Self-evaluation report

2014/2015

University of Zagreb
Faculty of Chemical
Engineering and Technology

University of Zagreb
Faculty of Chemical
Engineering and Technology

FKITMCMXIX

Class: 003-01/14-02/05
Reg. Number: 251-373-1/1-15-03

Zagreb, 26th January 2015

Name of the evaluated higher-education institution
University of Zagreb, Faculty of Chemical Engineering and Technology

Name of the University the evaluated higher-education institution is a component of:
University of Zagreb

Year of Establishment:
1919

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Dean, Prof. Bruno Zelić, Ph.D.

Name of the bank and the business account number of the higher education institution:
Zagrebačka banka, IBAN: HR7223600001101338626

Members of the Commissions for Preparation of Self-Evaluation Report of the Faculty of Chemical Engineering and Technology of the University of Zagreb within the Reaccreditation Procedure were nominated by the Dean's decision on 30th October 2014. (Class: 003-01/14-02/05; Reg. Number: 251-373-1/1-14-01).

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Content

1. MANAGEMENT OF THE HIGHER EDUCATION INSTITUTION AND QUALITY ASSURANCE

1.1. Faculty of Chemical Engineering and Technology Then and Now

The roots of the Faculty of Chemical Engineering and Technology date back to 1919, when the **Technical Institute** was founded in **Zagreb** with the aim of "*providing comprehensive theoretical, but also practical education as much as possible for such technical ranks, the professions of which are represented in this institute*".

One of the then departments was the Chemical Engineering Department, the first Dean of which, Prof. **Vladimir Njegovan**, Ph.D., from the very beginning strove to ensure the teaching and scientific activity modelled upon European and American higher-education institutions. He was especially engaged in the process of finding teachers, and how successful he was in so doing is best exemplified by the names of **Ivan Marek**, a well-known inventor of the furnace for elemental analysis of organic chemicals, **Ivan Plotnikov**, a world renowned photochemist, **Franjo Hanaman**, an inventor of a Tungsten filament for electric bulbs and later on, **Vladimir Prelog**, a future Nobel laureate.

In 1926 the Technical Institute became the **Technical Faculty of the University of Zagreb**, (with Chemical Engineering Department as its constituent part) allowing teachers and associates a more intensive scientific activity. In addition to Vladimir Prelog, who was the first to introduce organic synthesis in Croatia, there were many other junior scholars who became recognised in the world of science and technology, including: **Vjera Marjanović-Krajovan**, **Rikard Podhorsky**, **Karlo Weber**, **Matija Krajčinović** and **Miroslav Karšulin**.

All of them went abroad for scientific training and upon their return shared the experiences acquired by raising the level of knowledge and influencing the development of their profession. As early as in 1935 Rikard Podhorsky, in parallel with the developments in Europe and based on his American experiences, promoted chemical engineering as a distinct scientific discipline that is "equally important to a chemical engineer as pure disciplines of chemistry and physics".

Following the restructuring of the Technical Faculty in 1956, the Chemical Technology programme of study was taught at the Faculty of Chemical, Food and Mining Technology, and from 1957 within the newly-founded **Faculty of Technology**. In that period it became a core wherefrom new faculties were established. In 1978 the Faculty of Metallurgy and in 1980 the Faculty of Food Science and Biotechnology became separate faculties, and finally when on 16 November 1991 the Faculty of Technology split into the **Faculty of Chemical Engineering and Technology** and the Faculty of Textile Technology, the long lasting wish of the Faculty to become independent came true.

From its foundation until now the Faculty has paid undivided attention to the education of scientific, research-oriented and professional young generations in the academic areas of chemistry and chemical engineering, the mutually intertwined and complementary disciplines. Following the introduction of the Bologna model of higher education in 2005, four undergraduate and four graduate programmes of study were proposed and adopted as a result of a respectable scientific activity in the academic areas of chemistry, chemical engineering, fundamental technical sciences and interdisciplinary technical sciences: **Chemical Engineering, Environmental Engineering and Materials Chemistry and Engineering** in the field of technical sciences and **Applied Chemistry** in the field of natural sciences. Today the Faculty is licensed to conduct the elections to research and academic ranks in the field of natural sciences (academic area of chemistry), and in the field of technical sciences (academic areas of chemical

engineering and fundamental technical sciences). Nowadays the Faculty teachers also participate in the execution of courses taught in the undergraduate programmes of study of the University of Zagreb: Engineering (in English) and Military Engineering (major course of study: Nuclear-Biological-Chemical Defence).

The abundant scientific activity of the Faculty teachers was a foundation to initiate the postgraduate (PGPS) programmes of study of great importance. As early as in the academic year 1960/1961 the PGPS **Corrosion and Protection of Materials** was initiated, and in 1963/1964 also the PGPS **Silicate Chemistry and Technology** was introduced. In 1965 the PGPS **Engineering Chemistry** was organised as well with the following major courses of study: inorganic, organic and chemical engineering. In 1980 the PGPS **Engineering Chemistry** was established within which all students attend joint compulsory courses, and then enrol in the major courses of study: Chemical Engineering, Organic Processes, Polymer Engineering, Non-Metals, Construction Materials and Corrosion Protection, Petroleum and Petrochemistry, Protection of Working and Living Environment, Marine Technology, Energy and Textile Engineering. The major course of study: Automatic Process and Measurements Control was also introduced subsequently, and the major course of study: Protection of Working and Living Environment was renamed into Environmental Protection in Technological Processes. The completion of the programme of study resulted in the academic rank of the Master of Science in the academic area of Chemistry or Chemical Engineering, depending on the topic of the master thesis and the courses enrolled. In 1992 **Chemical Engineering** separated from the PGPS **Engineering Chemistry** as an independent PGPS. Following the introduction of the Bologna model in 2005, the postgraduate doctoral programmes of study (PGDPS) were introduced as follows: **Engineering Chemistry** in the field of natural sciences, academic area of chemistry and technical sciences, academic area of other fundamental technical sciences and **Chemical Engineering** in the field of technical sciences, academic area of chemical engineering. In the academic year 2013/2014, the Faculty, encouraged by the University of Zagreb, integrated the doctoral programmes of study: Engineering Chemistry and Chemical Engineering as the first one at the University. The accreditation procedure was carried out and in the academic year 2013/2014 the Faculty was granted the licence by the University to execute the new doctoral programme of study **Chemical Engineering and Applied Chemistry**. In the academic year 2013/2014 the Faculty was granted the licence by University of Zagreb for the specialist university programme of study **Petroleum and Petrochemical Engineering** initiated in accordance with the interest expressed by and in agreement with the Croatian petroleum and petrochemical industry. Furthermore, the Faculty is a coordinator of the postgraduate specialist university programmes of study: **Environmental Engineering** and **Corrosion and Protection**.

Throughout the period of the Faculty restructuring and development, the Faculty encountered great difficulties in the implementation of the curricula and research activities beyond the reach of the Faculty academic and non-academic staff. The basic reasons were modest financial resources available to the Faculty, which, augmented by increasing statutory obligations, and consequently higher costs of implementation of the measures of occupational health and safety (resulting from working with reagents) and environmental protection, are not sufficient to organise and implement teaching, research and professional activities in the premises used by the Faculty, which premises constitute cultural monuments. Consequently, the maintenance of the premises and the execution of instruction and research activities largely require the investment of financial resources resulting from the cooperation with the industry or contracted scientific and professional projects. Different locations at which the premises are situated also pose a problem to the Faculty. Today the Faculty uses the premises that are not under its ownership, and are situated at three basic locations: Marulićev trg 19 and 20, and Savska cesta 16. The Strategy of Spatial and Functional Development of the University of Zagreb, adopted on 8th July 2014, provides for the migration of the Faculty, together with other technological and some technical faculties of the University of Zagreb, to the Borongaj Research and Education Campus of the University of Zagreb by 2017. Accordingly, in its 177th regular session held on 24th March 2014, the Faculty Council rendered a decision, by absolute majority of votes of the Faculty

Council members, on the adoption of the proposal for the preliminary design of the building for the Faculty of Chemical Engineering and Technology of the University of Zagreb at the Borongaj Research and Education Campus.

In compliance with the Faculty Development Strategy for Period 2008-2013, the recommendations of the Expert Commission under the Final Faculty Evaluation Report of 11th November 2008, and the analysis carried out by the Commission for the Faculty Development Strategy and the Commission for the Faculty Restructuring, and taking into account the organisation of instruction, organisation of scientific and research activities and professional activity, teaching workload, availability and usage of equipment, requirements for occupational health and safety and the Faculty management, in its regular 182nd session held on 27 November 2014 the Faculty Council rendered a decision on the Faculty restructuring.

1.2. Organisational Structure

The Dean and the Faculty Council constitute the **Managing Bodies** of the Faculty. Departments, Chairs, the Library and Information Centre and the Secretariat are the **Organisational Units of the Faculty**. **The Faculty Departments and the Chairs** are organised in compliance with the teaching and scientific and research activity of the Faculty. The Department/Chair is managed by the Head.

The **Library and Information Centre** (BIC – *Bibliotečno-informacijski centar*) is an organisational unit and the central library of the Faculty headed by the senior librarian.

The **Secretariat of the Faculty** is an organisational unit in charge of joint administrative, general and auxiliary affairs of the Faculty. The Secretariat is run by the Secretary. The Secretariat is comprised of: the Dean's Office, Office of Administrative and General Affairs, Office of Material Transactions and Financial Management and Technical and Auxiliary Offices.

The students are involved in the management structure of the Faculty: students' representatives account for minimum 15% of the total number of members in the Faculty Council.

The organisational structure of the Faculty is shown in Figure 1.1.

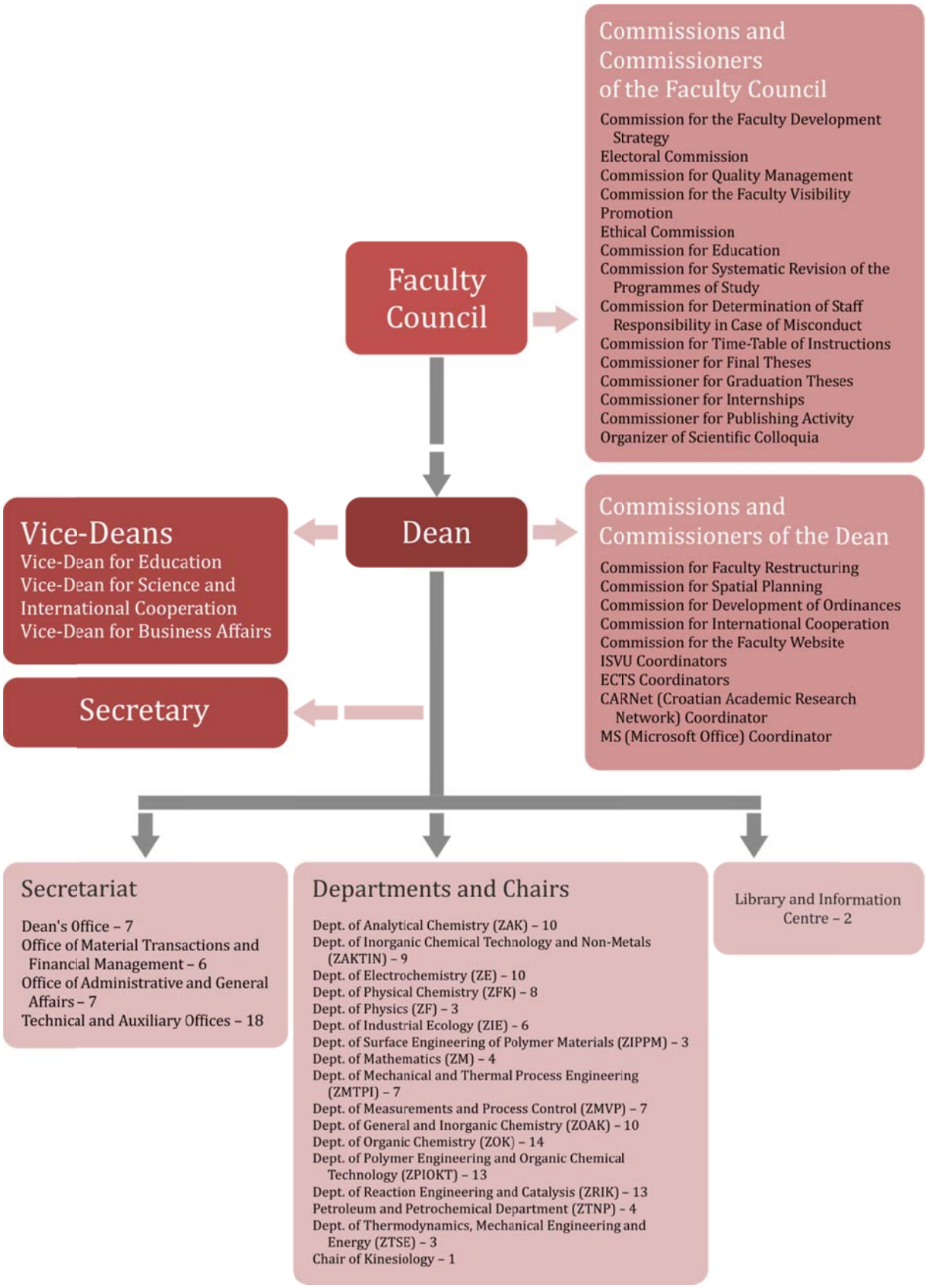

Figure 1.1 The organisational structure of the Faculty with indicated number of employees

1.3. The Faculty Leadership

The Dean and the Faculty Council are the Managing Bodies of the Faculty.

