

EVALUATION OF ADVANCES IN WOOD SCIENCE IN 1994-2003 AND MAIN AREAS AND DIRECTIONS OF FUTURE RESEARCH IN POLAND

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SYNOPSIS. The study analyses research projects realized in the field of wood science in the years 1994-2003 in Polish research centres. Priority fields and directions of future research, proposed by individual research institutions, are also listed. Moreover, needs and problems encountered by research workers are also mentioned.

KEY WORDS: wood technology, Polish research institutions, research personnel, present and future, threats and needs

INTRODUCTION

As it is commonly known, wood is the most important renewable resource, the importance of which as a raw material in the mechanical, chemical and physico-chemical aspect is constantly increasing. At a rationally conducted forest economy and proper utilization of wood its resources are practically unlimited. An obvious and valuable advantage of wood is its wide application and a lack of harmful effect on the environment throughout its whole service life. Although this material is within reach, readily available and used to various purposes and in different forms, it is still not thoroughly known. Its efficient industrial utilization still requires insight into numerous aspects of typically material, technological, ecological and economic knowledge. For this reason wood science, as a widely understood scientific discipline, has been developing rapidly worldwide, especially in the countries, in which the economic importance of wood is properly understood and appreciated.

In Poland, having considerable forest resources, thanks to proper forest management providing increasing amounts of wood, wood science – which practically

was created and has developed only after World War II – has not been appropriately represented within the circles of policy-makers and thus has not received the support it deserves. This pertains especially to recent years when wood industry has been privatized and in which financing of science through grants has been implemented.

However, the efforts of the circles of research workers, although decreasing in number and growing old, not only have not resulted in the past decade in a visible deterioration of the standard of research, but in most cases have made it possible to maintain or even improve it. It needs to be stressed, however, that this state of affairs, without a radical change in the expenditure on research as well as the level of salaries, especially for young scientists, may not be maintained for long. Thus, there is a justified fear that in the nearest future this may lead to the practical elimination of this – so important for the national economy – discipline of science.

RESEARCH PERSONNEL

The employment structure in Polish research institutions, involved in research and education for the needs of wood industry is presented through the data contained in Table 1. The total number of research workers directly involved in research projects for the needs of wood industry (except for employees of the Institute of Natural Fibres) is at present 195 and in comparison with 1993 it decreased by 22 persons, i.e. by approx. 10%. However, taking into consideration doctoral students (a total of 37 persons), presently 232 persons carry out research in this field. The core of the research staff is still composed by workers with the Ph.D. degree. Their share in the total number of employed scientists is as high as 46%. Junior lecturers rank next (19%), followed by doctoral students (almost 16%), persons with the post-doctoral degree (10.4%) and professors (8.6%). In terms of the total number of employed workers, the biggest research centre is the Faculty of Wood Technology of the Agricultural University of Poznań (46% of the total number of researchers). The Faculty of Wood Technology of the Warsaw Agricultural University (26%), the Research Institute of Wood Technology (13.3%) and the Institute of Papermaking and Printing of the Technical University of Łódź (almost 11%) rank next. However, the employment structure in individual institutions varies considerably. When the number of junior research workers per a senior research worker is taken as the index of research staff quality, the strongest research teams are those of the Institute of Papermaking and Printing of the Technical University of Łódź and the Faculty of Wood Technology of the Warsaw Agricultural University. In those institutions, for one professor and one worker with a postdoctoral degree there are 1.63 and 1.68 junior research workers, respectively. At the Faculty of Wood Technology of the Agricultural University of Poznań and the Technical Institute of the University of Bydgoszcz this index is approx. 5 persons.

While analyzing the data presented here it needs to be stressed that in the past decade the number of professors has fallen drastically, i.e. by 1/3, in comparison to the status in 1993. At present only 21 persons have the title of professor. In

Table 1. Scientific staff in Polish didactic and scientific institutions of wood technology
 Tabela 1. Kadra naukowa w polskich instytucjach dydaktycznych i naukowych technologii drewna

