

THE ROLE OF THE HUNGARIAN ENGINEERS IN THE DEVELOPMENT OF RADAR SYSTEMS

Péter RENNER¹

HungaroControl – Hungarian Air Navigation Service
H-1675, Budapest-Ferihegy, Pf. 80.
Tel: +36 1 296 9183.

Received:

Abstract

There is a radar unit at Ferihegy Airport for more than four decades. This period brought a lot of work, success and a real sense of achievement together with difficulties and problems for the operational staff. Their leaders — as technical experts participated in the installation of P-10 radar in 1958, and retired after four decades' heavy work at the turn of the millennium. During this period they had received different engineering degrees at the Technical University of Budapest, improved their knowledge by participating at different field trips, attending foreign schools and postgraduate studies. The engineering staff had attended postgraduate studies as well, most of them graduated at the Technical High School of Transportation and Telecommunication in Győr. The Ferihegy Airport itself was not an official, accredited field study, but reminding the main deeds of the last half-century, we can certainly regard it like that. A real researcher, developer and elaborator workshop was running here, where the Hungarian Engineers proved their enormous creativity. Their work actively contributed to the improvement of safety and efficiency of the air traffic flying over Hungary, to development and international admittance of the Hungarian flight and air traffic control. We can be sure of the fact, had they got the opportunity, they would have constructed better radar systems, then the ones they had received from the foreign suppliers.

Keywords: Air Traffic Control, Radar, Airport Ferihegy, Radar Engineers, Radiolocator.

1. Introduction

The desire for flight is as old as the humanity itself. In prehistoric times our ancestors looked at the birds with wonder, as the mountains, summits and seas did not constitute an obstacle for them, and could always reach their target. At the very beginning of the human civilization of course there were adventurous persons, who

¹After graduation I was employed by the Air Traffic and Airport Administration (ATAA), later on by its legal successor HungaroControl – Hungarian Air Traffic Services. During this time I had the opportunity to learn and like almost all aspects of air traffic control. I graduated as an electric-engineer in 1996 at the Széchenyi István Technical High School, as transportation engineer manager in 2000 and as a qualified transportation engineer in 2001 at the Budapest University of Technology and Economics. At present I am graduate for Master's degree (Ph. D.) at the Technical University (3rd year).

tried the impossible, to conquer the sky. The first legend about the flight was the story of Daedalus and Icarus.

The idea of flying accompanied the human progress. From the Italian scholar and contriver Leonardo da Vinci to the French author Jules Verne a huge row of individuals dealt theoretically or practically with this subject. According to our historical knowledge, the first flying machines, which stand a chance to stay in the air for a longer period and to make a safe landing appeared at the end of the 19^h century.

With the evolution and improvement of techniques and economy, more and more aircrafts were flying from year to year and thus aroused a new problem; the risk of collision and conflict had to be reduced, and the essential information, like the meteorological reports and forecasts had to be provided for the flights covering even longer distances. The first air traffic control centres to deal with these tasks were established in Europe and the USA in the twenties and the thirties. At the same time, the first airways² were assigned, basic radio navigation aid facilities were established and the aircrafts were equipped with wireless apparatus. The first air traffic control tower started its operation at Cleveland Municipal Airport in 1930, followed by the set up of the first air traffic control centre at Newark in 1935. This latter can be considered the antecedent of modern air traffic control centres.

After the Second World War, the grow of air transportation and the improvement air traffic control accelerated. The International Civil Aviation Organization (ICAO) had been established, the first civil surveillance radar equipments were constructed and later on the continuous development of air traffic brought along the use of computers and computerization. For the purpose of efficient and safe handling of the vast air traffic over Western Europe, the Eurocontrol was established and after the political changes, Hungary joined this organisation.

The development of radar equipments and systems tightly belongs to the history of flight for more than sixty years. The Hungarian engineers took their share of the planning, developing and producing work already from the beginning. During the Second World War, with an unprecedented engineering performance in hostile circumstances, Dr. Zoltán Bay³ (1900–1992), the professor of the Bu-

²An area of the sky, where civil aircrafts fly from place to place, usually 10 km wide with a centreline joining navigational beacons; later replaced by 10 nm wide air-routes, to give space for separation of increased traffic.