The Dean is responsible for the governance of the Faculty, and is its head and director. The Dean is appointed by the Faculty Council and elected by secret ballot in accordance with the rules stipulated under the Statute of the Faculty.

The Dean represents the Faculty, organises and runs the operations and business activities of the Faculty, takes business decisions in compliance with the regulations, chairs the Faculty Council and proposes the agenda for the sessions of the Faculty Council. In accordance with his/her position, s/he is a member of the relevant Academic Area Council, proposes to the Faculty Council the measures to improve the operation of the Faculty, implements the decisions of the Faculty Council, the decisions of the Senate and of the Academic Area Council relevant for the Faculty, by written power of attorney authorises another person to represent the Faculty, appoints the persons authorised to sign financial and other documentation, takes decisions on investment maintenance, proposes to the Faculty Council the appointment of the Vice-Dean, initiates and executes the disciplinary procedure against the Faculty staff, renders second instance decisions in administrative cases, and also performs other activities in accordance with the The Science and Higher Education Act (the Act), the Statute of the University and the Statute of the Faculty.

The Vice-Dean and the Secretary provide assistance to the Dean in his work. The Faculty has three Vice-Deans, including:

1. Vice-Dean for Education
2. Vice-Dean for Business Affairs
3. Vice-Dean for Science and International Cooperation

The Vice-Deans are appointed and acquitted by the Faculty Council as proposed by the Dean by secret ballot. In case of absence of the Dean, the Faculty is represented by one of the Vice-Deans. The Vice-Dean may be appointed from the ranks of teachers elected to the academic rank. The Vice-Deans are appointed for the period of two years. They are responsible to the Dean and the Faculty Council.

The Vice-Dean for Education is in charge of the activities relating to the implementation and improvement of the curricula in the undergraduate and graduate programmes of study and the life-long learning programmes, and carries out the activities which concern professional trainings and publishing activity.

The Vice-Dean for Business Affairs is in charge of the activities relating to the creation of business and development policies, budget of the Faculty, financial plan, that is, annual action plan and programme of the Faculty, and takes any measures necessary to prepare and implement the foregoing documents, including providing the sources of financing for the implementation as well as any measures necessary to coordinate the functioning of particular organisational units within his/her scope of activity.

The Vice-Dean for Science and International Cooperation is in charge of the activities relating to the implementation and improvement of the postgraduate programmes of study and international cooperation in the field of educational, scientific and professional activities of the Faculty.

The Secretary of the Faculty is an employee having special rights, authorisations and responsibilities who organises and coordinates the operation of the Secretariat, renders first-instance decisions in administrative cases, and also executes other activities stipulated under the Faculty acts and as ordered by the Dean of the Faculty. The Secretary is responsible to the Dean of the Faculty.

The Faculty Council is an expert council of the Faculty. The Faculty Council is composed of all teachers elected to the academic rank, five (5) representatives of teachers and associates elected to teaching and associate ranks and representatives of students of the Faculty undergraduate, graduate and postgraduate programmes of study. The students' representatives account for minimum 15% of the total number of the Council members.

The representatives of teachers and associates are elected by teachers and associates for the period of two years. The students' representatives also participate in the activities of the Faculty Council in a manner stipulated under the Statute and the Students' Union Act. The students' representatives participate in the activities of the Faculty Council equally with other members, excluding the awarding procedures for the doctoral degree, election of the nominee to the honorary rank of *professor emeritus* and election to academic ranks. When the issues of special concern to students are considered, the students' representatives have a right to a suspensive veto. The issues of special concern to students are the issues relating to the regulation of rights and obligations of students, changes in the system of the programme of study, quality assurance of the programme of study, adoption of the curricula, establishment of the curricula and the students' standard of living.

The Faculty Council adopts the Statute of the Faculty by more than fifty percent of votes of the total number of members, elects the Dean and the Vice-Deans, carries out the elections for the members of the Academic Area Councils and the Senate, adopts the Annual Dean's Report, adopts the budget and the annual financial statement of the Faculty, cares for and takes decisions with the aim of quality assurance of the programmes of study and the scientific activity, initiates the procedure of the curricula adoption and takes care of the execution of the curricula, programmes of study and scientific research projects, and gives opinions on the proposals for the university curricula and programmes in general or in the areas within its scope of activity, proposes to the Dean the act on job organisation in the Faculty, proposes to the Senate educational, scientific and professional programmes, determines the topics of undergraduate and graduate theses, as well as their mentors, as proposed by the applicant appoints mentors for doctoral dissertations, appoints the commissions in the awarding procedure for the Master's and Doctoral degree, gives consent for the engagement of teachers outside the Faculty and the University and refers the proposal to the University Senate for final adoption, establishes new and develops the current research capacities at the level of relevant scientific discipline, initiates and carries out the elections to academic, teaching and associate ranks in compliance with the Act, adopts the revision of courses for the current academic year as proposed by the Departments, that is, the Chairs, provides conditions for free individual and group initiatives of researchers, teachers and students in scientific, teaching and professional activities, provides its opinion concerning procurement, installation and usage of major, medium-size and minor equipment at the University, gives consent to the Dean to take legal actions in the name of and for the account of the Faculty in the value exceeding from HRK 1,000,000 to HRK 3,000,000, in any procedure for election or re-election takes decision on the announcement of vacancies and appoints the expert commission to implement the procedure for the election to academic and teaching ranks, carries out the awarding procedure for the Doctoral degree, initiates the awarding procedure for the academic rank of *professor emeritus*, adopts its Rules of Procedure and carries out other activities in accordance with the Act, Statute of the University and Statute of the Faculty.

The Faculty Council may appoint commissions and committees in order to resolve specific issues falling under its competence. The number of members of the commission and the committee and the scope of their activity is determined under the Appointment Decision. The members of the commission and the committee are largely persons who are holders of the academic rank and permanent employees of the Faculty. The Faculty Council discusses and takes decisions on the activities falling under its competence in its sessions. The sessions of the Faculty Council are held once a month as a rule. The Faculty Council's discussions and decisions are valid when more than a half of the total number of members is present in the session.

1.4. Elements of Integration

The Faculty is a component of the University of Zagreb (hereinafter: the University). Although it is an independent legal entity and has its own business account, the operation of the Faculty corresponds with the Statute of the University, effective University Development Strategies and any other legal and normative acts of the University. Additional elements of integration which show interconnection and interdependence between the Faculty and the University are the following:

- Teachers of the Faculty participate in work of the working bodies and committees of the University (Senate, Council of the Field of Engineering, Council of the Field of Natural Sciences, Commission for Doctoral Dissertations, Working Group for Programmes of Study, Commission for Academic Recognition of Foreign Higher Education Qualifications).
- The Faculty participates in the execution of instruction in the interdisciplinary postgraduate specialist university programme of study Environmental Engineering together with another 12 institutions (of which eight components of the University), and is also the coordinator of that programme of study.
- The Faculty participates in the execution of instruction in the interdisciplinary postgraduate specialist university programme of study Corrosion and Protection together with another four components of the University, and is also the coordinator of that programme of study.
- The Faculty participates in the execution of instruction in the interdisciplinary postgraduate specialist university programme of study Crisis Management together with another 12 components of the University.
- The Faculty participated in the preparation and establishment of the undergraduate university programme of study Engineering in English together with another four components of the University.
- The Faculty participated in the preparation and establishment of the undergraduate university programme of study Military Engineering together with another 11 components of the University and the Croatian Military Academy "Petar Zrinski".
- The teachers of the Faculty participate in the execution of instruction in undergraduate, graduate, specialist and doctoral programmes of study of other components of the University.
- The teachers of other components of the University participate in the execution of instruction in undergraduate, graduate, specialist and doctoral programmes of study of the Faculty.
- The teachers of the Faculty together with teachers of other components of the University participate in the preparation and implementation of different scientific and professional projects coordinated by the Faculty or other components of the University.
- The Faculty participates in joint projects of the University such as: e-learning, doctoral schools, University Fair, Centre for Development of Teacher Competences, establishment of the Croatian Centre for Advanced Materials and Nanotechnology, organisation of scientific conferences and panel discussions, etc.

1.5. Ethical Issues

Teachers, researchers and other employees of the Faculty have an obligation to act in accordance with moral and ethical principles contained under the Code of Ethics of the University of Zagreb (hereinafter: the Code of Ethics) when performing their professional and public activities. The principles of the Code of Ethics are applied appropriately to both students and persons other than the Faculty staff, who participate in the operation and activities of the Faculty and also in those cases in which the conduct and actions of such persons may be associated with the Faculty. Morally justified conduct especially implies acting in accordance with the following principles: the principle of peaceful exercise of rights, the principle of respect

for the integrity and dignity of the person, the principle of research, artistic and teaching autonomy, the principle of equality and fairness, the right to academic freedom, the principle of professionalism and the principle of respect for rights and legal procedures.

With regard to the foregoing, any form of direct or indirect discrimination on account of religion, ethnicity and nationality, race, gender, sexual orientation, style of life, material status, background, family and marital status, pregnancy, family obligations, age, disability, physical appearance, political affiliation and medical condition is considered inadmissible. The ethical rules concern in particular the following phenomena: harassment, prejudice, professional obligations for quality assurance in teaching, unacceptable teaching practices, exploitation of humans and animals in scientific research and artistic activity, fabrication of results, falsification, plagiarism, fabrication and alteration of letters of recommendation, acceptance of gifts and other assets, conflict of interest, transparency and confidentiality, right to and obligation of continuous professional training and life-long learning, professional advancement, public appearance and responsibility towards the academic community. The **Ethical Commission** of the Faculty takes care of the achievement and improvement of ethical standards at the Faculty and of the implementation of the Code of Ethics, all of which is under its competence. The Ethical Commission is authorised to interpret the provisions of the Code of Ethics autonomously and to apply them according to its discretion, in the spirit of their values. Morally justified conduct and ethical rules are also partially included in the internal acts of the Faculty: Ordinance on Students' Disciplinary Responsibility, Ordinance on the Staff Responsibility for Misconduct, Labour Ordinance, Occupational Health and Safety Ordinance and Ordinance on Studying in Undergraduate and Graduate Programmes of Study of the Faculty. Ethical conduct is additionally controlled by the analysis of the findings of the student survey wherein students have an opportunity to indicate any teacher's misconduct. The Dean and the Vice Dean for Education are responsible for the analysis of the survey findings and as appropriate initiate adequate procedure and notify the competent commissions, the Ethical Commission, the Commission for Determination of Staff Responsibility in Case of Misconduct and the Commission for Students' Disciplinary Responsibility.

The ethical conduct can also be supervised by means of a system which facilitates the procedure of anonymous reporting of unacceptable conducts in the academic community or other infringements of the provisions of the Code of Ethics, and which Code was taken over from the University of Zagreb. The system can be accessed over a link on the homepage of the Faculty website.

1.6. Mission and vision

The mission and vision of the Faculty are determined under the Faculty Development Strategy.

The mission of the Faculty is to promote chemical engineering, applied chemistry, materials engineering and environmental protection engineering as scientific disciplines by establishing links between science and technology and economy, industry and public activities, with the aim of achieving sustainable development, increasing the general level of innovation in the society, accelerating knowledge transfer, that is creating and promoting new entrepreneurship.

The vision of the Faculty is to become recognised in the Central European region as a venue of "good vibrations", a focal point of partnership- and cooperation-based gathering at the international, national and local level, in the projects developing innovative and improving current chemical processes, products, that is materials and in the environmental protection projects. The students who complete their undergraduate, graduate and postgraduate programmes at the Faculty will be sought as excellent and broadly educated human resources competent in finding efficient problem solutions within their scope of activity. The public at large will recognise the Faculty as an institution showing corporate social responsibility within the scope of its scientific, educational and professional activity.

