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TECHNOLOGY TRANSFER ACROSS INDUSTRIES OVER THE YEARS

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Abstract

This paper aims to establish

- Technology Transfer identical with Commercial Scientific Progress
- Broad classifications of observed technology transfer to industry,
- The impact of Technology Transfer in shaping our world
- Role of Technology Transfer in making inaccesible and unaffordable more accesible and affordable
- Indespensibility of Technology Transfer in bringing about productive side-effects of planned obsolescence.
- The deterimental effects of the lack of proactive and efficient technology transfer

Through real-life examples and case studies and tries to show the above aims, obectives and theoretical assumptions to be true.

It tries to consolidate most relevant information on technology transfer and its industrial and scientific roles to give a comprehensive qualitative analysis on the same.

Keywords: "technology" , "transfer" , "nature , " Military" , " academia" , " research" , "institutions" , "AIIMS" , "CERN" , "air" , "travel" , "jet" , " advantages" , " bullet train" , "shikansen" , "biomimicry" , "graphene" , "wireless", " headphones" , "IIT-H" , "Planned" , "obsolescence" , "phoebus", "radio" , " lightbulb"

INTRODUCTION

Technology transfer which serves as the base of this research is commonly described as process of transferring technology from the person or organization that owns or holds it to another person or organization. In most cases this is referenced and concerned with commercialization of technological innovations and solutions from organization(s) that develop it preliminarily. An important concept to grasp in order to comprehend the research as intended is that of the meaning of technology. Technology, the application of scientific knowledge to the practical aims of human life or, as it is sometimes phrased, to the change and manipulation of the human environment [0]. Simply put, it is the use of scientific phenomena and natural laws to solve a problem in the ecosystem, society, life processes, economy or with respect to human convenience. It is due to this interpretation that the main assumptions and conclusions are in line

with the belief that technology in its existence and development isn't solely by virtue of the activites of humankind or its forces. Keeping that in mind, it becomes very clear that transfer of technology as pointed out eventually has shaped, is shaping and will continue to shape the world as we know it. It is indirectly or directly integral to consistency in growth and incentivising scientific development of mankind.

Why technology transfer is intrinsic to scientific development

Technology that is developed in labs and as part of experimental studies have the power to change the world but as capitalism demonstrates, unless a monetary incentive associates itself with such science, it is impossible to successfully make the most impact with the technology. In today's modern economic world that monetary incentive is in the form of profit from commerce. So in order for a greater realization of the potentials of a technology leading to the wide-scale implementation of the same in the world that is consistent with the ultimate aims of technology development, this technology must find a way to be adapted for the consumer. This is brought about by technology transfer to industry.

Classification Of Technology Transfer To Industries

Technology transfer processes are observed from wide categrories; a very conservative scheme of describing technology transfer would classify most of it under transfer or commercialization of tech from academic institutions to co-orporate entities. They would also refer to some of the organizational technology however the classification in essence is seen to be more diverse.

They can be seen from Nature (Biomimicry), from research institutions, from academia, from another industry or Military.

a) **Technology transfer from Nature to Industry:**

The transfer or technology existent in nature in any way, shape or form to man made applications thus commercilized is refered to as technology transfer from nature to Industry.

This is where the thought process regarding the understanding technology comes into the picture. Technology can exist anywhere even without man's intervention. After all it is just a means to an end with respect to application of scientific phenomena and principles to resolve a problem. Therefore the various adaptations in nature for survival and growth if mimiced and replicated for use in the human world mainly in industry product.

Probably the best example of such a technology transfer is that of the Japanese Shinkansen.

The Shinkansen introduced in Japan arguably revolutionized high speed train-travel. It was the birth of the Bullet Train as we know it. However in the 1980s, one of the problems that eveloped with the early Shinkansen E1 was that it produced irritable loud sounds while running thus inconveniencing people especially in residential places[1]. To solve this issue a team was assembled toredesign the shinkansen and develop the E2. One big advantage they had was that Eiji Nakatsu, the general manager of the technical development department - was a bird watcher[1].

