to the number of adjacent pieces or types, but exactly two Research Pieces of the same type – no more, no less – form a Research Group. It may be possible to ‘rescue’ a *disrupted* Research Group by placing a new Research Piece adjacent to both an eligible colony with an active Epistemological Constructural Element and a Research Piece from the disrupted group. This is an alternative to attempting reactivation of the inactive Constructural Elements by Cohering (see 5 Culture, p. 421, *supra*).

“We will soon create intelligences greater than our own. When this happens, human history will have reached a kind of singularity, an intellectual transition as impenetrable as the knotted space-time at the center of a black hole, and the world will pass far beyond our understanding. This singularity, I believe, already haunts a number of science-fiction writers. It makes realistic extrapolation to an interstellar future impossible. To write a story set more than a century hence, one needs a nuclear war in between ... so that the world remains intelligible.”

– Vernor Vinge, op-ed for Omni Magazine, 1983

The Vinge Rule: Nuclear war provided a plausible out, before 1945, writers would have needed something with divine implications, such as a meteor. Though I do believe that Vernor Vinge is generally correct, I would note that 20 years before his article, Frank Herbert had created a setting – Dune – that was far more than 100 years into the future and didn’t involve a nuclear war.

However, perhaps the Butlerian Jihad and the vast spatial and temporal distance provided the same overall *do-over effect* (see Foresight discussion, 2 Colleges, p. 472, *supra*), while Star Trek, of course, used some sort of global nuclear war from a conventional world war backstory as did the Mad Max series, and is perhaps to what Mr. Vinge was alluding.

- ✓ “The development of full artificial intelligence could spell the end of the human race.” – Stephen Hawking.

Herbert's Dune remains generally intelligible (if by a stretch) because despite all, the characters, the human populations, and the story contains all of the normal human drives and elements we recognize from Earth in the now – power, greed, drug addiction, men still fight for mates and money, women still generally have babies the same way, they still use psychotic drugs and religion – and all of it ties into a subconscious messianic urge for divine enlightenment.

“As long as we don't program emotions into Robots, there is no reason to fear them taking over the world.” – Neil deGrasse Tyson

Deep Learning the Singularity: This game – a product of the information revolution – makes no assumption on whether or when the Technological Singularity may occur or what the effects might be. Participants may determine that it happened before the game (e.g., Battlestar Galactica), or that it never happened, or that it happens during the game as part of the story. It may occur in conjunction with the invention of Stardrive; the two might be related. However, current predictions suggest that we are a lot closer to the Singularity event than we are to faster-than-light travel. Most science-fiction works of any kind since 1950 can be classified as pre-singularity. Because of the frightening implications of the Singularity, we have barely begun to discuss it yet. The defining point for all intelligences however, is their comprehension of and reaction to the existential void. What will the machine intelligence do when confronted with the void?

- ✓ “Humans should be worried about the threat posed by artificial intelligence.” – Bill Gates.

Deep Learning software is already beyond our understanding and opaque to us, see Will Knight article excerpt in The AI Problem, Corporations, *infra*, but is being used in rapidly increasing range of applications. Quantum computing has not yet been achieved by engineering, though Microsoft released the first Quantum Computing language in 2017. Quantum communication has been achieved and nations are using Q-Comm Satellites for security now. What happens in a decade or two when the reality of quantum computing meets deep learning? This is why many experts feel or fear that the technological singularity is only 50 years away.

Could a Deep Learning AI play GGDM? You saw this coming.