1.7. Distinctive Quality of the Faculty within the Republic of Croatia

The scope of activity of the Faculty is determined under its mission. The Faculty is primarily active in the field of natural sciences, academic area of chemistry and in the field of technical sciences, academic area of chemical engineering, fundamental technical sciences and interdisciplinary technical sciences. Some teachers of the Faculty are also active scientifically in the field of biotechnical sciences, academic area of biotechnology, and in the field of natural sciences, academic areas of mathematics and physics. Given the primary scientific scope of activity of the Faculty, only the Faculty of Chemistry and Technology (KTF – *Kemijsko-tehnički fakultet*) of the University of Split can be considered a similar institution in the Republic of Croatia. The similarity between the scope of scientific activity of the Faculty and the KTF results in similar programmes of study at all levels and similar organisation of the two institutions, which is understandable as in 1960 it was precisely the Faculty academic staff who initiated the KTF; they were its first teachers and they appointed the first teachers and teaching assistants of the newly initiated KTF. The importance of the Faculty within its scope of activity can be clearly illustrated by a comparison between the scientific productivity and the number of students who complete their doctoral programmes of study at both institutions in compliance with the statistics available in the Croatian Scientific Bibliography[1]. In the last five years the employees of the Faculty elected to the academic ranks published 449 papers (74 of which in 2014) cited in the tertiary databases of Current Contents, which accounts for average 1.21 (1.28 in 2014) paper per year for that category of employees. On the other hand, in the last five years the employees of the KTF elected to the academic ranks published 134 papers (16 of which in 2014) cited in the tertiary databases of Current Contents, which accounts for average 0.70 paper (0.42 in 2014) per year for that category of employees. A similar ratio can also be found for students who completed their doctoral programme of study. Thus in the last five years the Faculty had 69 doctoral students (12 in 2014) who completed their doctoral programme of study in comparison with 17 doctoral students (4 in 2014) who completed their doctoral programme of study at the KTF. In the period 2007–2013 the Faculty had 34 projects in total financed by the Ministry of Science, Education and Sports in comparison with 13 projects funded by the same source at the KTF. The foregoing indicates that within the areas of chemical engineering and applied chemistry the Faculty represents approximately 80% of the total scientific productivity in the Republic of Croatia as expressed by the number of scientific papers of the highest category and the number of students who completed their doctoral programmes of study.

1.8. Redundancy and overlaps within the University of Zagreb

The activity of the Faculty is determined under its mission. The Faculty is the only component of the University of Zagreb primarily active scientifically and professionally in the field of technical sciences, academic area of chemical engineering and in the field of natural sciences, academic area of chemistry, branch of applied chemistry. As all undergraduate, graduate, specialist and doctoral programmes of study at the Faculty are based on scientific and professional activity of the Faculty teachers; there are no significant overlaps between the activity of the Faculty and the activity of other components of the University.

1.9. Quality Assurance System

The quality assurance of the scientific and teaching activity at the Faculty is fully implemented in accordance with the stipulated measures and the Action Plan of the **Faculty Development Strategy for Period 2008–2013** drafted during the Faculty evaluation procedure initiated according to the schedule of activities of the National Council for Higher Education in 2008.

[1] *https://bib.irb.hr/*

The Faculty Development Strategy for Period 2015–2020 was drafted within the procedure of drafting this Self-Evaluation Report and is attached as a separate document.

The Faculty Quality Assurance Manual (hereinafter: the Manual) was drafted in February 2015, and envisaged as a document whereby the current experience and activities concerning quality improvement at the Faculty will be connected with the Standards and Guidelines for Quality Assurance in the European Higher Education Area (commonly known as ESG), by representing the required concepts, standards, procedures, plans and activities to the professional public at large and will be used as a reminder, guideline and assistance to any stakeholders in the creation and improvement of the quality assurance standard and in promotion of the quality culture at the Faculty.

The Ordinance on Quality Assurance System of the Faculty[2]is harmonised in October 2014 with the Ordinance on Quality Assurance System of the University of Zagreb[3] drafted in January 2011. The Plan and the Annual Report on the Quality Assurance System for the last five-year period were submitted to the Committee for Quality Management of the University once a year.

The Bodies in charge of Quality Assurance System Implementation at the Faculty are the Faculty Council, the Dean and the Commission for Quality Management. These bodies are responsible for quality management in all areas of activity of the Faculty.

The Commission for Quality Management in its activities concerning the quality assurance system at the Faculty receives assistance of the following bodies: the Commission for Faculty Development Strategy, the Electoral Commission, the Commission for the Faculty Visibility Promotion, the Ethical Commission, the Commission for Education, the Commission for E-Learning, the Council of the Doctoral Programme of Study, the Council of the Specialist Programme of Study, the Commission for Systematic Revision of the Programmes of Study, the Commission for International Cooperation, the Commission for Spatial Planning, the Commissioner for Final Theses, the Commissioner for Graduation Theses, the ECTS Coordinator, the ISVU (Higher Education Institutions Information System – *Informacijski sustav visokih učilišta Republike Hrvatske*) Coordinator, and other commissions, committees, commissioners and coordinators appointed by the Faculty Council or the Dean.

During the previous five-year period all the bodies in charge of implementing the quality assurance system worked on the establishment of the objectives and procedures required to achieve the results in accordance with the requirements of the stakeholders and the policies of the Faculty, took care of the application of the procedures established, monitored and evaluated the procedures in compliance with the policies, objectives and requirements, reported on the results and took actions for ongoing improvement of the procedure implementation.

The Dean, the Commission for Quality Management, the Ethical Commission and the Council of Doctoral Programmes of Study submit annual reports to the Faculty Council and/or to the University of Zagreb with the Action Plan, whereas other quality management bodies submit their reports over the Dean or the Vice-Dean at the sessions of the Faculty Council.

The activity of all quality management bodies in the previous five-year old period was determined by the mission and vision of the Faculty and identified under the Faculty Development Strategy for Period 2008–2013, as well as under the strategic documents of the University of Zagreb. Since the activities and the measures provided under the Faculty Development Strategy for Period 2008–2013 were largely implemented, it can be concluded that all quality management bodies carried out the activities under their scope of activity as planned.

The elements of quality assurance systems are shown in table 1.1 as well.

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[2] *http://www.fkit.unizg.hr/_download/repository/Pravilnik_o_sustavu_osiguravanja_kvalitete_FKIT_Sveucilista_ZG.pdf*

[3] *http://www.unizg.hr/fileadmin/rektorat/O_Sveucilistu/Dokumenti_javnost/Propisi/Pravilnici/PRAVILNIK_KVALITETA_final.pdf*

1.10. Strategic Objectives of the Faculty Management

In each of the seven areas of the self-evaluation process one major strategic objective will be defined. Before them, the "zeroth" strategic objective will be defined as well.

STRATEGIC OBJECTIVE 0:

- To migrate the Faculty to the new location of Borongaj Research and Education Campus of the University of Zagreb

STRATEGIC OBJECTIVE 1: (Management of the Higher Education Institution and Quality Assurance)

- To implement the rendered decision on the Faculty restructuring

STRATEGIC OBJECTIVE 2: (Programmes of Study)

- To analyse and optimise permanently the programmes of study by interacting with all stakeholders of education system

STRATEGIC OBJECTIVE 3: (Students)

- To increase the input quality level of undergraduate students

STRATEGIC OBJECTIVE 4: (Academic Staff)

- To modernise the teaching process and thus to increase its quality level

STRATEGIC OBJECTIVE 4: (Scientific and Professional Activity)

- To confirm and raise the indicators of scientific and professional productivity

STRATEGIC OBJECTIVE 5: (Mobility and International Cooperation)

- To intensify the mobility and international cooperation

STRATEGIC OBJECTIVE 6: (Resources)

- To increase the financial autonomy

Strategic objectives are not lone islets; reaching one of them would affect reaching all the others. For example, migration of the Faculty to the new location would enable the achievement of full effect of implementation of the Faculty restructuring, which would then be transferred by the logical decision-making pathway and quality assurance procedures into all other strategic areas. Regardless of the migration, which is anyhow far beyond the financial reach of the Faculty and depends on the interest and investment of the state funds, more modern and increased-quality programmes of study and more motivated teachers would attract better – indigenous and foreign – students; this would in turn reduce the average duration of study and make it cheaper which would affect the financial result as well. Working with better students would be less exhausting for teachers, which could in turn put more effort into science and professional work with the involvement of the very same students. This would raise the indicators of productivity as well as increase the financial autonomy by the income generated by transfer of knowledge into industry. Better indicators of productivity would increase the level of international recognition and number of international contacts, facilitate the outgoing mobility of academic staff and students as well as attract more money from international projects. This would in turn raise the productivity level even further and so on. Beside the direct financial effect, better indicators of scientific and professional activity would increase the sphere of influence of the Faculty in the society – particularly with respect to those responsible for funding the migration to the new location of Borongaj Research and Education Campus.

1.11. SWOT Analysis

The main advantages and shortcomings of the programmes of study, human and material resources of the Faculty are indicated below as **SWOT** analysis (strengths, weaknesses, opportunities and threats).

Strengths

- Traditionally well substantiated teaching practice by scientific and professional activities
- Experiment- and problem-oriented science- and research-based teaching approach in compliance with the principles of contemporary organisation of instruction
- Academic staff with international scientific reputation and a large number of competent junior researchers and teaching assistants, as a guarantee of scientific production

Weaknesses

- Poor working conditions of the Faculty (premises)
- A lack of financing by line ministries as a result of a poor economic situation

Opportunities

- Foreseen migration to the new building at the Borongaj Research and Education Campus
- Broad level of knowledge of Faculty scholars in the field of natural and technical sciences, which in addition to scientific excellence, also facilitates understanding of a broad spectrum of issues encountered by the industry and the public sector
- Interdisciplinary approach based on tradition and activities of researchers in the fields of natural and technical sciences

Threats

- Claims filed by some employees on account of special working conditions
- A drop in quality of primary and secondary school education in combination with insisting on the pass rate, which directly affects the level of knowledge of applicants and as a consequence exerts pressure to lower the criteria in the higher-education system
- Difficult situation in the chemical industry which resulted in phasing out of a portion of chemical manufacturing plants and reduced the labour market demands

1.12. Previous evaluations

In the procedure of the Faculty evaluation initiated according to its annual schedule of activities the National Council for Higher-Education in the 53rd session held on 7th May 2008 rendered the Decision on the Appointment of the Expert Commission for the Faculty Quality and Efficiency Evaluation Procedure. After having examined the Faculty Self-Evaluation Report, the Expert Commission visited the Faculty (6th and 7th November 2008), and followed it up by a Report of the Commission on the Evaluation and its Findings adopted by the National Council for Higher-Education in its 60th session held on 8th April 2009.

In addition to the Report of the Commission, together with the final assessment and the recommendations for quality improvement and enhancement, the Decision was also rendered wherein the Minister was recommended to issue the License to the Faculty for Performing Higher Education Activity and Executing Programmes of Study. In accordance with the above-mentioned, on 20th May 2009 the State Secretary of the Ministry of Science, Education and Sports of the Republic of Croatia issued the License to the Faculty for Performing Higher Education Activity and Executing Programmes of Study, for the execution of which a preliminary license had been issued. The recommendations given by the Expert Commission in its Report were largely adopted and in accordance with the recommendations many improvements were made in all segments of activity of the Faculty within the timeline and the volume provided under the measures and the Action Plan of the Faculty Development Strategy for Period 2008–2013. A lack of functionality in the premises where the Faculty is currently operating, different

locations of the premises, high maintenance costs and inability to make adjustments to the needs of the teaching, research and professional activities in the 21st century is the only serious shortcoming the Faculty was not able to remove in the previous period, although it made ongoing investments in maintenance of the current premises. Nevertheless, there are certain guarantees that this problem will also be resolved in due time. The Strategy of Spatial and Functional Development of the University of Zagreb adopted on 8th July 2014 provides for migration of the Faculty to the new building on the Borongaj Research and Education Campus. In the framework of the activities around migration of the Faculty to the new location, in its 177th regular session held on 24th March 2014 the Faculty Council rendered a decision on adoption of the proposal for the preliminary design of the building of the Faculty on the Borongaj Research and Education Campus.