Throughout the entire design of the train, design cues have been seen to have been adapted from birds. For intance :

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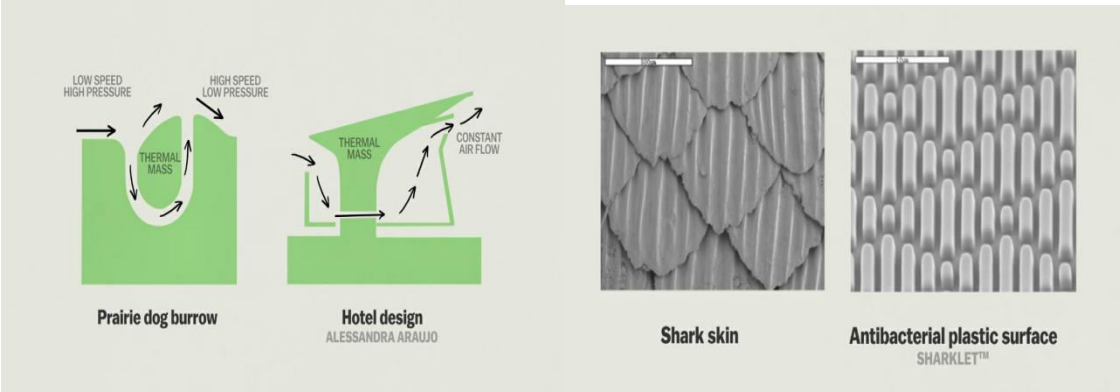
The Pantograph of the train was inspired by Owl feathers. The supporting shaft was adpated from the smooth body of the Penguin to reduce air drag and noise.
The most important part of the train - the nose was inspired by the beak of the Kingfisher which dives into water to catch its prey but the unique shape ofits beak allows it to do so while barely making a splash[1].

All in all these changes and biomimicry made the resultant 2nd generation shinkansen 10% faster, 15% more power efficient than the first and helped it remain under the 70dB noise limit in residential areas. The E2 broke numerous world speed records in part due to these birds and their inspiring biology[1].

Similarly companies like Kohler, Kraft, Nike, P&G, Boeing, nyserda, General Electric have all hired biomimcry experts and biologists to help them adapt efficient technologies and design elements from nature into their products.From designing air-ventilation systems in hotels after praire dog burrows Mimicing shark skin to create antibacterial plastic surfaces. Or arranging widn turbines in the same drag reducing pattern in which schools of fish swim in. Transfer of technology to industry fropm nature is helping shape the world around us[2].



Similarly the surfaces of lotus leaves can be mimiced to make any product water proof;Imagine it being applied in your cars. Newer ideas help to mimic communication systems between ants to find food can be mimicked in sotware; also in autonomous vehicles such as self driving cars.

b) Technology transfer from Research institutions

Technology transfer often us seen to occur from institutions usually government owned, that specilize in undertaking implementation of experimental technology at a very niche scale as a part of scientific explorations or studies. These technologies developed as proof of concepts can be later adapted for public use by consumers by commercialization of the said technology.

When Institutions like AIIMS, ISRO, NASA , CERN perform research, they use and develop certain technologies that have potentially revolutionary Implimentations

Embedded web technology was developed by NASA to enable astronauts to conduct and monitor experiments on the ISS, remotely over Internet. This embedded web technology was later released in the public domain, served as a foundation to the Internet of Things which was later developed at CERN[3].

An interesting spin-off from the research at CERN is that the GEM (Gas Electron Multiplier) which is a specialized gas detector is employed extensively in high energy physics and has been adopted in medical imaging, biotechnology, material analysis, radiotherapy dosimetry, radiation detection monitoring and even astrophysics[4].

c) Transfer of technolgy from academia

Transfer of technlogy from academia refers to the transfer of technology to Industry from instituions like colledges, polytechniques, universities, schools or anyother educational institutions by its students or faculty.