³Dr. Zoltán Bay was born at 24th June 1900 in Gyulavári (Békés county – Hungary) He graduated in Debrecen, at the Reformed College, one of his schoolfellows was the poet Lőrinc Szabó. He studied as physicists at the Budapest Scientific University and became assistant lecturer at the Institute of Theoretical Physics. He received his Master's degree in 1926, afterwards he made research work in Berlin for four years. Meanwhile he got the position of director and professor at the Theoretical Physics Department of the Szeged Scientific University, where he made a life-long friendship with the Nobel Prize professor Albert Szent-Györgyi. Dr. Zoltán Bay became the director of the Research Institute of Egyesült Izzó Rt. in 1936, and the nuclear/atomic physics dept. of Budapest Scientific University on the 28th July 1938. He continued his research work during the war, and in 1944 he was arrested for a short period. According to specific historical sources, he was the sole person to learn about commission of Professor Albert Szent-Györgyi in 1944, after the German occupation by

dapest University of Technology created one of the first equipments of this kind, the surveillance radar called 'Sas (Eagle)'. After the war, Hungary had always bought ready-made equipments and systems abroad, from the Soviet Union, Czechoslovakia, Italy and later France. The common feature to the equipments from almost all countries of Europe was, that these could be classified to more or less experimental, semi-developed categories, were in lot of cases untried pieces made with superficial work, therefore the installation and the practical operation required hard and inventive work from the Hungarian engineers. They solved among others these problems as well, providing the up-to-date technical support to the Hungarian air traffic control. It is worth to give some thoughts to the question, if some kinds of industrial background had been provided, would have been these engineers able to produce state-of-the-art radar equipments and systems here in Hungary? To receive an answer to the question, let us examine the most important steps of the experiments and developments.

2. The First Steps

In the Beginning...

The expression 'radar' comes from the Radio Detection and Ranging. This is the method of detecting distant objects and establishing their position, velocity or other characteristics by analysis of (very) high frequency radio waves reflected from their surfaces. As it is suggested by the name, the most important role of the equipment, which is called radio-locator as well, is the surveillance of objects in a given airspace, giving their exact momentary position. Its working principle is known since the twenties. The theoretical and mathematical basis was developed by two researcher doubles, Appleton and Barnett (frequency modulation 1925) and Breit and Tuve (pulse modulation 1926). One can clearly see, that already in the heroic age of the wireless some researchers dealt with the idea of using the radio waves for this purpose. (Let us not forget, that the radio broadcasting, the first widespread use of radio waves began in the twenties.) The idea was based on the recognition of reflecting echoes of radio signals from the different ground surfaces and objects. The first field of application was the search in the ionosphere.

The British Robert Wattson Watt first recognized the principle of radar detection for surveillance in 1935. He had emphasised the fact, that surveillance by radio waves would have great importance in a forthcoming war. The first experiment was

regent Miklós Horthy to look for the secret connection with the Allied Forces. After the war he had left Hungary with his family to Austria and later settled in the United States. He was the professor of George Washington University until 1955, and until his retirement the departmental head/manager of Survey Institute USA. His survey definition based on the travel time of the light in a given period instead of a part of the equatorial distance was accepted by the International Weight and Survey Institute in 1983. Dr. Bay died at the age of 92, on 4th October 1992. According to his will, he was buried in Hungary.

made by Mr. Watt and his research colleague in the village of Daventry, with the use of BBC's 10 kW radio transmitter on the 49 meter short wavelength. As it soon became evident in Germany, Great Britain and the USA, that the radio detecting will be first of all employed in the military surveillance, all the research and development efforts were kept hidden. The reason for the existence of radar detection was proved in 1941, in the Battle for Britain, when the RAF fighters repelled the German Air Force attacks, intended as preparation to invasion.

The Hungarian companies, for example the 'IZZÓ⁴Ltd.' has already in 1935 received military research tasks. The limited company, situated at the 13th district in Budapest, with serious experimental and scientific past, technical and financial resources and significant achievements, was entrusted with two main tasks; first to develop the microwave ground communications, than to construct a radar equipment suitable for aircraft surveillance.