In August and September 2014 the Croatian Engineers Association (HIS – *Hrvatski inženjerski savez*), in cooperation with the *European Federation of National Engineering Associations* (*FEANI*), carried out the independent external evaluation of undergraduate and graduate programmes of study of the Faculty completing in the technical field: Chemical Engineering, Materials Chemistry and Engineering and Environmental Engineering. All evaluated programmes of study were in compliance with the requirements for education of engineers and on 4th October 2014 were included in the so-called *FEANI* Index, i.e. a list of recognised faculties and programmes, which allows all students of the Faculty graduate programmes of study to obtain the so-called European Engineering Card after completing one of the foregoing programmes of study which provides them with free access to the EU labour market. All the recommendations received during the above-mentioned evaluation, which concern the foregoing programmes of study of the Faculty, were adopted and included in the execution of the course-related curricula.

1.13. Comparison with a Foreign Higher Education Institution

The higher education institution comparable with the Faculty is the Faculty of Chemistry and Chemical Engineering, University of Maribor (FCCE UM). Both institutions share the fundamental scientific fields of activity, that is, close cooperation between the researchers active in the field of natural sciences, academic area of chemistry and those active in the field of technical sciences, academic area of chemical engineering, fundamental technical sciences and interdisciplinary technical sciences. Due to similar scientific interests of the academic staff working for these two institutions, as a foundation of development of the programmes of study, both institutions execute programmes of study similar in content and with high level of correlation. A distinctive quality which makes these two institutions different in comparison with other faculties active in the field of technical sciences, is that some programmes of study are completed in the field of technical sciences, and some in the field of natural sciences. Furthermore, there is a high correlation between the ratio of the number of students in undergraduate and graduate programmes of study and the number of teachers holding academic ranks (16.5 the Faculty: 21.9 FCCE UM).

1.14. Participation in Public Hearings

In the previous five-year period the Faculty participated in public hearings relating to the adoption of the Scientific Activity and Higher Education Act, Environmental Protection Act and Construction Act. The greatest number of activities were carried out to prepare the baselines to regulate engineering professions, as well as to draft legislation to regulate the issue of the Chamber of Engineers. The Faculty staff participated in drafting of the Strategy of the University of Zagreb, as well as in the public hearing prior to the adoption of specific strategies. They were engaged with the Croatian Academy of Sciences and Arts, Croatian Academy of Engineering, Croatian Engineers Association, European and international scientific and professional

associations and public and invited lectures in forums and conferences organised in Croatia and abroad, books, papers published in scientific and professional references, and participated actively in adoption of various decisions of public concern and public dissemination primarily in the areas of chemical and pharmaceutical industry and environmental protection.

1.15. General Discussion and Proposals

The Faculty has four undergraduate and four graduate programmes of study, one doctoral and one postgraduate specialist programme of study, and is also a coordinator of two specialist postgraduate programmes of study of the University of Zagreb. The curricula of the foregoing programmes of study are executed in the scientific fields of technical and natural sciences and are based on strong publishing activity of the employees of the Faculty holding academic, teaching, associate and research ranks and offices. Despite science- and research-based, experiment- and programme-oriented approach to instruction in compliance with the principles of contemporary teaching organisation, the teachers having international scientific reputation and a large number of competent junior researchers and teaching assistants as guarantees of scientific production, the Faculty encounters many problems in the implementation of the curricula and scientific activity primarily connected with modest financial resources available to the Faculty and inadequate premises situated at different locations. A lack of financial resources required to cover material costs, statutory obligations connected with the specific scope of activity of the Faculty, the costs of implementation of occupational health and safety and environmental protection measures are compensated by the Faculty own revenues and business rationalisation. Inadequacy and different location of the premises in which the Faculty operates present an ongoing obstacle to the further Faculty development. This also constitutes the only strategic objective of the Faculty (**Strategic Objective 4**) determined under the Faculty Development Strategy for Period 2008–2013 which was left unachieved, although the Strategy of Spatial and Functional Development of the University of Zagreb provides for migration of the Faculty to the Borongaj Research and Education Campus by 2017.

Taking into account the results of the analysis carried out by the Commission for Faculty Development Strategy and the Commission for Faculty Restructuring, and having in mind the organisation of instruction, organisation of scientific, teaching and professional activity, teaching workload, availability and usage of equipment, occupational health and safety requirements and the Faculty management, the proposal for the Faculty restructuring was drafted and adopted by the Faculty Council, whereby **Strategic Objective 0** under the Faculty Development Strategy for Period 2008–2013 was achieved in full.

In the previous five-year period the reforms of the undergraduate and graduate programmes of study were also implemented, the doctoral programmes of study Chemical Engineering and Engineering Chemistry were rationalised and integrated into the doctoral programme of study Chemical Engineering and Applied Chemistry and a new postgraduate specialist study Petroleum and Petrochemical Engineering was initiated based on the interest expressed by and in cooperation with the Croatian petroleum and petrochemical industry, whereby the measures provided in **Strategic Objectives 1, 2 and 7** under the Faculty Development Strategy for Period 2008–2013 were largely achieved, which were used to analyse and reform the current programmes of study and to propose new programmes with the aim of establishing such programmes which will attract best potential students, as a result generating engineers and researchers of excellent education able to respond to the demands of the industry and public sector in the area of interest of the Faculty.

The implementation of the self-evaluation of the entire teaching process, an increase in the number of courses in English and the number of courses that can be taught in English, an increase in the number of e-courses, periodical internal evaluation carried out by the Commission for Systematic Review of the Programmes of Study and the Commission for Education, offering of substitute jobs having in mind the need for more rational execution of all

programmes of study of the Faculty, encouragement of mobility and involvement of external associates from the scientific institutions and industry in instruction in postgraduate programmes of study gave a significant contribution to the achievement of **Strategic Objective 3** under the Faculty Development Strategy for Period 2008–2013 connected with ongoing improvement of the teaching process in compliance with state-of-the-art trends in the area of higher education.

The scientific and research activity resulted in scientific production whereby the Faculty was classified to be at the very top of the University of Zagreb and in the Republic of Croatia by the number of employed scholars. In this way favourable indicators of scientific and professional activity of the Faculty were verified and partially also improved, whereby **Strategic Objective 4** under the Faculty Development Strategy for Period 2008–2013 was also largely achieved.

The research and professional, national and international projects, studies, reports, congresses and workshops, initiated and implemented in the last five-year period helped the Faculty to gather partners and associates from Croatia and foreign countries and to simultaneously enhance the financial autonomy of the Faculty, whereby **Strategic Objectives 5** and **8** under the Faculty Development Strategy for Period 2008–2013 were largely achieved.

Although the Strategic Objectives under the Faculty Development Strategy for Period 2008–2013 were largely achieved, alongside the afore-mentioned lack of funds, inadequate and premises situated at different locations and claims filed by some employees on account of special working conditions, this self-evaluation report also includes some other issues which do not impede considerably the regular activities of the Faculty, but provide an opportunity for further development of the quality assurance system of the Faculty. In addition to the foregoing, such issues primarily concern an increase in outgoing and incoming student, academic and non-academic staff mobility, development of new and reform of the current programmes of study in order to make adjustments to the demand of the labour market, more intensive cooperation with the industry on scientific and professional projects, an increase in the number of project applications and the resulting increase in the number of scientific projects financed by international and national funds, better visibility of the Faculty in the media and an increase in the general level of quality culture at the Faculty.

1.16. Tables

Table 1.1 Internal Quality Assurance

Type of activity	Activity holder (name of body or persons)	Frequency of activity (number of meetings or actions per year)	Number of reports resulting from specific activities in the last 5 years	Practical outcomes of the activity (descriptive in self-evaluation report)
Thematic sessions on teaching quality	Faculty Council/Dean	Monthly	Equal to Faculty Council session number	Faculty Council Minutes and corresponding decisions related to instructions in the undergraduate, graduate, specialist postgraduate and doctoral programs, Dean's Annual Reports, Commission for Quality Management Annual Reports, new programme of study proposals (doctoral program Chemical Engineering and Applied Chemistry; specialist postgraduate program Petroleum and Petrochemical Engineering), minor amendments of undergraduate programmes of study
	Dean's Council	Weekly	5	
	Commission for Education/Vice Dean for Education	Monthly	5	
	Commission for Quality Management	As needed	5	
	Council of the Doctoral Programme of Study /Vice Dean for Science and International Relations	Monthly	5	
Work of the Committee (Commission) for Teaching Quality Monitoring	Commission for Education/Vice Dean for Education	Monthly	5	Dean's Annual Reports, Commission for Quality Management Annual Reports, Analysis of undergraduate and graduate study programmes, doctoral study programme forms Dr.Sc.04, Dr.Sc.05 and Dr.Sc.09
	Council of the Doctoral Programme of Study /Vice Dean for Science and International Relations	Monthly	5	
	Commission for Quality Management	As needed	5	
	Commission for Systematic Revision of the Programmes of Study /Vice Dean for Education	As needed	2	
Student survey (implementation, analysis, dissemination of findings to students, opinions of teachers)	Vice Dean for Education/Commission for Quality Management	3	Student survey for individual courses + 10 student surveys for undergraduate and graduate study programmes	Student survey results for evaluation of teaching staff for academic years 2009/2010, 2010/2011, 2011/2012, 2012/2013 and 2013/2014 (winter and summer semester), Survey results for evaluation of undergraduate and graduate programmes of study performed by graduate students in academic year 2009/2010, 2010/2011, 2011/2012, 2012/2013 and 2013/2014
SWOT analysis at the higher-education institution level	Commission for Faculty Development Strategy	As needed	1	*SWOT* analysis as a part of Faculty Development Strategy for Period 2015–2020
Monitoring of quality indicators at the higher-education institution*	Commission for Quality Management	As needed	5	Commission for Quality Management Annual Report
Other forms of evaluation	Dean/Vice Dean for Science and International Relations/Commission for Education	As needed	1	Independent external evaluation of undergraduate and graduate programmes of study of the Faculty completing in the technical field: Chemical Engineering, Materials Chemistry and Engineering and Environmental Engineering carried out by the Croatian Engineers Association (HIS – *Hrvatski inženjerski savez*), in cooperation with the *European Federation of National Engineering Associations* (*FEANI*). All evaluated programmes of study were in compliance with the requirements for education of engineers included in the so-called *FEANI* Index, i.e. a list of recognised faculties and programmes.

*Ordinance on the Content of License and Conditions for Issuing the License for Performing Higher Education Activity, Executing Programmes of Study and Reaccreditation of Higher Education Institutions (Official Gazette, Number 24/10) and Ordinance on Conditions for Issuing License for Performing Scientific Activity, Conditions for Reaccreditation of Scientific Organisations and the Content of License (Official Gazette, Number 83/2010)

2. THE PROGRAMMES OF STUDY

2.1. The Configuration of the Programmes of Study

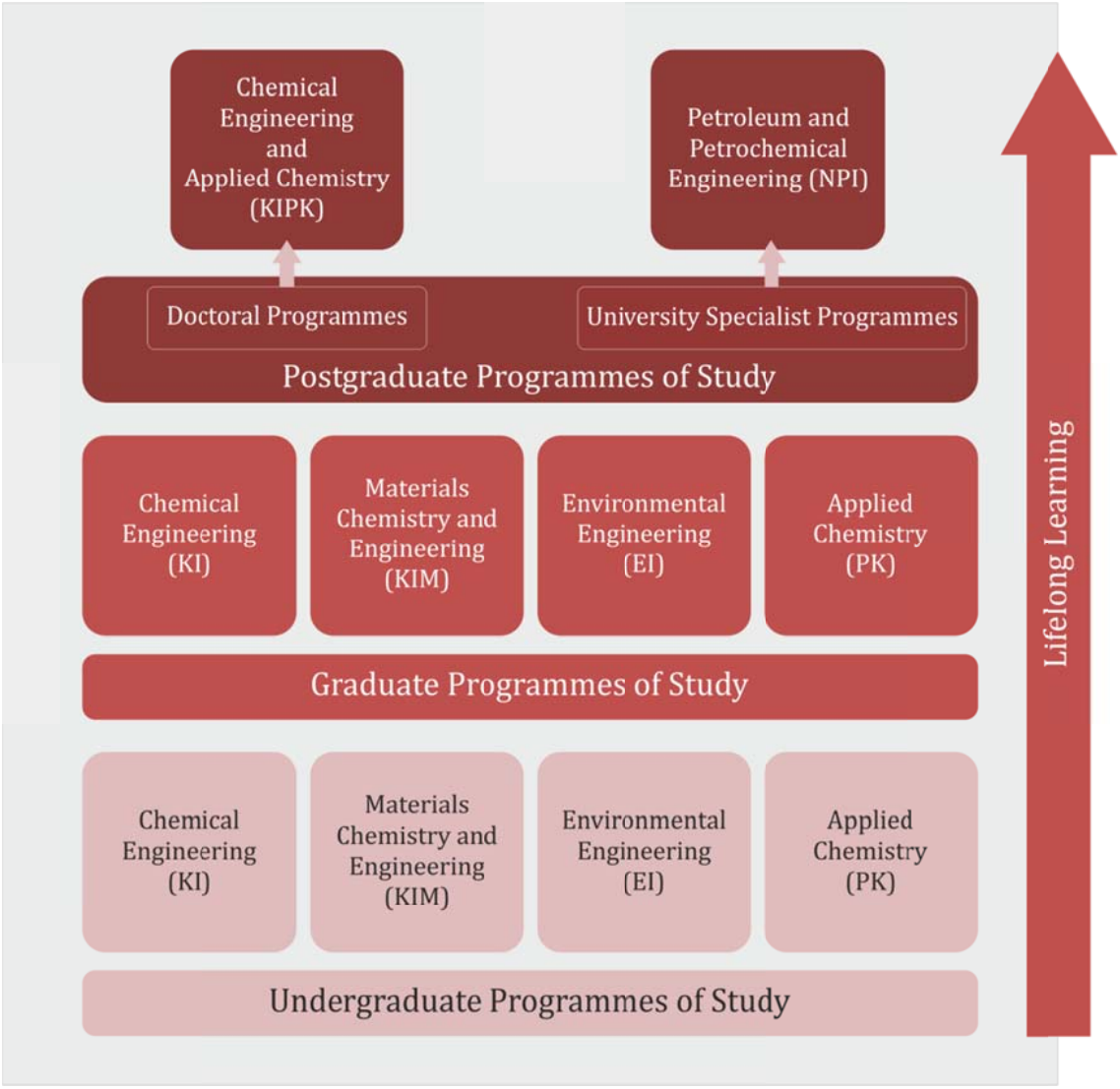

Figure 2.1 Diagram of the configuration of the Faculty programmes of study (by vertical axis)