A recent example of such technology is in India's solution to the blackfungus epidemic: Researchers at Indian Institute of Technology, Hyderabad (IIT-H) have developed oral solution for the blackungus, which could be mass-produced now, to treat it providing huge relief to patients affected with it and doctors finding it hard to treat the patients along with allaying the fears of another uncontrolled widescale health disaster. [5]

After two years of advancement of examination, the researchers are now confident that the technology as usually done, can be transferred to acceptable pharmaceutical industry-partners for wide-scale production[5].

Arguably academia plays a very important role in the technology transfer process because of scope of scholarly collaboration between them and research institutions and government agenicies that source ideas from youth scientists.

d) Transfer of technology from Military:

At the height of the Cold War, military commanders were seeking a computer communications system without a central core, headquarters or base of operations that could be sabotaged by enemies thus blacking out the entire network in one fell swoop.[6] This arose a desire to share information over great distances without the need for dedicated phone connections between each computer on a network. This gave birth to the devlopment of ARPANET

ARPA(research) played a key role in launching the “Information Revolution,” including developing or furthering much of the conceptual and theoretical basis for ARPANET, a pioneering network for sharing digital resources among geographically separated

computers. Its initial demonstration in 1969 built up to the Internet, whose world-changing consequences unfold on a daily basis today. A seminal step in this sequence took place in 1968 when ARPA contracted BBN Technologies to build the first routers, which later enabled ARPANET to become operational. [7]
ARPANET adopted TCP/IP on January 1, 1983, and from there researchers began to assemble the "network of networks" that became the modern Internet. This technology was adapted and then commercialized to form the mordern internet as we know today.
This is but one example of technology tranfser from Military to Industry.

Lets Discuss
Why Technology Transfer ?
The advantages of Technology Transfer are as follows:

1. It provides incentives for new innovations and discoveries in the field of Science and Technology by commercializing the products on a large scale thus allowing considerable royalties to the organization and person behind the technology.
2. It humanises the technology i.e adapts raw proof of concepts to better suit human needs.
3. Brings about co-operation between two nation, organizations and institutions when technology is shared between them(we will explore this further later).
4. Maximises resource utilization as any amount of monetary or infrastructure or any other resources provided for any research and development open avenues to innovations in the desired field or area but also simultaneously in seemingly unrelated applications.

Lack of Successful Technology Transfer Intiatives
In cases of lack of efficient technology transfer initiatives, humanity can miss out on potentially world changing innovations - the biggest example is the case of Graphene.
Graphene is a one-atom-thick layer of carbon atoms arranged in a hexagonal lattice[8]. It is the building-block of widely-used Graphite , but graphene is a mindblowing substance on its own - with a multitude of path-breaking properties which repeatedly earn it the title "wonder material"[8]. Harder than diamond, elastic than rubber; tougher than steel but lighter than aluminium. Graphene is the toughest or strongest known material[9]. Not only is its high electron mobility is 100x faster than silicon, its heat conductivity is also 2x better than diamond; its electrical conductivity is 13x better than copper; it absorbs only 2.3% of reflecting light[9]. Yet, graphene still hasnt taken over the world. Why?...The growth of graphene in industries are very much related to two main items: *money and research.*
Despite its easy method of isolation, researchers are still trying to find a way to optimise the commercialisation of this material. After the 15 years since it was first discovered, people have gone from producing flecks to barrels of graphene. The evolution of graphene is not an overnight process. Its production process requires further refining in order to enable graphene to leap out of the lab to the marketplace[10].