Institution Instytucja	Scientific degree, Tytuł lub stopień naukowy								
	Professors profesorowie		in this full professors w tym tytularni	Dr. hab. dr hab.		Dr. Eng. dr inż.		MSc Eng. mgr inż.	
	number liczba	mean age, years wiek (średnio) lat	number liczba	number liczba	mean age, years wiek (średnio) lat	number liczba	mean age, years wiek (średnio) lat	number liczba	mean age, years wiek (średnio) lat
Faculty of Wood Technology Warsaw Agricultural University WTD SGGW w Warszawie	7	63.6	7	12	52.5	28	46.6	4	35.5
Faculty of Wood Technology	14	57.5	8	7	53.5	53	48.5	23	30
Agricultural University of Poznań WTD AR w Poznaniu									
Research Institute of Wood Technology Instytut Technologii Drewna w Poznaniu	–	–	–	1	45	9	57	16	46.8
Institute of Papermaking & Printing at the Technical University of Łódź Instytut Papiernictwa i Poligrafii PŁ	4	65	4	4	65	13	52	–	–
Institute of Natural Fibres Instytut Włókien Naturalnych	1	65	1	1	55	11	47	33	46
Technical Institute, University in Bydgoszcz Instytut Techniki, Akademia Bydgoska	1	65	1	–	–	4	40	1	30
Together, average Razem, średnio	27	63.2	21	25	54.2	118	48.5	77	37.7

comparison to the status at the beginning of the reporting period, the biggest drop in the number of professors occurred at the Faculty of Wood Technology of the Agricultural University of Poznań (from 14 in 1993 to 8 in 2003), the Faculty of Wood Technology of the Warsaw Agricultural University (from 11 to 7, respectively) and the Research Institute of Wood Technology, where at present there are no titular professors. It needs to be emphasized here that the above data concerning the current state of research staff with the professor's title, pertain only to professors representing the discipline in question, employed full-time in their main workplace and aged up to 70 years. It may be assumed that this disadvantageous downward trend in the number of professors will be stopped in the next years or even hopefully reversed, as in the reporting period in comparison to the status in 1993, the number of research workers with the post-doctoral degree increased as much as 2.8 times (from 9 to 25). In the analysed period, only the Council of the Faculty of Wood Technology of the Agricultural University of Poznań conferred the post-doctoral degree in forestry sciences in the field of wood science to as many as 17 lecturers, including its 6 workers and 7 workers of the Faculty of Wood Technology at the Warsaw Agricultural University. It may be assumed that in the nearest future this high dynamics in the conferring of the post-doctoral degree will be maintained. However, this will not change the relatively high average age in this group (at present it is approx. 54 years), as a considerable percentage of post-doctoral dissertations to be realized in the nearest future concerns lecturers rather advanced in age (on average 49 years old), who are threatened with rotation. This fact will not contribute to the lowering of the average age of workers with the professor's title, which at present is around 63 years.

The fact that centrally allocated funds for statutory activity and individual research projects are reduced from year to year practically, eliminated the chances for young researchers to be employed as junior lecturers. Primarily for this reason the number of this group of workers decreased by almost 30% (from 61 employed in 1993 to 44 in 2003). Employment in this group was reduced most significantly at the Faculty of Wood Technology of the Warsaw Agricultural University (from 20 to 4) and in the Research Institute of Wood Technology – by 4 workers. Only at the Faculty of Wood Technology of the Agricultural University of Poznań the number of junior lecturers remained practically the same. A very high mean age in this group of workers amounting to approx. 36 years is first of all the effect of rather old junior research workers employed at the Research Institute of Wood Technology (which to a considerable degree results from the specific character of the research tasks). In this institution for 16 employed junior researchers as many as 7 are over 50 years of age. Junior lecturers employed at the Faculty of Wood Technology of the Warsaw Agricultural University are also of a relatively old age (mean age of 35 years).

In comparison to the previous reporting period the number of completed doctoral dissertations increased considerably. At the Faculty of Wood Technology of the Agricultural University of Poznań only in the years 1997-2003 the degree of doctor in forestry sciences in the field of wood science was conferred on 28 persons, including 10 doctoral dissertations written by researchers outside the faculty, originating primarily from other research units (8) and industry (2).

In the analyzed period the title of professor was granted to 6 persons from the Faculty of Wood Technology of the Agricultural University of Poznań, 4 from the analogous faculty of the Warsaw Agricultural University and 4 from the Technical University of Łódź.

STATE OF RESEARCH

Wood science comprises numerous disciplines, starting from chemical wood processing to purely mechanical woodworking. Almost all of them are to a bigger or smaller degree represented in Polish research institutions, which will be briefly discussed below.