The current structure of the programmes of study (Figure 2.1) follows up the tradition of the previous programmes of study, social needs, comparability with similar programmes in Europe and worldwide, and is a result of the aspiration to achieve excellence in education provided by the Faculty. The undergraduate programme of study **Chemical Engineering** (KI – *Kemijsko inženjerstvo*) is a direct follow-up of the tradition in chemical engineering education the Faculty rests upon, upgraded with new developments and technologies and close cooperation with the industry. The undergraduate programme of study **Materials Chemistry and Engineering** (KIM – *Kemija i inženjerstvo materijala*) relies on the scientific excellence of the Faculty in the area of

materials, as well as on the increasing development and application of advanced, nanostructured materials in all walks of life and industry. The undergraduate programme of study **Environmental Engineering** (EI – *Ekoinženjerstvo*) is developed in accordance with the growing need for highly educated experts in the area of environmental protection and sustainable development. The undergraduate programme of study **Applied Chemistry** (PK – *Primijenjena kemija*) is based on traditionally excellent education in the area of chemistry, on which account this Faculty generated top-notch experts in the area of organic and analytical chemistry who contributed significantly to the development of pharmaceutical industry in Croatia.

All undergraduate programmes of study are naturally followed up by their counterparts in the graduate programmes of study, in which programmes the knowledge and competences acquired during the first three years of studying are increased and broadened by visits to industrial facilities and participation in scientific research of the Faculty teachers. The graduate programmes of study of the Faculty are also available to students who completed similar undergraduate programmes of study at other Faculties, who have to take differential courses or sometimes enrol in differential years. This structure of undergraduate and graduate programmes of study strives to provide high quality education with abundant opportunities for future employment, in compliance with the needs of the society and industry for experts of specific and broad knowledge in the academic area of chemical engineering and similar disciplines. The information about undergraduate and graduate programmes of study is available both in Croatian and English on the website of the Faculty[4] and the links provided.

In the academic year 2014/2015 the postgraduate doctoral programme of study **Chemical Engineering** and **Engineering Chemistry** were integrated into a single programme of study **Chemical Engineering and Applied Chemistry** (KIPK – *Kemijsko inženjerstvo i primijenjena kemija*). The new programme of study, as well as its two predecessors, concerns the fields of technical and natural sciences and facilitates professional development in all areas covered by undergraduate and graduate programmes of study of the Faculty. The postgraduate specialist programme of study **Petroleum and Petrochemical Engineering** (NPI – *Naftno-petrokemijsko inženjerstvo*) was initiated in accordance with the interest expressed by the Croatian petroleum and petrochemical industry, and the first students are about to enrol in this programme of study. The Faculty is a coordinator of two interdisciplinary postgraduate specialist university programmes of study: **Environmental Engineering**, as a Faculty participating in the execution of instruction together with another 12 institutions (of which eight components of the University), and **Corrosion and Protection**, also as a participant in the execution of instruction together with another four components of the University. The Faculty also takes part in the execution of instruction in the interdisciplinary postgraduate specialist university programme of study **Crisis Management** together with another 12 components of the University, and it also gave its contribution to the preparation and establishment of the undergraduate university programme of study **Engineering** taught in English together with another five components of the University, and the undergraduate university programme of study **Military Engineering** together with another 11 components of the University and the Croatian Military Academy "Petar Zrinski".

In compliance with the statutory provisions the Faculty does not provide any professional programmes of study nor does it have any programmes of study executed in institutions outside Zagreb.

2.2. Overlapping Programmes of Study

The undergraduate programme of study of the Faculty **Applied Chemistry** and the undergraduate programme of study of the Faculty of Science of the University of Zagreb (PMF –

[4] *http://www.fkit.unizg.hr/studiji* i *http://www.fkit.unizg.hr/en/curricula*

Prirodoslovno-matematički fakultet) **Chemistry** overlap in the fundamental courses common to all standard programmes of study of chemistry (general, inorganic, organic, analytical and physical chemistry, mathematics and physics). However, whereas the programme of study **Chemistry** at the PMF is also extended by fundaments of other natural sciences (biochemistry and mineralogy) with more intensive additional chemical courses, the programme of study **Applied Chemistry** provides basic knowledge in the field of technical sciences (mechanical engineering, electrical engineering, chemical engineering, materials science), offering students much broader knowledge and fundaments for a wide spectrum of graduate programmes of study. Such difference is also followed-up in the graduate programmes of study. The graduate programme of study **Chemistry** at the PMF includes both teaching- and research-oriented profiles in the programmes of study. The research-oriented profile of the programme of study allows students to specialise in two of the five offered branches of chemistry (analytical, physical, inorganic, organic and biochemistry). The graduate programme of study **Applied Chemistry** of the Faculty is based on the modular principle and allows students to specialise in environmental chemistry, advanced materials and technologies or applied organic chemistry, with focus on medicinal chemistry. Nevertheless, the basic difference is not visible in the programme of the study, but in a different approach to chemistry adopted by the current Faculty ever since the Chemical Engineering Department was established at the then Technical Institute. The programmes of study of chemistry at the PMF and the Faculty are thus complementary and generate different profiles of experts.

The undergraduate and graduate programme of study **Materials Chemistry and Engineering** does not overlap to a great extent with the major course of study Materials Engineering in the undergraduate and graduate programme of study **Mechanical Engineering** at the Faculty of Mechanical Engineering and Naval Architecture of the University of Zagreb (FSB – *Fakultet strojarstva i brodogradnje*); they mostly overlap in the context of polymeric and composite materials. In comparison with the FSB programmes of study, focused on mechanical properties and applications of materials and their treatment, the Faculty programmes of study pay attention to the material synthesis and improvement methods and make a connection between the properties of materials and their chemical composition and structure. Consequently, the two programmes of study can also be considered to be complementary.

At the time when the undergraduate and graduate programme of study **Environmental Engineering** was proposed by the Faculty, the University did not offer any similar study. The undergraduate programme of study **Environmental Engineering** and the major course of study Environmental Engineering of the graduate programme of study **Geotechnical Engineering** of the Faculty of Geotechnical Engineering in Varaždin of the University of Zagreb are only similar to the programmes of study of the Faculty on the surface, but are based on essentially different courses and approaches.

The undergraduate programmes of study of the Faculty share a portion of their courses with other similar technological and biotechnological faculties (Faculty of Metallurgy, Faculty of Food Science and Biotechnology, Faculty of Textile Technology, all components of the University of Zagreb), but only in the context of fundamental courses, whereas the professional upgrading is completely different.

2.3. The Enrolment Quota

Undergraduate programmes of study. The most important criteria taken into account when the enrolment quota are proposed for the undergraduate programmes of study are social needs (primarily in the industry) and the current premises, technical and human resources required to provide adequate level of teaching quality. In accordance with the previous enrolment statistics and the information concerning general social developments, the estimation is also made of the number of competent and motivated students for specific programmes of studies. In the process, the situation in similar institutions providing educational services in the academic areas of

chemical engineering and technology in the region and in Europe is also taken into consideration. All undergraduate programmes of study of the Faculty have a valid license and thus comply with the essential prerequisite for their execution and determination of the proposal for the enrolment quota. In accordance with the statistics obtained from the Croatian Employment Service for 2014, there are only three unemployed bachelors (*baccalaurea*) as practically they all continue studying in the graduate programmes of study at the Faculty and other components of the University. The low recognisability and non-existence of a clear qualification framework for bachelors were also highlighted in the Final Faculty Evaluation Report during the last reaccreditation procedure, but such problem is not common only to the University of Zagreb as a whole, but also to all higher education institutions in the country. On 31st October 2014 the ratio between the number of students enrolled in the Faculty undergraduate and graduate programmes of study, guest students excluded (989) and the number of teachers holding the academic rank (60) at the Faculty was 16.5:1. On average, there are 10.0 m^2 of usable space per every student enrolled in undergraduate and graduate programmes of study of the Faculty. In 2008 the National Council for Higher Education of the Republic of Croatia carried out the evaluation procedure for higher education institutions within the university and integrated universities, in accordance with which the Faculty was granted the Licence for Performing Scientific Activity and Executing Programmes of Study on 20th May 2009. The current enrolment quotas proved to be adequate, since educated experts can be promptly employed and their employment rates are high. It is important to highlight in this context that for different reasons about a half of the enrolled students drop out of the programmes of study, largely as early as in the first year. This phenomenon is not only specific to our Faculty. In this way, consequently, the quality of education in higher years is simultaneously improved through more intensified mentoring and easier group organisation of classes (seminars, practical training). Since the introduction of the national high school graduation exam (*državna matura*), there has been a noticeable ongoing and increasing interest in the undergraduate programmes of study of the Faculty, seen also this year despite more stringent admission criteria (higher level of mathematics in the national high school graduation exam is a compulsory admission criterion). Although as a rule there is not a strong interest in enrolment in the programmes of study in the technical field, probably due to heavy demands of the programmes of study and subsequently greater responsibility and a stronger need for life-long learning in comparison with other fields, but also due to smaller income, the Faculty is able to meet the entire enrolment quota on regular basis during the first enrolment deadline. The enrolment quotas in the undergraduate programmes of study amount to 220 students in total (55 per every programme of study), with 10 places additionally foreseen for foreign students.

To be recognised in the society as an institution offering high and attractive level of education for future jobs, the Faculty is engaged in ongoing well-developed promotional activities, which should also be adequately supported by the Government, in comparison with other examples in the EU.

Graduate programmes of study. The proposal for the enrolment quotas in the graduate programmes of study of the Faculty wanted to provide all interested students of the undergraduate programmes of study with a possibility to continue studying at their home institution, to facilitate regular execution of instruction in compliance with the premises, financial and teaching resources of the Faculty, to attract students from similar faculties in the field of technical, biotechnical and natural sciences of the University of Zagreb, but also from other universities in the region and to meet the needs of the society for experts in the academic areas of chemical engineering, materials chemistry and engineering, environmental engineering and applied chemistry.

The basic admission criterion for graduate programmes of study of the Faculty is the grade point average of the undergraduate programme of study, which is in accordance with the fundamental idea of student mobility, the idea of interdisciplinary approach in compliance with the contemporary trends in Europe and worldwide, and the idea of a functionally integrated

University. In accordance with the Decision of the Senate of the University of Zagreb,[5] in order to harmonise the input competences, the students who enrol in the graduate programmes of study of the Faculty may be assigned differential courses corresponding to maximum 60 ECTS credits. In case of more than one differential course, the student is recommended to enrol in an appropriate undergraduate programme of study to acquire the required competences. For their performance the candidates receive additional credits, awarded for the time needed to complete the undergraduate programme of study, and for scientific, social and sports awards of the candidate. It is considered that such method of enrolment in the graduate programmes of study relieves the psychological pressure resulting from the placement exam. The candidates whose grade point average is below 3.00 in the undergraduate programme of study may only enrol in the graduate programme of study with letters of recommendation written by two teachers of the higher education institution where the candidate completed the undergraduate programme of study.