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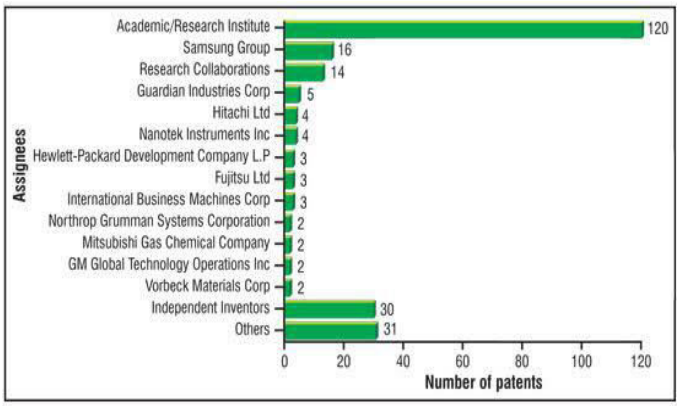

From the above chart we can infer that while graphene has been widey undertaken for research and experimentations - it has not been commercialized or tranferred to industries on a significant scale over the last two decades since its discovery.

How does technology transfer make technology more accesible and life easier ?

Sixty years ago, air travel was far too expensive for the masses. Book a flight between New York and London on Pan Am in 1960, and you'd be paying somewhere around $300, or about $2,600, adjusted for inflation. But in 2019, you can catch the same flight for almost a tenth of the price[11].

The cause of reduction of the averge flight price so drastically are

- Reduction of flight times and consequent increase in the number of flights
- Having more powerful engines to allow larger planes to fly which accomodates more people in a single flight thus improving the supply-demand ratio.
- There has also been reduced dependendency on pilots due to the integration of computers into the avionics thus reducing involvement of manual work if marginally.
- The use of computers to book plane tickets thus increasing reach of the service allowing airlines to reduce price by economies of scale.

Thus we can see from the above examples that computers are playing a great role in reducing flight prices and as we have discussed before, that is a product of technology.

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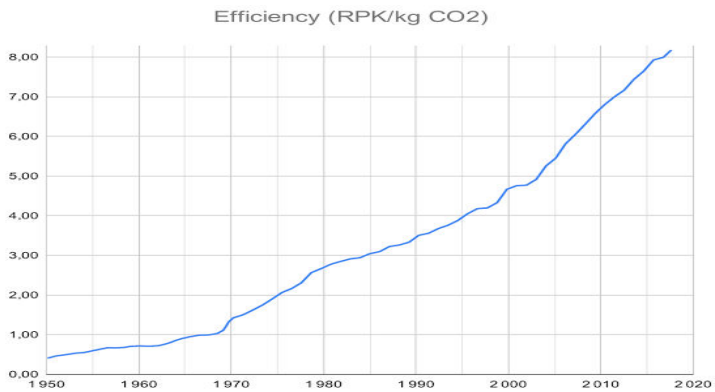
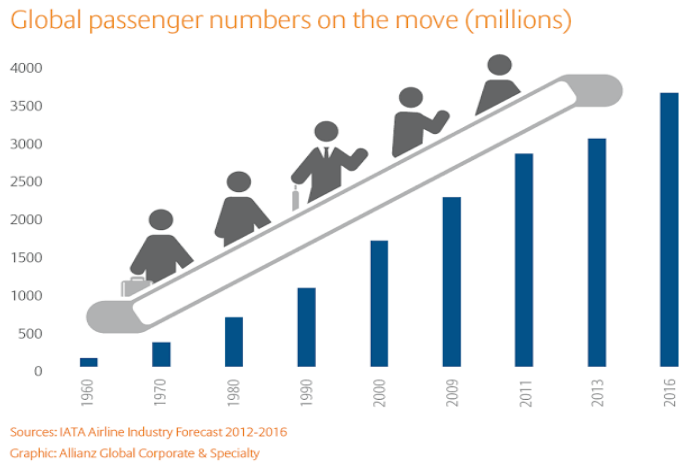
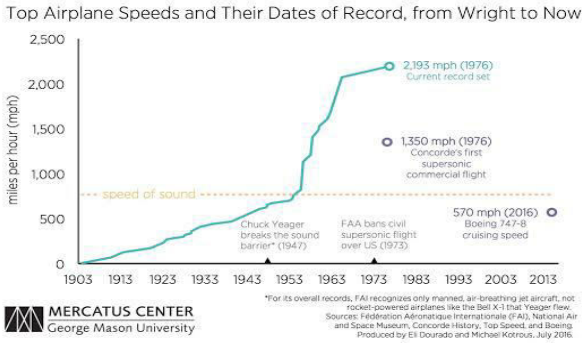
Furthermore the main factor affecting flight prices is that the airline industry is almost completely dependent on jet planes. In the 1960s this wasnt the case.
How does using Jet planes help ?