We have to emphasise, that although there were some researches in this field, the task itself was brand new. First the theoretical and mathematical bases as well as the technical realization had to be elaborated, then the production plans had to be developed and at last the equipments had to be built in secrecy, in hostile circumstances, with the total lack of foreign professional resources. The task was made even more difficult with the worsening of circumstances in the war torn Hungary. The chief engineer of 'IZZÓ' in those days Dr. Zoltán Bay had received the task of developing these two equipments. The 'Bay research work group' was created in 1942 at the research laboratories of the company, it consisted of 10 researcher academicians, two assistant lecturers and 30 electricians. The top-secret work group, established by the order of the Minister of Defense had received the task of radar development. On behalf of the Chief of Staff, Lt-Col. József Jáky supervised the work. As Dr. Bay remembers this era: *'In the autumn of 1942 the Minister of Defense summoned me and set forth, that I have to develop the basic radar principles and techniques for the Hungarian Army. I accepted the task with the idea in my mind, that if I have to make a military work in this unjust war, I prefer working on defence, than offensive weapons. (...) It is worth to mention and peculiar to it as well, that for the work on radar equipments we have not received any kind of help from our German allies, however the news, the radio broadcasts and the official war propaganda always emphasised the Hungarian – German alliance, the war fought for the common goals [2]. (...) It was an important help for the work group, that all its members, the engineers and technicians were exempted from military duties. We had first class priority for all materials, supplementary productions made by other companies, and for straitened, well reduced fuel resources to complete the field experiments. My service car had an 'Ü' letter licence plate, which authorized me to used it on holiday as well – according to the joke in Hungary, this was provided only for those with good 'influence connections' [3].*

Dr. Bay was well aware of the fact that in these circumstances the tool of the transmission, the microwave itself can only be produced by electronic valve.

⁴In what follows 'Egyesült Izzó Részvénytársaság'

Although he had some information about the invention of magnetron⁵ and klystron⁶, given the technical resources of the company, it was impossible to produce these tools in a relative short period at home. Meanwhile the employees of 'IZZÓ' had a lot of experience at the development and production of electronic valves and a well-equipped laboratory was available as well. Therefore they started their work with the improvement of the existing valves.

In 1942 the 'Standard' Electronic Works was included in the top-secret work of development and production of electronic valves. Due to the state of war at the end of 1941, Hungary was completely closed to foreign information, but from the last received copy of the English periodical 'Electronics' (October 1941) they could be informed of the USA war budget for 1942, where the half of the amount for weak-current improvement, 118 million USD was earmarked for the radar development. This amount roughly equals the reparations paid by Hungary to the Soviet Union after the Second World War. Due to the almost total lack of information, the research work-group had to elaborate all the important theoretical and practical questions, only a few and unreliable data or sources arrived from abroad. There was information that the radar antenna should be rotated. As Dr. Bay writes: 'Everything made on the field of microwaves and radio locator was the result of our own theoretical and practical efforts. We had to discover a lot of already invented but secret principles or procedures' [3].

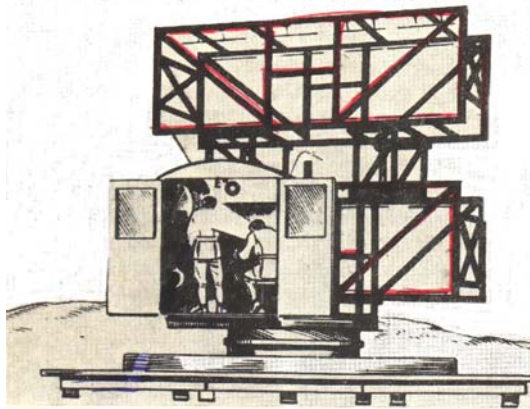


Fig. 1. 'Eagle (Sas)' long range locator

⁵Magnetron; a two-electrode electronic valve used with an applied magnetic field to generate high-power microwave oscillations, esp. for use in radar.

⁶Klystron; an electron tube for the amplification or generation of microwaves by means of velocity modulation.

The Birth of Radio Locator

During the war only the first two radar units were constructed, two pieces of Sas, and ten-twelve pieces of Borbála locators were produced. The first Sas unit could have been installed in the summer of 1943 for the defence of the capital (*Fig. 1* Private collection of Mr. Andor Gibás). The research group have decided, that the most suitable position of the unit was at a peak within the defended area. Therefore, they chose the peak of Mount János and the experimental unit was installed on the top of Elisabeth lookout tower. The radio locator had excellent performance; the range was better than 500 km. – in special broadcasting circumstances even the peaks of Alps could be seen. It could already detect a larger offensive unit above the Adriatic Sea or the Alps. Altogether it was an enormous engineering achievement in war circumstances.

