Eugenio Fubini from "Ferret" electronic systems to IBM: The battle for US electronics supremacy

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Abstract: Based on unclassified reports and movies, this paper presents some considerations on the Italian physicist Eugene Fubini and his works from the 40s to the 70s. It examines his contribution to the birth of the electronics reconnaissance in the WWII and Cold War contexts and his pledge to maintain peace between the nuclear powers. Fubini represents a typical Jewish European scientist who emigrated to the US in 1938 due to racial persecution. Overall, Fubini distinguished himself for his patriotism and direct involvement in the US Department of Defense in the role of Assistant Secretary of Defense. Indeed, as engineering scientist, and director, Fubini led a personal battle to gain pole position in research within the electronics field. Moreover, he foresaw computer technology as the new instrument for the development of a society made up of independent thinkers finding innovative solutions anchored on the principles of interoperability, interchange, and interactivity.
Keywords: Eugenio Fubini, Ferret systems, IBM360, WWII, Cold War.

1. Introduction

At the beginning of the nineteen sixties the physicist and engineer of Italian origin, Eugenio Fubini (Turin 1913 – Brookline 1997) was one of the most influential Pentagon directors involved in the research and development planning of electronic intelligence and space exploration technologies. He was the son of the mathematician Guido Fubini and achieved a degree in physics in Turin. In fact Eugenio was one of the youngest of Enrico Fermi's pupils in Rome, so called "puppies", but due to his Jewish origins, he was exiled to America along with the majority of those from the Via Panisperna boys. His prestigious contribution to the US field of electronics leads to some reflections: the close interaction in the 1900s between pure science and technology; the patriotic contribution of some Jewish scientists exiled from Nazi-fascist Europe; the relationships among a scientist – engineer – director and the political-military environment in the United States.

All of these aspects make it easier to explain Fubini's commitment to the battle for electronics supremacy in the US aerospace industry as well as his passion for computers. Furthermore, these aspects provide some clues towards understanding whether he was motivated purely by scientific interest or solely patriotic interest.

2. Science and engineering for a common mission: to save democracy

In 1961 the problem of efficiently processing technical information in order to monitor the USSR and China's offensive capabilities was of utmost importance for the American Ministry of Defense. President John F. Kennedy nominated Fubini as Assistant secretary of Defense to manage research and information systems. The scientist chose research and development programs to be financed according to the Cold War strategies and from 1963 he took on the role of Deputy director of Defense research and engineering (An. 1965, p. 4). The American dream was underway! An exiled Italian due to racial laws, had been employed as a radio-systems engineer at Columbia broadcasting system in New York until the start of the Second world war, at that time he managed some of the Ministry's most important decisions for national security. Managing weapon development required the ability to strike a balance between military needs, political interests and to have an advanced vision of rapidly changing technologies. Fubini had demonstrated on several occasions that he possessed the necessary personality to be able to create dialogue among these parties and the ability to ensure a balance among planning, functionality, distribution and simple to use projects. He also knew how to interpret the Defense secretary, Robert McNamara's (1916-2009) guidelines who, considering his background as managing director of Ford, evaluated each project in terms of costs/benefits.

At the Pentagon, from 1961 to 1965, Fubini found himself in a well-suited cultural working environment where scientists and research managers had been directly involved in the Second world war as civil experts serving their country and they all shared the same ideals: national security in the name of democracy. Among all these colleagues, Fubini shared a relationship with Harold Brown, Director of Defense research and engineering, nuclear physicist at Berkeley with Emilio Segrè, who had taken over from Herb York, the person responsible for Eugene's transfer to Washington (Fubini 2009, p. 178). In agreement with McNamara, Fubini worked on substituting air technology with satellite technology to be used for the secret surveillance of opposing powers. Indeed, his judgment influenced the decision to end the development of the "B-70 Valkirie" nuclear bomber in 1961 due to the excessively high costs and to substitute it with satellite ones (Fubini 2009, pp. 185-186).

3. From microwave circuits to phased array radars

Gene, as Fubini was known in America, was an expert in electromagnetic energy transmission and obtained approximately 30 patents. From 1945 to 1961 he worked in the role of Vice president and Director of research for the Airborne instruments laboratory (AIL) Company, a civil company which, at the end of the War, merged with its military laboratory namesake under the aegis of Columbia University and the Radio research lab (RRL) researchers from Harvard, which Fubini was involved in. In this new AIL, Gene worked on the secret development of radar systems and countermeasures: antennas, phased array radars and microwave circuits (Fubini 1960).