- Less vibrations in the plane body increases longetivity and reduces maintanence costs[12].
- They produce more overall thrust thus reducing flight times and increasing plane capacities[12].
- Can fly at higher altitudes thus increasing flexibility leading to greater number of flights even in bad weather[12].







Ever since the introduction of the jet planes in civil aviation in 1952[12], the sizes, capacities, fuel economy and number of people using air travel has only undergone a steady increase.
All of these reasons make the devlopment of jet engines one of the main factors which contributed the increased affordability of flight travel. Along with this the introduction of booking by personal computers, ncreased the reach of these services as people started availing these with increased flexibility.

BUT

Before World War II, in 1939, jet engines primarily existed in labs. The end of the war, however, illustrated that jet engines, with their great power and compactness, were at the forefront of aviation development[13].

A young German physicist, Hans von Ohain, worked for Ernst Heinkel, specializing in advanced engines, to develop the world's first jet plane, the experimental Heinkel He 178. It first flew on August 27, 1939[13].

Building on this advancement, German engine designer Anselm Franz developed an engine suitable for use in a jet fighter. This airplane, the Me 262, was built by Messerschmitt[13].

Following the end of the war the German jet aircraft and jet engines were extensively studied by the victorious allies and contributed to work on early Soviet and US jet fighters. The legacy of the axial-flow engine is seen in the fact that practically all jet engines on fixed-wing aircraft have had some inspiration from this design[13].

By the 1950s, the jet engine was used in almost every combat aircraft. By this point, some of the British designs were already cleared for civilian use, and had appeared on early models like the de Havilland Comet and Avro Canada Jetliner[13].

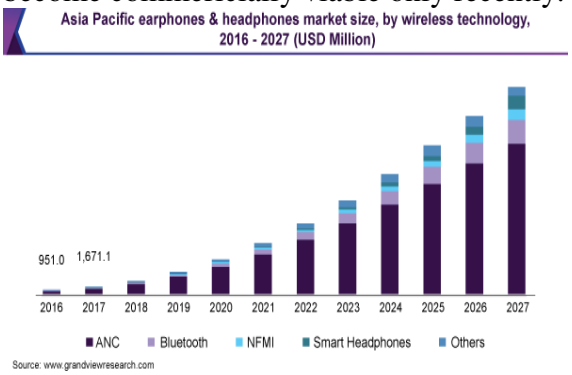
This affordabillity and increased accesibility is thus a by-product of technology and commercialization of technology once experimental in nature.

How does planned obsocelecence in the field of science of technology use tech transfer to incentivise innovation:

Planned obsolescence is the calculated act of making sure the existing version of a product will become dated or useless within a given time frame[14]. It involves deliberately worsening a product or technology for the sake of sales. In most cases and in a way of thinking, it might stand out as almost evil but this paper poses a different perspective to the practice pointing out that in certain cases mostly in the fields of science and technology, this infact causes innovation by availing technology transfer.

Case Study : Wireless Headphones

The wireless audio technology has existed as Proof of concept since the 1970s, however has become commericially viable only recently.