After the War

The first, Soviet made MIG 15 type jet fighters joined the Hungarian air force in 1951. These aircrafts were twice as fast as their predecessors and now the radar equipment was essential for their ground control. Therefore, three P-1. type radio locator vans arrived to Hungary in the very year, however, as being top-secret units, the Hungarian military engineers less the most necessary maintenance, were forbidden to handle them.

The first two radar equipments located at Ferihegy Airport at 6th May 1959 were Soviet made military ORL-5M approach (known as P-10 referring to the type of radar screen indicator) and the PRL-5M landing units. The name of the whole system was OPRL-5M, consisting of four vans – two for the radar units and two for the generator supplies. All the units of the system were first set up close to the runway and were protected by interior armed forces (AVH). As the system itself was rather expensive, originally developed for military purposes and its instruments were top secret, the controller and maintenance staff could approach it with a special permission. (*Fig. 2.* Private collection of Mr. Andor Gibás).

The other radar unit set up in 1959 helped the control of landing⁷ aircrafts. This PRL-5M unit detected the height and azimuth position of arriving aircraft on the final approach track. Accordingly the locator-van had two pieces of special, moveable aeriels. The horizontal piece detected the azimuth deviation from the centre-line; the horizontal one detected the deviation from the glide slope.

'The PRL-5M had a phase-controlled aerial made by the French Thompson Company. Two 'L' shaped aluminium profiles formed the rectangular supply line. By moving the profiles towards each other, its width changed, changing the wave-length as well. Of course, one piece was fixed and the other moveable. Connecting probes protruded into the fixed piece, feeding about 100 dipoles. (Due to the 3

⁷The controller can inform the pilot, if he departed from either the extended centre-line in horizontal angle or height or both.

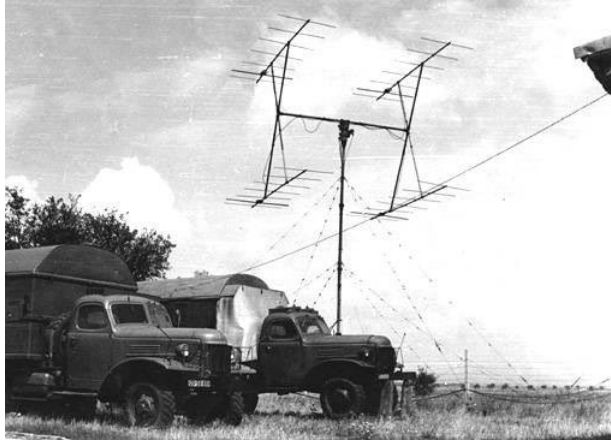


Fig. 2. Radar locator vans P-10. in the Hungarian Army

cm. wavelength, the size of the dipole was 1.5 cm. The azimuth aerial was about 2 meters, the glide slope aerial was about 3 meters long.) The dipoles produced directional transmission, with fan movement by the change of phase. It was the great disadvantage of the system that all parts of it were made of aluminium, having large thermal expansion coefficient, therefore the scanning sector depended on the temperature. It could be recognized on the azimuth with the help of a reflector, however, it was not possible for the glide slope. The little aid-unit, which we had constructed and named with not too much phantasm, detected the horizontal direction from the stationary targets and showed on the screen the 500 meter height at a distance of 9.8 km. This was the point, where the descent had to be commenced. The cowl of the aerial was insulated and supplied with heat-switch radiator.⁸

