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PHARMACEUTICAL INDUSTRY AND ITS INFLUENCE ON THE STATE OF HEALTHCARE IN POLAND, IN VIEW OF THE LOCAL INNOVATIVE POTENTIAL

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Ladies and gentlemen,

It is my honour to present you the second issue of the resumed magazine „Polish Technical Review". I owe a deep debt of gratitude to the authors of the published papers who decided to participate in not easy process of reincarnation of "Polish Technical Review" title. Nowadays, in the epoch of dynamic changes in Polish higher education system, it is hard to resist the temptation to gain the points needed for the evaluation by the Ministry of Higher Education and Science and to publish the articles in the magazine that is not found on the Ministry list. Undoubtedly, the authors of the mentioned articles are the people who are responsible and conscious representatives of scientists who are aware of the role of Polish technical magazine, published in English. Making "Polish Technical Review" a significant title on publishing market is possible only thanks to your commitment.

I wish you a pleasant reading and encourage you to participate in development of strong Polish brand on the publishing market.

Michał Szota
Editor in Chief

dr Wojciech KUŹMIERKIEWICZ (1); prof. Janusz RACHOŃ (2); prof. Grzegorz GRYNKIEWICZ* (3) DOI: 10.15199/180.2019.2.1

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PHARMACEUTICAL INDUSTRY AND ITS INFLUENCE ON THE STATE OF HEALTHCARE IN POLAND, IN VIEW OF THE LOCAL INNOVATIVE POTENTIAL

PRZEMYSŁ FARMACEUTYCZNY I JEGO WPŁYW NA STAN OPIEKI ZDROWOTNEJ W POLSCE, W ŚWIETLE LOKALNEGO POTENCJAŁU INNOWACYJNEGO

Summary: *Availability of medicinal products is a crucial issue of any healthcare system. Pharmaceutical industry, which is a global conglomerate of profit-driven private enterprises, needs much regulation and control from international and governmental agencies, to be able to fulfill its humanitarian mission efficiently. Serious concerns about local and regional pharmaceutical safety, fuelled by recent drug availability crisis, leads to conclusion that state support for mobilization of the local innovative potential in life sciences is desirable, particularly in a view of urgent need for revival of pharmaceutical active substance manufacturing.*

Keywords: *pharmaceutical industry, active pharmaceutical ingredients, pharmaceutical innovation, innovative drugs, generic drugs, new drug development, markets of pharmaceutical products.*

Streszczenie: *Dostępność produktów leczniczych jest kluczową kwestią każdego systemu opieki zdrowotnej. Przemysł farmaceutyczny, który jest globalnym konglomeratem prywatnych przedsiębiorstw nastawionych na zysk, potrzebuje wielu regulacji i kontroli ze strony agencji międzynarodowych i rządowych, aby móc skutecznie wypełniać swoją misję humanitarną. Poważne obawy dotyczące lokalnego i regionalnego bezpieczeństwa farmaceutycznego, podsycane niedawnym kryzysem dostępności leków, prowadzą do wniosku, że pożądane jest wsparcie państwa dla mobilizacji lokalnego potencjału innowacyjnego w naukach przyrodniczych, szczególnie w obliczu pilnej potrzeby ożywienia produkcji substancji farmaceutycznych.*

Słowa kluczowe: *przemysł farmaceutyczny, aktywne składniki farmaceutyczne, innowacje farmaceutyczne, leki innowacyjne, leki generyczne, opracowywanie nowych leków, rynki produktów farmaceutycznych*

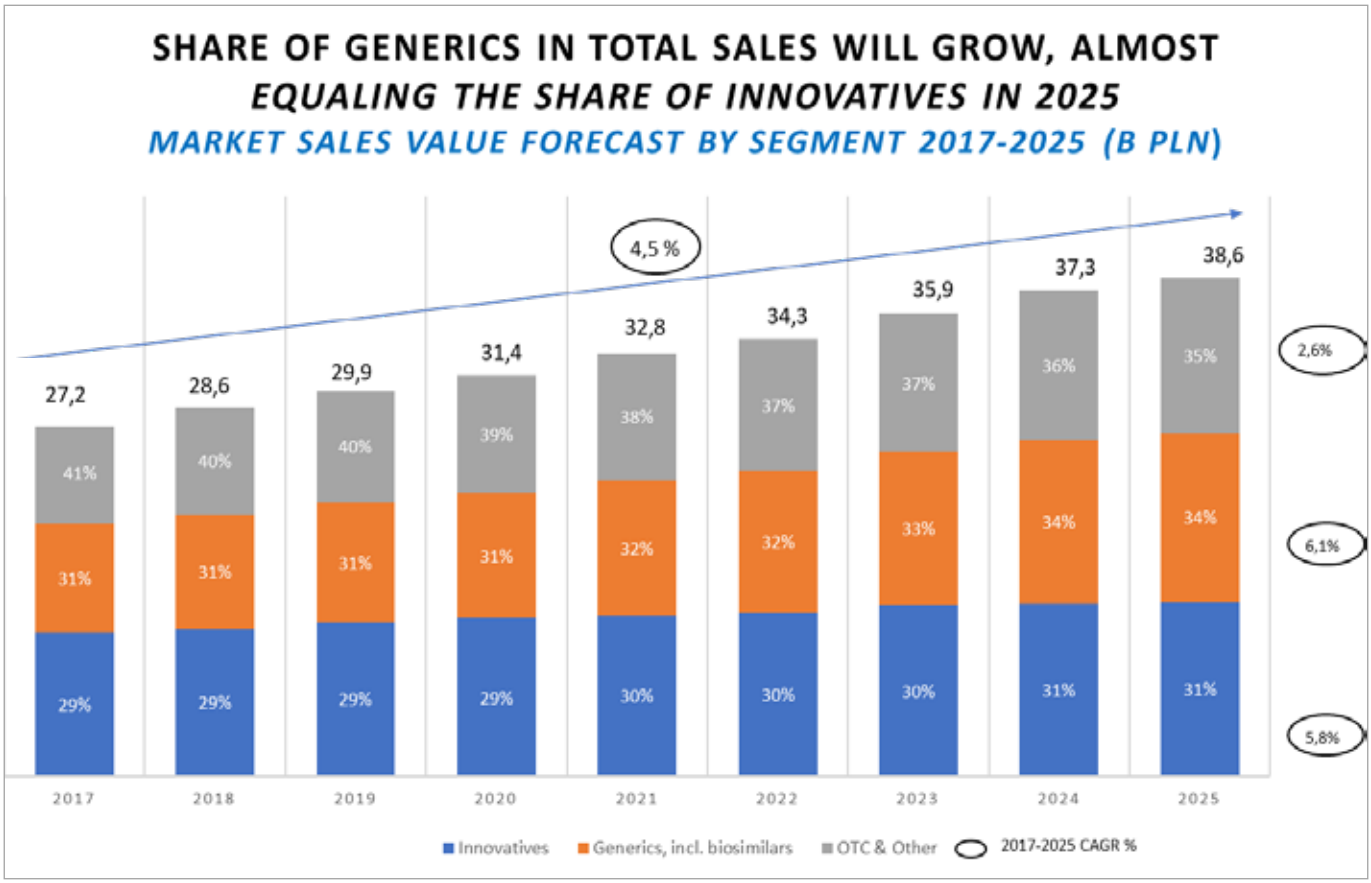
Introduction

Modern pharmaceutical and chemical industries are indisputably strongly interrelated and they both belong to the realm of high-technology, which is characterized, among other features, by the extensive innovativeness implemented by strong and dynamic R&D initiatives, and huge potential for generating very high value added products. This is achieved by advanced technical means among which modern chemical synthesis plays the leading role. On the other hand, these industries are worlds apart in terms how their manufacture their commodity and specialty products, shape their markets and relate to the individual customers. The chemical industry in Poland has been recently expertly characterized in this journal [1]. The authors take this opportunity to juxtapose the leading features of both sectors, in context of more general interest in innovativeness as an answer to challenges facing technical civilization.

Short characteristics of the contemporary pharmaceutical products, markets, and processes

General public perception of pharmaceutical industry is that of drug products' provider, expected to fulfill crucial healthcare needs of individuals, unconditionally. Such wishful thinking often collides with tough reality of highly competitive post-industrial economy, which is far from desired self-sustenance state. Among many systemic problems which recently plague contemporary pharmaceutical industry, these which cause painful drug shortages are much publicized [2-5], therefore make a good start for drafting some characteristic of the sector of such great importance for individual customers, patients populations, and the state organizations which are responsible for their well-being. According to the experts of the World Health Organization (WHO) medicines shortages occur when the supply of medicines identified as essential by the health system is insufficient to meet public and patient needs. This definition describes situation in which patients are unable to receive their prescribed treatment or a direct alternative for a period of time which their health outcome may be impacted. "Direct alternative" is defined by substitution due to medical need to the same chemical molecule produced by a different manufacturer. This applies to innovative drugs, as well as generics. In our country drug safety is traditionally taken for granted, as a consequence of the state declarations assuming responsibility for the public healthcare as a fundamental human right secured by the Constitution. As it is generally agreed that humanitarian missions should be supported by the governments and state organizations, the point should not be missed that pharmaceutical industry (often called "big pharma") is a global business, privately own and driven by profit. The basic conflict between pharmaceutical

Fig. 1 Trends in market value segmentation of pharmaceutical products in Poland; (Quoted by permission from IQVIA Poland)



companies interest, and individual customers (patients) of retail pharmacies rights, has evolved throughout the 20th century into rigorously regulated drug manufacturing ("good practices" like GMP assuring products quality and safety) and initially tightly controlled markets, which now comprise three distinctly different kinds of products: branded drugs and generics (available only upon prescription), and over the counter products (OTC), which contain potent, registered active pharmaceutical ingredients and are formulated as prescription drugs, but are freely available not only in pharmacies but also in places like supermarkets and gas stations.

The key points illustrated by Fig. 1 are the following: 2017 was a turning point in market value shares balance – share of generics started growing while share of innovative drugs started declining. Share of OTC and other products in total sales is also expected to grow faster than the entire market. This trend will inevitably result in co-existence of two kinds of pharmaceutical market customers; these taking only doctor's prescribed medicines are already in minority according to recent polls, which indicate that ca. 90% citizens of this country practice self-medication, at least to some extent. Polish pharmaceutical market (supplied by over hundred local manufacturing enterprises), which ranks 6th in the EU, attained 38 billion zlotys value level in 2017, and is currently split almost evenly between innovative medicines (manufactured by foreign companies, in most cases packaged locally), generic drugs, and the OTC products [6]. As a result of globalization, all three segments of pharmaceutical industry products depend on API substances which are presently produced outside Europe, formally under surveillance of the authorized final product manufactures. Such radical separation of the drug manufacturing process between API production, principally in China, and formulating finished pharmaceutical products in European countries is not without consequences which can jeopardize regional drug safety, as experienced recently in the EU. Recent example from the Polish market, of a drug withdrawal caused by the safety concerns illustrates how serious consequences could result from the total API outsourcing strategy, generally implemented by major drug manufacturing companies. In summer 2018, Polish authorities (GIF) withdrew from the market all pharmaceutical preparations containing valsartan as API of cardiovascular (CV) drugs, following information from European controlling agencies which identified potentially carcinogenic N-nitrozodimethylamine impurity in the active substance. Incidentally, it become evident that API manufacturing of the important drug, taken by millions of blood high pressure patients around the world, is practically monopolized by a single Chinese manufacturer - Zhejiang Huahai Pharmaceutical Co., Ltd.

The new regulations introduced in the UE in 2014, which enforced implementation of "good practices" in pharmaceutical manufacturing has involved many costly changes in API syntheses, particularly their safety, quality control and their environmental sustenance. As a consequence, over 400 pharmaceutical plants in India and China have been closed down, resulting in periodical API shortages in some regions. General trend to move over chemical plants from the European countries to Asia, for economic and environmental reasons proved rather short-sighted, since in case of complicated and multistep pharmaceutical processes the implementation time is considerably longer than in case of commodity chemical production.

Additional complication may result from a shortage of high quality technical staff in new factories, new local regulations concerning environmental safety, and last but not least – political stability. Enforced consolidation of the global API manufacturing business has resulted in drop of its potential for 30%, only in the last couple of years (2015-2017), which is a matter of serious concern for the European Union countries [7]. This situation is easy to explain in the retrospect, when European drug producers being under pressure of finished drug market prices, decided to look for the cheapest possible sources of the API in Asia, where labor force was temporarily available on competitive conditions, but it turned out that in the process both: the drug quality and safety could be seriously compromised. Since ca. 80% of the API formulated in EU is currently supplied by Asian manufacturer, the question of possible trend reversal is becoming serious, since it has been recently clearly demonstrated that not only economic efficiency is at stake when European drug markets are concerned. Italy has already decided to resurrect its API manufacturing potential, and France has proposed that EUC should encourage return of the API production, possibly as an all-union initiative [8].

Current global market value of the API substances is estimated at 182.2 USD bn., and predicted to reach 245.2 billion by 2024, while its largest part is generated by innovative (branded; still under patent protection) drugs. However since few years the trend of the generic drug segment value growth prevails, with a good likelihood to become constant for a while. According to pharmaceutical market analysts and experts, the decline of old blockbusters which come out of patent, will coincide with the global growth of generics and biosimilar products, and the average value of the mass unit of API is consistently diminishing (in the last period from 6695 USD/MT to 5483 USD/MT) [9].

Innovation in pharmaceutical industry beyond new drug discovery

During the last 25 years 943 new chemical entities (NCE) were introduced into medicinal use, to top 9 thousand compounds in current registry of western medicine (out of which a countless number of preparations, single API or composed, are prepared by pharmaceutical enterprises all over the world) [10]. A cost of novel API design, development and registration, counted as an average including many failures of advanced drug candidates during mandatory clinical studies is estimated at 2.6 bn. USD [11-12] but can vary largely. For companies, which introduced 8 – 13 new drugs over 10 year period, the cost of a single launch was estimated at 5.5 billion USD, while Astra-Zeneca reported 11 bn. USD figure [13]. Based on the data from big pharma, it seems evident that achievement of a new drug development and registration in Poland, based on own resources, is out of question, for as simple reason as lack of proper funding. This statement should not however exclude a debate over a potential of local academic and otherwise organized scientific manpower, which should not be underestimated, despite of greatly complicated management tasks involved in such lengthy and cost extensive projects as new drug discovery and development. Against popular opinion that drug discovery and development (DDD) is best institutionalized inside of private business of big pharma, there are numerous examples of breakthrough discoveries essential for pharmaceutical development which were initiated in academia, and later successfully commercialized, in industry. Admittedly, translation between basic science discovery and its technical implementation is much easier achieved in countries with a long tradition of civilization progress than in local environment. Thus, outstanding Polish scientists achievements in life sciences, which reached global markets are few (remarkable examples include Hilary Koprowski (Thomas Jefferson University) work on polio vaccines, Wacław Szybalski (University of Wisconsin-Madison) advancements in biocatalysis and biotechnology, or more recent participation of Ryszard Andruszkiewicz (Northwestern University) in discovery of a new drug – pregabalin), and were commercialized by big pharma. Nevertheless, there are many convincing signs that presently local academic discoveries get enough recognition of their potential to obtain necessary intellectual property protection, which allow for translation toward commercialization. Examples include: genetic oncology diagnostics (J. Lubiński, PAM Szczecin; K. Jażdżewski WUM Warszawa), innovative anticancer APIs (Selvita Kraków; Celon Pharma Łomianki, OncoArendi Warszawa), novel catalysts for olefin metathesis (K. Grela, IChO PAN Warszawa; Apeiron Wrocław), innovative drug encapsulation systems (T. Ciach, PW Warszawa), new advancements in synthesis of MOF materials (J. Lewiński, PW Warszawa), new methods for 5'-RNA end-capping (J. Jemielity, UW Warszawa). A special mention is deserved by innovative IT tool devised for assistance in multistep chemical synthesis planning, called Chematica. This very useful computer program was designed, developed and commercialized by B. Grzybowski (IChO PAN, Warszawa), and is currently globally available through license from Merck.