Studies on the chemical wood processing and wood chemistry are conducted at the Institute of Papermaking and Printing of the University of Łódź, at the Institute of Chemical Wood Technology of the Agricultural University of Poznań, at the Department of Wood Science and Wood Protection of the Warsaw Agricultural University, the Institute of Cellulose and Papermaking and the Research Institute of Wood Technology. In terms of chemical wood processing studies focus on e.g. environmentally friendly and biotechnological methods of wood and other fibrous raw materials delignification (the Institute of Papermaking and Printing, the Faculty of Wood Technology of the Agricultural University of Poznań, the Research Institute of Wood Technology), water-efficient papermaking technologies and energy-saving design of papermaking machines and equipment (the Institute of Papermaking and Printing), pulping of annual raw materials (the Institute of Cellulose and Papermaking), and utilization of harmful wood manufacturing residues using biotechnological methods (the Research Institute of Wood Technology). The most dynamically developing centre is undoubtedly the Institute of Papermaking and Printing of the University of Łódź. Researchers from this Institute are highly regarded in Poland and abroad. It is manifested in the participation in international research projects, exchange of researchers, participation in conferences and membership in Polish and international scientific organizations and committees (TAPPI, PAPTAC, CFPA, AAAS). The Institute cooperates with the following universities: Manchester University, the University of Technology in Helsinki, the Slovak Technical University, the University of Pardubice, Ecole Française de Papeterie et des Industries Graphiques, the Ukrainian Printing College in Lvov. The Institute is an organizer of INPAP, a cyclical, international scientific conference.

In the field of wood chemistry research is being conducted primarily on the chemical composition of wood substance depending on its location in the stem (the Faculty of Wood Technology, Warsaw Agricultural University) and fast growing species (the Faculty of Wood Technology, Agricultural University of Poznań) and its changes under the influence of biotic factors (microbial wood decomposition in delignification processes, composting, deposition in water or in the ground) and abiotic factors (wood from contaminated areas, wood from disaster areas, from trees grown in substrates fertilized with composts from wood based material

wastes - the Research Institute of Wood Technology). The Institute of Chemical Wood Technology of the Agricultural University of Poznań may boast of scientific advances in the international scale in the production of cellulose-based fibrous carbon materials. Outstanding research results were also obtained in the high temperature processing of lignocellulose materials and the production of sorption materials. The wood chemistry research team of the faculty of Wood Technology at the Warsaw Agricultural University owes its scientific achievements to their long-term fruitful cooperation with the world famous Institute of Wood Chemistry in Riga. The high position of both institutions may be evidenced by numerous publications in Polish and foreign journals.

An important area of scientific activity of both Faculties of Wood Technology and the Research Institute of Wood Technology is the field of adhesives, glueing and surface finishing of wood and wood-base materials. Undoubtedly the leading role in this respect is played by the Department of Glueing and Finishing of Wood, Agricultural University of Poznań. The research team of the Department in the last 10 years may boast of considerable achievements in such research projects as the synthesis and modification of resins, the determination of physico-chemical structure of these resins and lacquers, studies on surface phenomena in the polymer – wood system, the determination of bond quality and service value of finished surfaces and the application of environmentally friendly cementing and finishing agents. All these problems, found in the current trends in science worldwide, have also been presented in numerous publications in Polish and foreign journals. A lasting contribution to science is also the fact that 6 handbooks and monographs were published in the years 1994-2003, including one book in German, prepared together with an author from the Technical University of Dresden. The Department organized also 5 scientific conferences on studies and applications of adhesives, with the participation of many foreign researchers.

Another centre having considerable achievements in the discussed research field is the Research Institute of Wood Technology. The achievements of this research institution comprise e.g. the development of a novel production method of adhesives for the manufacturing of wood-base materials on the basis of reactive urea solvents, the determination of the structure and properties of model melamine-urea-formaldehyde resins (MUF), the development of new generation MUF polycondensates modified with natural polymers and the development of a novel method of melamine determination in liquid or hardened MUF resins using NIR, FTIR-ATR and FTIR-PAS technologies. Moreover, one of the achievements of the Institute may also be the development, within the framework of cooperation with the CTBA Institute in Paris and SDVU in Bratislava, of an original glueing method for veneers with elevated moisture contents, as well as an agent increasing initial adhesion of urea-formaldehyde resins and a formulation facilitating the application of this resin in the production of interior plywood in the technology with mechanical loading of multi-opening presses. The innovative and original character of these solutions is evidenced by the obtained patents. In the discussed period a monograph publication was also published on glues and glueing, entitled “Resin glues from reactive urea solvents for the production of wood-base materials”.