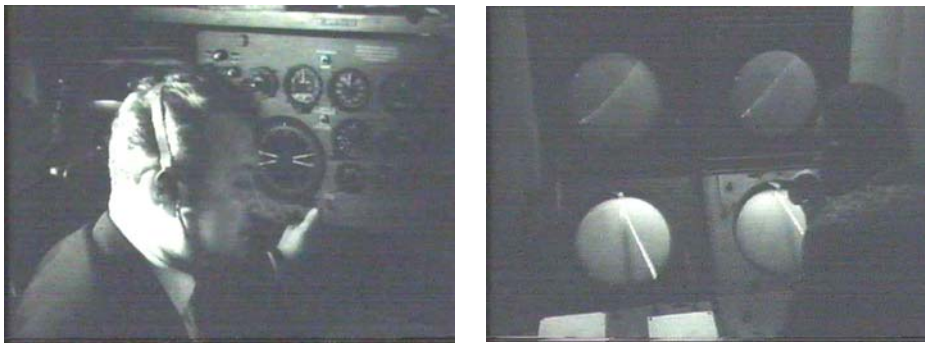


Fig. 3. PRL-5M landing radar locator switchboard and screens

'When we were in Moscow in 1964 to study the Russian maintenance methods,

⁸Recollections of Mr. Tamás Umann (2003)

we wanted to inform them about our findings. We were told: You came here to learn, not for obstinacy. A couple of years later the station manager of MALEV in Moscow informed us, that as a result of an investigation to a crash, the use of all PRL-5M was immediately banned in the Soviet Union. Well, if the Hungarian sense is mere obstinacy...' (Fig. 3a,b: The technical development of ATC — KÖZDOK short Nr. 18207)

3. The New Era

Arrival of State-of-the-art Techniques

The MALEV acquired a new, state-of-the-art AR-1 type approach radar equipment in 1965 made by the English PLESSEY Company. This type was specially designed and produced for airport approach purposes; its range was convenient for the objectives at Budapest Ferihegy Airport. It was a real radar station, not a mobile military system built on a van, therefore it was not necessary to build a special housing for it. The station was set up north of the service road beside the runway; the radar signals were transmitted by cable to the controller's workplace, into the 'dark room' at the third floor of the main building.

The aerial was built on a light structure beside the radar station. The Hungarian engineers took active part in the installation (Fig. 4 Private collection of Dr. László Hetényi). Mr. Umann said: *'We had installed the 14 meter tall aerial tower ourselves in one day and a half, including the full assembly of the aerial as well. This was made possible by two matters, the enthusiasm and the lack of industrial safety commissioner. The absence of latter helped on our work at other occasions, too.'*⁹

The installation started in the autumn of 1965 and the hand-over was completed in April 1966¹⁰. After the initial unsteadiness caused by the lack of experience of the operational staff and the shoddy workmanship of the manufacturer's fitter employees – these two English experts were working at Ferihegy Airport almost a half year long – the radar system proved to be rather reliable, it was working for

⁹Recollections of Mr. Tamás Umann, head of Radar Department ATAA (1998) 'Airport Magazine January issue'

¹⁰As a result of prolonged political discussions, in the spring of 1965 the Area Control Centre was moved into 'the Rock', which was a system of caves and tunnels built during World War II inside Gellért-Hill. Here, the Area Control Department of the former institution, OLEP, and the new Area Control Unit were combined to form ORISZ (National Air Traffic Control Service). The military personnel of the combined body worked under the watch of the commander in a roster of 24–48 hours while the civil controllers were employed by MALÉV as civil servants – nevertheless, they had to work and perform their operational duties under strict military subordination. This system was only advantageous for the military partners, since MALÉV employees had to toil under essentially much worse working conditions, compared to that enjoyed at the airport and they were at a disadvantage compared to Approach Control, as they could not use the signals of the new Plessey AR-1 approach radar set at Ferihegy in 1964-65. (Recollections of Dr. Péter Moys)

more than 110 thousand hours until its final shut down. It was worth to mention, that the several struck by lightning caused serious damages not only to the radar building, but the screens as well.

4. Deployment of a Uniform System

Increasing Traffic, Increasing Demands

With the direct assignment of the plans in the planned economy of the Soviet Union a 'product allotment' was in force, meaning that the state decided on the production and the manufacturer of different goods. The development of radar systems for civil air traffic control centres was allocated to the electronic developer and producer company VINYRA in Leningrad (today St. Petersburg). For the Soviet political elite the Hungarian demand came in very handy, because they would have liked to elaborate a new radar system, which they could supply to all ATC centres of the socialist countries. All this looked like a serious, promising deal for them.