Recent changes in EU pharmaceutical regulation and IP protection are likely to cause some revival of an interest even of big and innovative companies in generic business. Since effective patent protection time is only approximately half of the 20 years granted by law, supplementary protection certificates were introduced (SPC), which can extend the protection period up to 5 years [13], which was challenged from the beginning as discriminating generic development. After nearly a decade, European Generic Association, (now Medicines for Europe), under active support of the Polish Union of Pharmaceutical Employers and Lewiatan Confederation, an important change of the regulation was attained, which now allows for an API under SPC production in EU countries, for the purpose of its distribution at third party markets were patents are not valid, and also for storage, until SPC expires in the EU [14]. It is hoped that this change will increase chances of EU manufacturing enterprises of effective competition on the ground of API synthesis.

It is expected that Polish population in 2030 will contain ca. 18% fraction of citizens who are 65 and older, with characteristic for that age need for treatment of multiple ailments (diabetes, cardiovascular diseases, cancer, neurodegenerative diseases etc.), which will make a significant impact on the country drug requirements and availabilities. For the rapidly ageing society, the need for easier affordable generic drugs seems a critical issue in a foreseeable future. It should be reminded that generic drugs contain the same API, in the same dose as the reference drug. The two are in principle equally bioavailable, and have identical clinical efficacy, for which appropriate evidence has to be presented in the registration procedure [15]. Since manufacturers of generic drugs undergo substantially abbreviated registration procedure, without long and very expensive clinical trials, their products are considerably cheaper (sometimes up to 20 – 80%) than innovative drugs under patent protection, which can have a powerful impact on the total costs of the state healthcare system.

The generic drug sub-sector, which is a principal platform of Polish pharmaceutical industry, still leaves plenty of room for minor (or incremental) innovation, concerning APIs, finished products, synthetic or biotechnological intermediates, and processes of their manufacturing, sometime even suitable

for IP protection and patenting. Nanotechnology constructs and new tools and methods for analytical chemistry open additional avenues for such innovation. Traditionally well-educated life science specialists, alumni of local universities, constitute a great potential, which has not been sufficiently exploited for benefits of local pharmaceutical industry which needs revival in many aspects of its current activity. The state funding agencies like National Center for Research and Development (NCBiR) should strongly promote all forms of pharmaceutical innovation, in consideration for strategic planning of inevitably large future expenses of the public healthcare. Only systemic support of the translation process, from academic discoveries and innovations to pharmaceutical technologies can improve current, and potentially devastating future situation, in which large funds are spent on import of innovative medicines, for which export of relatively cheap generics could not possibly compensate.

Some good examples of bilateral industry – academia cooperation in the field of pharmaceutical API manufacturing can be drawn from recent technical and market achievements of Polpharma SA, which is known for long term cooperation with chemical team from Gdansk University of Technology (GUT/PG). Approximately two decades ago a formal agreement concerning research cooperation on synthesis of hydroxybisphosphonates, which are applied in treatment of osteoporosis, was signed featuring model sharing of patent ownership and split of production profits, in which GUT/PG participated. As a result of successful research of synthetic team led by Professor J. Rachoń, followed by joint development efforts at Polpharma, the partners have become owners of original and patented technical process for manufacturing of alendronic acid API and its salts. Following this success, Polpharma has started regular alendronate production and launched Ostemax 70 Comfort preparation, based on sodium alendronate as the active substance, which has established its position as manufacturer for the global market. The cooperation is continued, aiming at next generation hydroxybisphosphonates – risendronic, ibandronic and zolendronic acids, for which new processes have been already patented and implemented. Other examples of innovative generic processes of former blockbusters, commercialized recently in Poland include: sildenafil (Polpharma and PRI) and imatinib (non-alkylating, protein kinase inhibiting anticancer drug; PRI). Pharmaceutical Research Institute (Sieć Badawcza Łukasiewicz - Instytut Farmaceutyczny, formerly Instytut Przemysłu Farmaceutycznego) which was founded in the beginning of 1952 has a rich record of R & D achievements and their commercialization, spanning over the entire period of its existence, with a list of over 400 designed and developed processes (API syntheses as well as pharmaceutical formulations). It seems obvious that at present time innovative potential of research enterprises like PRI, has to be validated through active participation in, and contribution to, international scientific environment, not only in form of own patents and publications. PRI has performed well in this respect, participating in international programs like Orbis (Horizon 2020). Even in older EU programs, like FP6 and FP7, PRI took active part in development of very innovative pharmaceutical technologies like Microdosing, (also described as Clinical Phase 0) ; EU Programs: EUMAPP and ERA-NET PRIOMEDCHILD project - Paediatric Accelerator Mass Spectrometry Evaluation Research Study (PAMPER), which allows to study pharmacokinetics and metabolism of drugs and can eliminate much costs and efforts of advanced preclinical and early clinical studies, through application of sophisticated analytical methods based on accelerator mass spectrometry for isotopic label analysis [16]. What is important, the results of these multinational cooperative studies led by British researchers, are now available in public domain, contributing to open science, dedicated to wider and more efficient development of new drugs, globally.

It seems reasonable to postulate, based on the presented above evidence, that strategic program (focused on new original methods for the synthesis of API and generic drugs) directed at pharmaceutical security and basic drugs availability, is urgently needed in Poland for social reasons, among which poor prognosis for future safety of people suffering from so called civilization diseases – metabolic syndrome (diabetes, CVD, obesity, cancer, neurological ailments, etc.) should be considered as the crucial argument.

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THE BEST-CASE SCENARIO FOR WORLD STEEL PRODUCTION ON THE BASED OF FORECAST OF QUANTITY OF WORLD STEEL PRODUCTION

SCENARIUSZ ROZWOJU SEKTORA STALOWEGO NA ŚWIECIE NA PODSTAWIE PROGNOZY WIELKOŚCI PRODUKCJI STALI

Summary: *the analysis of the prognostic trends of the level of steel production on the basis of statistical data on the quantity of the world steel production in the years 2000 – 2017, was carried out. To determine the forecast for steel production level, different statistical methods were employed. The prognoses for the level of the world steel production were determined up to 2022. The real (historical data) data concerning the quantity of the world steel production in 2018 were compared to the forecast for the level of steel production in 2018, with the establishment of prognostic error (deviation of real data and the prognostic ones). The basic aim of the study was to obtain the answer to the following question: whether we may assume the development of the discussed industry in the future in the light of the determined forecasts of the world steel production level.*

Keywords*: world steel production, forecast for the amount of the steel production*

Streszczenie: *w publikacji dokonano analizy trendów prognostycznych wielkości produkcji stali na podstawie danych statystycznych o wielkości produkcji stali na świecie w latach 2000-2017. Do wyznaczenia prognoz wielkości produkcji stali zastosowano różne metody statystyczne. Prognozy wielkości produkcji stali na świecie wyznaczono do 2022 roku. Dane rzeczywiste (historyczne) dotyczące wielkości produkcji stali na świecie za 2018 rok porównano z prognozą wielkości produkcji stali w 2018 roku, ustalając błąd prognostyczny (odchylenie wielkości rzeczywistych od prognozowanych). Podstawowym celem pracy jest uzyskanie odpowiedzi na pytanie: czy w świetle wyznaczonych prognoz wielkości produkcji stali na świecie można zakładać rozwój przemysłu w przyszłości.*

Słowa kluczowe: *produkcja stali na świecie, prognoza wielkości produkcji stali*

Introduction

Forecasting the size of manufacture of the particular products is a basic component of strategic management. The forecasts for the level of production are implemented by the enterprises, for its internal use, as well as by the market researchers and scientists in relation to the particular industry sectors or national economy. The forecast is a scientifically justified judgement on the state of phenomenon in a defined moment (period), belonging to the past period. The forecast must be a reasonable inferring, leading from premises to conclusions, referring to the future [Cieślak, 1998, p. 91]. In spite of the fact that the forecast is a certain approximation of the size of a defined phenomenon in the future, it is recognized as an effective tool of planning. Each forecast is burdened with the error; however the smaller is the forecast's error, the more accurate the forecast is. Well defined and performed forecast has a key value in business and economy. The managers must possess the capability of forecasting the future situation of the company and consider various options of its development, perceive the possibilities (chances for development) and identify a business risk [O. Penc-Pietrzak, 2010, p. 10-11]. The forecast for the size of production is implemented in relation to different time intervals – for the nearest years to come, for days or even hours. The investment on construction of new technological line in manufacturing enterprise is preceded by the determination of the forecast for the level of production and demand on a given product. The steel industry belongs to the key sector of the economy. Steel is a basic material for production of cars, ships, machines and equipment and material used in construction. The development of the steel industry will require forecasting of the size of steel production level for the years to come in order to establish the strategic trends of changes via the adjustment of production size to the possibilities of the particular producers. In the present work, the forecasts for the size of steel production for the nearest years were developed, using the forecasting methods for time series, based on the data concerning the world steel production reports of World Steel Association]. Vector of historical data, i.e. size of the world steel production in the years 2000 – 2017 (steel production in million tonnes – Mt), has become the basis for establishing the forecast trends of the world production level until 2022 (trends of the size of the world steel production were established based upon the historical data).

The methodology of the studies

The prognostic methodology is a sequential process which runs according to a certain general scheme of the research (scientific) procedure. P. Dittmann [2003] in his book "Forecasting in enterprise" presents the prognostic study according to 8 stages: Stage 1 - definition of prognostic task, Stage 2 – determination of prognostic premises, Stage 3 – collection, statistical treatment and analysis of prognostic data, Stage 4 – Choice of the

Tab.1. Methodology for forecasting the size of the world steel production

No.	Stage	Methodological scope	Methodological details
1	Prognostic task	Forecasting the size of the world steel production until 2022 on the basis of the level of steel production (in million tonnes – Mt) in 2000 – 2017	• Prognostic variable size of the steel production (in total) for a given year (million tonnes, Mt) • Time period of historical data: world steel production in 2000-2017
2	Historical data	Collection of data necessary for construction of the forecast	• Source of information: reports Steel statistical yearbook, published by WorldSteel Association
3	Analysis of historical data	Analysis of the trend of the level of the world steel production in 2000 – 2017	• Establishment of the reasons for seasonal/situational variations in the level of world steel production in the adopted time period
4	Choice of the forecast method	Models of time series	• Technique of exponential smoothing of time series
5	Construction of the forecast	Determination of the forecast according to the scheme of the chosen forecasting method	• Comparison of the accuracy of the obtained forecasts
6	Evaluation of the acceptability of the forecast	Optimization of the forecasts	• Rejection of the inaccurate data
7	Analysis of the forecast	Analysis of the trend of the forecast for the size of the world steel production	• Establishment of the trend of changes in the size of the world steel production until 2022
8	Evaluation of the accuracy of the forecast	Valuation of the accuracy of the forecast using the ex post errors(equations 1-3)	• Comparison of the real data i.e. the size of steel production in a given year and the forecast for the size of steel production

Source: own development based on the methodology of forecasting (Dittmann, 2003)

forecast method, Stage 5 – construction of forecast, Stage 6 – evaluation of the acceptability of the forecast, Stage 7 – application of the forecast, stage 8 – evaluation of the accuracy of the forecast, using ex post errors. The mentioned above stages were implemented during the prognostic task entitled 'Forecast of the world steel production level until 2022'. The forecast was performed on the grounds of historical data for the period of 2000 – 2017. The methodological details have been shown in tab.1.

Equations for calculation of the forecast error:

$$RMSE^* = \sqrt{\frac{1}{n-m}\sum_{t=m+1}^{n}\left(y_t - y_t^*\right)^2} \quad (1)$$

$$\Psi = \frac{1}{n-m}\sum_{t=m+1}^{n}\frac{|y_t - y_t^*|}{y_t} \quad (2)$$

For world steel production in 2018 which was equal to 1.788.002 Mt, additionally, the forecast error was calculated according to the formula:

$$\Psi_t = \frac{y_t - y_t^*}{y_t} * 100 \quad (3)$$

Where:

yt – value of time series (value of variable forecast for a moment of t period),

yt* – value of expired forecast (ex post),

n – number of elements of time series (length of time series),

m – number of initial periods or moments of time t, for which the expired forecast was not implemented, or the mentioned forecast is the effect of start-up mechanism.

In his book" Forecasting: principles and practice", R. Hyndman pointed to the necessity of "constant care of models", therefore, he verifies periodically the earlier obtained models which were published [e.g. Gajdzik, 2018 – Monograph; Gajdzik, Gawlik, Skoczypiec, 2018, p. 1651 – 1660; Gajdzik, MAPE 2018; Gajdzik, Metal 2018, Gajdzik, 2017, p. 279 – 282]. Reliability of the forecast of the size of steel production is better in longer time horizon if the process of forecasting is continued.

It is worthy to pay also attention to a high quality of the data, used in determination of the forecast for the size of the world steel production. When creating the forecast, the current data on the level of steel production, being published by WorldSteel Association were employed [https://www.worldsteel.org].

Fig. 1. Steel production in the world in 2000-2018

Source: WorldSteel Association

Tab.2. World steel production in the years 2000 – 2017 (million tonnes – Mt)

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
846.811	849.365	903.020	968.826	1,061.854	1,144.827	1,247.873	1,351.188	1,330,313	1,212.157	1,431.570	1,535.693	1,558.323	1,648.023	1,667.154	1,597.926	1,627.004	1,690.479

Source: WorldSteel Association

Tab.3. The forecast of the size of the world steel production

No.	Model		Total *yt**	Forecast error *ex post*		Additional information about model	Production in 2018 y_{2018}= 1,788.002 [Mt]
			Mt	Ψ	*RMSE*		Ψ_{2018}
1	Single exponential smoothing (Brown's model) for: α opt. for Ψ	2018 2019 2020 2021 2022	1,727.833 1,756.928 1,779.589 1,797.239 1,810.987	0.0498	89.610	Ψ: α=0.7789	-3.365
2	Single exponential smoothing (Brown's model) for: α opt. for RMSE	2018 2019 2020 2021 2022	1,707.836 1,718.729 1,725.565 1,729.855 1,732.547	0.0531	85.354	RMSE: α=0.2716	-4.484
3	Brown's double exponential smoothing (linear), and with α opt. for Ψ	2018 2019 2020 2021 2022	1,706.754 1,732.993 1,759.231 1,785.470 1,811.709	0.0562	87.928	Ψ: α=0.5006	-4.544
4	Brown's double exponential smoothing (linear), and with α opt. for RMSE	2018 2019 2020 2021 2022	1,706.917 1,733.236 1,759.555 1,785.875 1,812.194	0.0564	87.931	RMSE: α=0.4952	-4.535
5	Brown's triple exponential smoothing (quadratic), and with α opt. for Ψ	2018 2019 2020 2021 2022	1,695.716 1,709.094 1,722.472 1,735.850 1,749.229	0.0525	96.930	Ψ: α=0.4436	-5.161
6	Brown's triple exponential smoothing (quadratic), and with α opt. for RMSE	2018 2019 2020 2021 2022	1,706.909 1,720.483 1,734.056 1,747.630 1,761.203	0.0560	93.750	RMSE: α=0.3344	-4.435

Source: Own research

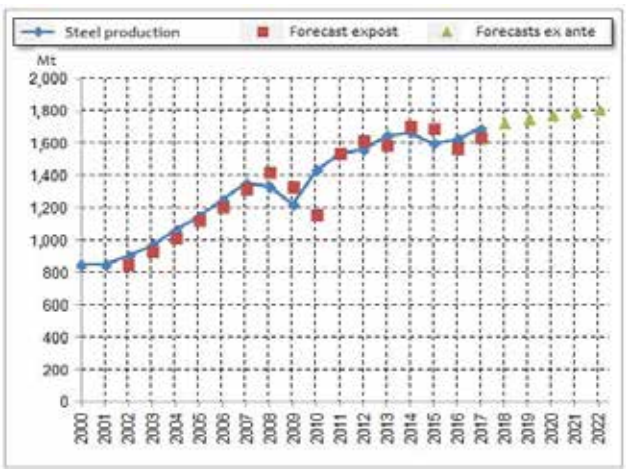
Production of steel in 2018 – the real data – during the construction of the forecast were not published (The report of World Steel Association appeared in the Quarter I of 2019 and the forecast was performed in December 2018).

Analysis of the trend (Fig.1):

- Increasing trend of the size of world steel production;
- Occurrence of economic variations
- Inconsiderable decrease in production in 2015 in relation to the previous year,
- A considerable decline in the level of steel production in 2009 in relation to the previous year as reaction of industry to the world economic crisis.