Research on radar countermeasures had already been taking place at the same time as research into radars in 1941 and after the War, this was established as the basis for aerial reconnaissance as, by collecting intelligence on electronic signals, Electronic-signal intelligence (ELINT), the United States was able to obtain information on China's and the Soviet Union's access to nuclear weapons, which was necessary in order to prevent possible surprise attacks. Indeed, from 1946 onwards monitoring nuclear weapon availability was carried out in two ways: signal espionage (SIGnal INTelligence or SIGINT) and via communication (COMmunication INTelligence). The B-17G reconnaissance aircrafts, the so-called "ferrets", just like their namesakes, sniffed the air, but with the objective of capturing the electromagnetic waves that were emitted by any possible nuclear testing. In comparison with the photographic apparatus used for aerial reconnaissance in the First and Second world wars, these electronic sensors provided exact quantitative data, which left no room for misunderstandings or suspicions. The "ferrets" were equipped with: AN/APN-4 and AN/APN-5 radar receivers, AN/APA-10 and AN/APA-11 impulse analyzers, Hewlett-Packard audio oscillators, impulse frequency repetition analyzers and data storage tapes. The aircrafts of the 311th Reconnaissance wing used this technology to identify possible Soviet radar sites in Northern Greenland. In 1947 the B-29 "ferrets" were turned into electronic surveillance stations, which required new operators onboard aircrafts in the form of electronics specialists known as "ravens": three technicians searching for and analyzing signals and three navigators. The aircrafts set off from Alaska with the aim to locate Soviet radar sites on the Siberian coastline so that if there were to be a Soviet nuclear attack, they would have indicated those sites to United States bombers, who would have, in turn, neutralized those sites guaranteeing an efficient and potentially destructive American offensive.

The SIGINT method was based on identifying the type of radar transmission and associating it to the source position whereas the COMINT was focused on cryptography in order to decipher the diplomacy's secret messages. On the 6th September 1961, all these top-secret operations were handed over to the new National reconnaissance office (Fubini 2009, p. 193; Berkowitz 2011, pp. 1-29).

4. Radar countermeasures

Gene worked on the first countermeasure radars, the English "carpets", which were installed on the first B-17 "ferrets" in Italy in 1943. He was placed in the Army as a senior, civil technician and was deployed in Sardinia to the Army signals corps, the communications division (Fubini 2009, p. 107). The "carpets" were used to pick up radar signals which hit the aircrafts and to send them back to the radar as false responses in order to blind the device. Electronic signal jammers studied by the RRL had a double objective: 1) prevent the radar from locating the target by creating confusion in the echo receivers using return signals generated by the aircraft itself; 2) use the signals in order to locate the radar. Fubini suggested placing APA-24 directional antennas on the aircrafts in order to scramble the radar signals which the "carpets" picked up with the

data from the station on the ground in Corsica and in this way, obtain the location of the enemy radar. In a short time, the scientist was able to create an exact map of the German radars on the Italian coastline, which were needed by the Allies in order to neutralize them and be able to land in Italy.

As shown in a training film for reconnaissance pilots (US Navy 1962), various jamming techniques existed, known as the "Spot Jammers." In each "ferret" team on night flights, two aircrafts without bombs carried jamming equipment: a signal receiver, manually tuned to scan and identify enemy radar bands, and three transmitters, manually tuned to the located spot frequency. The transmitters emitted a signal which was sent to the radar, as well as the signal which bounced back from the aircraft. This meant that the radar was unable to distinguish the true trace from the false one and thus it was accepted. In general, radar jamming was able to intentionally emit very strong and concentrated radio signals, aiming to saturate the radar receiver in two ways: with false information or with sounds. In both cases, the received signal was registered, modified and retransmitted. By respectively modifying the return time, the Doppler shift or the amplitude modulation in order to enter the victim radar's secondary lobe, it was possible to alter information about distance, speed or the recorded track azimuth. The noises, on the other hand, were made up of several responses which were sent to simulate the presence of several aircrafts. The analogy between the reconnaissance equipment and John Von Neumann's new digital computers development, in its early stages at that point, is worthy of note. Indeed, there is a receiver or an input unit, a controller or a control unit, a tuner or a storage unit, a modulator or a unit to calculate/modify signals and finally a transmitter or a results output unit. The process still required many operators because the devices did not communicate.