From grandviewresearch's charts we can infer that there has been significant growth in the wireless heaphone market since 2016 when Apple dropped the headphone jack from their iphone 7 series. It is worth noting that during the same time (about 2018-2019) as most of the

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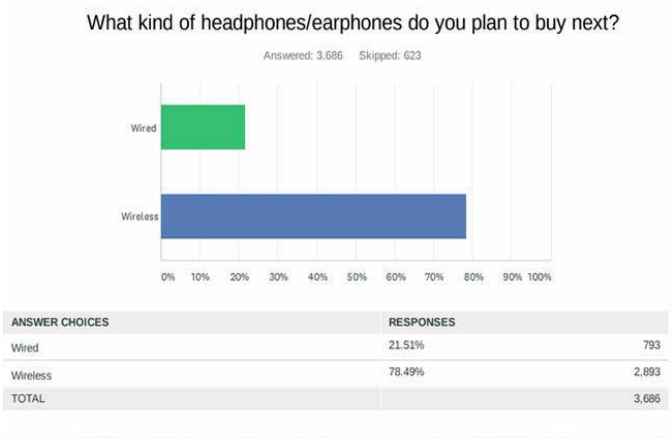
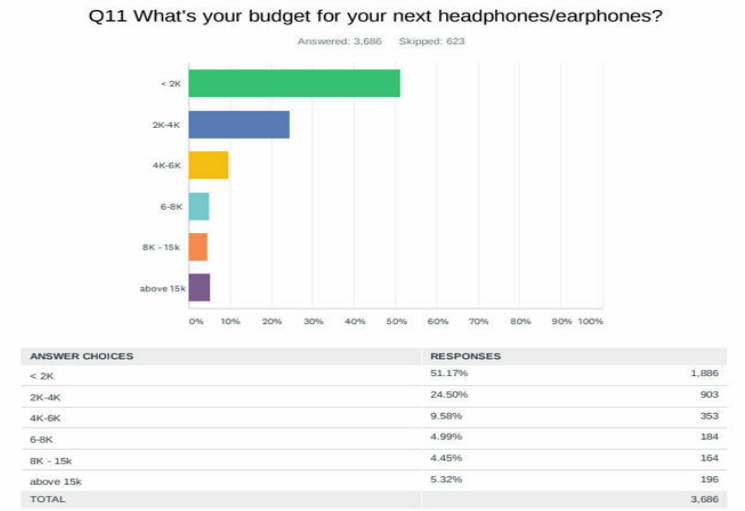
smartphone brands followed Apple's footsteps by dropping the headphone jack from their flagship or upper-midrange products and later their midrange products in 2019-2021 there was substantial growth in the market cap of wireless headphone products owing to the increased demand and promotion of the same as an alternative to conventional audio appliances born out of corporations' business strategies.



ANSWER CHOICES	RESPONSES	
Wired	21.51%	793
Wireless	78.49%	2,893
TOTAL		3,686

The increased demand for wireless headphones has incentivised innovation in the sector and more and more brands entering the market has imporved the variety and quality of products increasing competition and thus making them more affordable.



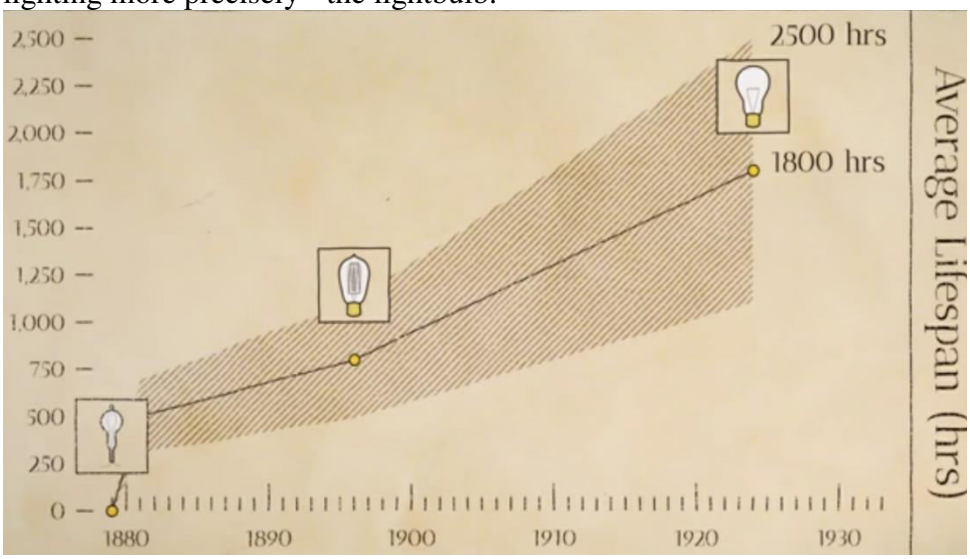
ANSWER CHOICES	RESPONSES	
< 2K	51.17%	1,886
2K-4K	24.50%	903
4K-6K	9.58%	353
6-8K	4.99%	184
8K - 15k	4.45%	164
above 15k	5.32%	196
TOTAL		3,686