The problem of adhesives and wood glueing is also investigated at the Faculty of Wood Technology of the Warsaw Agricultural University. As a result of the reorganization of the Faculty in 2000 research and teaching activities from the Department of Wood Science were transferred to the Department of Wood-Based Materials. In the analysed period, a considerable achievement of this team was the development – by Prof. Barbara Gos who died in July 1999 – of the technology of a series of hot melt glues with properties equal to or exceeding those of imported adhesives. Moreover, the project concerning the application of condensates from post-synthesis concentration of amino plastic resins as curing agents limiting the emission of free formaldehyde was also successfully completed.

The primary field of science for wood technologists is wood science. Studies in this area have been conducted at both Faculties of Wood Technology and at the Research Institute of Wood Technology. Research carried out in the last decade at the Department of Wood Science in Poznań focused on two main areas: ecological and technological wood science. In the first field the radial and height variation in structural properties and selected physical properties of wood were investigated in case of species preferred for afforestation of formerly agricultural areas.

In this respect conditions and the duration of juvenile tree growth were determined, among other things. An original achievement was the finding that at the same content of latewood in growth increments the worse the position of a tree in the stand, the higher wood density is. Results obtained recently suggest that the intensity of wood tissue formation affects the microfibril angle in the cell wall. Studies in this respect are also conducted in numerous other countries.

In terms of technological wood science the research conducted at the Department focused on e.g. studies on the process of flexural creep of beams under asymmetrical moisture changes. Moreover, an original method was developed for the determination of locked-in moisture stress from the course of mechano-sorptive creep of wood. Significant findings resulting from the conducted studies include also the determination of limiting values of wood strain, initiating the process of its destruction. Studies connected with the application of the acoustic emission method are also of practical importance, as they will facilitate its use in the monitoring, or even controlling the wood drying process and generally the assessment of its technical quality. Investigations conducted in this respect are consistent with the current trends represented by leading research institutions worldwide and the results of these studies were published in a major part in renowned foreign journals. The high scientific standing of the Department is evidenced by the membership of its workers in the past and in the present in such organizations as the International Association of Wood Anatomists (IAWA) and the International Academy of Wood Science (IAWS).

In Warsaw (the Department of Wood Science and Wood Protection) research in wood science covers also two areas. One of them includes structural studies, within the framework of which botanical identification of wood originating from historical monuments and archeological excavations has been conducted (in cooperation with the National Museum and the Archeological Museum, and provincial conservators of historical monuments). In this respect Polish and Coptic archeological wood needs to be mentioned here along with wood from the Tertiary

period excavated in Bełchatów (in cooperation with INIA – Madrid). In this area of interest there are also studies connected with the creation of an atlas of micro- and macrostructure of exotic wood and the Department wood collection of wood, in which as a result of exchange with 35 research institutions worldwide samples and documentation of over 2 thousand species have been collected to date. The other area comprises studies on the physico-mechanical properties of wood, including also rheology of excavation wood. Investigations aiming at the determination of transverse cohesion of knotty wood and elastic constants using radiation and ultrasound technology are also of considerable value. Results of the above mentioned studies were presented at numerous scientific conferences in Poland and abroad and published in renowned national and foreign journals. The team of wood science specialists of the Faculty of Wood Technology of the Warsaw Agricultural University is of well-established high scientific standing both in Poland and abroad and its head is a member of IAWA.

Considerable practical value is also rightfully attributed to research work carried out at the Research Institute of Wood Technology. It concentrated on the determination of properties of wood from degraded sites, wood of lower age grades and meranti wood in terms of its suitability for the production of building joinery.

Wood-based materials are the basic material used at present in furniture manufacturing. These materials are also commonly used worldwide in the construction of family housing, while in Poland this is the case only in a minimal degree. Studies on this application of wood-based materials are conducted at the Faculties of Wood Technology of both Warsaw and Poznań Agricultural Universities, the Research Institute of Wood Technology, the Research and Development Centre for Wood-Based Panels in Czarna Woda and partly at the Institute of Papermaking and Printing and the Institute of Natural Fibres.