- ✓ “Instead, it relied entirely on an algorithm that had taught itself to drive by watching a human do it.” – Will Knight, “The Dark Secret at the Heart of AI,” MIT Technology Review, April 11, 2017.
 - ✓ “The car's underlying AI technology, known as deep learning, has proved very powerful at solving problems in recent years, and it has been widely deployed for tasks like image captioning, voice recognition, and language translation.” *Id.*
 - ✓ See full quote, AI Problem excerpts, Corporations, *infra*.
- **All About Toasters:** There was an interesting shift in the Cylon creation story between the original Battlestar Galactica (1978) and the reimagined series (2004). In the original series, the Cylons were created by a long extinct reptilian species (*à la* Fred Saberhagen's ‘Berserkers’); this might have been intended to explain the shiny chrome coldness of the Cylons. This was the Erich von Däniken era and the opening narration stressed extraterrestrial origins of life on Earth (or at least of humanity) to attract a certain audience (like me in my youth) and it might not have sat well with the 1970s audience if we had created the monsters that were trying to exterminate us (following the human invention of the Bomb).

In the 2004 series, a generation after the end of the Cold War, the Cylon back story was changed so that humans created the Cylons. The chrome Centurion Cylons were created by the Twelve Colonies, the Final Five were created on the original Earth (not our Earth) by the Thirteenth Tribe (Cylon tribe) that left Kobol. The Final Five also recreated the resurrection technology and biological human versions of the Cylons (the Centurion Cylons had only created hybrids). After thousands of years of sub-light travel, they made contact with the Centurion Cylons of the Twelve Colonies (who had FTL drive).

- ✓ Thus, in the end of the series, in their quest for Earth, they did find “Earth” – not the Earth of the Thirteenth Tribe, but our ‘Earth’ about 150,000 B.C. That they found Earth, but did not find Earth, and both are true, is a fuzzy sapient statement, one that machines (currently) would/might not understand.
- ✓ A short spin-off series, Caprica (2010) was created to explain the human creation of the Cylons before the series; the story is entangled in the struggles of a radical monotheistic cult (including suicide bombers) against the majority polytheism.

“Everything is designed. Few things are designed well.”

– Brian Reed (brianreed.me, not to be confused with Brian Reid who sued Google)

“The world won’t care about your self-esteem. The world will expect you to accomplish something BEFORE you feel good about yourself.” – Bill Gates

Development: Development is the process by which Research Groups in the Public Space become Applications on the current Era Matrix (i.e. finding something useful to do with the research), which in turn, are used for Patent Interpretations that introduce new *major* technologies into the game. Development attempts require the activation of the Technology Power for that purpose with the use of two Acts and no Scenes. Development also requires that the position currently have on its Public Space at least one Research Group, as well as, some small, variable amount of RPs in the Treasury. Each Research Piece can only be involved in one Development attempt per Regular Turn, even if part of two or more overlapping undisrupted Research Groups.

➤ Development Fund: When attempting Development, the position must specify one existing *non-disrupted* Research Group as the target of the Development. Further, the Actions sent to the Concierge must contain the locations of one or more currently open spaces on the current **Era Matrix** for the position. At the time the Actions are submitted, a number of RPs will be deducted from the position’s Treasury equal to the number of Matrix locations specified in the Actions times the current Era number *squared*.

- ✓ Example, a position chooses a non-disrupted Energy Research Group on the Public Space and specifies two open spaces (by coordinates) on the current Era Matrix to which the Energy Research Group could be Developed into an Application. The position is currently in the 1st Era. Thus the cost of the Development attempt will be just 2 RPs ($2 \times 1^2 = 2$) which will be subtracted from the Treasury. If the position is currently in the 2nd Era, the cost of the Development attempt will be 8 RPs ($2 \times 2^2 = 8$) and in the 3rd Era, the cost will be 18 RPs ($2 \times 3^2 = 18$).

Each undisrupted Research Group may be the target of only *one* Development attempt each Regular Turn.

- The Kitty Incident:⁵ An attempt to Develop the target Research Group will be made by the Concierge each time the position's Regular Turn Actions are processed, until either successful, or until all of the specified Matrix locations are exhausted. Each turn that the Development is not successful, the target Research Group type⁶ (e.g., Industry Research Group, Defense Research Group) is permanently blocked from becoming an Application **at the specified Matrix location**. The next turn's Development attempt moves to the next specified Matrix location *as long as it is still open*, until all Matrix locations in the Action are exhausted.