The enrolment quotas in the graduate programmes of study amount to 125 students in total (35 students for the programmes of study of KE, EI and PK, and 20 students for the programme of study KIM) with another 5 places foreseen for foreign students. The foregoing number is in compliance with the Faculty capacities and corresponds with the demands of the labour market, taking into account low unemployment of bachelors of chemical engineering (old programme of study). The graduate programmes of study show a high completion rate, as a result of demanding admission criteria, focused on high grade point average. According to the statistics of the Croatian Employment Service on the number of unemployed graduates of the Faculty (Table 3.3), the statistics on the average number of students per year who complete graduate programmes of study of the Faculty (Table 2.2), and in accordance with the survey carried out by the Faculty Management,[6] they are all able to find a job within less than one year. The results indicate that the Faculty provides broad education which facilitates employment in a large number of most versatile industrial companies, public services, institutes and laboratories, depending on the interests and abilities of the candidates.

Postgraduate specialist programmes of study. There is a great interest of students in the interdisciplinary postgraduate specialist university programme of study **Environmental Engineering**, which is the best indicator of how purposeful it was to initiate such a programme, Table 2.a. It did not come as a surprise as this branch of technical sciences is going through a revival due to an increasing level of environmental awareness of the society and growing demands of the legislator concerning the relationship between the industry and households and the environment. Consequently, there is an evident and ongoing interest in education of this profile of experts who come from the industry, state, scientific and educational institutions, and the ongoing trend in the number of enrolled candidates is also expected in the forthcoming period.

[5] 21st May 2014.
[6] *http://www.fkit.unizg.hr/zaposljavanje*

Table 2.a The number of first time enrolled students and the total number of students enrolled in the interdisciplinary postgraduate specialist university programme of study Environmental Engineering

Academic year	Number of first time enrolled students	Total number of enrolled students
2009/2010	29	135
2010/2011	23	82
2011/2012	19	62
2012/2013	20	57
2013/2014	13	45

The University of Zagreb is the holder of the interdisciplinary postgraduate specialist university programme of study **Corrosion and Protection**, whereas the Faculty is its coordinator. There are another four faculties of the University of Zagreb participating in the execution of the programme of study. The problems with corrosion and protection of construction materials cover a very wide scope of human activity, which explains a broad range of different disciplines dealing with such issues. The needs of process industry for specialists of this profile are encouraging for the Faculty and hopefully there will be a more serious interest among students in this specialist area in comparison with the previous period.

The interdisciplinary character of such programmes is their good side (there are 5–13 higher education institutions and research institutes participating in their execution). There is a great number of specialist courses offered to candidates who may enrol in them depending on their interests and wishes. A considerable number of teachers participating in the teaching process in these programmes of study enable the candidates to select the final specialist thesis in compliance with their own needs and wishes. The shortcomings of such programmes primarily concern the teaching method (*ex cathedra*) with a practically negligible share of examples of practical processes and a negligible share of field instruction. The enrolment quota is proposed by the Expert Councils of the programmes of study, taking into account the needs of the industry and of the society as a whole, as well as the premises and organisational capacities of the Faculty.

The specialist programme of study **Petroleum and Petrochemical Engineering** (NPI – *Naftno-petrokemijsko inženjerstvo*) of the Faculty was initiated in accordance with the need expressed by the industry for competent experts in the foregoing area, due to an increasing demand for chemical engineers resulting from changes imposed in such branches of industry (change in raw materials, new legislation). This programme of study will allow the candidates to acquire expert knowledge in this programme which integrates engineering and technical aspects of process implementation and formulation of products in accordance with their economic and environmental justification. It will also allow the Faculty to focus some of its activities on the needs of and cooperation with the industry. The enrolment quota for this programme of study is 20 students, which takes into account the needs and the interest of the industry, as well as the premises and human resources of the Faculty. On average, 10–15 students are expected to enrol in this programme.

Postgraduate doctoral programme of study. The enrolment quota for the new postgraduate doctoral programme of study **Chemical Engineering and Applied Chemistry** (KIPK – *Kemijsko inženjerstvo i primijenjena kemija*) is 40 students per annum, which is in compliance with the premises, scientific, organisational and mentoring capacities of the Faculty. The number of internationally recognised mentors corresponds with the determined enrolment quota and real workload of mentors who have one doctoral student per year. The real number of enrolled students is smaller. Given the fact that the students were not enrolled in the new programme of study before the academic year 2014/2015, the analysis will cover the predecessors of this programme. Last year one student was enrolled in the doctoral programme of study **Chemical Engineering**, and five students in total in the doctoral programme of study **Engineering**

Chemistry. The number is extremely small, largely because the Ministry of Science, Education and Sports (MZOS – *Ministarstvo znanosti, obrazovanja i sporta*) reduced considerably the total allocations for financing of scientific projects and the number of approved junior researchers for the Faculty, who accounted for the majority of students in doctoral programmes of study in the previous period. Due to a smaller number of candidates, the doctoral programme of study was integrated and additionally upgraded as the share of lectures in the total teacher's workload was reduced. Thus the students can study more flexibly and acquire additional competences through workshops, participation in professional conferences, etc. A greater appeal of the integrated doctoral programme of study resulted in a larger interest in enrolment: 16 candidates were enrolled in the programme of study KIPK in the academic year 2014/2015.

The evaluation of the volume and the quality of work which the Faculty may offer to its doctoral students should take into separate account junior researchers and the candidates from the industry and primarily non-scientific institutions. The latter students are largely deprived as it is impossible for them to work continuously on the selected scientific subject matter (doctoral dissertation), they are not under constant supervision of the mentor and the topics they chose often depend on the overlap between their thesis and the interest of the institution they come from relating to the intellectual protection of the results of their thesis, that is the possibility of its publication. The impossibility to use the research equipment on continuous basis and to browse scientific references is an additional obstacle for them, which often makes them exceed considerably the period foreseen for studying. On the other hand, junior researchers and teaching assistants who are in the minority are additionally overloaded in the teaching process and thus may be compared with the candidates from industry to a certain extent. Junior researchers and teaching assistants mostly have access to any equipment and references required for normal development within the area of their scientific activity. The occasional lack of equipment or experimental restrictions are very efficiently resolved: some experiments are carried out in similar institutions in Croatia, but also abroad, during study visits. The high level of scientific activity and the quality of working conditions is confirmed by a great number of publications by junior researchers and teaching assistants of the Faculty (Table 2.4) and a high completion rate of their programmes of study (practically 100%). This is also connected with the scientific criteria of the Faculty according to which all doctoral students, prior to defence of their doctoral dissertation, have an obligation to publish minimum one paper in the area covered by their doctoral dissertation in the journal cited in the databases of *Current Contents*, *Science Citation Index* or *Science Citation Index – Expanded*.

2.4. The Pass Rate in the First Year of Undergraduate Programmes of Study

The majority of students who enrol in the undergraduate programmes of study of the Faculty come from gymnasiums (the average was 73% in the last five academic years, see Table 2.1, Section 3.1 and Figures 2.2–2.4), whereas about 15% of students come from vocational schools. The number was significantly reduced after the introduction of higher level mathematics as an admission criterion in the academic year 2013/2014. The impact of such change on the pass rate in the programmes of study is yet to be evaluated. The grade point average of students who enrol in the undergraduate programmes of study of the Faculty is above 4.00 for all four programmes of study. The students of the programmes of study KI and PK have a bit higher average than those of KIM and EI. Those two programmes of study also have a larger share of gymnasium students, and also a higher pass rate as shown by the first couple of Bologna programme generations (Table 2.2).

Figure 2.2 indicates that the number of students who received more than 2/3 of possible ECTS credits in the first year of studying remained approximately the same in the period under consideration, despite an increase in the number of enrolled students, which suggests that the pass rate of the first year gradually decreased. The same conclusion can be made on account of

the grade point average of students in the undergraduate programmes of study, which shows a statistically significant drop in such years, see Figure 2.3.

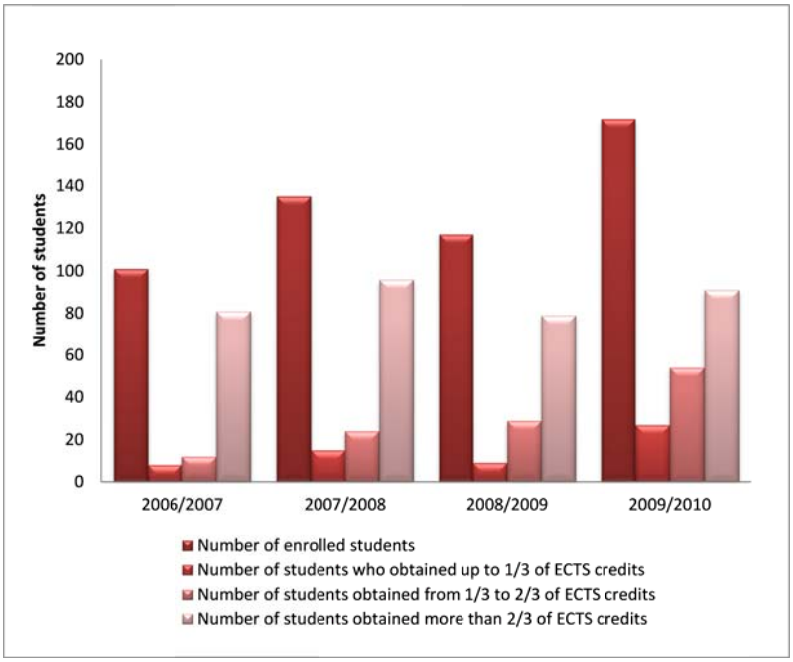

Figure 2.2 The structure of students according to ECTS credits obtained in the first year of undergraduate programmes of study

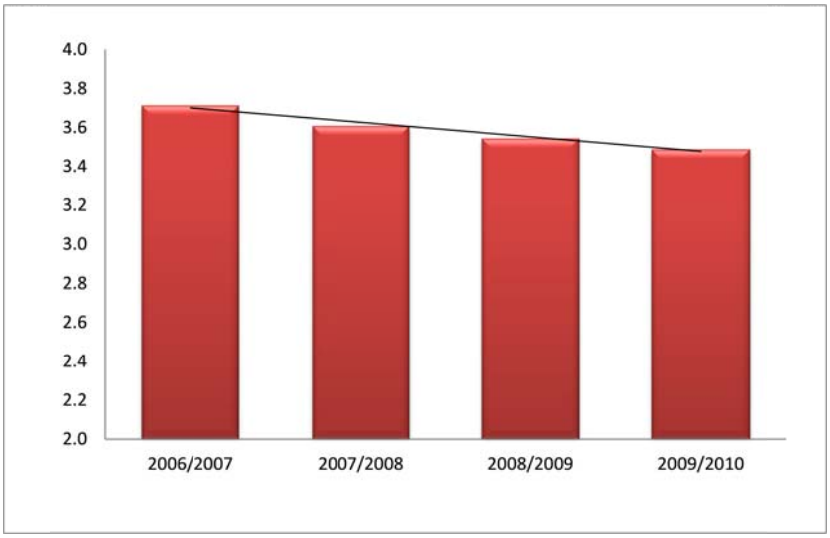

Figure 2.3 Grade point average of all undergraduate programmes of study by academic years

2.5. Learning Outcomes

The current Bologna undergraduate and graduate programmes of study were not developed in accordance with learning outcomes but in accordance with competences. The competences were compared with similar programmes of foreign higher education institutions and adapted to the competences of the Faculty academic staff. In some cases, for instance, the undergraduate and graduate programme of study **Chemical Engineering**, there were also relevant documents, such as *EFCE (European Federation of Chemical Engineering) Recommendations for Chemical Engineering Education in a Bologna Two Cycle Degree System* of September 2005, revised in

2010.[7] The same document also contains learning outcomes for the programmes of study of chemical engineering. Following such a model, the learning outcomes were derived which – admittedly intertwined with competences – are also included in supplementary documents (diploma supplement) for graduates of the undergraduate and graduate programmes of study from the beginning of the execution of this programme. Learning outcomes were subsequently determined for specific courses of undergraduate and graduate programmes of study. The Faculty teachers were introduced to the Bloom's taxonomy in the academic year 2010/2011, based on which they determined learning outcomes for their courses, and in the academic year 2014/2015 a workshop on learning outcomes was held and organised by the Centre for Development of Teacher Competences of the University of Zagreb. By the end of winter semester 2014/2015 all learning outcomes will be harmonised at the level of courses and clearly determined at the level of programmes of study in Croatian and English.