5. Intelligence systems for peace

During the Cold war, Fubini championed his equipment as peace systems because they represented a deterrent to surprise attacks (Fubini 1965a, pp. 60-64). He was convinced that a reconnaissance system based on scientific analysis and findings, i.e. measuring electronic variables, would provide exact information on weapon possession and any possible secret attempts at weapon proliferation. Therefore, it ensured that international treaties were abided by and eliminated unfounded suspicions and accidental errors (Greenwood 1972, p. 23).

Gene favored space projects which envisaged missile construction with safe and efficient vectors designed to launch satellites with new and more advanced surveillance systems installed on them: satellite photography or IMagery INTelligence (IMINT) and electronic satellites or SIGnal INTelligence (SIGINT). The first US satellites were developed based on the Soviet model: "Grab", "Explorer", "Corona" and "Gambit", which was the first true successful one. The science fiction idea of launching satellites into the Earth's orbit had become a reality thanks to the missiles and it was therefore possible to carry out safer and more accurate surveillance without encroaching on enemy space and putting aircraft pilots at risk. Sharing this new scientific knowledge

with the general public took place through specialized magazines such as "Popular Mechanics Magazine", which divulged the authorized secrets and the advantages of the new technologies used in space exploration. In turn, Fubini explained how satellites worked to the Pentagon's military assembly using the rudiments of astrophysics in order to overcome their proverbial reticence towards accepting new technologies that were not weapons (Fubini 2009, pp. 191-192).

The reconnaissance satellites orbited with sensors on board which were able to make use of the whole electromagnetic spectrum and they sent data to Earth where recording systems had been improved with high resolution tapes, optic systems, televisions and telemetry. Ultimately, the "ferret" satellites, which were camouflaged by television signals, carried out secret surveillance on enemy territories, collecting data on: military air base locations, missile launch sites, radar positions and secret messages transmitted from military enemy command centers. Therefore, the US super power had a network of satellites, aircrafts, submarines and ground control stations, which made up the new combat strategy that could count on its knowledge of enemy bases in order to respond efficiently in the event of a nuclear attack (Spezio 2002, pp. 633-644). However, according to pacifists, Fubini's technical in-depth work had taken priority over the real objective. Peace had fallen into second place compared to his research results. This led to claims that behind all the patriotism, there was ill-concealed political influence that «destroyed [...] the image of a "feasible" society» according to the USSR. In other words, behind the hypothesis of a possible nuclear catastrophe that justified the Single Integrated Operational Plan, there was a hidden battle between communism and liberalism (Tsipis 1972, p. 47).

6. Fubini - second vice president of IBM

In 1963 President Lyndon Johnson awarded Fubini with the *Department of Defense Citation* for his esteemed contribution to pacification, the most prestigious recognition endowed by the Pentagon. However, in 1965 Fubini resigned from the Ministry in order to accept the role of vice president and executive director for the development of advanced research systems for the International business machines corporation (IBM), a situation which was somewhat a novelty for an enterprise. Fubini's invested interest in the innovative IBM S/360, that is the first family of compatible computers, was driven by his vision to modernize how society used these computers to work and think as they finally made it possible for the different components to communicate with each other, introducing the principles of interoperability, interchange and interactivity. The S/360 had a completely new architecture that modelled all the internal and external communication on the CPU's internal log dimensions. Six different models of processors were produced which could be associated with various peripheral devices as well as other brands. All the different machines from different production lines were able to work together! After the S/360 model, carrying out automized actions with a "computer" was no longer the order of the day but instead it was known as managing complex processes through "computer systems" (Lecht 1979, pp. 12-17). Within IBM, the S/360 project launched an extraordinary period of technological creativity despite

beginning as a cannibalization of all the other production lines, some might say a business gamble! Fubini continued in a research and technological consultancy role at IBM following his resignation in 1969 due to his discontent with the new and purely commercial direction taken (Pugh 1991, p. 789). In his opinion, at this point computers would have transformed the programming "style", how program problem solving took place, and they would have modified society itself (O'Connell 1969, p. 30).

All in all, Fubini's contribution to electronic development can be considered as on the boundary between science and patriotism which favored the military industrial complex, however, overall his intention was scientific development for the good of society. For this reason, he urged the authorities to invest in new electronic innovations and encouraged his colleagues to take on new creative challenges presenting "elegant and imaginative" projects that upheld the electronics standards of simplicity, imagination and interoperability (Fubini 1965b, p. 339). From this perspective, it is therefore pertinent to acknowledge the happy encounter with the psychologist Joseph Likclider's idea of a "global network", which became reality with the birth of the Internet just ten years later.

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