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**The Polish Contribution
to Scientific and
Technical Civilisation
(outline)**

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Introduction

During the last three centuries, when most nations were primarily occupied with creating the foundations of material prosperity, the aware part of Polish society focused its efforts mainly on preserving national identity and striving for independence. In these circumstances, our historiography took first note of patriotic activists, protagonists fighting for a national cause and those who supported this fight with their writing. The literature of the time, which was created mainly with the goal to lift the spirits, shaped the awareness of the public that was sensitive to such activity. Any achievements in other fields were outside the mainstream of common interests and were thus more easily forgotten.

As a result of such an approach, Polish biographical dictionaries and encyclopaedias are surfeited with records dedicated to military commanders, politicians and men of letters, while very many of our outstanding naturalists, inventors, engineers, businessmen and other ‘constructivists’ are completely forgotten. This is particularly true on what concerns those Poles whose fate sent them abroad.

Representatives of this trend, apart from some completely unique characters, are mainly present in the collective conscience only due to links with much better-researched ‘privileged’ areas: Ignacy Domeyko because of the youth episode in the Philomath conspiracy; Karol Brzozowski, because he was also a talented poet; Ludwik Nabelak for his participation in the preparation of the November Uprising; Gabriel Narutowicz, because he was the first President of the reborn Republic and was murdered in the Zachęta art gallery; Henryk

Dembiński because he was also a talented general; or Rudolf Modrzejewski, who was the son of a great actress.

This tendency to present, sometimes in an exaggerated manner, everything related to a broad patriotic activity, is also visible in the way individual biographies are presented. Few people know that Ignacy Mościcki was one of the leading European inventors of his times; that Gabriel Narutowicz was an outstanding hydrotechnician, building hydro power plants in several countries; that General Henryk Dembiński earned royalties on inventions he patented in France or that the poet Karol Brzozowski built 40,000 km of telegraphic lines in 19th-century Turkey.

Paying due respect to the fighters for the most important Polish issues, it should at the same time be emphasised that due to such an approach, the image of our national achievements has been deformed and impoverished. So, we have a biased concept of the nature of our true cultural achievements (which is not due to any conspiracy, but to circumstances). It makes us overestimate the importance of Polish literature, which was focussed to a large extent on supporting aspirations towards independence and thus not quite understandable for many readers from other countries, and not for linguistic reasons only. It also makes us not see numerous and important –often even globally – achievements in life sciences. Finally, it makes us completely disregard the Polish contribution to the development of world technology. However, our large 19th-century emigration contributed significantly to the civilisational development of a few countries, sometimes exotic (such as the Ottoman Turkey or Peru), and the Second Polish Republic, established in the inter-war period, was in many areas of technology competing with the biggest

global players, which finally resulted in the epic contribution of Polish inventors to the victory of the Allies in the Second World War.

Since 1956, I have been professionally dealing with the history of science and technology. My most important work so far is the biographical dictionary I edited, entitled *Polski wkład w przyrodoznawstwo i technikę. Słownik polskich i związanych z Polską odkrywców, wynalazców oraz pionierów nauk matematyczno-przyrodniczych i techniki* [The Polish Contribution to Natural Science and Technology. Dictionary of Polish and Polish-related discoverers, inventors and pioneers of the mathematical and natural science and the technology] (Warsaw, 2015-2019). It presents useful information about Poles who have gained recognition – often on a transnational scale – in the development of broadly understood natural sciences, science and technology. The Polish reader, especially with a certain humanities background, has never heard of most of these achievements. I myself learned about some of them only during the editing of this work. So, I found it useful to write this short book, presenting, against the background of our history, the most important Polish achievements –sometimes surprising in scale and significance. In order to enrich and improve the knowledge on our cultural achievements.

In my opinion, these – most often forgotten – achievements are our main cause for pride. Especially today, when the significance and rank of nations are determined by the place they occupy in this constant competition in the field of ideas and works. This should prevent us from developing some inferiority complexes. They have been invented, contrary to the historical truth, by those unfavourable to us, while the facts certify that science and technology are by no means our weak side. On the contrary.

In conclusion, I allow myself to draw attention to a common mistake, which has the terms ‘discovery’ and ‘invention’ being treated as synonyms. It happens even to the academics. Actually, discovery is an observation of some truth in the reality around us, i.e., in nature, whereas invention is the creation by a human person of something that did not exist before.