At the Faculty of Wood Technology, the Warsaw Agricultural University several studies connected with industrial practice were conducted on the effect of technological parameters on the properties of plywood and on new designs and glueing methods for this material. The chemical composition of industrial wastes from the production of plywood was analysed in all production plants, along with the possibility of their pretreatment and utilization (a patent). The technology of pressing homogenous particle boards was developed (a patent), as well as the technology of non-glue adhesion of wood particles and the technology of plaster-cardboards manufactured from waste materials. Moreover, the suitability of cereal straw for the production of particle boards was also determined. At present long-term studies have been initiated on the application of waste plastics in the technology of wood-based materials. In this respect a new technology was developed, which in 2003 was awarded the first prize in the national competition “Recycling of Technology – Technology of Recycling” organized by the National Environment Protection Fund and the daily “Gazeta Wyborcza”. Studies conducted at the Department of Wood-Based Materials, which in the 1990’s was transformed into the Sub-department, follow the newest trends in science worldwide.

At the Faculty of Wood Technology, the Agricultural University of Poznań, at the Department of Wood-Based Materials most research projects focused on problems connected with the production and modification of resins to improve their

hygienic standard, water resistance and strength of boards. This area is especially important nowadays at the development of frame building construction, observed recently in Poland. Numerous scientific and practical achievements were reported in this field. It needs to be stressed that a large part of the results of research carried out at the Department was published in journals from so-called Philadelphian list.

The most important scientific and practical achievements of the Research Institute of Wood Technology in the field of wood-based materials are the identification and determination of buffer capacity of various wood assortments and its effect on properties of particle boards. This made it possible to develop formulations of adhesives and technological guidelines for waste recovery (an international patent and practical application). Moreover, numerous studies for industry were realized here, which facilitated the production of boards meeting strict standards of environment protection, fungi- and fire-resistant boards, plywood from veneers with elevated moisture contents, etc. It needs to be emphasized here that the results of work carried out at the Institute were generally successfully implemented in production plants.

During the reporting period the Research and Development Centre for Wood-Based Panels in Czarna Woda within the framework of a theme project designed, manufactured and tested structural elements from OSB boards, which were subsequently used to construct a two-storey building solely from these boards. Within the framework of another theme project the possible application of used wood in particle board technology was tested under industrial conditions. A significant achievement of the Centre was its co-participation in the construction of the new type defibrator RT150 with increased capacity. At present studies are being conducted on a new single-stage defibrating system. At this Centre the production of a special type of floor boards was developed and initiated.

The Institute of Papermaking and Printing participated in the designing, construction and start-up of a new dewatering machine for fiberboards. At the Institute of Natural Fibres studies are conducted on composites with the addition of annual plant materials.

Although the wood drying process is one of the most important in wood technology, research achievements in this area are rather modest. At the Faculty of Wood Technology, the Agricultural University of Poznań, the interdependency of process and material factors was investigated in case of the process of lumber drying, while at the analogous Faculty of the Warsaw Agricultural University studies were realized on the possible application of solar energy in wood drying. In turn, at the Research Institute of Wood Technology principles were developed for thermal processing of packaging materials in order to reduce the risk of spreading harmful organisms.

Final products from solid wood and from wood-based materials comprise furniture and all types of wood structures. Problems in this field are investigated at the Department of Furniture Design of the Faculty of Wood Technology of the Agricultural University of Poznań, the Sub-department of Wood Product Construction and Technology of the analogous faculty at the Warsaw Agricultural University, at the Technical Institute of the University of Bydgoszcz and the Research Institute of Wood Technology. In terms of basic research concerning wood

structures the Poznań centre plays the leading role. Achievements of the Department of Furniture Design of the Agricultural University of Poznań are not smaller than those of leading research centres worldwide and focus primarily on the optimization of structures, especially the strength of all types of joints and furniture and construction structural elements. In these studies modern research and analytical techniques are used (e.g. acoustic emission method, MES, computer digital image analysis). The effect of conducted studies were numerous doctoral dissertations and a dissertation for the post-doctoral degree, as well as publications in renowned foreign journals. A similar research area is investigated at the Technical Institute of the University of Bydgoszcz.

At the Faculty of Wood Technology, the Warsaw Agricultural University the field for continuing studies is historical furniture (cooperation with museums), designing special purpose furniture (school, preschool, office furniture and furniture for the disabled) as well as new materials. In the latter field the technology of manufacturing laminated veneer lumber (LVL) from hardwood was developed.

Studies conducted over the period of many years and experiments in furniture design made it possible for the Research Institute of Wood Technology to obtain certification authority in furniture safety.

Research in mechanical wood and wood-based materials woodworking processes focuses around problems connected with woodworking itself and with the technology and quality of manufactured products.