In digit's survey, observtions were a pretty decent shift in the price range that the respondents would make their next purchase in[15]. The above Rs. 15,000 price range climbed to 5.32 percent, however, the sub Rs. 2000 range saw a colossal shift, with a whopping 51.17 percent saying that their next purchase of headphones would be under Rs.2,000[15]. That's an increase of almost 10 percent in this price range! This is mainly due to the fact that brands such as Xiaomi, Realme, Zebronics, pTron, and others are offering an array of sub Rs.2000 audio products with a decent set of features as well[15]. There are even multiple true wireless in-ears that are being offered at this price range, which is a massive shift from 2016-2017, when only the premium, high-end brands had captured this segment. There are sub Rs.2000 products that offer

voice assistant support, a sizable battery life, an IP rating, and sometimes, even touch controls[15]!

Wireless headphones use low power radio signals to communicate wirelessly with your audio source[16]. This technology can be said to have been adopted from the military communication devices such asthose used by the secret service for morse communication using aformentioned radio technology again used by the military for remote control[17]. It is from here that the technology was transferred to consumer electronics industry which enabled mass commericalization.

A good example of such phenomenon is also the planned obsolescence in the field of artificial lighting more precisely - the lightbulb.



Since lightbulbs were invented, their lifespan rose from 14hours to 100hours to 1000 hours and kept growing throught the 1900s till 1930s with some bulbs reaching even 2500 hours at that point, but thats when this growth not stopped but infact saw reduction in average bulb lifespans[18].

The singlemost threat faced by manuacturers at that time were longlasting lightbulbs, as it discouraged second round of sales after explosive first round of sales.

It was to solve this problem that in christmas of 1924, top executives from International General Electric, Osram, Philips, Tokyo Electric and Associated Electric held a closed-doors meeting in Geneva to form the Phoebus cartel[19]. All these corporations deicded to work together to help each other by controlling the world average of lightbulb life because by this time all the world's smaller smaller lightbulb manufacturers had been more or less consoliated into these 5 corporations[19]. They themselves would refrain from manuacturing lightbulbs with lifespans above 1500 hours and would ensure the same for other cartel members by auditing their products and issuing fines incase of violation of agreed upon terms of product lifespan[19]. It is therefore a classic example of planned obsolescence. This in turn had manufacturing companies looking towards other areas to incentives their products through[19].

This eventually lead to transfer of the LED technology to this industry from Nasa's Space program to create LED bulbs which are brighter, more eco friendly than traditional incandescent bulbs and last longer.

CONCLUSION

We thus conclude that the process of technology transfer is fairly identical with trying to bring about practical implementations of science and technology by seeing the various ways in which this process and its forms has helped create the technologies that we now commonly use . We see the diverse and often non-intuitive links between popular technologies and their sources, tertiary adaptations or implementations. Technology transfer has and will continue to make novel and exclusive scientific and technological wonders more accessible to the common masses while helping employment and economies through industries. The wireless headphone market boom caused due to planned obsolescence by IOT companies, was actually prepared by the ready technology transfers performed to optimize and adapt military technology to consumer electronics and the point is only further complemented by the historical analysis and study of the evolution of the lightbulb and the proven phoebus conspiracy. Furthermore to omit or prevent mistakes like those in the case of graphene, we must look aid the technology transfer process in terms of funding and commercial research to avoid waste of intellectual resources and scientific study.

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