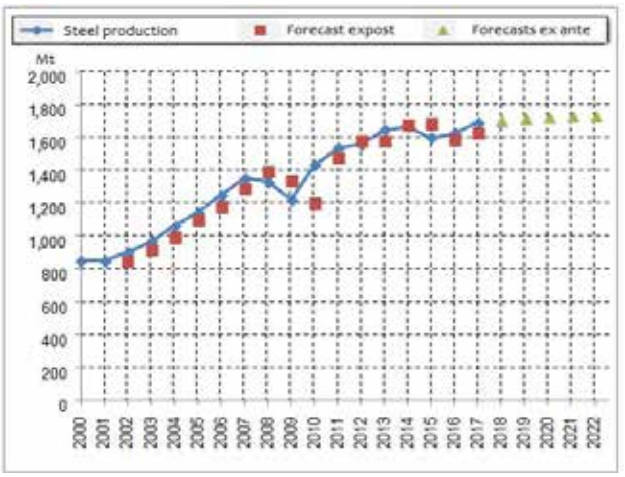
The aim of the forecast in the analyzed time series was to define how the model-constructing observations - the size of the world steel production - would behave in the future. When ignoring the external conditions, the models of time series determine accurately the trends and seasonability of observations. In the methods for analysis of the time series, the attempts were undertaken to capture quite subtle, internal mechanism, causing that the past of the time series affected its future. The forecasts of the size of the world steel production were created with the aim to facilitate undertaking (in advance) appropriate decisions and measures, having a short-term and strategic nature. On the ground of the mentioned activities, it is possible to undertake the corrective measures and optimize the results. The forecasts concerning the level of steel production are aimed at helping the metallurgical enterprises to construct competitive advantage by decrease of the decision risk.

Fig. 2. Single exponential smoothing (Brown's model) – model no. 1



Source: Own research.

Fig. 3. Single exponential smoothing (Brown's model) – model no. 2



Source: Own research.

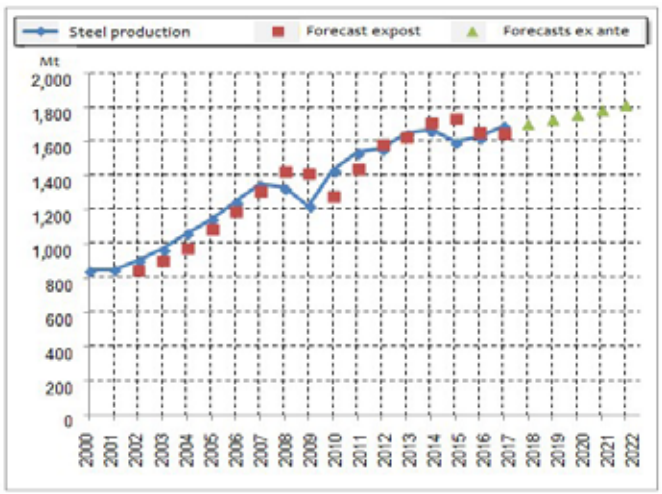
Presentation of the forecast of the world steel production

For construction of the forecast of the world steel production until 2022, the selected models for time series were used. The following models were presented: model of simple exponential smoothing (Brown's model), model of single exponential smoothing (Brown's model) for linear model and model of triple exponential smoothing (Brown's model) for quadratic model. The particular models were obtained for different start-up points and with optimization α due to value of forecast errors: Ψ and RSME* (equations 1-2). The results of the forecasting using the mentioned models were given in Tab. 3. In Tab. 3, the forecast obtained with the application of simple model of exponential smoothing (Brown's model) was not presented due to a low accuracy of forecasts.

The forecast of the size of the world steel production as obtained using the models for time series (Tab. 3) is shown in Fig. 2 – 7.

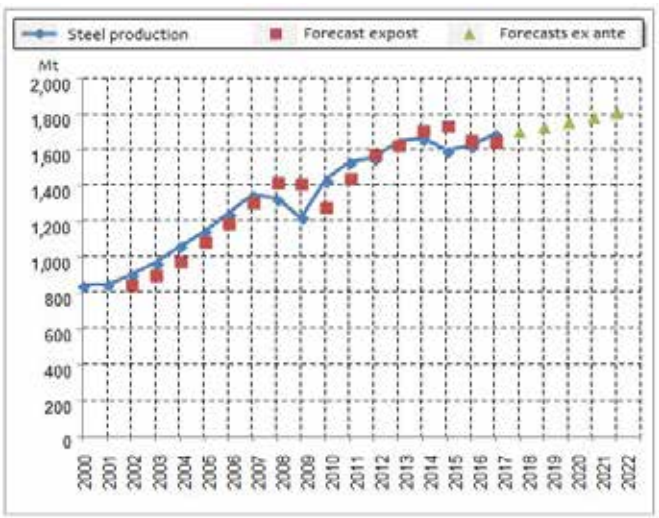
The obtained forecast of the size of the world steel production until 2022 was arranged on the grounds of the forecast trend. In the obtained models, the forecast trend of the level of steel production is growing. The distribution of the forecast points (models 1 – 6) has been given in Fig. 8.

Fig. 4. Brown's double exponential smoothing (linear) – model no. 3



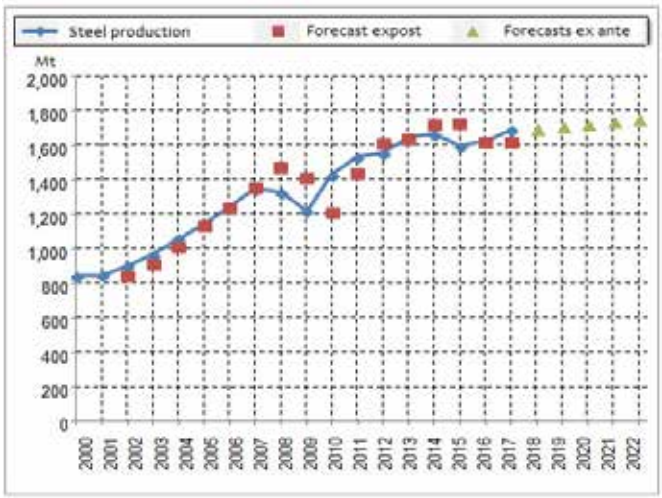
Source: Own research

Fig. 5. Brown's double exponential smoothing (linear) – model no. 4



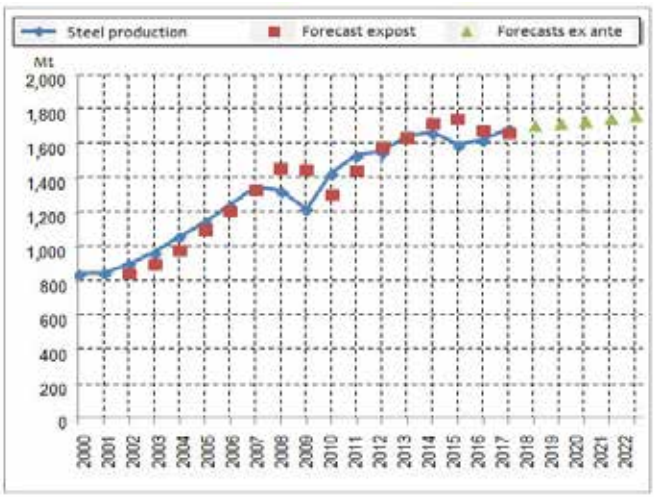
Source: Own research

Fig. 6. Brown's triple exponential smoothing (quadratic) – model no. 5



Source: Own research

Fig. 7. Brown's triple exponential smoothing (quadratic) – model no. 6



Source: Own research

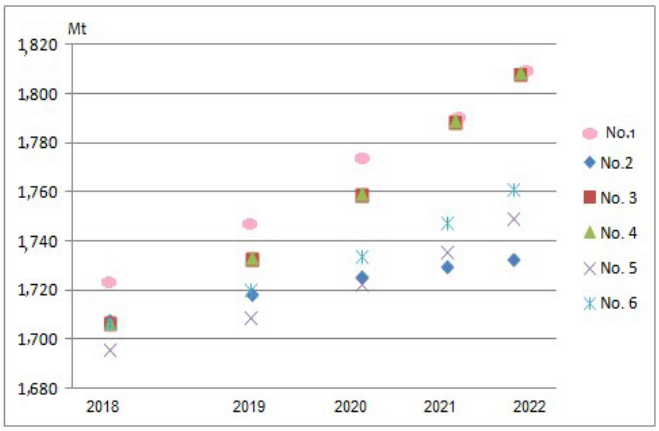
Scenario for the forecast of the world steel production

The scenario for the forecast of the size of steel production is a logic and supposed description of changes in the future. In methodological context, the mentioned scenario is a result of the forecasting methodology and allows passing from quantitative methods (statistical models) to the quality methods (description of the change in the phenomenon in the future). The combination of the forecast and the scenario is the prognostic-scenario analysis, constituting a certain comprehensive hypothetic vision of the future for the examined phenomenon [Rue, Holland, 1986, p. 430 – 432]. We may distinguish the following scenarios for the future [Bensoussan, Fleisher, 2010]:

- Base-case scenario for the most probable situation;
- Worst-case scenario as projections of the worst change of the examined phenomenon;
- Best-case scenario as the best anticipated situation.

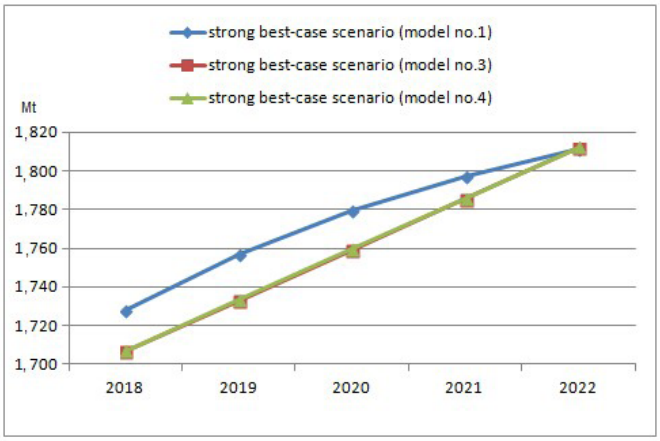
We may also establish average-case scenario, as a medium scenario between the basic and the extreme one: worst-case scenario or best-case scenario. The prognostic-scenario analysis was already the subject of the

Fig.8. World steel production forecast based on models 2-7



Source: Own research

Fig.9. Strong-best scenario for the forecast of the world steel production



Source: Own research

studies of the author but for steel production in Poland [Gajdzik, Nova, 2018]. In the present publication, the scenario of the forecasts for the size of the world steel production has been shown. On the grounds of the distribution of the points of the forecast for the size of the world steel production, there were established three optimistic prognostic scenarios:

Strong best-case scenario for steel production in the world with more than 1 800 million tonnes of steel production in 2022 (models 1, 3, 4),

Average best-case scenario with 1 760 million tonnes of the world steel production in 2022 (Model no. 6),

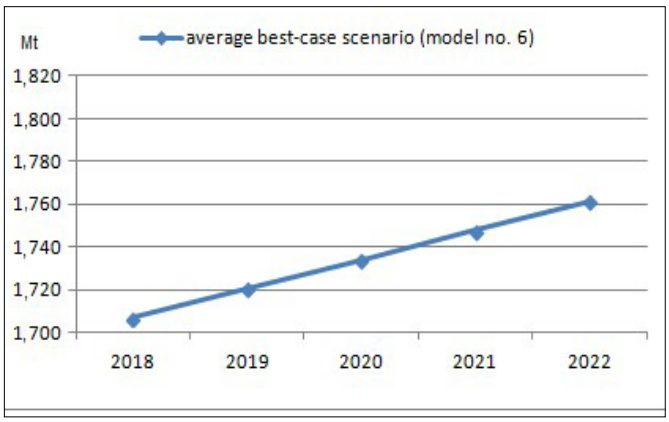
Weak best-case scenario with less than 1 750 million tonnes of the world steel production in 2002 (Models 2 and 5).

Due to the trend of the world steel production (Fig.1) – increasing steel production in the years 2000 – 2017 – the obtained scenarios of the forecast are optimistic (Fig. 9 – 11).

For the particular scenarios (Fig. 9 – 11), the dynamics of the changes in the forecast world steel production in the system: year to year (Tab.4) was calculated.

The dynamics of the changes year to year in strong scenario reaches maximum 1.7%, in the average one – 0.8% and in the weak case - in model 5, the dynamics of the changes in the forecast year to year is equal to 0.8% (oscillating around 0.8% in 2018 – 2022); on the other head, for model 2, it amounts to 0.6% and less (the lower level of dynamics is ca. 0.2%). Due to the dynamics of the changes, model 5 may be classified as a moderate scenario.

Fig.10. Average best-case scenario for the forecast of the world steel production



Source: Own research

The conducted analysis considered also the so-far existing dynamics of the changes in the size of the world steel production (Tab. 5) and the mean real gain was calculated. The mean annual gain in the world steel production was equal to 4.4%.

Tab. 4. Dynamics of the changes (year to year) in forecasts of the world steel production [Mt]

year	Strong best-case scenario						Average best-case scenario		Weak best-case scenario			
	No.1	%	No. 3	%	No. 4	%	No. 6	%	No.2	%	No. 5	%
2018	1,727.833	-	1,706.754	-	1,706.917	-	1,706.909	-	1,707.836	-	1,695.716	-
2019	1,756.928	1.684	1,732.993	1.537	1,733.236	1.542	1,720.483	0.795	1,718.729	0.638	1,709.094	0.789
2020	1,779.589	1.290	1,759.231	1.514	1,759.555	1.519	1,734.056	0.789	1,725.565	0.398	1,722.472	0.783
2021	1,797.239	0.992	1,785.470	1.491	1,785.875	1.496	1,747.630	0.783	1,729.855	0.249	1,735.850	0.777
2022	1,810.987	0.765	1,811.709	1.470	1,812.194	1.474	1,761.203	0.777	1,732.547	0.156	1,749.229	0.771

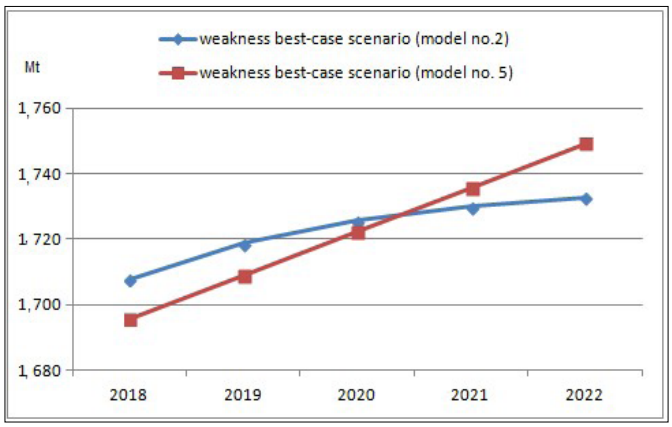
Source: Own research

Tab.5. Dynamics of the changes (year to year) in the world steel production in 2000 – 2018

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	average
%	0.302	6.317	7.287	9.602	7.818	8.993	8.283	-1.545	-8.205	17.231	7.273	1.474	5.756	1.161	-4.152	1.820	3.901	5.769	4.394
decline								-1.545	-8.205						-4.152				-4.634
growth	0.302	6.317	7.287	9.602	7.818	8.993	8.283			17.231	7.273	1.474	5.756			1.820	3.901	5.769	6.199

Source: Own research.

Fig. 11. Weak best-case scenario for forecast of world steel production



Source: Own research

Summing up

Understanding the forecast of the world steel production supports the decision processes of metallurgical enterprises. The managers possess the operational knowledge about the strategy of the company, and the forecast enables the additional verification of the adopted directions of development. Based upon the so-far existing trend of the changes in the world steel production, we may adopt the optimistic scenario of the forecasts. The forecasts, as obtained on the basis of the selected models of time series, supply information about the steel industry.