If the Development of the Research Group into an Application fails on the first turn, Development on subsequent turns *will not require any additional activations of the Technology Power* or expenditure of additional RPs, it will be processed automatically. Development attempts will terminate if the Research Group becomes *disrupted* and will **not** restart automatically when restored. Because Enlightenment *can only be assigned to Power Activations*, there is no opportunity to add Enlightenment on the second and subsequent Development attempts. Unused Enlightenment will be returned when either it fails or is successful, see Vampire Suicide, 2 Colleges, p. 478, *supra*.

- ✓ Multiple Development attempts may be ongoing at any time as long as there is a *separate and specific Research Group assigned to each* (i.e. two Development attempts may not be made on the same Research Group in a turn). Multiple Development attempts can target the same Matrix location; if one is successful, the others following will be blocked. Development attempts will be processed in the order submitted.
- ✓ It is possible through incredibly bad luck and/or Development of other Applications at the target locations to permanently foreclose Development of a specific Research Group in the current Era Matrix. The group will again become eligible for Development in the next Era Matrix when it becomes available (see The Progress of Eras, 1 Eras, p. 759, *infra*).
- Short One Wingnut: The base chance of Development of the Research Group each turn is 50%. If there is only one remaining space on the current Era Matrix, the Development of the Research Group is automatically successful. The base chance is increased by 5% if any of the adjacent spaces contain an Application with the same Research Area. The base chance is reduced by 10% if there are no Applications adjacent to the target space on the Matrix, including instances where there are no Applications currently on the Era Matrix.
 - ✓ Thus, the base chance for Development of the first Application on an Era Matrix is 40%. Breaking into a new Era is an entire scientific revolution.
 - ✓ There is a dynamic between the number of currently open spaces on the Era Matrix, the number of spaces specified for Development of a specific Research Group, and cost and certainty of success.
- The Better Mousetrap: When the Research Group is successfully developed into an Application, it is removed from the Public Space (freeing up two Monads) and placed on the specified single space on the Matrix as an Application. All Applications on the Era Matrix occupy one space and are labeled with the Research Area from which they were Developed (e.g., Weapons Application). Applications on the Era Matrix do not have Constructural Elements.

- ✓ There is no rules provision in GGDM for removing single Research Pieces from the Public Space, only for removal of Research Groups by successful Development into Applications. There is no process for removal of Research Groups other than by successful Development. Placement of a Research Piece on the Public Space is a permanent act and a commitment to future successful Development. In some instances, Research Pieces may be moved or lost due to the need to form new Pathways (e.g., see Capital Chaos, 2 Government Titles, p. 598, *supra*) or from other necessary rearrangements of the Public Space during the game.

“Cong Cao, an expert on China’s science and technology, put it more bluntly in an article he wrote: ‘When the paper bubble bursts, which will happen sooner or later, one may find that the real situation of scientific research in China probably is not that rosy.’”

– “‘Publish or perish’ leads to fraud and paper bubbles in research,” Shanghai Daily, October 10, 2011 (authorship unattributed)

Paper Bubble: The Technology Power is not immune to entropic effects or Interventions by the Concierge during the game, but there are some careful guidelines that should be followed.

For example, it is possible to use Interventions to occasionally remove Research Pieces from the position’s Public Space on the basis of research fraud, bad data, duplication, plagiarism, etc.⁷ However, as Applications on the Matrix are expected to represent concrete, provable, repeatable results of research applied through engineering – ultimately leading to the physical laws of the game universe – they probably cannot be removed, especially if they are part of a Patent.