If one day we encounter an alien civilisation – which cannot be excluded, considering the vastness of the universe – our life sciences and their life sciences will be identical in some areas. However, in the field of technology, we will certainly differ a lot. For our technical activity is original, impacted as it is by the characteristics of humans and earthlings.

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Boleslaw Orłowski

Origins

We entered the scene of history in 966 when the Polish ruler Mieszko accepted baptism and thus joined the community of Latin Christian states. If he had not done so, we would have shared the fate of Obotrites, Veleti, or other Slavic neighbours who used to live then in the European Plain that ran all the way to the Elbe.

We would not have the chance to survive as an autonomous political body, because a wide civilisational backwardness divided us from the countries that were earlier Roman provinces. To quote just one, for example England, the extent of whose state was comparable to that of Mieszko I, where, according to the 1086 census, there were 5624 water mills in operation. In Poland, the first such mill appeared as late as in 1145.

It is understandable that for the next few centuries, in most cases we were only passive participants in European civilisation and culture. Its achievements – known for hundreds and sometimes thousands of years as the direct heirs of the Roman Empire – reached Poland thanks to the influx of experts from the West bringing new skills and devices. Some of these new developments were probably treated by the local population as pure magic.

This is certified by a fairy-tale about Baba Yaga, a witch who lives in a little hut on a chicken foot. It is easy to recognise that this is actually the simplest windmill, known as post-mill. It was installed on the pillar so that it can be rotated and its wings were thus always placed in the wind direction. Can you be surprised that someone for whom the wind works was recognised as a kind of wizard? Especially if he or she did not look like the local people and used some foreign, incomprehensible language...

It can be said that we were initially in a situation similar to the one of today's native inhabitants of the Amazon Forest, invaded by modernity.

The rulers from the Piast dynasty consistently supported the influx of foreign experts by providing them with legal facilities. The absorbent market and lack of competition attracted many of them. Most came from the nearby Germany, so historians call this process German Colonisation. As a result, cities with defence walls, water pipes and paved streets were built in Poland, as well as Gothic brick structures (mainly churches), grain mills, and fulling mills producing cloth, forges and mines. The efficiency of the mine in Bochnia and Wieliczka made salt more widely available in Poland than in other European countries.

The last king from the Piast dynasty, Casimir the Great, is said to 'have turned the Poland of wood into the Poland of brick...'. He raised walls around almost thirty towns and erected over fifty castles, creating a defence system that protected the country's interior from the raids of Tatars and the Teutonic Knights. But in this appraisal we can hear the satisfaction with the general state of Poland, which in the 14th century already reached a civilisation level comparable to that of Western European countries.

Since the 13th century, Poles were increasingly studying at the numerous universities in the West that were emerging at the time, mainly in France and Italy. The first of our academics who gained international recognition was Vitello from Silesia (ca. 1230–1292) – probably the son of a Pole and a colonist from Thuringia. After studying in Paris, he wrote the most important optical work of the medieval Europe: *Perspectiva* (1273). It contains all the existing knowledge in this field, enriched with his own findings (e.g., the phenomena of spherical mirror aberration). It must have been relevant for a long time, as it was published as late as in 1535 and 1572.

The biggest number of Poles studied medicine, sometimes later making their careers as court doctors. In 1364, Casimir the Great established the first university in Cracow to provide the state with the necessary number of educated people, especially lawyers. The academia also attracted students from outside the

borders of the then Poland – from Silesia, Pomerania, Germany and Hungary. It was among the few that in 1514 were asked by Pope Leon X for proposals regarding the planned reform of the calendar.

At the end of the 14th century Poland joined Lithuania, facilitating its integration into the world of the Latin Christian states. We thus became the largest power of Europe in terms of territory, and a kind of ‘transmission belt’ which transferred European achievements to the huge, less civilised territories to the east. First under the rule of the Jagiellonian dynasty, and then after the Lublin Union (1569) as the Polish-Lithuanian Commonwealth, we chose a different model of development than the vast majority of European countries. It was a democracy of the nobility which ensured this layer of society (including about 10 per cent of the population – more than anywhere else) broad civil liberties. This resulted in, among others, extensive religious tolerance, which made us an oasis of peace in a 16th-century Europe torn apart by bloody religious wars. That was why people who were discriminated in their own countries were looking for shelter in Poland. This group included refugees known for ‘politically incorrect’ views such as Valeriano Magni (1586-1661), who publicly presented in Warsaw an experience demonstrating the existence of vacuum (1647), which was contrary to Aristotle’s science officially recognised at that time.