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DEVELOPMENT OF PLANT CULTIVATION USING PRECISION AGRICULTURE

ROZWÓJ UPRAW ROŚLIN Z ZASTOSOWANIEM ROLNICTWA PRECYZYJNEGO

Summary: *Processed aerial and satellite photographs, adjusted to the points of geodesy base in a specified coordinate system occur in a form of ortofotomaps. Satellite systems make possible to obtain information about soil structure and different types of crops including feed plants; owing to precision agriculture we may obtain not only obtain very high and good quality yields but also have an influence on limiting of natural environment pollution and reduction of production costs. Obtaining data by using teledetection methods are integrated with information concerning spatial variability of soil and plants, which comes from register units provided recording of changes of different parameters, heaving importance from the point of view application in precision agriculture. IACS computer system, contribute to the development of precise agriculture by steering of farm machinery during field work, doing monitoring of biomass and crop yields, soil sampling, dosing of mineral fertilizers and pesticides, field crops measurement, monitoring of animals, generation of field parcels ID, monitoring of farm machinery work. Besides that it can rationalize process of payments management concerning IACS computer system, contribute to the development of precise agriculture by steering of farm machinery during field work, doing monitoring of biomass and crop yields, taking soil samples, dosing of mineral fertilizers and pesticides, field crops measurement, monitoring of animals, generation of field parcels ID and monitoring of farm machinery work.*

Key words: *precision agriculture, agricultural engineering, ecology, cultivation, control, satellite systems, aerial photographs, GPS, monitoring, digital maps, fertilization, harvesting, progress*

Streszczenie: *Przetworzone zdjęcia lotnicze i satelitarne, dostosowane do punktów bazy geodezyjnej w określonym układzie współrzędnych występują w postaci ortofotomap. Systemy satelitarne umożliwiają uzyskiwanie informacji o strukturze gleby i różnych rodzajach upraw włącznie z roślinami paszowymi, a także dzięki rolnictwu precyzyjnemu nie tylko uzyskuje się bardzo wysokie i dobrej jakości plony, ale także wpływa się na ograniczenie zanieczyszczenia środowiska naturalnego i zmniejszenie kosztów produkcji. Uzyskanie danych za pomocą metod teledetekcyjnych jest zintegrowane z informacją o przestrzennej zmienności gleby i roślin, która pochodzi z jednostek monitorujących wykonujących rejestrację zmian w czasie, co ma znaczenie z punktu widzenia stosowania rolnictwa precyzyjnego. Poza tym może zracjonalizować proces zarządzania płatnościami w systemie komputerowym IACS, przyczynić się do rozwoju rolnictwa precyzyjnego na większą skalę poprzez sterowanie maszynami rolniczymi podczas prac polowych, monitorowanie biomasy i plonów, pobieranie próbek gleby, dozowanie nawozów mineralnych i pestycydów, pomiary upraw polowych, monitorowanie ilości zwierząt w gospodarstwie i monitorowanie pracy maszyn rolniczych.*

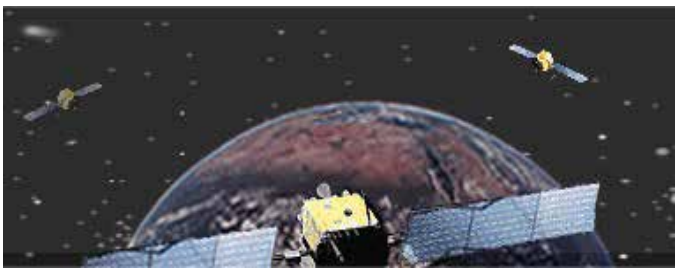
Słowa kluczowe: *rolnictwo precyzyjne, inżynieria rolnicza, ekologia, uprawa, kontrola, systemy satelitarne, zdjęcia lotnicze, GPS, monitoring, mapy cyfrowe, nawożenie, zbiory, postęp*

Introduction

Precision agriculture is the title given to a method of crop management owing to which areas of crop within a field may be managed with different levels of input depending upon the yield potential of the crop in that particular area of land. The benefits of so doing are as follows: cost of producing the crop in the discussed area can be reduced and the risk of environmental pollution from agrochemicals applied at levels higher than those required by the crop can be reduced as well (Earl et al, 1996). Precision agriculture is an integrated agricultural management system incorporating several technologies. The technological tools often include the global positioning system, geographical information system, yield monitor, variable rate technology and remote sensing. Literature review shows that there are quite a lot of problems to be solved by utilization of precision agriculture.

The global positioning system GPS is a network of satellites developed by the U.S. Defense Department shown on figure 1. The GPS constellation of 24 satellites, orbiting the earth, transmits precise satellite time and location information to the ground receivers. The ground receiving units are able to receive this location information from several satellites at a time for use in calculating a triangulation fix thus determining the exact location of the receiver.

Fig. 1 Global Positioning System (GPS)



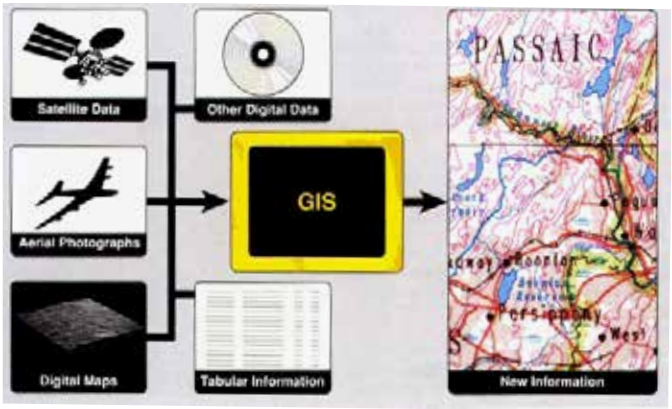
Source: United States Department of Agriculture (USDA), 2010

Formerly, agronomic practices and management recommendations have been developed for implementation on a field basis. This generally results in the uniform application of tillage, fertilizer, sowing and pest control treatments at a field scale. Farm fields, however, display considerable spatial variation in crop yield, at the field scale. Such uniform treatment of a field ignores the natural and induced variation in soil properties, and may result in areas being under- or over-treated, giving rise to economic and environmental problems.

The more substantial of these problems include: economically significant yield losses, excessive chemical costs, gaseous or percolator

release of chemical components, unacceptable long-term retention of chemical components and a less than optimal crop growing environment. A geographical information system GIS consists of a computer software data base system used to input, store, retrieve, analyze, and display, in map-like form, spatially referenced geographical information in figure 2.

Fig. 2. Data integrated through a geographical information system (GIS)



Source: [United States Department of Agriculture (USDA), 2010]

Precision agriculture offers a remedy to many of these concerns. The philosophy involves matching resource application and agronomic practices with soil properties and crop requirements as they vary across a site. Precision agriculture involves the observation, impact assessment and timely strategic response to fine-scale variation in causative components of an agricultural production process.

Therefore, precision agriculture may cover a range of agricultural enterprises, from dairy herd management through horticulture to field crop production. The philosophy can be also applied to pre- and post-production aspects of agricultural enterprises. With this definition in mind, the present attention is focused on applying precision agriculture in field crop production systems. The term 'site-specific management' describes precision agriculture.

Collectively, these actions are referred to as the "differential" treatment of field variation as opposed to the "uniform" treatment underlying traditional management systems. The result is an improvement in the efficiency and environmental impact of crop production systems. Elaboration of precision digital maps concerns fertilization (mineral fertilizer, liquid fertilizer, manure spreading), sowing, spraying, on the basis of field soil tests. In a similar way, the elaboration of digital maps of yield concerns different crops. Also it is important to collect yield models from different farm machinery such as corn and fodder harvesters of different models and companies.

It is important to have data concerning plots' area, exclusion of fields' area, dividing on cultivation groups, plot localization regarding to registries' plots. As an example of measurement unit, we may mention DGPS Crescent with accuracy of position evaluation to better than 60 centimetres at 95 percent of working time of a measurement apparatus at frequency 10 Hz (10 measurement points per second). It is possible to obtain measurement accuracy lower than 2 percent, but in practice, it can be achieved in the range from 0.5 to 0.9 percent. Elaborated maps contain a few layers as it is shown in figure 3.

Besides that, it is a rationalized process of payment management concerning IACS computer system and also contributing to the development of precision agriculture by steering of farm machinery during field work, they doing monitoring of biomass and crop yields, soil sampling, dosing of mineral fertilizers and pesticides, field crops measurement, monitoring of animals, generation of field parcels ID and monitoring of farm machinery work.

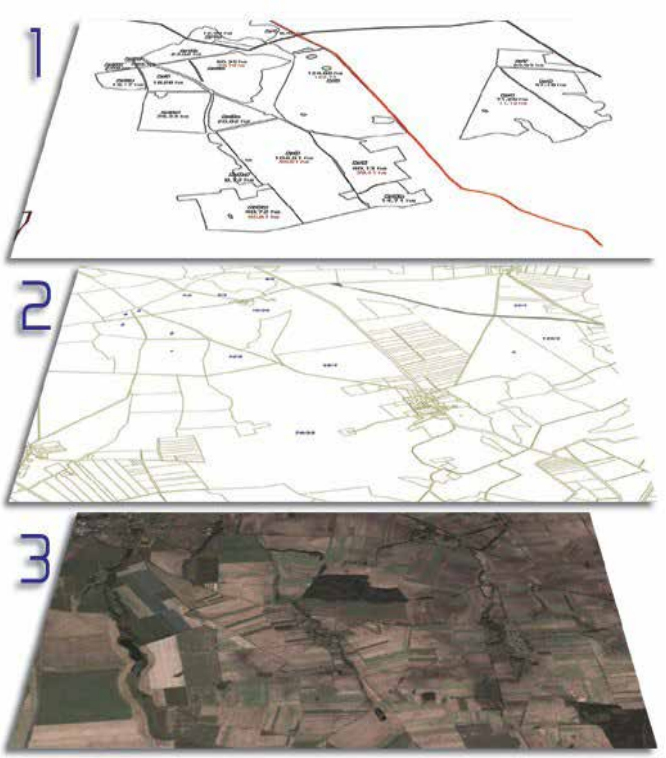
Processed aerial and satellite photographs, adjusted to the points of geodesy base in specified coordinate system occur in a form of ortofotomaps. Precision agriculture warrantees not only obtaining very high and good quality yields but also has an influence on limiting of natural environment pollution and reduction of production costs. Aerial photographs adapted to the form of ortofotomaps can be purchased in Geodesy and Cartography Centre in Warsaw at a price of 700 PLN for 500 hectares of the land concerned [Barwicki, 2011].

Precision agriculture depends on circumstances in which we want to introduce modern organization, technology and knowledge. First of all is to check resources. Digital maps of plots will be utilized for different field work, but their proper area can be used for direct payments from EU. [Barwicki, 2011] Soil tests on the farm are recommended by Good Agriculture Practice and it can be also utilized for both purposes.

The goal of precision agriculture

The goal of precision agriculture is to gather and analyze information about the variability of soil and crop conditions in order to maximize the efficiency of crop inputs within small areas of the farm field. To meet this efficiency goal the variability within the field must be controllable. Efficiency in the use of crop inputs means that fewer crop inputs such as fertilizer and chemicals will be used and placed where needed. The benefits from this efficiency will be both economical and environmental.

Fig. 3. Elaboration of digital layer maps for different plants cultivation purposes as: sowing, fertilization, harvesting and yield evaluation



Source: [TPI Agrisystem, 2011]

Development of environment protection

Environmental costs are difficult to quantify in monetary terms. The reduction of soil and groundwater pollution from farming activities has a desirable benefit to the farmer and to society. If maps of the spatial distribution of soil productivity potential (maps of the expected yield) and maps of the spatial distribution of plant nutrients available from the soil are developed for a field, fertilizers and organic wastes can be applied in amounts per acre that are directly proportional to the soil's expected yield and adjusted for the soil's fertility at any location in the field. Such a procedure would optimize the economic potential of a field, yet minimize the leaching of nutrients.

The above protocol depends on having a good map of the spatial variation of expected yields for crop fields. Maps of past crop yields for a field could be used for this purpose. However, multiple years of spatial yield data would be needed to overcome variations caused by year to year differences in weather, especially rainfall, and there are multiple factors which result in lack of year to year correlation. An alternative to mapping of actual crop yields would be to use remote sensing to determine spatial distribution of plant status (health or efficiency) and the subsequent expected yields.

A major advantage of this approach is that remote sensing can provide a current assessment of the overall plant health of the crop rather than relying on past history of yields. Several different approaches exist for using remote sensing data for this purpose. Most of the commonly recognized techniques depend on measuring the greenness of the field.

Typically, this involves some relationship comparing the reflectance of a visible band (such as red light) to the reflectance of a near-infrared band. Since green vegetation has a very sharp change in reflectivity across this range and other materials do not, virtually any technique will in fact detect it. The approach suffers from several defects.

Fig. 4. Aircraft NASA jet equipped in ATLAS scanner - left

Source: [NASA Stennis Space Center, 2010]

For example, it is a relative technique and can be significantly affected by soil conditions. It have been pursued a different path in this research. It have been examined the thermodynamic efficiency of the crop.

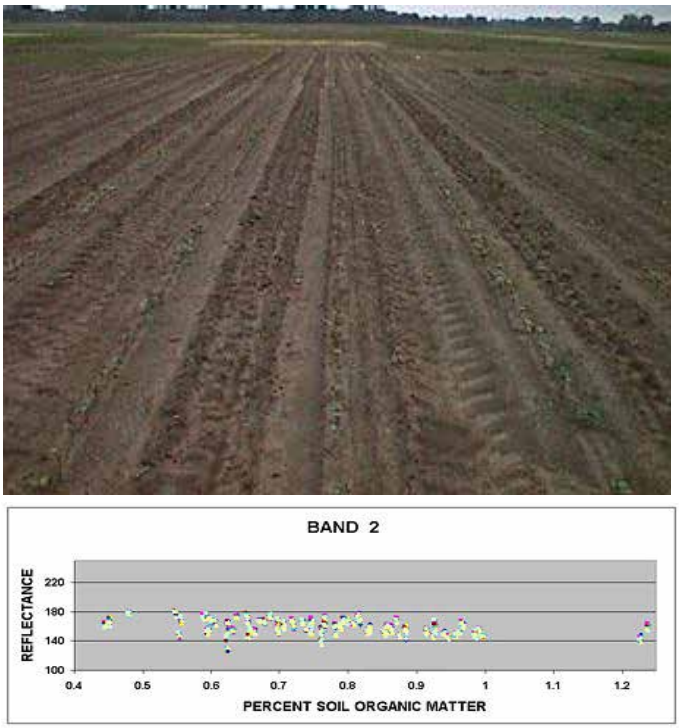
The core of this approach depends on energy in the thermal-IR. This experiment relied on the study of the energy budget of the crops and obtaining a relationship between multi-temporal thermal imagery and crop yield. The precision agriculture study utilizes the advanced thermal and land applications sensor ATLAS remote sensing instrument flown on the NASA Lear jet figure shown in figure 4.

ATLAS is able to sense 15 multispectral radiation channels across the thermal - near infrared - visible spectrums. The sensor also incorporates onboard, active calibration sources for all bands. Atlas is capable of approximately 2.0 meter resolution per pixel when flown in NASA's Lear jet and sees about a 30 degree swath width to each side of the aircraft.

The position of the aircraft, its orientation and the sensor orientation are all recorded at least once a second. The active calibration and record of position mean it is possible to accurately and reproducibly measure the field plots while flying in a jet aircraft.

A tremendous amount of data is collected on each flight, and must be processed by investigators prior to conducting research on the imagery. The data must be corrected for geometric abnormalities due to flight path variations, and must be radio metrically calibrated. These raw sensor scan lines are then reconstructed into a two dimensional image data set.

Fig. 5. Soil organic matter tests at Wiregrass Experiment Station



Source: [Auburn University, Headland, Alabama, USA, 2009]

Knowing that the data is an image, the scientist is able to begin data inquiries. This is typically done by creating false colour images based on 3 spectral channels from the sensor. Dependent on whether vegetation health or soil characteristics are of concern, differing channels of the data will be combined. Data from one channel is assigned to shades of red, another to those of green and a third to the blue ones.

The discussed pictures then visually reveal a tremendous amount of information to the investigator. Our remote sensing is driven by the biology and physics of the crop and the soil. We need visible and near infra red bands for several reasons. Vegetation has a very strong reflectance feature at 0.7 microns see the plot of typical reflectance curves in figure 5.