And of course, Patents which are actual demonstrable technologies, probably cannot be affected by Interventions (certainly cannot be lost). In other words, short of the apocalyptic or catastrophic collapse of civilization, it is not likely that humanity will *unlearn* electronic computing, rocketry, vaccinations, aircraft, nuclear technologies, contraception, or cocaine, but the true advance of technology and science is currently perceived to be in some danger of corruption and dilution. However, there are a couple of other ways in which the Concierge can gently Intervene to apply entropic effects to Technology Power Activations short of removing existing pieces:

Inactivation of the Epistemological Constructural Element in the right places (due to social upheaval, incompetence, change in worldview locally, anti-intellectualism or anti-education) can disrupt Research Groups. The Concierge is also free to ‘embezzle’ RPs dedicated for research or adjust percentages for success through the use of Interventions. Developments and construction abilities from Patents might sometimes be unavailable for a period, representing ‘lost’ tech.

- **Dumpster Fire Alarm:** The following article is not offered to criticize China – the alarm bells have been raised in the West as well as in India (see discussion, 1 Information, bottom feature quote and EN 6, pp. 1337-1338, *infra*) – but rather because this article presents the issue most succinctly for GGDM purposes. In fact, this article suggests that a well-funded Technology College or activation of Technology Power Writs in GGDM may serve to aggravate systemic problems almost as much as it helps the position advance in technology. That is, the systems created by or for the technological and scientific advancement of humanity have become a drag on the very endeavor. Within every process lie the seeds of its demise (echoing Dean Inge, 5 Government Titles, p. 641, *supra*). Where do we find the proper balance?

- ✓ “Editor’s note: How can China become an innovative country when many professionals are judged not by their real accomplishments but by their output of papers? The following Xinhua article identifies one of the biggest hurdles to innovation: blind worship of academic publishing – the more the better.

[Article begins] AS China’s economy has soared to the second place in the world, the country’s scientific strength has also surged – if only measured by the numbers. Chinese researchers published more than 1.2 million papers from 2006 to 2010 – second only to the United States but well ahead of Britain, Germany and Japan, according to data recently published by Elsevier, a leading international scientific publisher and data provider. This figure represents a 14 percent increase over the period from 2005 to 2009. The number of published academic papers in science and technology is often seen as a gauge of national scientific prowess. But these impressive numbers mask an uncomfortable fact: most of these papers are of low quality or have little impact. ...

China’s CPA [Citations per Article] dropped ... for the period from 2005 to 2009, and is now below emerging countries such as India and Brazil. Among papers lead-authored by Chinese researchers, most citations were by domestic peers and, in many cases, were self-citations. ‘While quantity is an important indicator because it gives a sense of scientific capacity and the overall level of scientific activity in any particular field, citations are the primary indicator of overall scientific impact,’ said Daniel Calto, Director of SciVal Solutions at Elsevier North America. Calto attributed China’s low CPA to a ‘dilution effect.’ ‘When the rise in the number of publications is so rapid, as it has been in China – increasing quantity does not necessarily imply an overall increase in quality,’ said Calto.

‘Chinese researchers are too obsessed with SCI (Science Citation Index), churning out too many articles of low quality,’ said Mu Rongping, director-general of the Institute of Policy and Management at the Chinese Academy of Sciences, China’s major think tank. SCI is one of the databases used by Chinese researchers to look-up their citation performance. The alternative, Scopus, provides a wider coverage worldwide. ‘Chinese researchers from a wide range of areas and institutions are vying for publication, as it is a key criterion for academic appraisal in China, if not the only one. As a result, the growth of quality pales in comparison to that of quantity,’ said Mu, an expert on China’s national science policy and competitiveness.

On the other hand, China also falls behind the United States in multidisciplinary research, which is a core engine for scientific advance and research excellence. From 2006 to 2010, China published 1,229,706 papers while the United States churned out 2,082,733. According to a new metric introduced by Elsevier’s Spotlight research assessment solution, China generated 885 competencies while the United States had 1,817. In other words, China’s total research output is more than half that of the United States, while the number of competencies showing China’s strength in multidisciplinary research is less than half that of the United States. Cong Cao, an expert on China’s science and technology, put it more bluntly in an article he wrote: ‘When the paper bubble bursts, which will happen sooner or later, one may find that the real situation of scientific research in China probably is not that rosy.’ – ‘‘Publish or perish’ leads to fraud and paper bubbles in research,’’ Shanghai Daily, October 10, 2011 (authorship unattributed) (available free online).