It also had its weaknesses, as the dominance of the nobility did not allow the development in Poland of two factors that were essential to the power of the state – the bourgeoisie providing economic prosperity, and a strong royal power guaranteeing internal governance and external security. By ensuring that cereals are easily transported by river, the nobility made it difficult to install water wheels on the rivers, which were used at that time in many production areas.

The nobility was not interested in technology. In the 16th century, the staff of qualified engineers, already necessary for the operation of many areas of life, was in the main recruited from foreign experts, mainly from Italy, later from France

and Germany. It was through them that technical innovations, mainly in the military, construction, steel and mining fields, were introduced to Poland.

We owe to these people the erection of the Renaissance Wawel Castle (1502–1529), the construction of Zamość in full accordance with the then-current town-planning principles (1581–1586), a lot of churches, mansions of the magnates, town halls and tenement houses. It is thanks to them that the artillery of Stefan Batory used incendiary missiles to force the Muscovy fortresses Velizh and Velikiye Luki to capitulate, and that since 1613 large melting furnaces were at work in the Staropolski Basin in the Kielce region.

So, we were still mainly passive members of the European civilisation and culture. But there were also the beginnings of Poland's more active participation in it.

Stanislaus Polonus from Seville (died in 1514) was known for popularising printing in Spain, Rafał Skrzetuski (ca. 1525–1558) from Poznań popularised it in Hungary and Transylvania, and his son Rudolf (died in 1586) also in Serbia and Croatia.

The example of Nicolaus Copernicus (1473–1543), with all its uniqueness, certifies that during this time Polish academics were able not only to participate fully in international intellectual life, but to contribute to it by creating a creative contribution at the highest level. Copernicus studied in Cracow, Bologna, Padua and Ferrara. The revolutionary concept, which assumes the triple movement of the Earth, was born in his mind probably before 1510, and the manuscript describing it and providing mathematical justification, *De revolutionibus orbium coelestium* (On the Revolutions of the Heavenly Spheres) was ready about 1530. However, it was only printed in 1543 and – for tactical reasons – in the disguise of a hypothesis.

In a dedicated letter addressed to Pope Paul III, Copernicus wrote:

Perhaps there will be some who like to be delirious and, despite the complete lack of knowledge of mathematical sciences, claim the right to speak about

them on the basis of an excerpt in the Scriptures, which are misinterpreted and interpreted and manipulatively adapted to their intentions; they will dare to condemn and persecute my theory. However, I do not care of them completely and I entirely despise their judgement...

The discovery of Copernicus was one of the most important ones in the history of humanity. By determining that the Earth is not the centre of the universe, but one of the planets rotating around the Sun, he also showed how extremely huge distances separate us from the fixed stars. He thus refuted the old ideas and undermined the conviction of the uniqueness of humanity and the planet it lives on. This had extensive consequences in the world of ideas.

All the other achievements from that period pale in comparison to the discovery of Copernicus. However, it is also worth taking note of the person of Józef Struś or of Josephus Struthius (1510–1569), a doctor from Poznań who gained international recognition as one of the pioneers of studying the heart rate, which made him an unrivalled diagnostician. He studied and lectured at Padua, and served as a doctor for the Jagiellonian dynasty and the magnates as well as for Sultan Suleiman the Magnificent.

Michał Sędziwój (1566–1636), referred to abroad as Sendigovius, educated in Cracow, Leipzig, Vienna and Altdorf, became famous as an alchemist. In the diplomatic service of Emperor Rudolf II and King Sigismund III Vasa, he travelled around the whole of Europe, from Portugal to Moscow. Carrying out chemical research, he gained extensive practical chemical knowledge that was ahead of his time. He knew the product of the thermal decomposition of saltpetre, which he called the ‘food of life’ contained in the air, identified today with oxygen. He was also aware of the role it played in the process of breathing. There are many indications that Cornelius Drebbel used the method of Sendigovius to refresh the air in the submarine he invented (1624), as these two figures could have met at the imperial court in Prague. It is also worth adding that the official discoverers of

oxygen from the end of the 18th century, namely Joseph Priestley and Carl Scheele, were perceiving oxygen in a similar way.