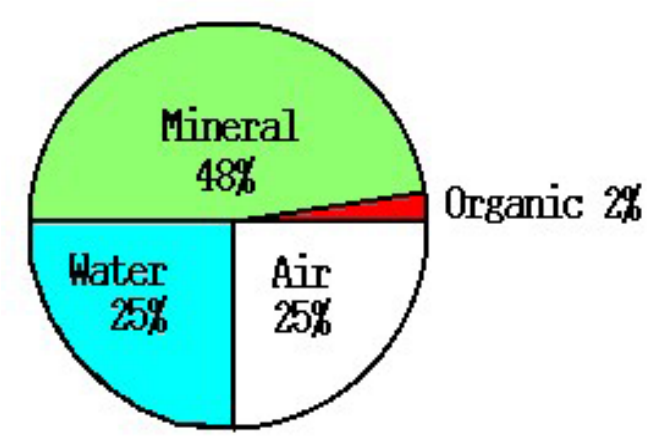
A pair of bands which bracket this can be used to determine the amount of green vegetation. Clay minerals have a strong absorption feature in the 2.2 micron region. Comparison of a 2.2 micron band with a 1.6 micron band is therefore sensitive to clay. Iron, as hydrated iron oxides, has a high reflectivity in the red portion near 0.7 microns of the spectrum and a reflectance depression near 0.8 microns. Bands which cover these features can measure iron content. Thermal bands are used for completely different reasons. Plants cool themselves by evaporating of water. Some of plants which are warm and the other ones, which are cool show up differently in thermal bands.

Crop stage, spatial resolution, seasonal and daily weather conditions must be controlled. For example spatial resolution in the 2-5 meter range was chosen, avoiding many complexities caused by aliasing crop row spacing at higher resolutions yet finer than the harvester's tightest recording rate. This dictates use of an airborne system.

Use of an airborne system also makes scheduling around weather much simpler than use of satellite data. Active video calibration was recognized as essential if quantitative measures were ever to be obtained or reproduced. The system would also have to have onboard geometry recorded during data acquisition.

There are a limited number of sensor/aircraft combinations that provide the needed features. There is presented a currently available system that meets all of these criteria and is called the Atlas scanner, flown out of NASA Stennis Space Centre.

Fig.6. Components of a loamy Alabama soil in ideal condition for plant growth. Source:



[Wiregrass Experiment Station, Auburn University, Headland, Alabama, USA, 2009]

Soil composition ang moisture

With remote sensing we can estimate many important properties of the soil. The organic carbon content can be estimated from albedo. Clay, iron and other mineral contents can also be estimated. While nutrients are important to plant growth, more critical to their vitality is plant available moisture. Water is essential for the transport of nutrients to and from the plant. This transport occurs laterally within the soil, and vertically within the plant.

Water therefore, is the lifeblood of the system. Without sufficient moisture, photosynthesis is impossible. Perhaps more importantly is a proper balance of available water. Root systems of plants also require air in order to survive, with too much water, plants will literally drown. Components of a loamy Alabama soil in ideal condition for plant growth are presented on figure 7.

Remote sensing in precision agriculture

Remote sensing refers to the process of gathering information about an object, at a distance, without touching the object itself. The most common remote sensing method that comes to most people's minds is the photographic image of an object taken with a camera. Remote sensing has evolved into much more than looking at objects with our eyes.

It now includes using instruments, which can measure attributes of the objects. Photogrammetric and remote sensing is the technology of obtaining reliable information about physical objects and the environment, through a process of recording, measuring and interpreting imagery and digital representations of energy patterns derived from noncontact sensor systems [Colwell, 1997]. Remote sensing may be broadly defined as the collection of information about an object without being in physical contact with the object. Aircraft and satellites are the common platforms from which remote sensing observations are carried out.

The term remote sensing is restricted to the methods that employ electromagnetic energy as the means of detecting and measuring target characteristics. Remote sensing is the information obtaining from a distance about the objects or phenomena without being in physical contact with them. The science of remote sensing provides the instruments and theory to understand how objects and phenomena can be detected. [Aronoff, 1995].

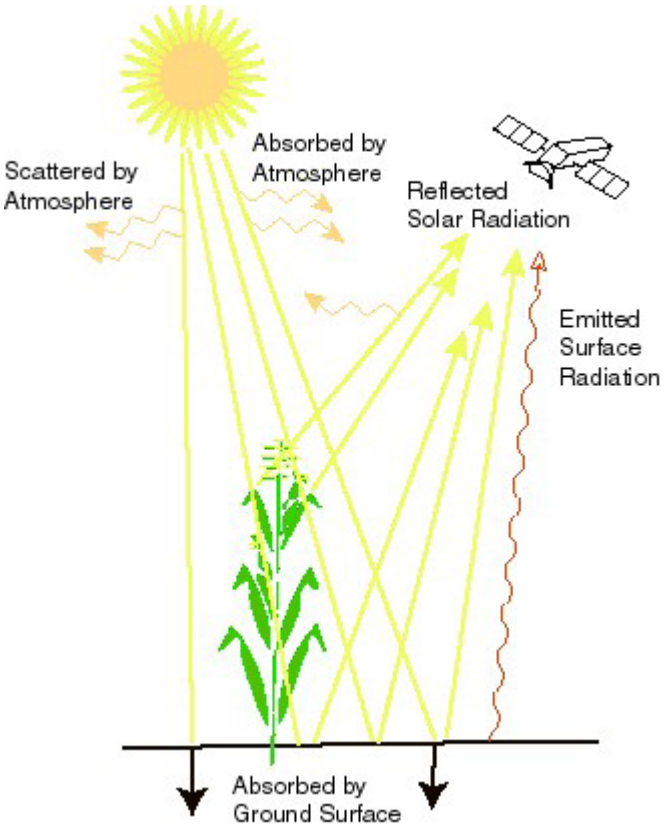
Satellite images have been used to monitor the degradation and pollution of the environment. These images also can be used to assess the damage of floods and natural disasters, assist in forecasting the weather, locate minerals and oil reserves, locate fish stocks, monitor ocean currents, assist in land use mapping and planning, produce geologic maps, and monitor range, forestry and agricultural resources.

Utylization of electromagnetic spectrum

All objects including plants and soil emit and/ or reflect energy in the form of electromagnetic radiation. Electromagnetic radiation travels in waves propagating through space similar to that shown in figure 9. Three major components of these waves are frequency, amplitude and wavelength. Frequency is the number of cycle crests passing a point during a given period of time. One cycle per second is referred to as one hertz. Amplitude is the energy level of each wave measuring the height of each wave peak. Wavelength is the distance from the top of one wave peak to the top of the following wave peak.

It is the sun that most often provides the energy to illuminate objects as we can see in figure 7. The sun's radiant energy strikes an object on the ground and some of this energy that is not scattered or absorbed is then reflected back to the remote sensor. A portion of the sun's energy is absorbed by objects on the earth's surface and is then emitted back into the atmosphere as thermal energy.

Fig. 7. Absorption and reflection of electromagnetic radiation concerning soil surface and plant



Source: [USDA, 2010]

The visible light portion of the electromagnetic spectrum ranges from 0.4 micrometers ("µm") (shorter wavelength, higher frequency) to 0.7 µm (longer wavelength, lower frequency). This is the frequency range of light that the human eye is sensitive to. Every object reflects, absorbs and transmits electromagnetic energy in the visible portion of the electromagnetic spectrum and also other non-visible frequencies.

Electromagnetic energy which completely passes through an object is referred to as transmittance. Our eyes receive the visible light reflected from an object. The non-visible infrared spectral region lies between the visible light and the microwave portion of the electromagnetic spectrum. The infrared region covers a wavelength range from .7 µm to 14 µm.

Disccusion and conclusions

- Remote sensing collect data on energy reflected from the surface of plants and soil. The physics used in remote sensing technology is very complicated. Farm operators will be dependent upon professional engineers and precision farming consultants to process the raw image data into useable information for making management decisions. There is an abundance of remote sensing technology available to measure variability in plants and soils. Also, there is a shortage of information about the causes of plant condition variability and the management solutions needed manage variability to improve crop production. The lack of knowledge needed to answer these variability questions is restricting the development of precision farming management decision support systems.
- The concept of precision agriculture has emerged over the past 15 years with the introduction of new electronic equipment which has allowed farmers to increase the efficiency of their operations and develop new farming practices. However, the investment in precision agriculture equipment represents a significant financial outlay and as with all 'high-tech' equipment it can become superseded relatively quickly and therefore does not tend to hold its capital value. When deciding what equipment to purchase farmers need to understand the capabilities of currently available equipment as well as the likely evolution of the technology in order to 'future proof' their investment. This presentation looks at a number of technologies that are being used on a commercial basis in agriculture today and some research that is being conducted by universities into the technology of tomorrow.
- Most precision agriculture equipment is based around the Global Navigation Satellite System (GNSS). The United States and Russia are planning updates to their systems, while the European Union and China are planning to launch their own systems. This will significantly improve the accuracy and robustness of satellite navigation but will require new receivers to be purchased, however, the timeframe of the upgrade is around 10 years so may not influence purchasing decisions in the short term.
- There is a major push from farmers and equipment manufacturers for standardisation between different precision agriculture equipment and the associated data. This has led to the development of the ISOBUS 11783 standard which outlines both the hardware requirements in terms of plugs and wiring as well as the communication protocols so that equipment from different manufacturers can interact. Manufacturers are well down the path of meeting the standard with a lot of commercially available equipment already compliant. It is recommended that farmers should now look to purchase only ISOBUS compatible equipment to ensure maximum functionality into the future.
- Electronic monitors and controllers have long been utilised with boom sprayers, from simple running totals to today's automatic boom section controllers. Research is being conducted into further advancing application control across the boom, driven by increasing boom widths and wider travel speeds. A lot of this work is centred on controlling the application rate and spray pattern of individual nozzles. Another line of research is based around further advancing the concept of weed identification and automatic spot spraying. Systems are being developed that can identify and even differentiate plant species. This research is also closely tied to 'Micro Spray' research whereby several different systems are being developed to target and control weeds on a finer scale or individual basis. Given that an increasing proportion of cropping system is converting to minimum and no-till with the associate heavy reliance on bigger boom sprayers, it should be considered actively contributing to this major research effort.
- Advances in digital technology and sensor systems over the past decade have resulted in a great deal of research and development of more intelligent agricultural vehicles capable of automation tasks with minimal operator input. The ultimate aim is to remove the human operator all together and have tasks completed autonomously. While most of the hardware and control systems are already a reality, issues of machine interaction with an essentially unpredictable environment still need to be addressed. It is generally accepted that autonomous operations will need to be conducted by a number of small machines which interact to

complete a task rather that one large machine. This not only improves the safety aspects but also offers greater flexibility in terms of scalability. It should also be a part of this research effort as there are many operations in our farming systems which could greatly benefit from this technology.

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JACEK SZPOTAŃSKI (1927-2019) - ELECTRICAL ENGINEER

JACEK SZPOTAŃSKI (1927-2019) – INŻYNIER ELEKTRYK

Summary: *Jacek Szpotański was electric engineer and Master of science in economy. For many years he had been employed in commercial energetic plants and then, in the central organs of Polish commercial energetic sector. He acted actively, on a social basis, in many associations dealing with the problems of electricity and related domains. He had been the President of Polish Electricians Association (SEP) for 12 years.*

Keywords: *Jacek Szpotański, electrician, Association of Polish Electricians (SEP)*

Streszczenie: *Jacek Szpotański – inżynier elektryk i magister ekonomii. Przez wiele lat pracował w zakładach energetyki zawodowej, a następnie w instytucjach centralnych polskiej energetyki zawodowej. Społecznie działał w wielu stowarzyszeniach zajmujących się zagadnieniami elektryczności i dziedzin pokrewnych. Przez 12 lat był prezesem Stowarzyszenia Elektryków Polskich (SEP).*

Słowa kluczowe: *Jacek Szpotański, elektryk, Stowarzyszenie Elektryków Polskich (SEP)*

He derived from noble descent of Dunin, with heraldic arms: Łabędź (Swan). The mentioned family included numerous figures, enrolled in the history of Poland throughout the centuries – knights, senior clergymen, court officials, land managers, urban clerks, industrialists, writers and poets. In the 14th century, the two-part names of the members of the discussed family originated. The second part of the family name means the name of the estate or a characteristic feature of a person. For example, club foot of horse, hence the name Dunin Szpot (Szpotański). Zygmunt Dunin Szpot, who lived at the turn of the 17th century in Szpotawa Wola in Radom Governorate, was the first person who gave up the first part of the family name and began to call himself "Szpotański". The contemporary Dunins are associated in the Association of the Dunin Family Members with heraldic arms Łabędź. The mentioned association has pre-war traditions but it stopped acting during the war period. It was reactivated as late as in 1992 in Lublin during the First Post-War Convention of the Members of Dunin Family.

Jacek Szpotański was born in August 17, 1927 in Warsaw. His father was electric engineer, Kazimierz Szpotański who built Polish factory of electrical devices, being the highest one in the inter-war period, universally known as "Factory of Electric Devices Kazimierz Szpotański and Co., having its trademark "FAE". The mentioned factory was situated at Kamionek in Praga District of Warsaw and had its affiliate department in Międzylesie, being presently situated in Warsaw - Wawer District. The factory was taken over by the State as early as in October, 20, 1944 and, officially nationalized in 1945.

The wish of father was that his son Jacek could be able to manage the big, constantly developing factory in the future. When Jacek was still a pupil of primary school, his father showed him the whole factory and ordered his foremen to take care of him when performing simple assembly operations;

Fig. 1. Jacek Szpotański

Source: www.sep.com.pl

then, he received the so-called "pocket money". During the war period, when having graduated primary school, Jacek continued learning at the Konarski vocational school, in class with electrical specialization. According to the program of school, he performed vocational practices in different factories, producing electrical equipment. They included, inter alia, BRABORK, belonging to Borkowski brothers, Perkun and Perun. The most difficult practice was however conducted in the factory of his father as he did not have any special treatment; on the contrary, they required more from him. After graduation of school in June 1944, he received a title of apprentice, and as early as in July, his father employed him in his factory.

Fig. 2. Heraldic arms: Łabędź (Swan)

Source: www.wikipedia.pl

In August, 1, 1944, Warsaw Uprising was commenced in the left-side part of the Capital City. Factory of Kazimierz Szpotański was situated on the right side of the Vistula River where the direct activity of the insurgents was not carried on. Jacek wanted to take part in the uprising but he had to swim the Vistula River as to reach the left side part of Warsaw. Together with his friend, he tried three times to do it, but each time he returned to the right side of the river as the German patrol boats were approaching. Then the boys decided to swim the Vistula River in the site remote from Warsaw. When going in the chosen direction, they did not pay attention to the fact that they entered the line of front near Otwock. They were arrested by the patrol of German soldiers and transported to filtration camp of NKVD (Peoples' Commissariat for Internal Affairs) in Majdanek near Lublin. Jacek escaped from the camp after several days. He travelled on foot and by the occasional transport and reached Praga District which was already liberated by the Soviet Army. He lived alone in his family house as his parents and sister were evacuated by Germans in the 1st September and came back as late as in January 1945 when a left-side part of Warsaw was liberated. The buildings of the factory were destroyed but the family house, being situated at the territory of the factory remained unchanged. Jacek was 17 years old at this moment and felt as a host of the place. He repaired the fence as the territory of the factory

Fig. 3. Kazimierz Szpatański - father of Jacek Szpotański

Source: https://warszawa.wyborcza.pl/warszawa/7,54420,24200031,kazimierz-szpotanski-nasz-elon-musk-z-z-kamionka.html

was constantly plundered by the thieves. He asked the army for giving him a police station for protection of the factory from plundering and he received such protection. In October 1944, when the factory was taken over by the State Management, he was again employed there.

He continued learning in a form of evening studies at the Reytan secondary school. He graduated in 1946 (certificate of maturity) and then, he was directed by his employer to the full-time studies in the Wawelberg and Rotwand Engineering School. It is interesting to mention that in July 1949, he performed a summer practice in the State Factory of Counters and Clocks in Świdnica, that is, in the factory where – after the war – the manufacture of electrical counters was commenced and, at the same time, such production was stopped in the factory, founded by his father. Simultaneously, he undertook the work at the Polish Institute of Electrical Engineering in Międzylesie as an assistant in the Department of Electrical Measurements. He graduated his studies in June, 29, 1951; however he received a diploma as late as in February 2, 1952 and it was issued by Warsaw University of Technology as in 1951 a fusion of Engineering School and Warsaw University of Technology has place.

After completing his studies, Jacek Szpotański, as graduate of higher education institution, had to performed the so-called compulsory work which was appointed by the Minister of Higher Educaiton and Science. At the beginning, it was a job in Coal Mine "Kleofas" in Katowice – Załęże since

Fig. 3. Kazimierz Szpatański Factory

Source: www.warszawa.wyborcza.pl/warszawa/1,40543,14602262,Historyczna_fabryka_Szpotanskiego_ozyje_na_dwa_weekendy.html

July 1951, at the post of electrical foreman. The work in the coal mine was however inconsistent with the direction of his studies and specialization (operation of electro-energetic networks of high voltage. The command of work in the coal mine and not in the power plant was the successive case of applying the repressions in relation to the pre-war owners and co-owners of factories and land estates, carried on by the contemporary authorities. Earlier, Kazimierz Szpotański was deprived of the possibility of earning and living means and then, his son was compulsorily directed to work in the coal mine. The fates of both gentlemen were changes in 1951. The contemporary authorities applied for compensation for explosion of the factory by Germans in September 1944. Such application required plenipotentiary, signed by one of the shareholders. After a long persuasion, Kazimierz Szpotański gave such powers. In consequence, he received a work at the Central Management of Design Offices of Industrial Building Constructions at the post of electricity specialist. He was employed there until his retirement in 1960. On the other hand, in October 4, 1951, Jacek applied to the Minister of Higher Education and

Science for the change of his work place in the system of compulsory work and the Minister agreed to his request. He issued another work command, this time at the Office of Studies and Design of Typical Industrial Building Constructions in Warsaw in the period of 1.11. 1951- until 30.06. 1951 at the post of designer; since January 1, 1952, Jacek Szpotański was transferred to Warsaw Design Office of Industrial Constructions. The new job, however did not meet his expectations and after 3 months, he submitted a termination notice. It was considered positively for him in spite of the obligatory work command valid until 1954. This decision allowed him commencing the work in commercial power industry.

At the beginning, since 1st of May 1952, he worked in technical section in the management of Power Industry of the Central District (ZEOC). In 1954, he was transferred to Design-Constructional Office of ZEOC at the post of designer of power stations. He was quickly promoted to the successive higher posts: senior designer, head of the team and the chief designer.

Apart from professional work, he developed expertises in the field of operation of electrical devices and machines, inter alia, for Heating Network Plant, State Enterprise Polcargo, and Polish Academy of Sciences – Bureau of Studies for the Electrification of Poland.

Since 1st of October 1957 he took over a post of the head of Design-Constructional Office in ZEOC. He managed the teams, developing the conceptions and plans of developing the dispatching networks 220 and 110 kV and distributive network systems 110 kV and 15 kV at the territory of the Central District and , first of all, Warsaw and Łódź agglomerations.

In 1964, he commenced the studies in the field of economy at the Łódź University in the program "Evening economic stadium for engineers"; he completed it in 1966. He received a diploma of graduating the stadium and not the studies; therefore, he decided to continue further learning in the years 1968 – 69. He finished his MSc thesis in 1969 and obtained a title of M.Sc. in economy.

Since 1st of August 1966 he took over the post of director for investment affairs in Power Plant Warsaw outside Territory. After almost one year he returned to work at ZEOC at the post of the main specialist for organizational matters.

After few months he was directed to technical practice in France (4.07 1967 until 20.5 1968), organized by French Governmental Agency ASTEF.

Fig. 5. Jacek Szpotański during the XXII General Assembly of SEP Delegates (1981) in Wroclaw

Source: www.sep.com.pl/aktualnosci/90-lecie-urodzin-jacka-szpotanskiego.html

Fig. 6. Jacek Szpotański during the XXII General Assembly of SEP Delegates (1981) in Wroclaw

Source: www.sep.com.pl/aktualnosci/90-lecie-urodzin-jacka-szpotanskiego.html

Within the frames of the practice program, he had the opportunity to get familiarized with the French producers of electrical devices. After completion of the practice, he received a diploma with distinction and received the invitation to the so-called après stage – that is, work after the practice which he had as late as in 1973 for three months.

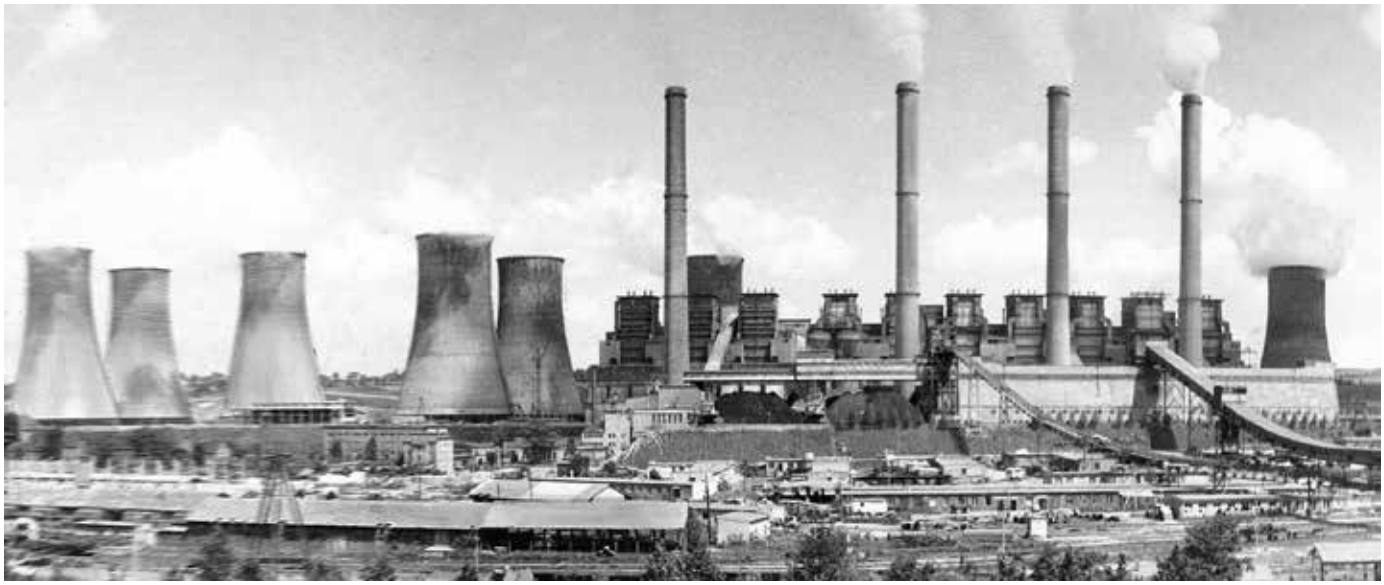
Since 1 January 1968, Jacek Szpotański became the Main Specialist for dispatching and distribution of energy in the Central Management of Energy Generation and then, since 1st January 1973 he took over the post of the Chief Engineer – Deputy Director for Electrical Networks. At the same time, in the years 1972 – 1975 he was the member of Scientific Economic-Technical Council of the Warsaw Voivode. The mentioned Council was dissolved in 1975 due to the changes in administrative system of Poland.

Since 1st January 1976, after liquidation of the Central Management of Energy Generation he was nominated on the post of the deputy director of the Department for Planning and Development in the new Ministry of Power Engineering and Atomic Energy (MEiEA). On 21t November he was nominated to the post of director of Department for Exploitation and Renovations of MEiEA.

When working at MEiEA he coordinated the work connected with the development of conception and then, implementation of electro-energetic networks of the highest voltage at the territory of the whole country. He was the co-organizer of the first course for electricians, performing the repairing and conservation work under the high voltage lines – Dzierżno 1976.

He cooperated with many outstanding Polish specialists in the field of power engineering. He was an active member of the Scientific Council of the Institute of Power Engineering. He was the opinion-giver of the Conception for Development of Highest Voltage Networks, being developed at the Department for Development of Electro-energetic System of the Institute. He was interested not only in the defined planning solutions but also consulted the choice of calculating instruments , generated in the Institute of power Engineering as well as of those ones adapted on the grounds of foreign licences. He was the co-initiator of creating the IT Centre for Power Engineering and Atomic Energy. The mentioned enterprise gave a high contribution

Fig. 7. 1970s - development of electricity networks - Bełchatów CHP plant



Source: www.energetyka-polska.pl

to computerization of many branches of power engineering sector which include automation of service of the customers (ZBYT), automation of the processes connected with the prognoses of demand on power and energy at the territory of the whole Poland, the economic distribution of loadings on generating sources for coverage of varying demand on electricity, optimization of propagation of power and shaping the levels of voltages in the national network, management of renovation of generating sources and dispatch network and also, distributional network at the territory of the whole country.

In relation to the employees, he was a demanding boss but at the same time, he was able to appreciate their vocational achievements. He was capable to organize the people around him who were friendly each other and could cooperate mutually. He participated in many scientific-technical conferences, inter alia, in Kołobrzeg (15 – 16 may, 1980) where he submitted a general lecture on the current problems in exploitation of transformers in the highest voltage networks.

The year 1981 came. It was the year of social tensions in Poland, completed with the introduction of the state of war (13th of December, 1981 – 22nd July 1983). It was also a special year in life of Jacek Szpotański. The 22nd General Convention of SEP Delegates had place in Wrocław in the period of 26 - 28 June. During the mentioned Convention he was elected as the President of SEP; it was a social function without remuneration. In July there was liquidation of the Ministry of Power Engineering and Atomic Energy and in connection with this fact, Jacek Szpotański was transferred to a new ministry at the post of vice-director of department but he was not obliged to perform the work as on the 1st of December was retired.

Being already a retired person, he was the consultant at the Institute of Power Engineering in Międzylesie (1985 – 1987). Besides it, he was the member of the Supervising Council in some companies, such as, inter alia, Elektromontaż Eksport S.A., SELPOL S.A., ZWAR S.A.

Jacek Szpotański joined SEP in 1953. He was the active member of the association. In 1959, he participated in the Jubilee Convention of SEP Delegates on the occasion of the 40th anniversary of SEP foundation. In the years 1971 and 1977, he was the co-organizer of the "Days of French Electricity in Poland', organized by the Chief Board of SEP. In the years 1974 – 76, he was the member of the Central Collegial Body of Power Engineering Section of SEP and in the period of 1976-81 he was the member of the Central Commission for Electricity Regulations of SEP. In 1979 he was the co-organizer of ceremony of celebrating 60 years of SEP establishment.

In cadences of 1975 – 1980 he played a function of Vice-president of Warsaw Department and in the period of 1977/1978, he performed also the duties of the President of Warsaw Department.

He played the function of the President of SEP in the following cadences: 198 – 1984, 1984 – 1987 and 1990 – 1994; in the years 1994 – 2003, he was the member of the Chief Board.

In the publication:" History of SEP 1919 – 1999", the period of playing the function of the President of SEP by Jacek Szpotański was described as it follows:

"Undoubtedly, in the period difficult for the country and for the society, it was successful to run the activity of the association possibly without

Fig. 8. The Presidium of the SEP Main Board with the participation of the Minister of Communications Władysław Majewski (1987)

Source: www.sep.com.pl/aktualnosci/90-lecie-urodzin-jacka-szpotanskiego.html

Fig. 9. Plenary meeting at the Electrotechnical Institute (1987)

Source: www.sep.com.pl/aktualnosci/90-lecie-urodzin-jacka-szpotanskiego.html

special shocks. It was possible to protect the Association from the attempts to involve it into the political activity. It was also successful to maintain the consolidation of the environments of electrical engineers and counteract the disintegration tendencies e.g. in a form of the undertaken attempts to create the new associations. During the discussed period, there were implemented the principles of friendly cooperation and a high level of social harmony, inter alia, by propagation of the idea "SEP – the Association of Friends". Owing to this fact, a specific climate of friendship and reliance was developed in the Association".

Jacek Szpotański had his vision of Polish power engineering and a role which should SEP association possess. As far as the problems of commercial energetic sector are concerned, he had big limitations, resulting from the contemporary political and economic situation of the country. In relation to SEP, such limitations occurred to a much lesser extent. During the period when he was the President of SEP, numerous opinions, expertises, conceptions and reports in the field of electricity were developed in the association. The mentioned elaborations were addressed first of all to the Government, Parliament and Polish Academy of Sciences (PAN).

He inspired the cooperation of SEP with the associations of electrical engineers in other countries, first of all in France, Germany, Hungary and Italy. He continued organizing, alternatively, the Days of Polish Electricity in the mentioned countries and in Poland – the Days of French, German and Hungarian Electricity. He was the initiator of establishing the Day of Electricity – 10th of June, in the anniversary of birthday of A. Ampère, the ceremony organized only by SEP. After few years, Polish Day of Electricity was undertaken by the associations in other countries and adopted the name of "International Day of Electricity".

His important achievements include animation of the activity of Research Office for SEP Quality (BBJ) and then, location of its particular units in one site, at the territory of the Institute of Power Engineering in Międzylesie, with its branch in Lublin.

As the head of the association, he inspired the activity of the particular Departments of SEP. He often participated in working meetings of the managements of the mentioned departments. He was also present in majority of important meetings and ceremonies, organized at the territory of the particular departments. He was a recognizable person in the whole environment of electricians, even those being not associated in SEP. He was also initiator of cooperation with the associations, being not the members of Polish Federation of Engineering Associations – NOT, such as SARP, or PTE.

He was the member of many technical, economic and social organizations, including inter alia: Conseil International des Grands Reseaux Electriques (CIGRE), International Union of producers and Distributors of Electrical Energy (UNIPEDE), Polish Committee of the Worls Energy Council, Polish Society of Dispatch and Distribution of Electric Energy (PTPiREE), Engineering Academy (since 1993), Polish Nucleonic Society, Association of Members of the Dunin Family (since 1995). He was the co-founder of the Association of Polish Industrialists (1990).

He was also "The Member of Polish Committee of Great Electrical Networks (PKWSE), the association, affiliated at CIGRE. He was awarded with the distinction "Distinguished Member of CIGRE" for his activity in favour of CIGRE.

Jacek Szpotański was long-time member and the chairman of Programme Council of "Power Engineering" and "Around Power Engineering". Since 1995, he was a founder of the annual Kazimierz Szpotański reward, awarded during the Fair ENERGETAB held in Bielsko-Biała, for the product, manufactured by Polish company and having the properties of a high quality, economics, aesthetics and modernity. At first it was a cup and since 2001, it has been a statuette made of bronze, presenting a lion. Every year, it has a different silhouette. A new name of award was also adopted – Golden Lion". On the grounds of the agreement of 18 November 2018, the organizer of the Fair "ZIAD Bielsko-Biała" S.A. took over the function of founder of the award.

For his work and activity in professional work and in the association, Jacek Szpotański was honoured with numerous distinctions given by the following bodies:

Fig. 10. Jacek Szpotański with the Diamond Honorary Diploma of A. M. Ampere

Source: www.sep.com.pl/aktualnosci/90-lecie-urodzin-jacka-szpotanskiego.html

- State: Silver Cross of Merits (1957), Order of Polonia Restituta Fifth Class (the Knight's Cross) and Order of Polonia Restituta Third Class (the Commander's Cross);
- Professional branch: The Meritorious Employee of Power Engineering Plant Łódź; Voivodeship (1972), Honorary distinction: the Meritorious Worker of ZWAR (the Resolution of the Conference of Self-Governing Workers' Organization) , the Man of Merits for Power Engineering (1977), the Meritorious Employee of Communication (1983), the Meritorious worker of Power Engineering Plant in Lublin (1977), The Meritorious Employee of Elektromontaż (1978), distinction of the 50 years of railway electrification in Poland (Minister of Transport, 19860, the award on the occasion of 50 years of railway electrification in Poland (Minister of Transport, 1986);
- Self-governing organizations: Golden Honorary Distinction – "Warszawska Syrenka " (Emblem of Warsaw) (1979), Meritorious for Warmia and Mazury Region" (1980), For merits in development of the Koszalin Voivodeship (1980);
- Associations: Silver, Golden (1984) and Diamond Honorary Distinction of NOT; Silver (1975), Golden (1979) and Sapphire (206) Honorary Distinction of SEP, Medals of SEP of the following names: Prof. M. Pożaryski, J. Groszkowski, A. Hoffman, J. Obrąpalski, K. Szpotański, S. Fryze, S. Bieliński (Cracow Department), K. Idaszewski (Wrocław Department), Stanisław Szpor, Z. Białkiewicz (Department of Coal Basin), E. Jezierski (Łódź Department), Jan Nowacki (Warsaw Department) , the Gabriel Narutowicz medal (Engineering Academy 2005), Bronce Distinction of Polish Horse Riding Association (1977).

In 1985 he was honoured with the French Ampère Prize. In 1987, the 24th General Meeting of Delegates conferred him a dignity of Honourable Member of SEP.

His family life was as it follows: he was married in December 4, 1953 (ceremony in church; 14 April 1954). His wife was Irena Lebert (1929 – 2002), medical internist. He had two children: Piotr (born in 1956) and Beata (born in 1961).

Fig. 11. Jacek Szpotański - founder of the Kazimierz Szpotański Golden Lion award

Source: www.sep.com.pl/aktualnosci/90-lecie-urodzin-jacka-szpotanskiego.html

Fig. 12. Jacek Szpotański member of Presidium of the First Congress of Polish Electrical Engineering (2009)

Source: www.sep.com.pl/aktualnosci/90-lecie-urodzin-jacka-szpotanskiego.html

Since 12010, due to a trauma, he was very much limited in moving, he left his house very seldom. He participated however actively in everyday life of SEP. He invited his friends whom he had met during his professional and association life almost every day. In the period of 2010 – 2018, he worked – together with the team – upon the publication of Biography of his father, Kazimierz Szpotański. The first edition of the mentioned work appeared in 2012. The second one – as being considerably developed and more comprehensive – was published in 2018 as number 1 of the editorial series of SEP under the motto: "Books for 100th anniversary of SEP". In his professional and social life, Jacek Szpotański gave many interviews to press, broadcasting and TV. He appeared as the main narrator in historical film "Child of His Life" in which he presented interestingly many details from life of his father, Kazimierz Szpotański and his factory "Factory of Electrical devices K. Szpotański and Co.".

Jacek Szpotański had many features of decisive man in his activity. In the preserved documents, we may often find the strong words, addressed to his superiors and offices of all levels, pointing out a lack of action or the activity inconsistent with the obligatory rules. He defended individual persons as well as institutions. It may be supposed that it was a reason for his earlier retirement.

He was respected very much and first of all, the people from the environment of electricians liked him very much. It may be supported by the fact that about 500 his friends from the whole Poland arrived at the occasion of solemn cerebration of his 90th anniversary.

Jacek Szpotański died on 3 January 2019. He was buried in a family grave at Powązki Cemetery in Warsaw (quarter 53/VI/20).

The elaboration of the paper: Zbigniew Filinger and Ryszard Frydrychowski

Sources:

The documents stored at the house of the Szpotański family. In connection with this fact, in certain cases, the change in dates had place in relation to the dates, given in the so-far earlier publications.

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WATERWAYS – IN REFERENCE TO THE PREVIOUS COMMENTS

DROGI WODNE – W NAWIĄZANIU DO WCZEŚNIEJSZYCH UWAG

Summary: *The comments to the assumptions for development of waterways in Poland, as submitted in the article entitled „Expertise on the development of inland waterways in Poland in the years 2016-2020 with the perspectives up to 2030" have been presented. The conception of implementing another (authorial) solution together with the arguments, supporting the mentioned proposals has been suggested.*

Keywords*: waterways, conceptions, perspectives for implementation*

Streszczenie: *W artykule przedstawiono uwagi do zamierzeń rozwoju dróg wodnych w Polsce przedstawionych w artykule pt. „Ekspertyza w zakresie rozwoju śródlądowych dróg wodnych w Polsce na lata 2016-2020 z perspektywą do roku 2030". Zaproponowano koncepcję realizacji innego (autorskiego) rozwiązania wraz z argumentacją uzasadniającą te propozycje.*

Słowa kluczowe: *drogi wodne, koncepcje, perspektywy realizacji*

Introduction

When formulating the comments, I utilized the elaboration of the Ministry of Marine Economy and Inland Navigation, dating to 2006 entitled "Expertise on development of inland waterways in Poland in the years 2016-2020 with the perspectives up to 2030". The mentioned expertise was the basis for undertaking the Resolution no 79 of the Council of Ministers of 14, June 2016 (Polish Monitor of 2016, item 711).

The present text refers to the article "Waterways – some remarks" published in the monthly "Gospodarka Wodna" no 6/2019 and to my earlier articles.

I have worked in hydro engineering for almost 60 years, so, based upon my previous experience I confirm the maxim of my older colleagues-professionals about running the national water management "from flood to drought and from drought to flood".

Similar situation is in the case of water management branch, i.e. inland navigation where – after tens of years of stagnation and event its intentional limitation, we have suddenly to enter the epoch of stormy development of national waterways, being risen to the name of international waterways. I would recommend cold head and common sense.

The mentioned "civilization jump" is expected to result from signing the European Agreement on Main Waterways of International Importance (AGN),

The waterways in Poland constitute too important, expensive and disputable matter as to commence it on the grounds of the program, resulting from the signed AGN Convention.

We have difficult meteorological, hydrological, economic and natural conditions in Poland for inland navigation, not to mention non-understanding of the subject and disapproval of many environments.

Our natural water flows have a principal direction from the south to the north – reversely to distinctly occurring differences in terms of annual climate periods on which the navigation seasons are dependent.

Fig. 1. Category E inland waterways in Poland

Source: www.mgm.gov.pl

The greatest rivers: Oder and Vistula are shallow and very unevenly supplied with water. Their catchment areas are situated in the European zone where the abundance in water is the poorest one. The relations of the rivers' lengths and the distances between sources and the river mounts are very disadvantageous.

Fig. 2. The graphic shows a map of Poland's inland waterways on a scale of 1: 700,000

Source: www.mgm.gov.pl

Routes of the waterways, as indicated for Poland, supplemented by Silesian Channel

The justness of implementing waterways of international class IV (non officially with option of their rising up to class V a) in the directions marked with symbols E 30, E 40 and E 70 is doubtful.

The route E 30 is the Oder River, with the anticipated prolongation to the south from the Danube River. Water resources of the Oder River with old and new reservoirs even in the segment of being modernized Cascade of the Upper Oder from Koźle to Malczyce will not assure the required transit depth. Preliminarily, it is anticipated to perform the cascade on the whole route. Beginning of the program E 30 from reconstruction of recently modernized Cascade of the Upper Oder is nonsense.

Prolongation of waterway of the Oder River by Silesian Canal cannot be justified by transit of goods. For delivery and exportation of the local goods, it would be better to build terminal ports for the Cascade of the Upper Oder and Cascade of the Upper Vistula linked with the direct railway line.

The eventual implementation of the Silesian Canal should be decisively postponed in time. The Cascade of the Upper Vistula should be supplemented with a barrage in Niepołomice and then, probably the lateral canal up to Szczucin could be purposeful.

In AGN program, the waterway of the Oder River (E 30) became linked with waterway of the Vistula River (E 40) with a fragment of waterway E 70.

The waterway E 70 (Warta – Noteć – Bydgoszcz Channel – Brda – Vistula – Nogat – Vistula Lagoon) is an old imperial route constructed directly after Poland's partitions with the aim to link the imperial capital cities - Berlin and Królewiec. After few modernizations of the mentioned route in the segment of the Noteć – Bydgoszcz Channel, it has nowadays a historical- touristic meaning (with limitations). Building of a new road with parameters of class IV on the mentioned route, being connected with the implementation of the cascade, will have natural limitations and will not find the economic justification, in spite of the fact that from the west, the branching of Mittellandkanal, linking the while network of waterways from France, is approaching the border of Poland (the Oder River).

Waterway E 40 from Gdańsk to the Dnieper River has not any historical traditions. Gdańsk became a rich city owing to mediation in exportation of cereals and wood, being flown down by the Vistula River.

The waterway running from the Bug River to the Dnieper River got the importance when after the partitions of Poland, the whole Lower Vistula was found in the hands of Prussia. The different canals as being then constructed between the river catchments of Bug, Narew, Niemen and Prypeć either do not exist or do not have any economic meaning.

The water way of the Dnieper River flowing in the opposite direction as compared to the rivers in Poland, i.e. from the north to the south, runs by ca. 700 km eastwards from the Vistula River Valley. Theoretically, from Brześć to the Dnieper River, there is a waterway via the Muchawiec, Royal Canal

and Prypeć. From the mouth of the Prypeć to Kherson at the Black Sea, the Dnieper River is canalized, forming a huge waterway.

From Orsza above the Dnieper River to Witebsk over the Dźwina River, there is only 100 km; therefore, the canal connection may create a competitive – for E 40 – waterway from Riga to Kherson. The both ways have the same distance in a straight line – 1200 km but Riga is better situated in direction to the north-south of Europe. It may limit the importance of route E 40.

The Valley of the Bug River and the Muchawiec in the Vistula catchment and the Prypeć in the Dnieper catchment is a natural direction of linking the Vistula River with the Dnieper, as being mentioned in the AGN Convention.

The recent elaboration concerning a segment of waterway from the Vistula by the Bug valley to the mouth of the Muchawiec in Brześć , i.e. up to the border of Poland, dates back to 1962.

For several years, there has been a complete blocking of the Bug valley by different from of nature protection what may result in non-availability of the Bug valley for navigation on the mentioned segment of E 40.

So, there is a successive (after the Noteć River) "gap" in the routes, suggested by AGN for Poland.

The route which does not appear in the AGN program

For Poland, the most important water way should run absolutely centrally in parallel direction from the mouth of the Nysa Łużycka River to the region of Brześć over the Bug. The importance of other segments of water ways will results from their relation with the main direction which should appear under one symbol.

From the Nysa Łużycka River to Brześć near the Bug River, there is a continuous waterway, created by the segments of the Oder, Warta, Noteć, Bydgoszcz Canal, Vistula and Bug rivers. In the discussed line, there are successively fragments of E 30, E 70 and E 40 routes.

The Noteć between the Oder and Vistula and the Bug River between the Vistula and the Dnieper, as indicated below, being practically non-available for navigation call in question the implementation of E 70 and E 40.

On the other hand, the implementation of a central parallel route, necessary for Poland, should consider the possibility of replacing the Noteć River on the route between the Oder and Vistula and the Bug River on the route between the Vistula and Dnieper with other segments of waterways. In the first segment, between the Oder and Vistula, the replacement route would lead from the mouth of the Nysa Łużycka by the Oder to Cigacice, then by valleys of the Obra canals to the Warta River in the region of Mosiny. The setting up of the further route should result from the comprehensive analysis of advantages and weak points of few possible variants:

a. Via Poznań to the region of Solec Kujawski,
b. Via the Warta valley and Warta-Gopło Canal to the region of Nieszawa,
c. Via valleys of the Warta, Ner and Bzura Rivers.

There may be various modifications, resulting from the detailed analyses.

In variants b and c, we have to consider the performance of lateral way to Poznań.

In the segment of the Vistula River to Brześć, elimination of the route on the Bug River causes the necessity of coming back to the conception of waterway Vistula – Bug River via the Lublin Upland region.

In the primary assumption, it was expected to serve for exportation of coal from the Lublin Coal Basin.

The assumptions to the mentioned conception included running the waterway from Dęblin (water reservoir on the Wieprz River with lifting in locality Skoki being equal to great waters in the Vistula River) alongside the southern edge of the Wieprz and Tyśmienica valley and then, more to the south from the Żelizna reservoir, Biała Podlaska, Małaszewicze and Brześć.

In the main waterway between the Wieprz and Bug rivers, there is conducted the Wieprz – Krzna Canal which may constitute a source of supply of the peak position of navigation channel in water. The by-pass of Brześć from the south would decisively facilitate the implementation of this difficult crossing of waterways.

There was also analyzed the crossing of the Bug river in the region of once planned Włodawa reservoir with the exit to a new route alongside the valley of the Upper Prypeć. In such case, the beginning of the canal from the Vistula side could be commenced with the mechanical lifter over the Puławy.

The current proposal for combining the Vistula River from Warsaw to Brześć near the Bug River by the navigation route coming from variant III (acc. to "Expertise...")is consistent with the idea of the hydro engineers – designers from the beginning of the seventies of the previous century. The complexity of the problems, occurring when designing the waterway in the segment, defined now as variant III of the combination of Warsaw and Brześć, requires a very reliable and comprehensive study.

A final solution of the route may considerably differ from the present variant III as well as from the conception dating back to 50 years ago.

The Vistula – Bug Canal via the Lublin region should be performed as a model for other segments of waterways and must be adapted to the innovative floating rolling stock. Poland, when practically commencing the new program for implementation of waterways has a chance to outline the hydro-technical and constructional solutions, referring to modern stock with new driving systems.

The Vistula – Bug Canal running through the Lublin region should be implemented even before the completion of links up and down the Vistula River as to stimulate the implementation of the successive segments.

The discussed canal has the justification for route E 40 as well as for the central parallel canal, also in combination with the non-canalized but regulated Vistula River.

The program of international waterways and the current urgent investment of Polish navigation

We should treat the whole matter of development of waterways in Poland very carefully, especially in respect of the conditions, resulting from AGN Convention.

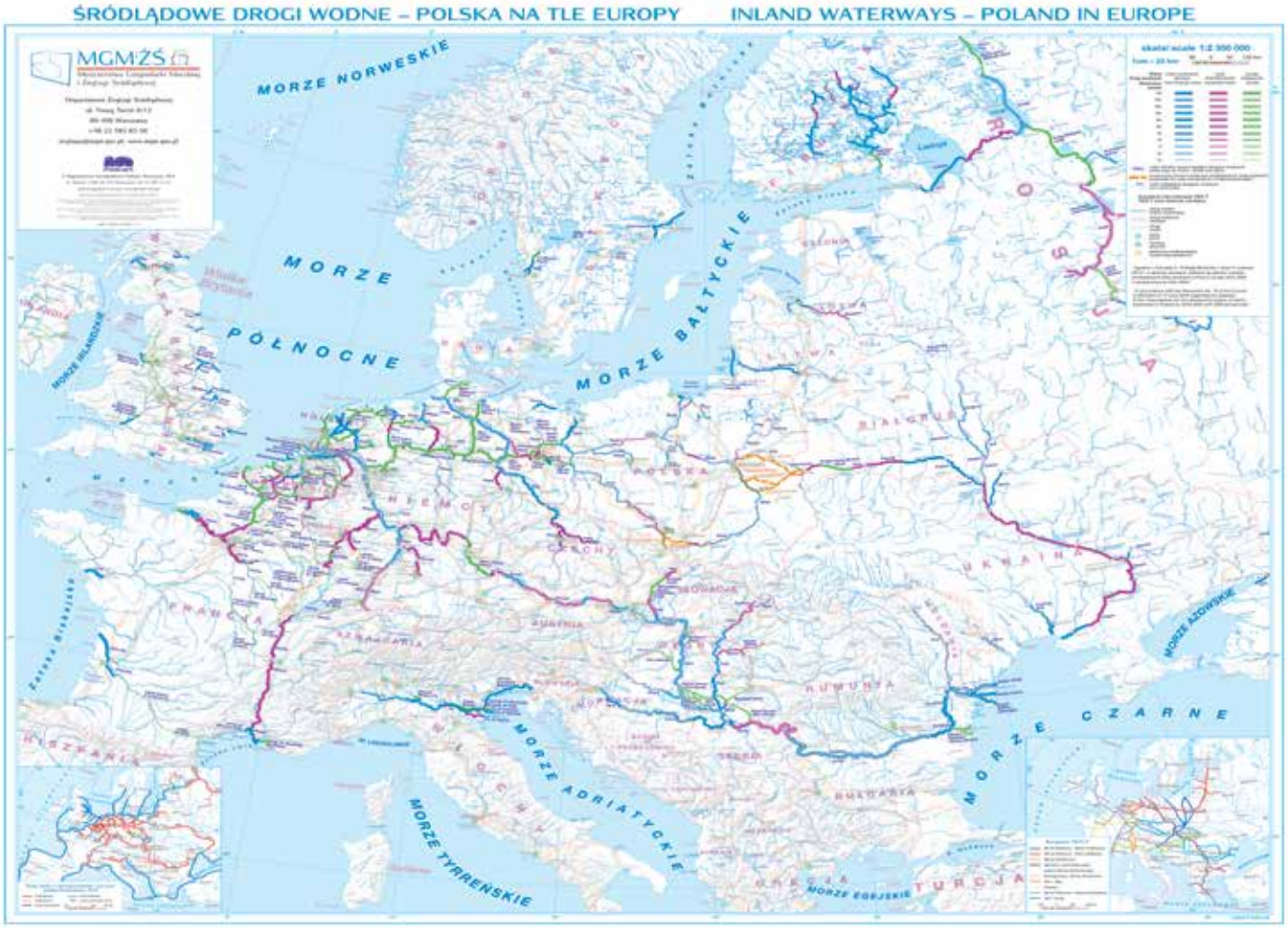
To reach the parameters of class IV, or even the considered class V a, all segments of routes E 30, E 40 and E 70 must be implemented in a form of cascade. It is rather completely excluded on the Noteć and Bug Rivers what indicates the deficiency of the discussed program. It is not possible to approve the program having a lot of limitations and question marks.