Basic research, concerning woodworking processes, is practically carried out only at the Faculty of Wood Technology, the Warsaw Agricultural University at the Department of Woodworking Machines and Woodworking Processes. Some of the major achievements include e.g. the analysis of grinding with a new type grinder, a study on the cutting process using a chain saw, investigations on the cutting parameters using new generation tools, the determination of heat balance of the cutting process, a reduction of noise emission by circular saws, etc.

Studies on the technology and quality of sawn timber are carried out at the Faculties of Wood Technology of the Agricultural Universities in Warsaw and Poznań, and at the Research Institute of Wood Technology. In this field at the Department of Wood Science and Wood Protection of the Warsaw Agricultural University development studies were conducted on a large scale together with educational activities concerning strength grading of structural lumber (e.g. dependencies were established between wood density and lumber strength), directions and effects were investigated of adaptation activities of the Polish wood industry for the purpose of integration with the EU in terms of standardization. At the Faculty of Wood Technology, the Agricultural University of Poznań a computer program TarGraf was developed for the analysis of efficiency of sawmill production and the specific character of wood processing was investigated in small and medium-sized plants in Poland. At the Research Institute of Wood Technology strength-graded structural softwood lumber was tested, the technology of small-sized wood converting with circular saws was implemented, the quality of hardwood from flooded areas was determined, as well as economic usability of wood from post-agricultural areas and wasteland.

In each wood processing technology waste materials are produced. The utilization of wastes and used wood is at present a serious problem. Depending on the degree of contamination with components other than wood, industrial residues need to be used for further processing (recycling), or possibly used as a source of energy, or for composting. Processing of industrial residues in production plants requires special care, due to the chemical contamination they contain. The problem of appropriate management of wood industrial residues and wood products after the completion of their life cycle, is thus a serious research task. Studies in this respect are conducted first of all at the Research Institute of Wood Technology, where an original method was developed, in which national resources of industrial residues and used wood were estimated. At the Institute studies are also conducted on the thermal conversion, composting and incineration of wastes. The utilization of manufacturing residues for the production of composites was also the subject of investigations at the Faculty of Wood Technology in Warsaw and in the Research and Development Centre for Wood-Based Panels in Czarna Woda.

Research and development work in wood protection against fire, abiotic and biological depreciation has been conducted at the Faculties of Wood Technology in Poznań and Warsaw, at the Research Institute of Wood Technology and the Institute of Natural Fibres. The main direction of research in wood protection, both in Poland and worldwide, is the development and implementation in practice of agents harmless for the environment. Considerable achievements in this respect were obtained at the Research Institute of Wood Technology, where in cooperation with the Poznań University of Technology biodegradable biocides were developed – new generation quaternary ammonium salts. Moreover, a fungicide, FUNGOSEPT, was developed and implemented for production for the protection against stain caused by blue-stain fungi. Studies are also conducted on increasing wood resistance to light and biological factors through its thermal processing and on the biological activity of ion liquids.

Studies on new wood protection agents are also carried out at the Faculties of Wood Technology in Warsaw and Poznań.

At the Institute of Natural Fibres studies are focused on agents for protection against fungi and fire (patents) first of all of fibres, but also of wood.

In the recent period a radical change was observed in the conditions and principles of management, also in wood industry, which also resulted in a huge demand and interest in economics, organization and management in wood industry. Science in this respect is represented by a separate Sub-department of the Department of Technology, Organization and Management in Wood Industry of the Warsaw Agricultural University, at the Department of Economics and Wood Industry Management of the Agricultural University of Poznań and the Department of Wood Industry Economics of the Research Institute of Wood Technology. While in both universities the dominant object of studies has been a company as a unit, at the Research Institute the focus is on complex and multidimensional studies concerning the whole wood industry sector and its individual branches. In such a type of studies the Institute plays generally the role of the national research coordinator and it may boast of extensive achievements in this respect. This research institution contributed greatly to the process of creating the theoretical founda-

tions for wood industry economics under conditions of market economy. In this respect the problems of the wood market were systematized, a monograph study was prepared concerning trends in wood prices; an original method was developed to assess resources of used wood, as well as a new method to assess the efficiency of raw material utilization and a method to assess the competitiveness of Polish wood industry. At the Institute numerous studies were carried out, mostly of practical application. Some of them were prepared for central administrative organs. The Institute is also an official creator of statistics for this branch of industry on the international scale. Within the framework of realized grant projects principles of raw material policy were established for wood and wood-base products, forecasts were prepared for the development of the forestry and wood industry sector taking into consideration the regional structure and the primary part of the governmental "Strategy for wood industry up to the year 2006" was prepared.