As a partner of the Faculty of Mining, Geology and Petroleum Engineering of the University of Zagreb, the Faculty applied the project proposal *Establishment of Higher Education Qualifications and Professions Standards in the Sector of Mining, Geology and Petroleum Engineering (TARGET)*. The objective of the project proposal is to establish the quality assurance system in higher education in the sector of mining, geology and chemical technology in the Republic of Croatia connected with the Croatian Qualifications Framework (HKO – *Hrvatski kvalifikacijski okvir*). The specific objectives are as follows:

- To establish higher education standards of integrated qualifications in the relevant sector in accordance with the demands of the labour market, individuals and society as a whole
- To improve the current higher education programmes of study (by determination of learning outcomes, determination of workload to achieve learning outcomes – ECTS credits, and compliance with qualifications standards)
- improve the competences of teachers and teaching assistants and to enhance the quality of the teaching process by increasing the level of e-courses

The forms of testing of the achieved learning outcomes in undergraduate and graduate programmes of study of the Faculty are shown in Table 2.3 and illustrated by Figures 2.4 and 2.5. In conclusion, it can be said that they largely consist of preliminary exams/assignments and practical training, and other types of testing. Other forms of testing include tests of knowledge through entrance and final preliminary exams connected with laboratory exercises, field instruction and internship, assignments, e-learning, e-learning assignments and quizzes, and participation in seminars (auditory exercises).

[7] *http://www.efce.info/Bologna_Recommendation.html*

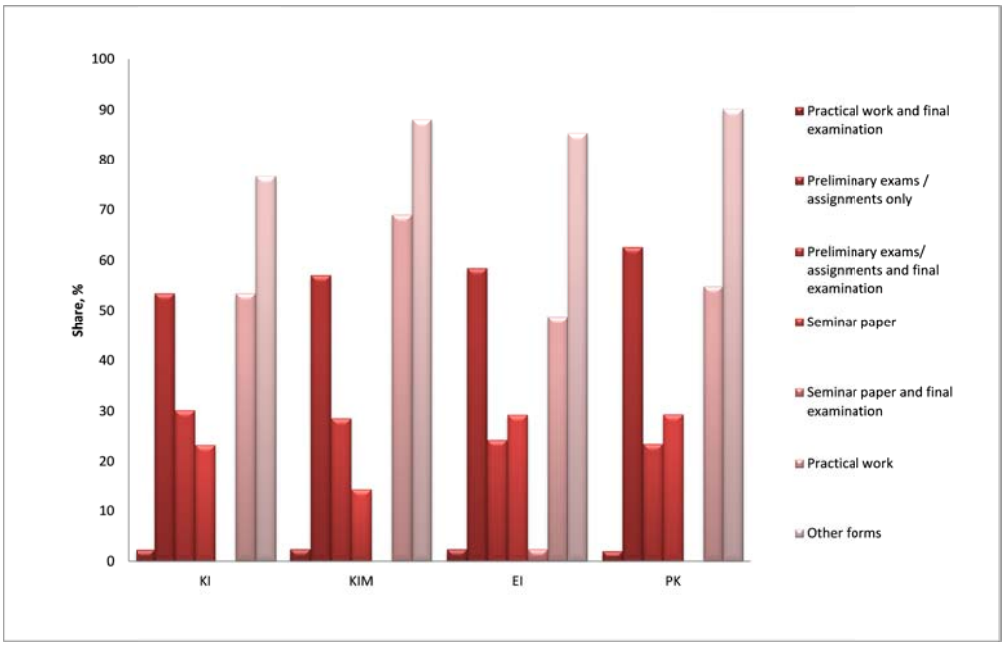

Figure 2.4 Forms of tests of knowledge in undergraduate study programmes. The Figure shows a share of the total number of courses of the relevant programme of study with the indicated form of the knowledge test. The sum total of the shares exceeds 100% as many courses have more ways of knowledge testing.

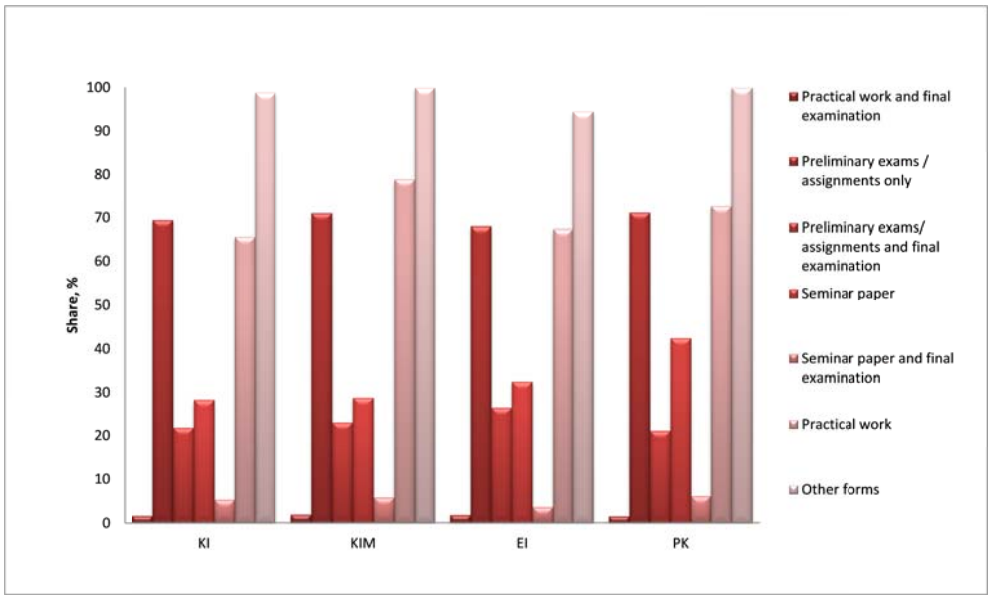

Figure 2.5 Forms of tests of knowledge in graduate programmes of study. The Figure shows a share of the total number of courses of the relevant programme of study with the indicated form of the knowledge test. The sum total of the shares exceeds 100% as many courses have more ways of knowledge testing.

The postgraduate specialist and doctoral programmes of study do not have any determined learning outcomes at the level of the programme of study or the level of courses. This will be dealt with after harmonisation of the learning outcomes of courses and programmes of study for undergraduate and graduate programmes of study. In the foregoing document *EFCE Recommendations*, the third cycle (postgraduate programme of study) is otherwise not quantified in terms of achievement of learning outcomes, i.e. the provider of the programme of study has maximum discretion in this context.

The most relevant learning outcome of the doctoral programme of study is the ability to solve independently a high level problem, as best testified by defended doctoral dissertations, that is, papers analysing the topics covered by the doctoral dissertation published in journals of the highest level (Figures 2.6–2.8).

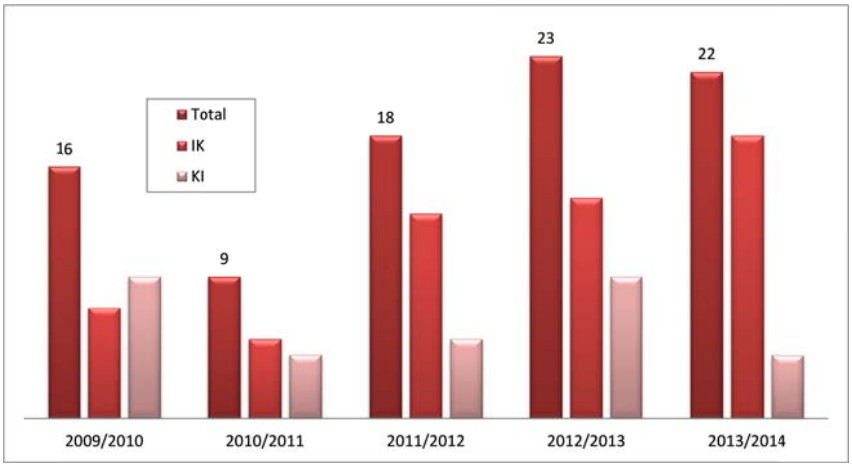

Figure 2.6 Number of defended doctoral dissertations by academic years and doctoral programmes of study

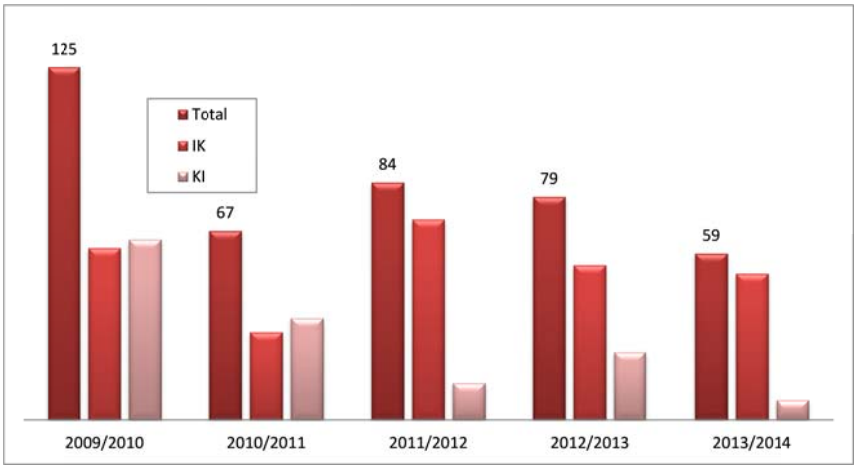

Figure 2.7 Papers of doctoral students published in foreign scientific journals, by academic years of thesis defence

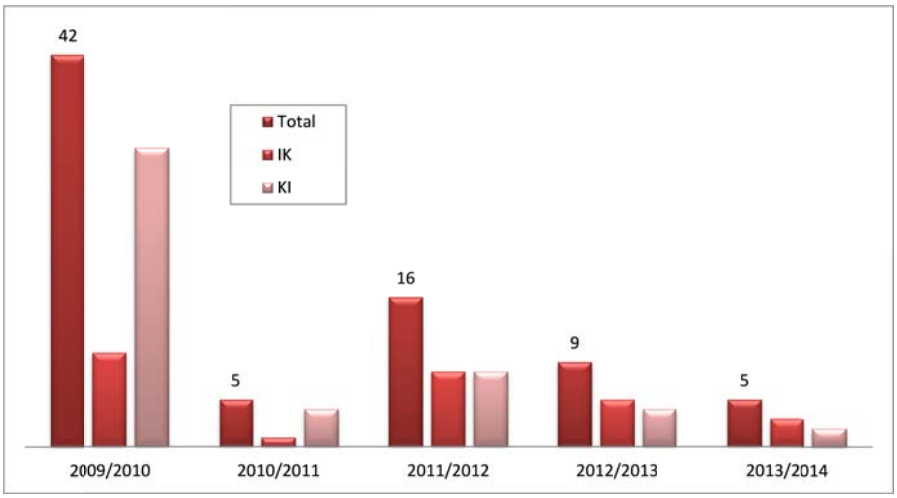

Figure 2.8 Papers of doctoral students published in Croatian scientific journals, by academic years of thesis defence

2.6. Workload assessment (ECTS)

In the process of development of the Bologna programmes of study the ETCS credits were primarily allocated in accordance with the schedule of specific courses, taking into account the sum total of 30 ECTS credits per semester, which in turn resulted in incompliance between the allocated ECTS credits and the real student workload. As far as possible, this was subsequently harmonised after additional analysis and minor modifications in the programmes of study in the academic years of 2009/2010 and 2013/2014. The real student workload can be assessed by the student survey (e.g. the assessment of time allocated to completion of a particular course) and the analysis of the pass rate by courses.

2.7. The Competences of Graduates

The competences of experts who complete the programme of study at the Faculty can be compared with similar programmes of study at renowned foreign universities by using the findings of surveys carried out among former students. The first survey of this kind entitled: "Does the programme of study Chemical Engineering fulfil the employment demands?" was conducted by the Faculty in cooperation with the Croatian Society of Chemical Engineers in 2003, in response to the invitation extended by the World Chemical Engineering Council (WCEC). The survey was repeated in 2008. The findings of such surveys were compared with the findings of the WCEC[8]. The findings indicate good correlation with international trends.

In late 2009 the in-house survey was carried out by the Faculty concerning employment of students who graduated in 2008 and 2009, and a similar survey was conducted in the spring of 2014 for the students who graduated in the period from 2009 to 2013 in all undergraduate that is graduate programmes of study. The first survey was conducted when the conditions on the market were favourable in terms of ratio between supply and demand, and practically all our students were employed immediately. Despite the background showing deep economic crisis, the graduates were still able to find jobs relatively quickly as found in 2014 survey[9] (58% within six months and 78% within 12 months of graduation) and there was a large share of graduates who continued their education in doctoral programmes of study (5.7% at foreign and 7.5% at national higher education institutions respectively). The foreign institutions, where the graduates of the Faculty enrol in the doctoral programmes of study are listed under section 6.9, indicating direct recognition of competences of our graduates by completely independent highly ranked international institutions.