GGDM is my only ‘paper’ so far, and no one would mistake it for ‘research.’

Russian Ambassador: *Cobalt thorium G has a radioactive half-life of ninety three years. If you take, say, fifty H-bombs in the hundred megaton range and jacket them with cobalt thorium G, when they are exploded they will produce a doomsday shroud. A lethal cloud of radioactivity which will encircle the Earth for ninety three years!*

President Muffley: *I'm afraid I don't understand something. Is the Premier threatening to explode this if our planes carry out their attack?*

Russian Ambassador: *No sir. It is not a thing a sane man would do. The doomsday machine is designed to trigger itself automatically.*

– Dr. Strangelove (1964)

Endnotes.

¹ Citation: “What is happening, you ask? Well, nothing. We have not made progress for 40 years. The problems we are trying to solve today are the same problems we were trying to solve half a century ago. This worries me because if we do not make progress understanding nature on the most fundamental level, then scientific progress will eventually be reduced to working out details of applications of what we already know. This means that overall societal progress depends crucially on progress in the foundations of physics more so than any other discipline. I know that a lot of scientists in other disciplines find that tremendously offensive, but if they object, all I have to do is remind them that without progress in the foundations of physics, there would be no transistors, no microchips, no hard disks, no computers, no wi-fi, no internet; there would be no artificial intelligence, no lasers, no magnetic resonance imaging, no electron microscopes, no digital cameras, computer science would not exist, modern medicine would not exist either because the imaging methods and tools for data analysis would never have been invented. In brief, without the work that physicist did 100 years ago, modern civilization as we know it today would not exist.” – Sabine Hossenfelder, “Physics is still in crisis,” Sabine Hossenfelder YouTube Channel, June 5, 2020.

² Citation: A fantastic video made from the author’s reading of “Day Million” is available on YouTube at <https://www.youtube.com/watch?v=ec7SJy26tLA>.

³ Commentary: I wonder if Frederik Pohl’s “Day Million” (1966) is related to Zager & Evans “In the Year 2525” (1968)? The song was written in 1964, so it predates “Day Million” publication by two years.

⁴ Commentary: Long ago, I participated as a player in, and assisted in the late design of a free PBEM game called Empire Forge. I created a FAQ page that was eventually 200 questions long clarifying the rules and operation of the game program, I also created a Ringer Board page, a Pink Floyd inspired short story and a background mythology, “Mythology of the Maj.” I noticed as a result that over time, new players coming into the game were playing it at a higher level in shorter time than when I had begun the game. Unfortunately, it didn’t go well when I suggested re-writing the rules; no set of game rules should have 200 FAQ.

- ✓ Similarly, in one afternoon, two friends and I played three consecutive games of the steampunk time-travel board game Khronos. We each won one game. But each game played became progressively more complex and longer as our calculations of ripple effects, building placement, and resource management deepened. It was an extraordinary phenomena to witness. Deep Learning in humans.

⁵ Citation: Reference to an old television commercial where the cat on the lab table knocked over some beakers of chemicals and the scientist found the mess the next morning on the floor and ‘discovered’ plastic.

⁶ Clarification: Thus, because a Research Group is made of two Research Pieces of the same type, a ‘blocked’ location on the Matrix cannot be unblocked by simply shifting to another Research Group of the same type. This prevents having to track which individual Research Groups have been blocked or having players making shifty moves with overlapping Research Groups to get around the blocked Matrix location. Blockage of Research Group ‘types’ solves the issue in a broad stroke. The blocked Research Group types must be displayed for the players to know.

⁷ Commentary & Citation: “You copy from one book, it’s plagiarism, if you copy from 100 books, it’s research.”

- ✓ There are many variations of this on the internet attributed to several different authors and has a long history, see <https://quoteinvestigator.com/2010/09/20/plagiarism/>.