New Radar Locators

The installation of the long-range radar equipments was commenced in 1975 at Kőrishegy and later at Püspökladány. The primary radar system, called UTYOSZ-M detected the direction and distance of the aircrafts, and the KORENY secondary radar identified the aircrafts by the active target replies to the interrogation unit. For the identification of Warsaw Pact military aircrafts the basically civil radar units were equipped with military friend-or-foe identification component called 'BAZALT', however it had never been used, because not any aircraft with this kind of transponder was flying over Hungary. The installation of the radar stations was lead by Mr. Ferenc Gárdonyi; for the operation the 'Kőrishegy Ops. Unit' was formed and the staff of 'Budapest Ops. Unit' was substantially increased. The staff enlargement was accomplished by the postgradual education of Hungarian engineers; a Soviet team of experts aided the installation itself. The most typical part of the radar station was the aerial, in case of UTYOSZ it was rather impressive: the reflecting unit was 11 meters tall and the whole aerial weighted 12 tons. (Fig. 5 from periodical 'Air Transportation' 16th January 1985).

*'The installation of the radar station started in 1975 and our team took part in it right from the beginning. (...) We had started the heavy-duty handwork in October, mostly with the use of spanner sized 60. I do remember well, we had a very strong winter by that time.'*¹¹

The deployment of radar signal processor and display units to the area control centre at the 'Rock' started in September 1977, to accomplish this task, the technical

¹¹Recollections of Mr. Ferenc Gárdonyi, head of Technical Department ATAA (1996), Airport Magazine February issue

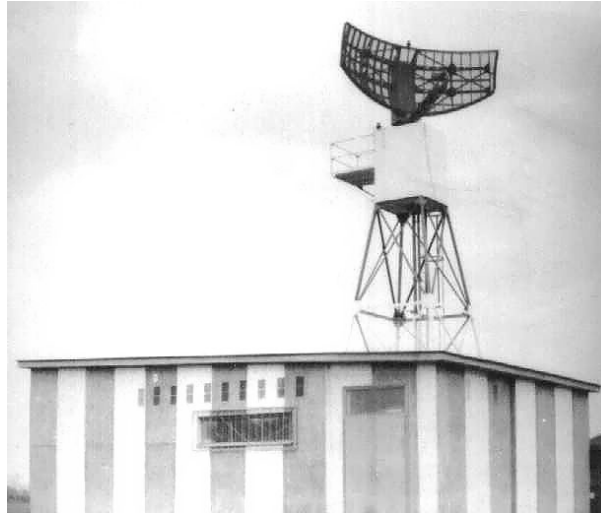


Fig. 4. AR-1 PLESSEY radar locator and its aerial

installation department of ORISZ (National Air Traffic Control Service) was formed at the 13th September. The head of department was Mr. József Bárány, he led the operation and the technical development for the next 25 years until the closure of this centre. During the works, the air traffic control service moved from their separate building close to the 'Rock' back to the project called 'Cellar-23'.

A typical event gives an impression of the technical maturity of the Soviet system. The installation experts, led by Mr. Stanislaw Smirnow read huge circuit diagrams to find out, where the wires must have been soldered on. After trying to solder on a unit a couple of times, they realized that the drawing was incorrect. They had no other change, but had spread the whole, more square meter large drawing on the floor, cut the incorrect part out of it and on all four ones made a new circuit diagram to brown paper.

The SZIGMA system was significantly developed in 1985, when the experts of ATAA¹² modified the signal processing and display units for microprocessor control. As the ATAA might not remunerate directly its own employees for this development work in that kind of economic conditions, peculiar to the era, a third company, the 'KOMPLEX' industrial and technical work-group of 'Lenin' agricultural co-operative was commissioned. The work-group employed the same experts of ATAA by task-assignment agreement. The Civil Aviation Authority licensed the modified system for use at 6th January 1986. As a result of the modification, the serial SZPI display units of the so-called 'main channel' now became independent work positions.