The stringent criteria for the tests of knowledge, a large number of courses which include practical training (in laboratory or during internship) and require acquiring the skill of finding and using a source of knowledge, dealing with newly arisen situations, learning how to process and present one's own findings, acquiring communication skills and involving in teamwork, ensure high quality of final competency of students in the graduate programmes of study of the Faculty.

2.8. Monitoring and Improvement of the Programmes of Study

The quality of the programmes of study is primarily monitored over exit surveys in which graduates express their opinion of the programme of study. Individual complaints made by students to the Vice-Dean for Education or relevant course teachers are also taken into account, as well as the employment rate of graduates (see previous section), and impressions of employers about the employees coming from the Faculty. Particular programmes of study are

[8] *http://www.chemengworld.org/*
[9] *http://www.fkit.unizg.hr/zaposljavanje*

also analysed on regular basis in order to remove any overlaps and resolve any issues indicated by students and teachers.

In compliance with the self-evaluation report on the undergraduate programmes of study of the Faculty conducted in the academic year 2013/2014, using the findings of the student surveys and the feedback of external shareholders in the quality assurance system, a proposal was made for minor amendments to be made to the undergraduate programmes of study – up to 20%. In accordance with the Decision of the Faculty Council of September 2014 the amendments were referred to the Working Group for the Programmes of Study of the University of Zagreb. On 10th December 2014 the amendments were approved by the Quality Management Committee of the University of Zagreb. The amendments will be implemented into the undergraduate programmes of study starting with the academic year 2015/2016. First of all, the amendments strive to harmonise the student workload in different programmes of study and to facilitate the execution of classes, primarily by harmonisation of the schedule and ECTS credits of optional courses and final theses in all four programmes of study.

The University encourages new courses held in English, which are introduced on regular basis. The introduction of such courses is voluntary and the courses of such kind do not constitute a coherent programme of study which could be offered to visiting or foreign students as an integrated programme of study. It is assumed that foreign students would not show a considerable interest in such programme of study, and the average Croatian student – according to current experiences – would have difficulties with following classes in English at the undergraduate level. Therefore, for the time being the introduction of an integrated programme of study in English is not considered. The first such experimental programme of study could be introduced at the right moment at the graduate level instead of one of the current programmes, primarily for Croatian students with participation of foreign students.

In the academic year 2013/2014 a big step forward was made to introduce e-learning in all undergraduate and graduate programmes of study at the Faculty. In the academic year 2013/2014 the Faculty became one of the institutional users of the Merlin e-learning system. For this purpose, in 2013/2014 two workshops were held on the topic of developing e-courses for teachers of the Faculty. With great additional engagement of the members of the Commission for E-Learning of the Faculty, it brought about 20 new e-courses of level 3 of e-learning (13 in undergraduate and 7 in graduate programmes of study) and 12 new e-courses of level 2 of e-learning. In addition, all courses in undergraduate and graduate programmes of study are open in the Merlin system and comply with minimum level 1 of e-learning. E-learning is introduced to get students more involved in specific courses and to facilitate their communication with teachers. In this way students work independently to increase their competences acquired in specific courses. Since this process is in its initial phase, it is still early to speak of its efficiency in the context of achieving objectives as planned. The Action Plan for the academic year 2014/2015 provides for ongoing encouragement of teachers to develop e-courses of level 3. In accordance with the Decision of the Dean of the academic year 2013/2014 every year the authors of new e-courses which, in opinion of the Commission for E-Learning of the Faculty comply with level 3 of e-learning, are rewarded.

In the end, the instruction in all programmes of study relies upon scientific activity of the teachers to whom it is entrusted, and the content of courses is regularly adapted to new scientific developments. This is tacitly known at the doctoral level, but at the undergraduate and graduate level it is mostly conducted by involving students in the scientific activity while they work on their final theses (final year of undergraduate programmes of study), during project-type courses such as Chemical Engineering Exercises, Materials Engineering Exercises, Chemical Technology Exercises, Environmental Engineering Laboratory and Environmental Engineering project and when they work on their graduation thesis. A smaller number of students also opt for additional extracurricular engagement in the scientific activity, which results in a considerable number of papers co-authored by students published in journals of the highest

category. It is also one of the requirements for teachers' promotion in compliance with the Criteria of the Rectors' Conference for the Election to Academic and Teaching Ranks.

2.9. Regular Class Attendance

Attendance of any type of classes (lectures, seminars, practical training and exercises) is compulsory and monitored by collecting students' signatures on regular or occasional basis. According to the findings of the student survey for winter and summer semesters of the academic year 2013/2014, class attendance is mostly satisfactory. Every relevant course teacher determines the method how regular class attendance will be monitored during the first lecture and in the course curriculum, which is available on the Faculty website.

2.10. Teaching Methods, Practical Instruction

The instruction at the Faculty is carried out in the classical form of lectures (*ex cathedra*), mixed forms of instruction (e-learning), consultations, computer seminars, laboratory exercises, individual laboratory work, seminar paper, field instruction and internship. The field instruction and internship are described in more detail under section 2.11. All lecture rooms have a computer and a projector, and bigger lecture rooms also have a microphone and a sound system. Two IT classrooms facilitate the execution of IT seminars and IT exercises. The students' laboratories are adapted and fitted for the execution of laboratory exercises as provided under the curricula. The laboratory exercises and seminars allow teachers to work with smaller groups of students (10–30), which facilitates individual contact between the teacher and the student and direct transfer of knowledge. Due to an insufficient number of adequate lecture rooms and teaching staff, the instruction cannot entirely be executed in groups of optimum size. The consultations and recently introduced e-learning bridge this shortcoming allowing students to have direct access to teachers. Seminar papers and individual laboratory work in the framework of specific courses and while writing final and graduation theses encourage students to work independently and be creative. As it often happens, a number of students work on similar topics, which fosters teamwork. The selection of teaching methods is adjusted to specific courses and acquired competences of students, and made by teachers, course coordinators, at their own discretion.

After the introduction of the Bologna programmes of study the schedule of laboratory exercises and seminars in fundamental courses was considerably reduced. According to the Bologna system, the course content is partially covered by individual work of students outside the course schedule, but it is not really like that in practice. Therefore, the Faculty will try to overcome this shortcoming by reinstituting the preliminary schedule of some courses and by introducing optional courses the aim of which is providing students, who cannot do it on their own, with basic competences. The level of laboratory equipment does not always correspond with modern teaching requirements, largely due to a lack of sources of financing for such type of equipment. A lack of motivation of some students, especially in undergraduate programmes of study, still remains the biggest issue. The teachers should be trained in pedagogical and teaching methods which would encourage students to work extra in order to achieve learning outcomes and to complete their studying successfully. The teachers are continuously encouraged and trained to provide students with most comprehensive information on the possibilities offered by the Faculty and to determine the expectations from students as clearly and accurately as possible.

The teaching methods are also continuously improved by introducing e-learning and providing students with more possibilities for scientific and research activity, see section 2.8.

2.11. Instruction outside the Faculty

Some parts of instruction are also carried out in the premises outside the Faculty. They mostly include visits to industrial facilities provided under the curricula of specific courses, organised mostly due to individual efforts invested by some teachers and supported financially and organisationally by the Faculty as far as it is possible. The teachers are continuously encouraged to plan the field instruction within their courses.

The internship is compulsory for all students of undergraduate programmes of study and as such is a component of the programmes of study. The internship is regulated under the Ordinance on Compulsory Internship of Students of the Faculty of Chemical Engineering and Technology of the University of Zagreb.[10] The aim of internship is to introduce students to operations and issues concerning industrial or research institutions. The duration of internship is twenty working days in total (160 hours). As a rule, the students start with internship after the second year of studying during the non-teaching period. During internship the students have an obligation to keep a daily log, certified after internship by the person appointed by the relevant internship-providing institution to supervise the work of the student. After the internship has been completed, the certified log, together with the internship report, is submitted by the student to the preliminarily appointed supervising teacher at the Faculty. A list of internship-providing companies available to students of undergraduate programmes of study of our Faculty is uploaded on the website of the Faculty as an aid which helps students to select the appropriate institution.[11]

In cooperation with the RGNF and in the framework of the afore mentioned TARGET project proposal, Specific Objective 3 covers the development of student internship programmes within the Croatian Qualification Framework (HKO), which also includes interviewing of a large number of companies and employers in the sector concerning their demands and required competences of their future employees, and establishing and implementing a pilot internship model.

2.12. Online Content of the Programmes of Studies

Every course in undergraduate and graduate programmes of study has its own separate website with notifications, results of preliminary and other exams and auxiliary teaching materials (Power Point presentations of lectures, lecture notes, exercises with key, multimedia content). The websites also show the curriculum (with the objectives and content of the course, method of knowledge testing and a list of references) and learning outcomes of a large majority of courses (Table 2.6).[12] In the academic year 2013/2014 such courses were included in the ISVU system (Higher Education Institutions Information System – *Informacijski sustav visokih učilišta Republike Hrvatske*) over the teachers' portal. It is also important to say that the Faculty has been using the ISVU in full since the academic year 2005/2006.

The regular promotion or re-election of teachers comprises systematic revision of the teaching materials (lecture notes) prepared by teachers for their courses. This is especially important as only a small number of courses have references available in Croatian, and are in compliance with the recommendations given under the Final Faculty Evaluation Report resulting from the former reaccreditation process. The review is carried out by a specially appointed expert commission, which also includes the Vice-Dean for Education.

On the other side, the websites for postgraduate programmes of study, both professional and doctoral, provide only basic information about specific courses, without any more elaborate details. Some courses neither have any website available, nor the possibility of uploading

[10] *https://www.fkit.unizg.hr/_download/repository/Pravilnik_o_obaveznoj_strucnoj_praksi_studenata.pdf*
[11] *http://www.fkit.unizg.hr/preddiplomski*
[12] *http://www.fkit.unizg.hr/studiji*

teaching materials and announcements. Due to a smaller number of students enrolled in such programmes of study, they rely on direct communication between students and teachers.

In comparison with other Croatian and foreign institutions taken into consideration, the Faculty website includes a wider selection of materials. For example, the FCCT UM has only 23 offered teaching materials.

Figure 2.9 shows a summary of online course content in undergraduate and graduate programmes of study of the Faculty.

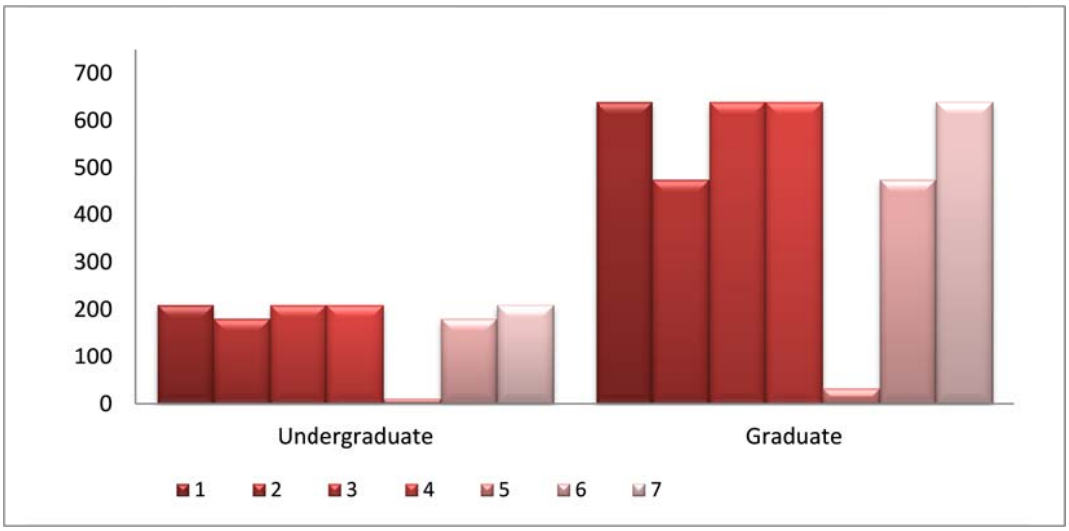

Figure 2.9 The number of courses in the Faculty undergraduate and graduate programmes of study with online content. It also includes the number of courses which:
1) Have their own separate website
2) Provide online course objectives and content and a list of references
3) Make online announcements of written and oral examination periods and consultation hours
4) Upload the results of preliminary exams and written exams for students
5) Upload assignments included in previous examination periods
6) Upload auxiliary teaching material
7) