Quality Management Principles as Illustrated by the Organization of Romanian Inter-War Factories. A Century of Romanian Industrial Tradition in Aeronautics

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Abstract: *Inter-war Romania developed 6 aircraft factories, the first starting its activity in 1916. Four of these, with three located in Bucharest, produced over 2000 aircraft, maily for the military use as Romania entered the Second World War. The activity of these factories was undertaken in times when nobody thought about formulating the principles of quality management and the research of the first scientists in quality, Deming, Shewhart and Juran had not yet been accepted or published. The work aims to present the inter-war Romanian aeronautical industry developments regarding the quality management.*

Key Words: *Principles of quality, The General Aviation Reserve, The Aeronautic Arsenal, Astra Arad, SET, IAR, ICAR, Mircea Grossu-Viziru, Ion Grosu, Elie Carafoli, Radu Manicatide, Deming, Shewhart*

1. INTRODUCTION

We gladly celebrate a century since the first aeronautical industrial unit was founded (27th of September, 1916, Bucharest, The Romanian Old Kingdom). At the time we were among the few countries in the world building heavier-than-air flying machines.

The article aims to analyze the organizational structure of these factories from their founding until 1946.

The year 1946 marks the ban on military aircraft production in Romania as a consequence of the Paris Peace Treaty.

The analysis is carried out from the quality principle system point of view –as implemented today.

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2. QUALITY PRINCIPLES

The collective experience and the competence of the experts assembled in the Technical Committee of ISO-TC-176 "Quality management and quality assurance'' led to the formulation of the principles of quality. According to EN ISO 9001:2001, they are as follows:

First Principle. Client orientation

The organizations depend on the client and other interested parties and as a consequence it is necessary to:

- Understand present and future necessities of the clients and interested parties;
- Fulfill the said necessities and maintain a close relation with the client;
- Aim to surpass the client expectations.

Second Principle. Leadership

Managers establish the unity between the purpose and orientation of the organization and create conditions for the personnel to be fully involved in accomplishing the organization's objectives [1].

This principle could be translated as "manager's charisma" meaning that, apart from the training that one must have to take the best managerial decisions, the manager must also be proactive, communicate easily and cooperate with employees and authorities as well as with the business environment and clients, and, must offer and receive trust.

Third Principle. Personnel Commitment

"Capable employees at all levels are essential to create and deliver value" [1].

Fourth Principle. Process Approach (includes a systematic approach to management)

"The desired result is more efficient when the resources and total commitment allow that their abilities are best used to the benefit of the organization". The management of the processes and of the system as an assembly is carried out by the PDCA Cycle = Plan-Do-Control-Act also called Deming cycle.

Fifth principle. Improvement

"Organizational success means constant focus on improvement" [1].

Sixth principle. Proof-based decisions

"Decisions taken based on data analysis and evaluation of data and information are the ones that lead to the expected results" [1].

Seventh principle. Relations management

Relations between Supplier and Partners as well as other interested parties have a major impact on optimizing organizational performance [1].

The article aims to analyze the spirit of the 7 quality principles as reflected in the activity of the first industrial companies in the field of aeronautics during the inter-war period.

3. A SORT HISTORY OF THE ROMANIAN AIRCRAFT COMPANIES

3.1 CERCHEZ&Co

In 1909 the lawyer Mihai Cerchez founded a company that aimed to "develop aerial locomotion in all its forms". Until the summer of 1910 he organized the first airfield in Romania at Chitila, with five air sheds, workshops with repair and aircraft manufacture tooling and spectator seating for the public wishing to witness the demonstrations. The

"Crechez&Co" had two Farman biplanes and a Wright type aircraft for flight training and a engineless Demoiselle aircraft for ground training. In addition, Cerchez obtained a license to build Farman and Wright aircraft in his own workshops. In 1910 he starts building 4 Farman biplanes under license. Unfortunately, Cherchez&Co went bankrupt in 1912 because the conservative government preferred to equip the Romanian army with Bleriot-built aircraft instead of encouraging Romanian aircraft manufacture [3].

Conclusion regarding the activity of "CERCHEZ&Co"

Although he had the logistics to carry out the activity, the lack of a customer to valorize the production of license-built Farman airplanes caused the organization to go bankrupt.

3.2 General Aviation Reserve, The aeronautical Arsenal

More than 100 years ago, on September 27, 1916 the General Aviation Reserve is founded as the first aeronautical enterprise in Romania. During the war the General Aviation Reserve and its workshops in Cotroceni and Baneasa were evacuated to Iasi.

The purpose of this organization was to maintain, repair and assemble aircraft and aviation engines .With the fame gained in the Second Balkan war, and with a fleet of 44 aircraft- with only 24 operational – the aviation corps enters World War I. The activity of the General Aviation Reserve was carried out in Iasi until November 1919 when the materials and the majority of personnel were transferred back to Bucharest.

Then on July 1, 1920, the name of the Bucharest-based factory was changed to the Aeronautic Arsenal.

First Principle. Client orientation. Besides the maintainance and assembly of the aircraft and aviation engines, the General Aviation Reserve built the first Romanian post-war training aircraft protype, PROTO-1.

PROTO-1 is the prototype of the first national aircraft- built in a Romanian industrial unit. This prototype went into production as PROTO-2 at Astra Arad factory, with 25 items being built for the Romanian Army.

At the arrival of the French military mission led by General Berthelot, among maintenance, repair and assembly of aircraft and aviation engines the society begun the assembly of French aircraft so that the General Aviation Reserve workshops assembled and repaired 242 aircraft and 545 aircraft engines. Between 1922 and 1925 the Aeronautic Arsenal (the organization was renamed after transferring to Bucharest) builds and repairs:

- 77 primary and secondary training and reconnaissance Brandenburg 269 biplanes with 160 hp Austro-Daimler engines having the inscription "Built in Romania" applied to the fuselage;
- 100 Brandenburg 269 aircraft with 160 hp Benz engines and 220hp Mercedes engines built from war spoil parts;
- 10 military De Havilland DH-9 aircraft transformed to passenger, cargo and postal transportation planes;
- the AERON prototype built in 1929, a biplane with highly staggered wings (by almost two mean aerodynamic chords) of a trapezoidal shape, of cantilever without struts or flying wires between them.

At the Aeronautic Arsenal a redesign of the fuselage for the De Havilland bombers was made to convert them into passenger or freight transport aircraft. These modified De Havilland aircraft were used to equip Romanian air lines that were funded at the time.

The second principle. Leadership. The directors of the General Aviation Reserve were Eng. Constantin Silisteanu and second lieutenant Petre Macavei.

The third principle. Personnel Commitment. As the organization's activity took place during wartime the commitment of the staff was total, as they were considered mobilized. As a military unit, The Aeronautic Arsenal recruited its personnel since their adolescence (among the war orphans), sent them to arts and crafts school and then trained them by experimented technicians. The workers and technicians of the Arsenal were held in high regard by their superiors and by the society, and their financial gains placed them above the mean wages in a capitalist society.

The fourth principle. Processual approach. In 1924 Arsenal conducted the first attempt at evaluating the conformity, by load-testing an aircraft cell by placing sand bags on the lifting surfaces until these broke under load, establishing thus the maximum load factor for the aircraft operation.

After 1929 because of the necessity of ensuring a continuous reliability and guided by the vision of the military aviation chiefs in office at the time, the Aeronautic Arsenal was furnished with an Aviation Material Testing and Trial Lab. This laboratory was led by captain chemist Ion Gudiu. This laboratory represents the first real step to ensure the quality control in the aeronautical industry. From the historic descriptions [1] we know that the management as a system (processual approach) is well reflected in the organizational diagram in figure 1.

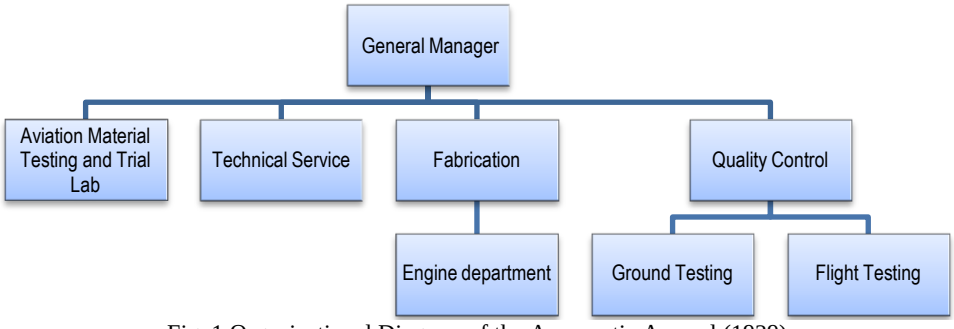

Fig. 1 Organizational Diagram of the Aeronautic Arsenal (1929)

The fifth Principle. Improvement. The continuous diversification of the production and the assimilation of new technologies are a proof of the military leadership's preoccupation for improvement.

In 1923 a process and installation to fabricate enamel was conceived a lacquer for aviation fabric treatment designed by Eng. Gheorghe Ionescu.

The sixth principle. Evidence-based decision making. In conformity with the time's military rigors decision making was based on proof. As a civilian might say, orders were given and received.

The seventh principle. Connection Management with the suppliers (of engines, chemical products, wood, fabric), partners (The Aviation Corps of the Army) and other interested parties (The General Aeronautics Inspectorate in the Ministry of the Army) allowed optimizing the performance of the organization, leading to the development of other Romanian industry branches (metallurgy, textile).

3.3 The Astra Arad Aircraft Factory

At the railcar factory Astra Arad (funded in 1891 by the Austrian industrialist Johann Weitzer) aircraft engines of the Martha- Benz and Daimler-Benz were already in production under license when it was decided to organize a section for the aircraft construction.

Principle 1. Client Orientation. The first aircraft to be manufactured was a reconnaissance and training biplane, the ASTRA-Sesefschi. After passing the flight test this aircraft model was sent to several aviation units for performances testing. The pilots Ion Sava and Petre Macavei flew a raid from Arad to Bucharest in just two hours and a half without stopping. The plane was fitted with a Martha – Benz 250 HP engine that was the first Romanian built engine that equipped a flying aircraft.

Proto-2 was a reconnaissance biplane built in 1924. It was the second aircraft designed in Romania which was built at the ASTRA factory. It was designed by Lieutenant Commander Eng. Stefan Protopopescu, using the Proto-1 aircraft built at the Aeronautic Arsenal in Bucharest as a model. The 25 built items were delivered to the Military Air Pilotage School in Tecuci.

Astra-proto was the third type of aircraft built at the ASTRA aircraft manufacturing plant, in 1925. It was a reconnaissance biplane. Also conceived by the designer of Proto-2, Lieutenant Commander Eng. Stefan Protopopescu, the aircraft had a wooden structure covered in lacquer-treated aviation cloth. Although the aircraft was compliant to the requirements of a reconnaissance airplane, the factory did not receive orders to manufacture it in series.

Principle 2. Leadership. The commander Andrei Popovici was appointed as director of the factory. He was a commander of the Second Aviation Corps in the battle of Mărășești.

Principle 3. Personnel Commitment. The designers and builders team also included Eng. Radu Onciul, Eng. Stefan Urziceanu, Eng. Dumitru Barbieri, Eng. Stanislav Sesefschi and Victor Fedorov. The factory personnel already had over 20 years of experience of work acquired in the ASTRA ARAD railcar factory. The personnel was highly qualified, esteemed in the time's society and well-paid.

Principle 4. Processual approach to management (management as a system). The aircraft division was part of a factory that built aircraft, railcars and owned its own iron foundry. This way the process separation (design, production) was implemented.

Principle 5. Improvement. Two prototypes have been made in three years (Astra-Şeşefschi, Astra-Proto) and 25 Proto-2 aircraft were produced.

Principle 6. The principle of evidence-based decision making. The testing of the Astra-Şeşefschi and Astra-Proto aircraft proved that the technical decisions were based on thorough analysis.

Principle 7. Connections Management. The suppliers were in charge of wood, chemicals, fabric; the client was the Tecuci Air Pilotage School, other interested parties were the aeronautical authorities of the The Romanian Old Kingdom.

3.4 The "Schiell Brothers" Factory

The "Schiell Brothers" Factory was a metal working enterprise in Brasov, Romania. Here between 1924 and 1926 the RA-BO-1 aircraft was designed and built; it was the first aircraft built in Brasov by Engineers Radu Onciul and Bo Carlsson.

The young alumni of the Vienna Polytechnic Institute, Eng. Radu Onciul and Bo Carlsson already worked at the "Schiell" factory when they began developing an aircraft of their own design. The design was financed by Andrei Popovici, then Secretary of the Romanian Air Club, who donated 100.000 lei. The aircraft was a twin seater monoplane built entirely of wood, with plywood covered fuselage and the wings covered in lacquered fabric. The aircraft was powered by an 80 HP Gnôme-Rhône engine.

Two items were built. The first was completed in 1925 and was used for ground testing, and the second completed in 1926 was used for flight testing. This flight testing aircraft was

named RA-BO-1 (using the designer's first name initials). Although built for school, the aircraft was tested in acrobatic flight by Flight Captains Gheorghe Jinescu and Gheorghe Banciulescu and was received by the Ministry of the Army. Both appreciated the aircraft's flight qualities. RA-BO-1 was presented in the International Aviation Exhibition in Prague, in 1927.

Unfortunately the factory did not receive any orders and the following year the "Industria Aeronautica Romana" IAR Brasov was inaugurated. The tenacity of the two designers still is praiseworthy.

3.5 The Society of Technical Exploitation "SET-Eng. Gr. Zamfirescu"

In 1923, Eng. Zamfirescu takes over the workshops of a small enterprise in the Obor area and establishes the Society for Technical Exploitation SET (after 1948 the AVERSA pump factory was built on the same location and currently there is a hypermarket on that place).

Principle 1. Client orientation. After 1924 the division for aeronautical repairs starts its activity with:

- technical check-ups and repair of the PROTO-2 aircraft
- participation in the retrofit of the DeHavilland -9 aircraft.

In 1927 the SET factory begins working on the design and construction of the Proto-SET prototype powered by a Lorraine-Dietrich 450 HP engine. Following in 1928:

- SET 3 (10 items ordered by Tecuci Air Pilotage School)
- in 1930 a supplemental order for 50 more aircraft of the same type.

Beginning with 1931 the factory re-organizes to better handle the orders, becoming "SET-Eng. Gr. Zamfirescu" and design and build 10 more original aircraft types for different applications, from training aircraft to fighters. We also should mention the orders:

- SET 31 G, touring biplane. Fitted with auxiliary tanks, it participated in the Bucharest-Saigon raid and was flown by Ionel Ghica.
- SET 4
- SET 4.1
- SET 7
- SET 7K
- SET 7KD
- SET 10, a trainer aircraft powered by a DeHavilland Gipsy Major engine
- SET 11 XV a sesquiplane configuration biplane (6 staggered wings) with a transparent canopy, oxygen supply for high altitude, two machine guns that fired through the propeller disc, and powered by a 500 HP Gnome-Rhone-K9.

The planes produced by "SET-Ing. Gr. Zamfirescu" were biplanes with equal or almost equal wing surfaces of moderate stagger, with a wooden or metallic clothed structure.

The "SET-Ing. Gr. Zamfirescu" enterprise manufactured under license the following aircraft:

- 80 Fleet F-10G aircraft;
- 120 Nardi FN-305 school and fighter trainers;
- 80 IAR-27 trainers;
- 96 reconnaissance and light bombardment IAR-39 aircraft;
- 40 Grunau Baby IIA/B school gliders.

Principle 2. Leadership. Eng. Grigore Zamfirescu graduated the Bridges and Roads School in Bucharest in 1920, followed up by two years of Aeronautic and Automobile Construction School in Paris. In 1922 he began working at the Aeronautical Arsenal, and in 1923 he started his own business.

Principle 3. Personnel Commitment. The personnel commitment was reflected in the fact that during its 25 years of activity the factory trained the engineers and technicians that designed and built 12 original aircraft types, all this in a time when in Romania there wasn't any aviation faculty.

The organizational diagram in figure 2 below demonstrates **Principle 4** systematic approach to management (processual approach).

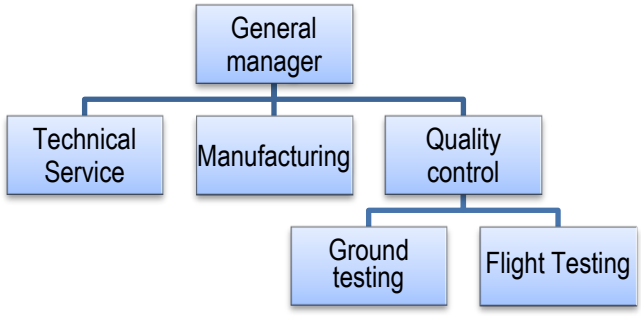

Fig. 2 Organizational diagram of "SET-Ing. Gr. Zamfirescu"

Principle 5. Improvement. The continuous diversification, the understanding of the market needs, the aircraft quality and conformity and the fact that it survived in a competitive environment suported by the Romanian state (IAR Aeronautic Arsenal) and German financing (ICAR) – all prove the company's superiority, due in part to a flexible management.

Principle 6. Proof based decision making is best illustrated in this organization that did not need Administrative Councils with members scattered across all Europe to take a decision, the development needs being obvious from the market needs at any given time.

Principle 7. Supplier relations management (suppliers of engines, chemicals, wood and fabric), the partners (Tecuci Air Pilotage School) and other interested parties (authorities in the Romanian Old Kingdom) allowed the organization to optimize its performance, leading to the development of other branches of Romanian industry (metallurgy, textiles).

The success of "SET-Ing. Gr. Zamfirescu" shows that the management of Eng. Gr. Zamfirescu - who started alone and trained his own personnel –was in accordance to today's quality management principles. Unfortunately there is not even one street in Bucharest to bear the name of the first and only Romanian who owned an aircraft factory that was so successful both technically and commercially.

3.6 STC-Constanta Transportation Society GETTA

In 1925 the seaplane squadron of Constanta is organized, using old and degraded aircraft.

Principle 2. Leadership. Georgescu was the owner and general director of STC, the only to have knowledge about engines and bodywork, and capable of self-financing.

Principle 1. Customer orientation. Director Georgescu aimed to build seaplanes given the vicinity of the Black Sea and the Danube Delta.

For the seaplane squadron, Eng. Radu A. Stoica (trained at Astra Arad and Arsenalul Aeronautic) designed and built the single engined floating hull biplane RAS-1, inspired by the "Brandenburg" seaplane.

One prototype was built for ground testing, and a small 3 items series for training flights was completed. It is supposed that the acceptance under reserve of the seaplanes built by STC and the refusal of the aeronautic authorities to order more of that type was due to an

incomplete project that was not suported by a proper calculations workbook and also due to the low performance of the engine.

In 1927, the authorities acquire S.I.A.I-Savoia S-59 seaplanes, so that the production at STC-Societatea de Transport Constanta stopped.

Lacking a customer (the aeronautical authorities) to valorize its seaplane production and marked by the incomplete design project, the organization goes bankrupt.

3.7 "Industria Aeronautica Romana" IAR Brasov – (Romanian Aeronautic Industry –IAR Brasov)

On 6 august 1925 the company "Industria Aeronautica Romana" IAR Brasov is founded according to the High Royal Decree issued on 26 of June 1925, and was organized and equipped with state of the art technology. The official reception took place on 11 October 1927. The first president of the Administration Council was General Constantin Coanda (father of Engineer and inventor Henry Coanda), and initially Louis Bleriot was a member. One could wonder if the presence of Bleriot in the administrative council explains the fact that although the IAR-80, A, B, C, IAR-81 A, and C ranked among the top 4 pursuit and light bomber planes in the world, the factory could not sell a single aircraft abroad.

The contract stated that on the 1st of November 1926 the aircraft factory would start production and on the 1st November the following year the engine factory would follow suit. In the first 4 years of existence IAR Brasov built under license 5 types of aircraft, counting 230 totals and thus starting its design and production control organizing efforts.

Principle 1. Client Orientation. Client-oriented approach was proven by the fact that the factory orders were personalized for their main beneficiary, the Romanian Army.

The fabrication of in-house designed aircraft starts at IAR during 1929-1930. The IAR CV 11 is the first one to bear the insignia of IAR. Two items were built, one for ground testing and another for flight testing. IAR Brasov built 21 types of aircraft of own design, 5 of which entered series production IAR-37, IAR-38, IAR-39, IAR-80, A, B, C, IAR-81 A, C. This performance was not equaled by ICA Brasov (the new post-1968 IAR), because the client-orientation principle no longer applied. The client was forced to buy just what the seller offered. Until 1940 the tooling and technology of the enterprise were perfected, new technologies were assimilated (duraluminium constructions with resistant skin), the personnel was qualified and the flight testing and quality control showed improvement.

Principle 2. Leadership. The state of the art tooling and machines and the work conditions offered attracted the brightest alumni of mechanical faculties and technical schools.

Mircea Grossu-Viziru (1903 Braila California-1980), attended the Lycée St. Louis, Paris and in 1921 he obtained the high school diploma. After then he enrolled in the courses of "Ecole Technique d'Aeronautique et Construction Automobile" in Paris; in 1926 he became a diplomat engineer specialized in Aeronautics. The following year he returned to the country and was hired to IAR Brasov factory where he held the following positions:

May 1927 - February 1928 - Head of Control Services of the IAR cells factory; February 1928 - March 1929 - Civil Engineer in the Office of Secret studies of the IAR cells factory;

March 1929 - June 1930 - Head of the Office of Secret Studies of the IAR cells factory;

June 1930 -March 1931 - Head of Prototypes Building Workshops;

March 1931- May 1932 - Chief of Manufacturing Workshops for series aircraft and prototypes, in addition to general assembly and test flights;

May 1932 - November 1934 - The head of all existing workshops in the cells factory, including the air shed; he was also responsible for the flight tests;

November 1934 - June 1935 – Substitute Director of the cells factory;

June 1935 - August 1940 - Appointed Director of the cells factory;

August 1940 - August 1944 – General Manager of IAR and member of the IAR Board of Directors.

Mircea Grossu-Viziru, worked at IAR almost the whole existence of the factory. Due to his professional capacity, he was well appreciated and quickly advanced up to the supreme position of General Manager. He was the author of several inventions and valuable projects implemented within IAR, but also in other aircraft factories in Romania and abroad. Between 1925 and 1961, he patented 10 valuable inventions: one in Romania; 4 in France and 5 in the USA. Among these we should mention the "Guns nacelle for aircraft" patent Ro.20588 / 1932-IAR also named Grossu Turret-IAR, mounted on the IAR Potez XXV aircraft, IAR-37; 38, 38 and SET-7K. Grossu-IAR turrets were exported in several countries such as France; Czechoslovakia; Poland and USA where he obtained the patent US.1.953.710/ 1934.

From the documents in the National Historical Central Archives and Military Archives, it appears that Mircea Grossu-Viziru is the author of the projects IAR-37, 38, 39 and IAR-80. IAR-80 project was awarded the Medal of Aeronautics, class III.We cite from the Official Monitor no.149/ July 1, 1939:

"Viziru Mircea Grossu, Engineer, IAR. Employed for 12 years he went by through the whole chain up to the position of high responsibility as director of the cells factory. He executed the whole range of aircraft in our Aeronautics working successfully both for the planes under license and for the Romanian prototypes of which the last fighter IAR 80 is one of the brightest of our aviation equipment".

On August 21, 1944 while he was working at Caransebes where some departments of the of IAR factory were dislocated he was called up from the Air Minister Gheorghe Jienescu. At the Ministry of Air and Navy he was received by the Minister himself who, because of the events advised him to take his family and leave the country as quickly as possible. One of the following days, together with family and close friends he boarded an IAR SM-79B and flew to Turkey where he was met by some representatives of the US military, then he was taken to Brazil, and the United States. He was employed as an engineer at Martin-Marrett Aluminium Company until retirement, and then he held the position of technical advisor at the same company until the end of his life. [5]

Ion Grosu Ion Grosu (1901-1970) attended the Faculty of Mathematics in Bucharest (graduated in 1926) and then the Polytechnic School, becoming an aviation engineer (1931). Between1931 and1935 he worked as engineer at the Office for studies and construction of airplanes; from 1935 he became Head of the same department, then, between 1940 and 1943, Director of the Cells Factory and since 1946 he was appointed CEO. During 1950-1954 he was Chief Engineer of the Processing Metallurgy Central Office within the ministry. In 1936 Ion Grosu, designed the IAR-80 fighter aircraft, of which 460 items were made. Because Royal Romanian Air Force had not competitive fighter jets, the War Office commissioned the design and construction of a modern all-metal monocoque fighter. After the first tests IAR-80 was considered among the fastest in the world, achieving a speed of 510 km/ h, as a result of the amendments made on the flight test program, (the aircraft was comparable to contemporary designs such as the British Hawker- Hurricane - 570 km/ h, the American Curtiss-Wright P-37-550 km / h and the German model Messerschmitt Me-109 - 520 km / h). Some sources state that the perfected model even reached 550 km/ h. IAR-80 had a

retractable landing gear and a pressurized cabin. Among its features we mention: it reached an altitude of 5,000 meters in 6 minutes; the maximum ceiling altitude of 10,500 meters; range of 940 km; aerodynamic line; Triple propeller; gull wing and excellent maneuverability. The prototype was achieved in December 1936, the manufacture preparing lasted from October 1937 to February 1939, and starting from 1940 it was delivered in series. Also under the lidership of engineer Grosu the dive-bomber and long-range fighter IAR-81 was built, equipped with a 1,050 hp IAR-1000 A engine. New solutions introduced by Eng. Grosu to the jet fighter were taken subsequently to German Focke-Wulf 190 D9. Since 1948 he was a Lecturer at the Faculty of Mechanical Engineering, and in 1968, Professor, teaching the calculation and construction of aircraft. [5]

Elie Carafoli He was born in 1901 in Veria City (near Salonic) in a Macedo-Romanian community. In 1919 he enters the Polytechnic School from Bucharest and after graduating he obtained the Electromechanical Engineer diploma (1924).

His high qualification was accomplished in Paris at the Sorbonne where he took his diploma and Ph.D. degree in Mathematics and Physics. Until 1928 he works for the Aerotechnic Institute of Saint-Cyr where he develops a more lot of ample works and monographs, published in Paris. In October 1928 he founded the chair of Aerodynamics and Fluid Mechanics within the Electromechanical Department at the Polytechnic School in Bucharest, which he leads for 45 years. Elie Carafoli also held the position of Chief-engineer and later on he became the Director of the Aircraft Factories IAR-Romanian Aeronautical Industry of Brasov, position held until 1936. Aerodynamics was a new discipline, which arose from the need to exactly understand the phenomena that take place around the aircraft, in order to determine the most appropriate aircraft shapes and to determine accurately the forces acting on the various parts of the aircraft, aiming to obtain a perfect sizing and optimization. In 1930, together with the French engineer Lucien Virmaux, the representative of the Bleriot Spad Plants) he designed the first Romanian aircraft: a CV-11 (Carafoli-Virmaux)-type low-wing monoplane, manufactured by IAR Plants of Brasov. This aircraft was equipped with a Hispano-Suiza engine 12Mc, 500 hp, and was intended to overcome the basic speed record of 500 km. The main features of this aircraft are: span 11.5 meters, length 6.98 meters, wing area 18.2 square meters, total weight 1510 kg, maximum speed 325 km/ h, ceiling 10,000 meters; Time of climbing to 5,000 meters, 5 min. 15 s. Later on he conceived, designed, manufactured and even experimented, IAR-13, IAR-14 , IAR-15 and IAR-16-type aircraft which had remarkable performances for that time and comparable to the best achievements in the world .It worth mentioning his contribution to the design of the famous IAR-80.

Since 1939, Engineer **Radu Manicatide**, specialist in structures, worked at IAR Brasov as Head of the department of structures, then as Head of the Prototyping and Experimentation Workshop, where he participated in building the aircraft designed at IAR (IAR 27, IAR-37 and IAR-80) and the aircraft under license (IAR-79 - Savoia Marchetti, Me-109 - Messerschmitt).

During 1931-1937 he attended the Polytechnic School in Bucharest and the School of Aeronautics and Construction of Automobiles in Paris (being a valedictorian). Since April 1926 he was concerned with aviation, obtaining the first place in a competition of model airplanes and gliders with his own glider M-1.In 1931 he attended the flying school and he got his pilot license.

In 1942 continuing his older preoccupations he built at IAR Brasov his RM-9-monobloc plane (with a maximum weight of 350 kg and maximum speed 138 km/ h).

In 1944, Radu Manicatide built the two-seater plane with front horizontal tail (canard type), RM-11 (weighing up to 530 kg and a maximum speed of 175 km/ h); in 1949 he built also in Brasov the IAR-811, a two-seater trainer (maximum weight of 650 kg and a maximum speed of 150 km/ h). [5]

We should not forget the contributions made by Eng. Erast Berenţan, Eng. Ovidiu Cionca, pilot Alexandru Frim, Eng. Teodor Gârneţ, Eng. and pilot Constantin C. Gheorghiu, Eng. Radu Emil Mărdărescu, Commander Eugene Pârvulescu, Captain Aviator Eng. Constantin Radoi, Eng. Iosif Silimon [5].

Principle 3. Personnel commitment. The factory personnel were constituted initially of the specialists brought from ASTRA ARAD. The great majority of the personnel were formed in Brasov, a city with a strong crafting tradition (descending from the old craftsman guilds of the burg).

The personnel working in the field consisted of highly qualified workers, well regarded in the society and well-paid.

Principle 4. Systematic approach to management (processual approach). The increase in market demands and the perspective of war in Europe led to the necessity of state controlled production and financing, and to the imposing of the organizational diagram of IAR shown in Figure 3.

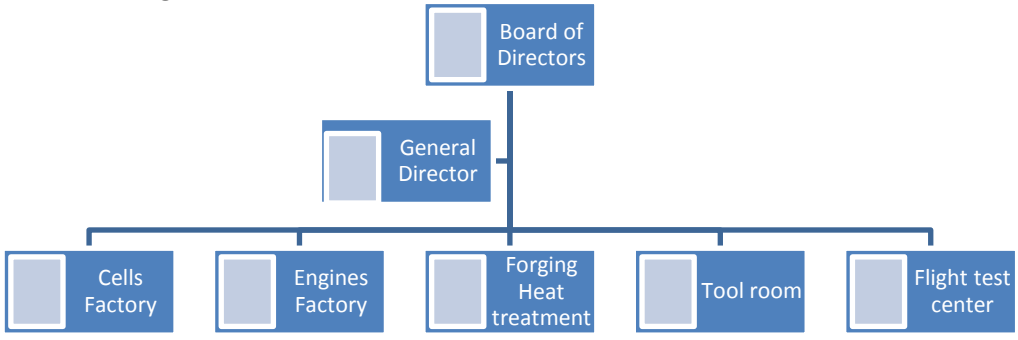

Fig. 3 Organizational diagram of IAR 1938

It is seen today that the historic circumstances of the moment led naturally to militarizing the enterprise without affecting processual organization, by respecting the systematic approach to management still viable today (fig.4).

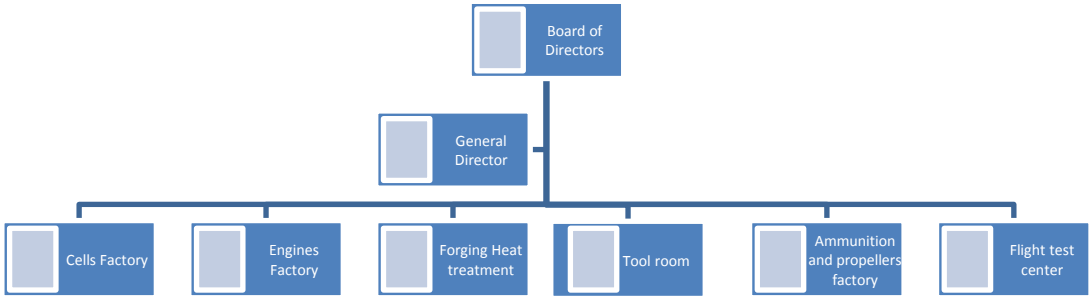

Fig. 4 Organizational diagram of IAR 1940

Principle 5. Improvement. The continuous diversification in production and assimilation of new technologies are proof of the military leadership's interest in improvement.

Principle 6. Proof-based decision making. Decision making based on proof in an enterprise that respects the military requirements of the time meant the managerial decisions were based on proof.

Principle7. Supplier relations management. (the suppliers for metallurgy products, aluminum, chemicals, wood, fabric and chemicals), the partners (Ministry of the Army) and other interested parties (The Sub-Secretariat for Aeronautics –SSA) allowed optimizing organizational performance, leading to development of other Romanian industry branches (metallurgy, textiles).

Conclusions regarding the activity at IAR. Historic data from references [3] and [5], allowed for evaluation of the superior management of the organization that we find to be compliant to the principles of quality viable today.

We must observe the true quality of the specialists that were formed or worked at IAR. Part of these specialists left for the aircraft companies in Bucharest and Bacau, and some others built the Romanian tractors.

3.8 Intreprinderea de Constructii Aeronautice Romanesti ICAR-Bucuresti- Romanian Aeronautic Construction Enterprise - ICAR Bucharest

In 1932, Intreprinderea de Constructii Aeronautice Romanesti ICAR-Bucuresti is founded (becoming "Ventilatorul" post-war enterprise) with a partial German funding involved.

Principle 1. Client Orientation. In the ICAR enterprise the Messerschimitt M-23b trainer aircraft was designed and produced under license, a batch of 10 aircraft being produced for ARPA Asociatia Romana de Propaganda Aviatica (The Romanian Association for Aviation Propaganda), with a modern low-set wing, having a high form factor, with a wooden structure covered in plywood just like the fuselage.

The following aircraft were subsequently produced:

-ICAR-Universal, with a radial Siemens-Halske SH-14A, 150 HP engine, as a single seater for acrobatics and two seaters for training;

-ICAR-Commercial, the first Romanian aircraft for passenger and postal carry, single engined, built under license from Messerschimitt (M-36)

-ICAR-Acrobatic, Siddele Linx engine biplane.

-ICAR-Touring, twin seater with high wing and closed cabin, powered by a 90 HP POBJOY Niagara

-ICAR-Divizionar, twin engined reconnaissance and attack aircraft (powered by IAR-V1-G1) that was not accepted by the Army

Between 1936 and 1937, ICAR builds under license the wings for the Savoia-Marcheti S-62bis seaplanes.

Although activity started by building aircraft under license, within the decade, 5 types of own design aircraft were developed.

Principle 2. Leadership. The first general manager was Engineer Mihail Racoviță, the technical director was Eng. Constantin Bulgaru and the workshop supervisor was Eng. Nicușor Racoviță.

On April the 1st, 1941 before getting his license, Lt. Aviator Constantin Rădoi is transferred to the Technical Direction within the Ministry of Air and Navy (MAM), at the Sub-secretariat for Aeronautics (SSA) as a representative of the Superior Control Commission (CSC) of ICAR where he was in charge of monitoring and control repairs on flying stock, monitoring and control at the airfield and pre-flight adjustment of aircraft as well as fabrication control of gliders in the Racovita workshops. From a personal note that he

wrote we know that in October 1943 he and some ICAR workers were at the last crankshaft turn on the first Fiesler Storch Fi-156 that was fabricated at the time [5].

Principle 3. Personnel Commitment. Personnel commitment is reflected in the fact that in less than 20 years of operation the engineers and technicians for the technical service were trained and then designed and built 12 original aircraft types –while in Romania there was no aviation faculty at the time.

Principle 4. Systematic approach to management (processual approach) is reflected in the organizational diagram in fig. 5.

Principle 5. Improvement. The continuous diversification, the understanding of the markets demands , the quality and conformity of the aircraft and the fact that it thrived in a competitive environment suported by the Romanian state (IAR Aeronautical Arsenal), the SET proved the superiority of a military management with German influences.

Principle 6. Proof-based decision making is illustrated in this organization also named The Racovita Workshop-Atelierele Racovita).

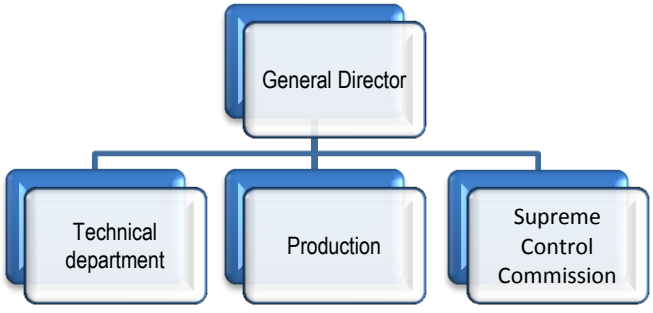

Fig. 5 Organizational diagram of ICAR

Principle 7. Supplier Relations management (supplied engines, metallurgical and chemical products, wood, fabric), the partners (ARPA) - the Romanian Association for Aviation Propaganda and other interested parties (The Ministry of Air and Navy - MAM), and the state sub-secretariat of Aeronautics (SSA) allowed to improve organizational efficiency leading to the development of other branches of Romanian industry (metallurgy, textiles).