¹²Air Transport and Airport Administration (LRI)

5. The Digital Age

New SELENIA Approach Radar

However, the AR-1 analogue radar locator ranked among the best in its period, by the end of the seventies it had become pretty old, the time came to replace it. After having a market research and competition bidding, the ELEKTORIMPEX foreign trade company entered into an agreement with the Italian SELENIA Company at 25th September 1978 for a new radar station.¹³ The experts of ATAA started the installation of the new ATCR-33 radar station at Ferihegy Airport in 1979. This meant a change of technical era, because the new radar comprised digital signal processing. The radar building was set up beside the old KORENY secondary unit. (Fig. 6.) *'Considering the fact, that this small building was a tiny piece for the gigantic constructing companies of the time and private enterprise did not exist, we could not find a contractor. Therefore the engineers of the radar department had constructed the building with the assistance of a professional bricklayer and an electrician. They had the skills, as most of them had already built a house for themselves. The Italians handed the plans of the building over at the 25^h September 1978, which still had to be registered. However, at the beginning of winter the building was ready. This was the first and the last time in the history of radars, that the construction works were finished in time. It was the matter of worry in that phase of building a socialist community, that the construction industry did not want to deal with little petty things, like a 100 sq. meter large building.'*¹⁴

The radar engineer can walk on sea, can lay his hands upon a few sick to cure, he doesn't give birth only to leave his wife a real kick, could not he merely set up even a building? When Mr. Elmi, the representative of SELENIA asked me about the state of affairs, I answered him the truth, that the building had been practically ready. In January at Ferihegy Airport he said with dismay; this was really finished! Poor man, he was confused by his previous experience in Sofia, where he had been told the same, but at the time, when the radar building at Mount Vitosa was really erected, the delivered equipment had to be renewed, because it had grown aged in the storehouse.

*How the building was constructed? The whole staff of radar department had been working there. Such a nice huge trench had been dug for the earth⁵ with the direction of Mr. Lajos Varga, that the ones at Verdun could have concealed itself. Certainly, we have not got a single lightning struck, not even any damage like at the old AR-1. (...) There was Mr. Szabó Pista; the great bricklayer. He have complained a lot, since it have been rather unusual for him that the brick and mortar was always at hand. He had never had an experience like that earlier in his career.'*¹⁶

¹³Agreement for a new radar station (Air Transportation – periodical; October 1978)

¹⁴Recollections of Mr. Tamas Umann (2003)

¹⁵To link the electrical appliances to zero potential

¹⁶Recollections of Mr. Tamás Umann: The ATCR-33K building was ready made for us (1998),



Fig. 5. UTYOSZ-M radar locator and its aerial

The adaptive type radar equipment was able to adjust to its surroundings, which denoted a new era as well. The great deficiency of the analogue radar was, that it produced a lot of false targets – the adaptability improves this weakness a lot. As for the analogue techniques there could be only two, less effective solutions (the regulation of the lower beam of the aerial and the MTI moving target indicator), whilst the opportunities in the digital technology are practically unlimited.

Italian Technology in the 'Rock'

With the appearance of the Italian SELENIA radar equipment a new period started in the history of the area control. The new ATCR-22 type radar stations with the range of 350 km were located at Kőrishegy (1988) and Püspökladány (1989), replacing the old equipment. The life of the operators at the radar stations were made sometimes rather difficult by the weather. The station at Kőrishegy was built on the peak of the mountain and there was only one 16 km long, narrow, twisting service road, which was occasionally made inaccessible by the fresh snow even for days. Therefore so-called 'winter reserves' of food and water were stocked at the station and the staff was among others equipped with chain saw, to be able to remove the trees fallen on the road by thunderstorms or freezing rain. Hence the new shift, after having a few ordeals or sometimes nightmares, sooner or later always arrived by its jeep. (Fig. 7 from the radar station staff) *'The night shift can reach the station after removing ten fallen trees. In the courtyard of the station the snowdrift is almost two meter deep;*

the doors at ground level cannot be opened, the snow blocks them off. Meanwhile, there is no power since yesterday. As long as the air traffic control needed it, the radar was working on diesel secondary power supply, but it was stopped for the night, therefore we had no heating. Two successes in the morning: at seven o'clock the power is resumed, and we can get out to the courtyard from the first floor balcony. (...) The shift applies for instruction regarding the catering: what should be eaten to the cucumber conserve: smoked fish in oil, apricot preserve, stuffed cabbage or marmalade? They advise, that the connoisseur, who at the University of Techniques had optionally learned gastronomy as well, shall order the next winter reserves.'[10]