Some of the major achievements of the Faculty of Wood Technology, the Warsaw Agricultural University include the participation in the development (together with the Research Institute of Wood Technology) of the strategy for the development of wood industry in Poland and the introduction, starting from 1999, of studies on the adaptation of the Polish wood industry for its operation within the EU. Moreover, a unique study (a post-doctoral dissertation) was prepared on "Technical and technological changes in wood industry in Poland in the years 1870-1939".

The Department of Economics and Wood Industry Management, the Agricultural University of Poznań has conducted studies concerning the development of small and medium-sized enterprises. In this respect a total of over 30 papers were published, together with a book, which was highly regarded by business. The research subjects investigated at the Department include also: management of manufacturing processes, utilization of wastes (especially waste paper), the development of marketing tools, product quality and organization of manufacturing processes.

PRIORITY FIELDS AND DIRECTIONS OF RESEARCH

Each discipline of science, including wood science, is global in its scope. It is thus expected from Polish science that it will not only affect the development of Polish wood industry, but also ensure appropriate contribution to the advance of science worldwide. Thus, research tasks realized in Polish research institutions, characterized briefly above, included also the basic problems of world wood industry. Studies in the field of wood science, planned for the nearest years in Polish research centres will follow the trends in world science.

Research priorities in wood chemistry and chemical wood technology will include:

- the creation of a data base on the chemical composition of wood species found in Poland,
- chemical and thermal modification of wood to improve its service life,

- chemical conversion of used wood,
- studies on cellulose-based fibrous carbon materials,
- studies on environmentally friendly methods of manufacturing and bleaching fibrous pulps and water-efficient papermaking technologies.

In the field of adhesives, glueing and finishing wood surfaces and wood-based materials work will focus on such problems as:

- new, environmentally friendly bonding agents,
- improvement and optimization of polycondensation of MUF resins modified with natural polymers,
- reactive hot melt adhesives based on polyurethane resins and silanes,
- investigations on surface phenomena in the polymer – wood system,
- preparation of surfaces of materials with limited glueability,
- new generation adhesives for upholstered furniture in solvent-borne and dispersion versions,
- dispersion polyurethane adhesives,
- aminoplastic polycondensation resins based on reactive solvents,
- the application of MDI in the modification of waterborne wood adhesives,
- surface finishing of wood species with limited paintability,
- new lacquers for building joinery,
- properties of used finish.

In terms of wood science currently important research problems include:

- the determination of the effect of conditions of wood tissue formation on its technical properties,
- structural conditions of wood shaking as a result of simultaneous action of moisture, thermal and mechanical stress,
- improvement of non-destructive testing methods for studies on wood properties,
- creation of a data base on properties of wood from different geographical regions of Poland,
- determination of performance of tropical wood.

Priority research subjects in wood-based materials will cover:

- new laminated materials,
- new agglomerated materials, obtained on the basis of industrial residues, annual plants and plastic waste materials,
- wood-based materials capable of being formed curvilinearly,
- wood-based boards for the building industry,
- improvement of machines for energy-saving wood defibration.

In wood drying processes research problems will include:

- automation and control of solid wood drying to ensure its appropriate quality,
- new methods of monitoring and controlling the drying process (e.g. acoustic emission and ultrasound methods),
- new drying methods (e.g. drying of whole logs).

In terms of wood structures and furniture design in the nearest future studies will focus on the following problems:

- new methods of strength optimization of joints in case of furniture and construction elements (acoustic emission method, method of finite elements, computer digital strain image analysis),
- rationalization of furniture structures,
- conservation of historic furniture.

Research problems concerning sawn lumber will concern:

- properties of elements of joined structures and wood-non-wood material composites taking into consideration newly determined Poisson's ratios,
- the effect of strength quality of lumber on the properties of laminated elements,
- strength grading of structural lumber and improvement of standardization in this respect,
- material-efficient wood working and utilization of small-sized wood,
- forecasts and systems of computer production control of sawn lumber,
- new techniques and technologies to manufacture high quality sawn lumber in view of EU standards,
- adaptation of Polish technologies and production systems to EU standards,
- efficiency of wood processing at local resources,
- new applications for solid wood and processing technologies for Polish and exotic hardwood materials.