Conclusion regarding the activity at ICAR. Historical data from [3] and [5], allowed evaluating the superiority of the management of this organization, comparable with the principles of quality that are valid today.

4. EVOLUTION OF THE QUALITY SCIENCE DURING THE INTERWAR PERIOD [4]

Walter Andrew Shewhart (1891-1967), an electronics engineer at Bell Telephone Laboratories was interested at first in improving the transmission systems. He began to process statistically the information about the activity of the organization. The problems were identified in terms of allocation -cause and defect-cause variation; he introduced the control chart to distinguish between the two terms. Shewhart introduced the conclusions on efficiency drawn from the control chart and the statistical control in the production activity. In 1931, he published **"Economic Control of Quality of Manufactured Product".**

William Edwards Deming (1900-1993), electrical engineer, mathematician, worked in the US Department of Census and Bureau of Labor Statistics. In his book "The New Economics for Industry, Government and Education", Deming promoted the work of Walter

Shewhart, including the processes statistical control, and also what Deming called "the Shewhart Cycle" which evolved into the PDCA (Plan-Do-Check-Act) concept. In 1933 he completed the final version of the PDCA, stemmed from his personal experience gained in Japan in the 1950s.

5. CONCLUSIONS ON THE ACTIVITY DEVELOPED WITHIN THE ROMANIAN AIRCRAFT COMPANIES

Looking back to the boom phase in Romanian aeronautics, we find that the Romanian sky was then crossed by nearly 2,000 aircraft manufactured in the country, at 4 big companies of which 3 were located in Bucharest and activating in a strong competitive regime.

The competition between the four aircraft manufacturers demonstrates the quality of the management. The graph in Figure 6 quantifies the extent to which the aviation companies have fulfilled the principles of quality, at that time.

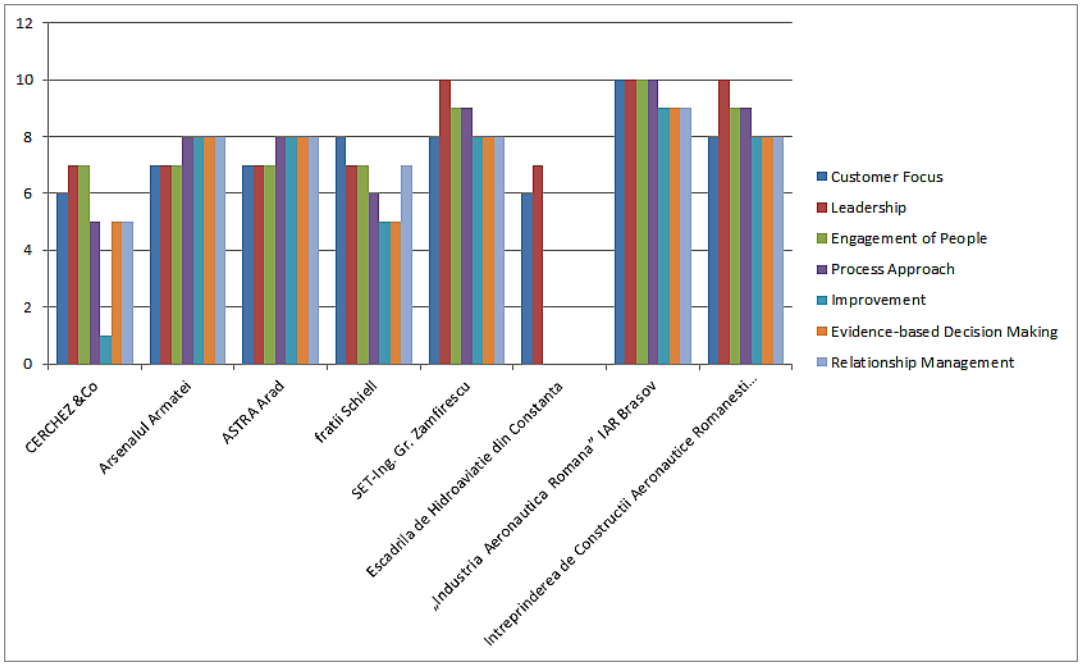

Fig. 6 Degree of fulfillment of the principles of quality

Without a good management during the 30 years marked by an economic crisis and a World War, the 4 aircraft companies could neither achieve, nor continue to improve the production above mentioned by building new high performance models. The success of these 4 aircraft companies was developed in a viable capitalist society as defined by Adam Smith. The staff working in this area consisted of highly skilled workers and technicians, trained in factories and motivated, valued in society and paid accordingly. In the socialist society, the organization of enterprises (central planning, priority in state supply orders to the detriment of domestic consumption) generates principles of quality similar to those presented in Chapter 1, principles which were successively adjusted as a result of the continuous pressure from the UK partners (BAC). International collaborations in the socialist period (assimilation of licenses) determined the practices of organization and production to reach a competitive efficiency and formed generations of highly skilled workers. The only companies that

worked in accordance with the principles of quality were the *Aeronautical Constructions Company of Brasov*, Aircraft Company of Brasov, the Aircraft Company of Bucharest, the Aircraft Repair Enterprise of Bacau, the Aircraft Company of Craiova, TURBOMECANICA of Bucharest, Research and Production company for navigation instruments (ICPAEBA), which became later **SC Aerofina SA**, The Research and Production Company for Forgings and Castings for Aviation (ICPPFTA) which became later METAV, Rom Control Data Bucharest, Dacia Pitesti, OLTCIT Craiova.

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