Fig. 6. SELANIA ATCR-33 radar building and its aerial

The demolition of the old UTYOSZ radar units, the reconstruction of buildings and aerial stands with the installation of the new technical system gave a tough and trying task to the experts. The radar unit at Kőrishegy was shut down at 13th July 1988. *'First of all, we had disassembled the 30 boards in the transmitter room, which weighted 15 tons, and took them to the waste recycling premises. The heating and ventilating distributor units with the man's waist thick pipes were loaded onto four huge vans, the generators weighted another four tons. (...) At the beginning of September we were in Naples, when the aerial system was loaded onto six trucks. We had already told them by that time, that there was not enough place, on the mountain besides the building, so they should not get there together. They*



Fig. 7. Two more kilometres and we are there...

did not follow our advice; consequently we had to work with extreme care, slowly moving the huge trucks inch by inch. In lots of cases some forgotten parts arrived from Italy in 50–80 kg packages’.[11]

Followed by the installation and operation of the new radar unit at Kőrishegy, the station at Püspökladány was brought to an end at 13th April 1989. The aim was its replacement, too. It made the work more difficult, that even the aerial platform had to be replaced. *‘The 120 tons heavy aerial was demolished and taken away by the GANZ Company. A 29 strong staff carried out the building and installation work. After a plenty of destruction, we had started the building at first of July. We built five walls, made shutters, iron grids for concrete, crafted most of the doors and windows on the spot. Meanwhile, a construction company built the aerial tower out of ready-made elements’.*[12]

There was no trouble with the building, which was reconstructed by radar engineers, but the aerial tower built by a state owned construction company was not a real success at the first run. Namely a platform, a concrete paved area had to be built on the top of the tower, where the aerial itself would be placed. According to the plans the grids of iron bars crossing each other have been carefully set before laying the concrete. After the concrete became dry, they started to remove the shutters. Eventually the platform slowly but surely started to bend downwards, so the constructors rebuilt the shutters panic-stricken fast, before the whole tower would spectacularly collapse. The prompt examination revealed, that they overlooked a small item on the plans...

In August the Italians were trying to start the appliances of the transmitters. These were made with Latin-style ease... *‘At the end of the month a new expert had arrived from SELENIA, and he tried to revive the secondary radar unit in vain. He flew home with some faulty circuits to change them. (...) They are working, trying to repair the electrical devices on the spot, at least those, which can be repaired here – showing the Italian experts soldering in the transmitter hall (...).*’[13] The

radar station started its work at 9th April 1990.

The final resolution was achieved in 1993, when the Hungarian engineers had built a home developed multi-radar tracking computer with the use of an industrial computer, and this solved almost all the problems. This duplicated system called 'SZUMMA' began its work at 8th July 1993, processed and summarized the target signals from the two area control radar stations and transferred them by two independent data-links to the work positions. One more distinguished task was the implementation of the brand new 'MATHIAS' air traffic control centre with the technical systems purchased for a change from France. This system had plentiful malfunctions too, therefore the story of its installation, on site repairs, development and operation will be the subject of another study...

References

- [1] BÁRÁNY, J., radar engineer: Verbal recollections 2000–2003.
- [2] BAY, Z., *The Life is Stronger*, Csokonai and Püski Publishing House 1990; page 19.
- [3] BAY, Z., *Selected Essays*, Gondolat Publishing House 1988; page 156.
- [4] CSIBI, I., radar engineer: Verbal recollections 2000–2003.
- [5] MOYS, P., air traffic controller: Verbal and written recollections 1998–2003.
- [6] HETÉNYI, L., Electronics and Air Transportation, *Radiotechnics*, (periodical); 1980–1981.
- [7] MR. SÍPOS, GY., The First Moon-Echo Experiments, *Radiotechnics*, (yearbook) 1998.
- [8] PUNKA, GY., *The Night Fighters*, Study, 2000.
- [9] UMANN, T., head of the Radar Division of ATAA, *Studies of Air Traffic Controller Course*, ATC Education Centre of ATAA, 1991.
- [10] UMANN, T., We Had Been Snowed Over, *Airport Magazine*, February, 1994.
- [11] TÍMÁR, T., SELENIA Radar Before Trial, *Air Transportation*, December, 1988.
- [12] TÍMÁR, T., SELENIA Radar on Trial, *Air Transportation*, October, 1989.
- [13] TÍMÁR, T., SELENIA Radar is Working, *Air Transportation*, July, 1990.