In terms of mechanical processing of wood and wood-based materials, research will be directed at the improvement of working conditions and tools used in mechanical wood material processing.

In the nearest future the research task connected with industrial residues and used wood will be continued in the aspect of their utilization as an energy source and for composting.

Research problems in wood protection will remain the same as before. They will still focus on:

- new, harmless for the environment wood protection methods against biological corrosion and natural ageing processes, studies on their structure and mechanism of action on wood and the influence on soil and water,
- protection and conservation of wooden historical monuments,
- fire protection of wood,
- increasing service life of wood using physical methods.

Economic, organization and management aspects in wood industry may be outlined in the following research subjects:

- economic and organizational aspects of operation in case of a wood industry enterprise,
- management methods and techniques in small and medium-sized wood industry companies,
- formation of clusters in the wood sector,

- international competitiveness of branches of wood industry and of wood products,
- innovative character of wood products and their manufacturing technologies,
- principles of manufacturing residue management,
- functioning of prices on international markets of wood raw materials,
- behaviour and preferences of wood product buyers on the market,
- principles and forms of wood product sale.

RISKS AND NEEDS CONNECTED WITH DEVELOPMENT

The major problems in this respect include:

1. The accelerating process, extending over the past decade, of ageing of research workers, a decreasing number of professors with the scientific title (by 1/3 since 1994) and a lack of progress in the fulfillment of this generation gap. In the opinion of most respondents the system of junior lecturers employed full time is a much better system of educating young researchers, since it makes it possible to gain research experience and acquire the necessary expertise and ensures a conscious selection of the subject of the dissertation. Doctoral studies should remain as an additional education system.
2. Insufficient funds for scientific research allocated both by the state budget and supplied by business.

Funds within the framework of scarce grants are allocated to randomly selected projects, not those included in the schedule of priority problems, agreed upon by the scientific community.

Primary branches of wood industry were privatized and are owned by international corporations, with their own research and development centres, hence not interested in the development and implementation of Polish technologies. In the process of privatization no system was created ensuring the inflow of funds for research from this source.

The possibility to join framework EU programmes is at present and will remain limited for some time in the future. It is necessary to create an international team and meet numerous formal requirements. Technical projects have to include the participation of a company interested in their implementation. Moreover, financing on the part of EU may only cover up to 50% planned expenditure. The basis for the creation of the research team are personal contacts between the participants and the common knowledge of their research standard and potential. To achieve this it is necessary to have frequent, direct contacts, either through research stays and training periods, or through participation in scientific conferences. It is also necessary to considerably increase the number of publications in renowned professional journals. However, “starting” funds are required to initiate all these actions.

There is no unemployment among graduates from both Faculties of Wood Technology. Moreover, working in industry already at the beginning of the professional

career ensures a better financial status than starting a job at a university. Without any solution to this problem, i.e. not providing appropriate conditions for young researchers at the onset of their career and not showing to them a possibility for further professional development and a proper position among the elite of the society may lead to the squandering of the achievements, which were created from nothing in the course of several decades since the end of World War II.

OCENA DOKONAŃ W DYSCYPLINIE NAUKOWEJ DRZEWNICTWO ZA LATA 1994-2003 ORAZ GŁÓWNE OBSZARY I KIERUNKI PRZYSZŁYCH BADAŃ W POLSCE

Streszczenie

W pracy przedstawiono strukturę i stan liczebny kadry naukowowo-badawczej w polskich placówkach realizujących badania na rzecz drzewnictwa. Opisano problematykę badawczą realizowaną w latach 1994-2003 oraz wymieniono, zgłoszone przez poszczególne placówki naukowe, priorytetowe obszary i kierunki przyszłościowych badań. Wskazano także na potrzeby i zagrożenia, z jakimi boryka się kadra naukowa.

Stwierdzono, że wysiłki malejącej liczbowo i starzejącej się kadry pracowników naukowych nie tylko nie doprowadziły w ubiegłym dziesięcioleciu do widocznego obniżenia poziomu badań, lecz w większości przypadków pozwoliły ten poziom utrzymać, a niekiedy nawet podwyższyć. Stan ten jednakże, bez radykalnej zmiany nakładów na badania, jak i poziomu uposażeń, szczególnie młodych pracowników nauki, nie da się długo utrzymać. Istnieje przeto uzasadniona obawa, że w najbliższej przyszłości doprowadzić to może do marginalizowania tej, tak potrzebnej gospodarce narodowej, dyscypliny.

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