It is also worth noting some further Polish accents in the European intellectual agitation that shaped the empirical foundations of modern science. The Cracow-based Jan Pudłowski (1597–1645), educated in Italy, was one of the earliest promoters of introducing a universal measure based on the length of the second pendulum. His idea was developed into a system of linked measures of length, volume and weight by Tito Livio Burattini (1617–1681), an Italian who became a Pole by choice and who published his theory in Vilnius under the title *Misura universale* (1675). Burattini conducted air tests in Warsaw (1647–1648) with a dragon-like machine which were widely commented throughout Europe. He also ground excellent parabolic lenses for the great telescope of the Gdańsk astronomer Johannes Hevelius (1611–1687), an investigator of the surface of the Moon and the comets, the inventor of a prototype of the periscope (1637). Adam Kochański (1631–1700), a Jesuit, participated in international discussions on the issues of statics (including the parallelogram of force) in the collection of essays in the Leipzig scientific journal *Acta Eruditorum* and introduced several important improvements in the design of clocks.

Two Poles educated in the Netherlands marked forever the history of the systematisation of technical military knowledge. Adam Freytag (1608–1650) from Toruń published in Leiden the first manual of bastion fortification in the so-called ‘old-Dutch system’, *Architectura militaris nova et aucta* (1631), which was read across the whole of Europe and was further published several times as well as translated into French (up to 1669). Kazimierz Siemieniowicz, originating from the Great Duchy of Lithuania (about 1600 – after 1651), published in Amsterdam the work entitled *Artis magnae artilleriae pars prima* (1650). It contained all the current knowledge in this field, including in the area of missile technology. Siemieniowicz was the first one to have published a project of a multi-phase rocket, without which

there would be no space conquerors today. His work was translated into French (1651), German (1676) and English (1729).

Poles, who very much appreciated their freedoms, tolerance and personal independence, for several centuries restricted the scope of the powers of the Polish kings they were electing. They were afraid that Poland would transform into an absolute monarchy, as it was the case of subsequent European countries in the modern era. They went too far. The weak central power also meant being defenceless against external threats from increasingly stronger neighbours.

The Republic of Poland, having enormous territory rich in resources but a small army, ceased to count as a power. This was especially so when the West experienced an industrial revolution, the growth of economic power, and modernisation. This multiplied the unfavourable military imbalances, all of which led to an increasing dependence, mainly on a powerful, intrusive Russia which was constantly expanding its empire. However, Poland was also threatened by Prussia – having a smaller territory but at the same time a modern, much more numerically superior army.

The unfavourable configuration of circumstances resulted in a disaster that was difficult to predict in advance. The much stronger neighbours divided the lands of the Republic of Poland among themselves in three successive partitions (1772–1795).

A conscious part of the Polish elite tried to save the state. However, the efforts made to strengthen the Republic proved to be too late and lacking in effectiveness. The Third May Constitution (1791) remained a symbolic expression of these attempts.

The erasure of Poland from the political map of Europe was a shock to the majority of the citizens of the Republic and the end of the world in which they used to live. Paradoxically, this made many of them aware of the value of what they lost forever, as well as of the importance of what remained but which was at risk –

the national identity being a foundation of the Polish spiritual culture. The most active of them joined the Dąbrowski Legions (1797), initiating the Polish commitment to the Napoleonic wars. Others decided to protect and cultivate the glorious traditions of Polish culture by setting up the Warsaw Society of Friends of Science (1800).

Both of these currents grew increasingly aware that the major cause of our fall was backwardness, a failure to keep up with the main trend of scientific and technical progress. Polish soldiers of the Napoleonic army came into contact with the achievements of a developed French civilisation. And their university colleagues in the country set themselves a second but equally important target, 'get to know the native land with all its resources, as well as develop skills and arts required to make the proper use of them...'.

The Polish sacrifice in the Napoleonic wars, when 'our men were sent by fate to foreign lands', resulted in Poland returning to the map in 1815, although in a deeply limited form that was politically dependent on Russia. Yet it was Poland, with its own Parliament, its own army and broad autonomy, which our elites then used well to modernise the country's economy, industry and education inspired by the West. In many areas this meant laying the foundations of modernity — and also on what concerned the public awareness.

The Polish opinion-forming circles were under the charm of French culture and civilisation which remained a point of reference for them for more than a century. That is why the July Revolution that took place there in 1830 was followed with hope. The rumours on the penal expedition intended by the partitioning powers to restore the order imposed on France by the Vienna Congress (1815) were arousing concern. The expedition, by the way, that was also supposed to erase from the map the independent Belgian state newly created with the help of the post-July 1830 France. All the more so that the Polish army was to be involved in this expedition.