It is better to utilize the waterway with lower parameters but with a higher assurance of functioning, with the application of safe and efficient stock.

The inland waterways are not only the river or channel routes and the accompanying different engineering objects with the land, water and environment.

They include also roads and railways, handling and lifting equipment, operating terrestrial and floating service, automatics, communication, monitoring and energy supply. It covers also utilization of waste and environment protection. It refers also to stock for mass loads and containers with modern drives and service.

Fig. 3. Map of inland waterways - Poland and Europe on a scale of 1: 2 300 000



Source: https://mgm.gov.pl

And – first of all – it means the people for programming, designing, implementing and servicing as well as for different negotiations.

And the most important question: time and money: who and how much will expend? Who and how much will earn? Who and how much will lose? Who will risk a freezing of assets?

Due to its territorial and environmental range and also, enormous level of costs and doubtful profits, the program of building the international waterways according to AGN Convention concerns all citizens. Meanwhile, information of the discussed intentions is not easily available.

In the situation of the country being underinvested in the field of inland waterways, we should try to utilize those matters which were implemented on the grounds of other projects and to supplement them with the elements resulting from the old projects of new requirements and needs.

First of all, we should implement the objects and programs which do not raise greater doubts. I include the following ones:

a. Waterway from Gdańsk to the Vistula Lagoon,
b. Navigation canal from the Vistula River to the region of the planned Central Port near Grodzisk,
c. A barrage, stabilizing the level of water table in the Warsaw region of the Vistula River,
d. Navigation canal the Vistula – Bug via the Lublin region ,
e. Water barrage below Przewóz on the Vistula River, ending the Cascade of the Upper Vistula River.

Ad.a. On the grounds of the existing canal and equipment, a modern waterway, linking Gdańsk and Elbląg, should be constructed. The mentioned system has three existing entrances to the sea. After the supplementation of the road Gdańsk – Elbląg with the lifting barrage on the Vistula River at the height of ca. 4.0 ÷ 4.5 m, situated below Przegalin, the beginning of the Cascade of the Lower Vistula River, reaching to Tczew is formed. The start-up of the system Gdańsk – Tczew – Elbląg will facilitate the performance of the Vistula Spit ditch and erection of peak power plant in the region of Tolkmicko. On the other hand, the subject of the Cascade of the Lower Vistula River upwards from Tczew is also the matter of a wider discussion.

Ad.b. The communication system of the Central Port near Grodzisk should be supplemented with shipping canal, utilized as early as during the development of the Port. The importance of the discussed canal will be not overestimated in spite of the initial utility limitations, resulting from the linking of the canal with the natural segment of the Vistula River. After completion of the designing process, it may be too late for supplementation of the discussed investment with the shipping canal.

Ad.c. The stabilization of the level of water table in the Warsaw region of the Vistula River is necessary for the city and its inhabitants. To implement such undertaking, the stabilizing degree at the cross-section Buraków –

Nowodwory, with water lifting in respect of the shore water (NPP – 79.50 m over the sea level) should be constructed. It would be create a recreation-economic complex, including the Zegrze Lake and Żerań Canal. In the cross-section, the power plant (ca. 15 MW power and production of ca. 85 million kWh annually) and road bridge will be erected. The implementation of the discussed investment is consistent with the system of inland waterways in Poland.

Ad.d. As it was given above, the Vistula River – Bug Canal via the Lublin region stays in the conformity with the route E 40 and the central parallel route, leading from the mouth of the Nysa Łużycka River to Brześć near Bug. The performance of the discussed canal may immediately activate navigation between the Vistula and Dnieper Rivers regardless the expected way of targeted development of the Vistula River.

Ad.e. At present, the Cascade of the Upper Vistula River is ended with the Przewóz lifting near Nowa Huta. It is the highest time to activate the discussed Cascade via constructing one or two degrees below with eventual lateral canal coming to the region of Szczucin.

Summing up

The implementation of inland waterways with parameters and routes indicates by AGN Convention in Poland requires canalization of total routes, and in the case of route E 40 – the reconstruction of the existing Cascade of the Upper Oder River. Apart from it, the Noteć River on the route E 70 and the Bug River on the route E 40 may be at all excluded from the possibility of utilizing for shipping purposes. This calls into question the conditions, specified by the AGN Convention concerning the parameters and routes, possible to be adopted in Poland.

For Poland, the parallel conducted route throughout the centre of the country from the mouth of the Nysa Łużycka River to Brześć may be the most important waterway.

Variant of segment of waterway, replacing the Bur River in the route E 40 as well as in the parallel route includes the Vistula – Bug canal via the Lublin region. In my opinion, the mentioned canal should be implemented prior to the analyzed variants of waterways in Poland.

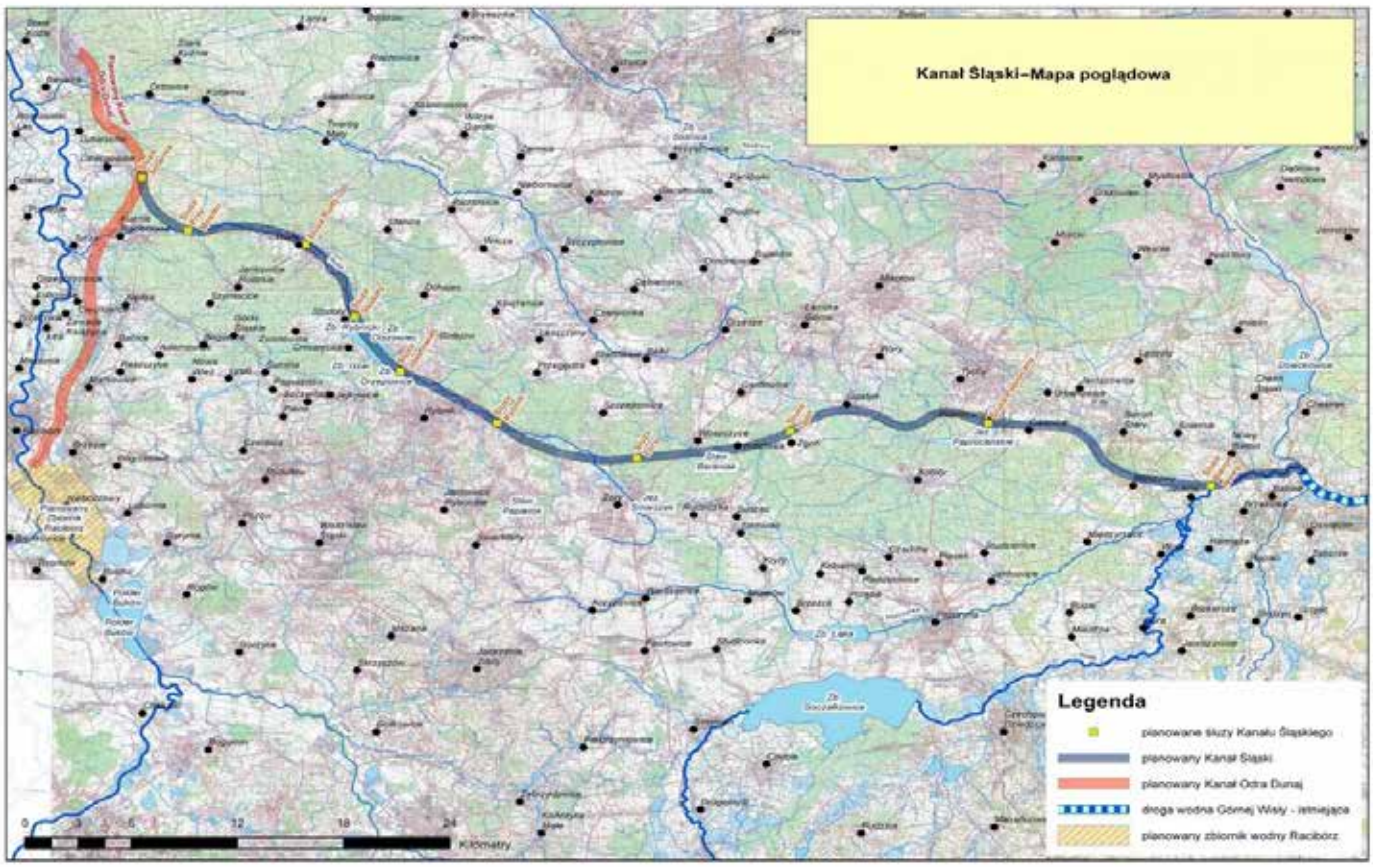
Technical solutions of the canal and shipping stock should become a model for the successive segments of waterways.

The navigation investments, as being absolutely necessary as the priorities should also include as follows:

- Waterway from Gdańsk to Elbląg with lifting on the Vistula River below Przegalin,
- Canal from the Vistula River to the region of the Central Port near Grodzisk,
- The barrage, stabilizing the level of water table in the Warsaw segment of the Vistula River,
- The Upper Vistula River.

The preparations to the development of waterways in Poland should consider the undertaking of production of modern shipping stock with innovative drives and the possibility of completing the auxiliary technological equipment.

Fig. 4. The construction of the channel connecting the Upper Oder with the Upper Vistula is a chance to include the Upper Vistula waterway to national and European inland waterway system



Source: RZGW Krakow

Practical start-up of the navigation route occurs no earlier than after implementation of the last object what does not allow the decisive errors.

The launched program of development of inland waterways in Poland shall directly concern the thousands of households, being found in the range of the conducted work and millions of inhabitants of our country, being "the stakeholders" of the enterprise. Such a big program of development of inland waterways must be commonly acceptable.

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POLISH TECHNICAL REVIEW

SCIENCE AND INDUSTRY IN A COUNTRY OF CHANGES

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THE CRACOW MEETING OF POLISH ENGINEERS

KRAKOWSKIE SPOTKANIE POLSKICH INŻYNIERÓW

The 4th World Convention of Polish Engineers, as summoned together with the 26th Congress of Polish Technicians, was ended with the summing up session held on 15 June 2019 in the Auditorium of the Stanisław Staszic AGH University of Science and Technology in Cracow.

During the inauguration on 13 June 2019, when addressing to the participants of the meeting in the special message, the President of the Republic of Poland, Mr Andrzej Duda wrote as follows: "It is an extremely valuable and important meeting as the quickly varying reality requires a look at the future and vision of development, corresponding to the current civilization trends. I am very glad that you not only perceive the mentioned need but also you respond to the expectations and undertake the substantial activity. It is you who keep our future in your hands to a great extent. It is the imagination of the engineers that changes the world and human life in all its aspects. It is you who are able to foresee the threats and to manage the progress in such a way that it could best serve the people. It is a big gift and, at the same time, a big responsibility. The technique has also social and ethical aspects and affects our perception of the world, our relations and our personality".

The Convention was attended by ca. 200 participants, including Polonia engineers from Canada, the United States of America, Australia, Lithuania, Austria, Greece, Germany, France, Switzerland and Great Britain, and by numerous representation of Polish engineering environment from research institutes and innovative companies, and also, the scientists and students of Cracow technical universities.

On the one hand, the Convention and the Congress, as being convoked during the period of celebration of the Centenary of Regaining the Independence by Poland referred to the estimable past: the lecture entitled "The Role of Engineer in Regaining the Independence and Construction of Statehood" was delivered by Mrs. Ewa Mankiewicz-Cudny, the President of FSNT-NOT. On the other hand, the leading motto of the Cracow debate was: "Engineer of the Future". The introductory speech was delivered by Prof. Dr. Jan Szmidt, PhD – the Chairman of the Conference of the Rectors of Polish Universities and the Rector of Warsaw University of Technology.

Immediately after the inauguration, the working sessions were commenced. "Engineers of the Future at the Centenary of Regaining the Independence", reminding the silhouettes of the outstanding creators of engineering, was the subject of the first panel session. Its moderators were: Prof. Dr. Tadeusz Słomka, PhD., - the Rector of AGH University of Science and Technology and Prof. Dr. Andrzej Nowak, Eng., - the President of the Council of Polish Engineers in the North America (Auburn University). The panellists were: Prof. Jerzy Hausner (Cracow University of Economics), Prof. Dr. Jan Kazior (Cracow Technical

University), Prof. Dr Tadeusz Łodygowski, Eng. (Poznań University of Technology), Mariusz Kondraciuk (Siemens) and Dr Wojciech Kamieniecki (NCBR),

The subject of the successive sessions included was as follows: "Polish Engineers in the Work for Independence". The Centenary of AGH University of Science and Technology in social and political aspects was discussed by Dr. Anna Siwik – the Pro-Rector of AGH. The moderators of the session were: Janusz Romański, PhD. – the President of the Association of Polish Engineers Polonia Technica, Vice-President of the Council of Polish Engineers in the North America and Prof. dr hab. Jerzy Lis, Eng.,- the Pro-Rector for Cooperation of AGH. The participants of the panel were: Prof. Wojciech Stankiewicz (Lithuania), Dr Piotr Szymczak, Eng. (the President of the Association of Polish Electrical Engineers, SEP), Janusz Zastocki, MSc, Polonia Technica (USA) and Bronisław Hynowski from the Society of Technical Culture.

In the evening, during the solemn Engineer's Gala, there were awarded the titles of "Golden Engineer of Polish Technical Review" in category Polonia Engineer and the titles of "Master of Engineering of FSNT-NOT". The title of the Master of Engineering 2018 went to tramway Moderus Gamma – the work of the Modertrans company from Poznań. The Gala was celebrated by the performance of the Assembly of Song and Dance "Krakus" and the Choir Con Fuoco from AGH.

The program of the next day included 6 following sessions: "Engineer and environment", "Engineer – the proposal for the young people", "Engineer in the world of machines (Industry 4.0)", "Engineer and medicine", "Engineer in IT" and "Engineer and infrastructure". During the sessions, the exchange of experience had place and vivid discussions were carried out.

After the closing session which adopted the message and the conclusions from the 4th Convention and the 26th Congress, the solemn Gala "the Poles together" had place. During the Gala, the group of engineers was distinguished with the Piotr S. Drzewiecki Medal. The NOT Cups were also rewarded to the authors and editors, participating in the competition TECHNICUS 2019 for the best technical book and the best technical guidebook. On the occasion of the 15th anniversary of the European Federation of Polonia Engineering Associations, the distinctions were handed by its representatives.

The Convention was ended by the meeting of the presidents and activists of Polonia Engineering Associations and the members of the Chief Board of FSNT-NOT, the Presidium of the Board of Cracow Council of FSNT-NOT and the Steering Committee of the 26th Congress of Polish Technicians and the 4th Convention of Polish Engineers. It had place in historical, 113 years old Cracow House of Engineer of NOT.

The partners of the 4th Convention of Polish Engineers and the 26th Congress of Polish Technicians were: Association "Polish Community" and the Senate of the Republic of Poland and Polish Agency for Enterprise Development (PARP), National Centre for Research and Development in Poland, Office of Technical Inspection (UDT), KGHM Polish Copper, and Polish Scientific Publishers PWN.

The sponsors of the discussed above events included also Siemens Ltd., Polish Chamber of Construction Engineers, Stern Weber Polska Krzysztof Błażejczyk, Enkelman Technologies PTY Ltd., P.M.S.T. Transmeble International Ltd., and Integration B2B.

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