Such moods were the background for the breaking out of the November Uprising at the end of 1830, which was followed by the close fight of the highly trained Polish army against the dominant Russian forces. The Polish insurrection leaders – who participated not so long ago in the Grande Armée, led by the genius Napoleon – had an army ten times as small, which did not make them at all optimistic. They tried to ‘play for a tie’, counting for a peaceful agreement with the tsar, so they did not want to irritate him. They are even accused of failing to exploit a couple of opportunities to inflict severe losses on the Russians. But it is quite easy to understand that attitude. In any case, the imbalance of forces was so large that these failed opportunities could not affect the final result of the fights.

The uprising collapsed, which worsened the Polish fate, but rescued France and Belgium. It has also initiated an exceptional phenomenon in the history of not just the Polish people but that of other peoples as well– the Great Emigration.

Great Emigration

During the times of glory of the Republic, Poland was the place that welcomed all those who sought refuge from for political or religious discrimination in their home countries. Since the end of the 18th century, it was the Poles who for political reasons began to emigrate from their steadily weakening country. After the defeat of the November Uprising, several thousand of its participants, mainly young officers of the Polish Army, left. This event deserves to be remembered not only because of its sweeping nature. It was unique – not only in our history – also because of its universal character. It covered all the political operatives who cared for the Poland's independence, no matter the differences between them.

The main forces of our army were interned in Prussia beginning in the autumn of 1831, and it was from there that they went to a hospitable France in 1832. On the way, they were received with enthusiasm and as heroes in many German countries. They differed in their views and they quarrelled, but they were all united by the hopes for liberating their homeland as soon as possible. They represented an unquestionable moral representation of Poland. And they assured, particularly thanks to literature, the cultivation of the identity of the nation divided by the borders of the partitioning powers. They prayed for a great war of nations that would present an opportunity to regain independence. They were preparing for it, studying militarily useful engineering and medical professions. This was supported by the French authorities. This is why over time the educated Polish emigrant was associated with doctors and engineers.

Polish refugees were using their stay in France for educational purposes not only with the war of liberation in mind. They also thought about the necessary modernisation of the country that one day would be liberated. This was clearly formulated in the introduction to the programme of the Polish Polytechnical Society in Paris, founded in 1835 by General Józef Bem (1794–1850):

The Polish emigration, which has the opportunity to study abroad all kinds of sciences and arts, should consider it a holy duty to educate its sons who are capable and talented to the purposes of the homeland, so that, once returned to the country, they can transplant to the land of their fathers, covered with a thick layer of grief, all kinds of its branches developed abroad, which would spread throughout the Polish soil and soon give fruits...

Having clear objectives and responsibilities that they subordinated to themselves, the emigrants treated their forced stay abroad as a form of quarantine. There was a time of waiting, imposed on them by Providence, but with a sure salvation of the country in perspective. In the meantime, they tried to stay together, close enough to Poland not to miss the right moment and to get involved in its liberation.

The Spring of Nations (1848–1849) seemed to meet their hopes, so they participated in several of the events it involved. This included first of all the Greater Poland Uprising and the Hungarian Revolution, but also historical events in Germany and Italy. In many places they proved to be skilled and courageous leaders.

However, this great struggle for independence ultimately brought nothing good for the Polish cause. And it became obvious that the hopes attached to it should be postponed for a future that was difficult to foresee. This hard clash with reality forced the emigrants to change their way of thinking. Temporary quarantine proved to be a permanent stay. This required taking care of their own interests, finding a place for themselves in realities that were more fixed than had been expected.

France welcomed the Polish refugees and for decades bore the cost of sustaining them. France became their shelter, but not the promised land. Several hundred of them worked in the government Corps of Bridges and Roads. But they could not hold any engineering positions because the regulations did not allow foreigners, even graduates of the best French universities with the highest

qualifications, to do so. They could only perform ancillary functions. It was also more difficult for them to find employment in private companies.

They naturally started to seek the fulfilment of their professional ambitions outside France, where competition was weaker, especially in nearby Spain. And, since the moral duty to stay together and near Poland ceased to apply, the more courageous among them went across the ocean to the South American republics, where engineers with French diplomas were very much welcomed and were given the opportunity to make a career. Their motivations changed to the idea of the civilisational mission. As 'citizens of the world' they promoted the achievements of European science and civilisation in countries, often exotic ones, that had not yet enjoyed its benefits.

After the events of the Spring of Nations, more than a thousand Polish participants ended up in the Turkish empire, creating there a second largest emigrant community after the one in France. Individual units went to many countries, sometimes taking careers there and entering the pages of their history.

And after the January Uprising (1863), the new, even more numerous wave of patriotic emigration reached all these Polish centres. It followed perfectly the idea of the Great Emigration and acted as its continuation.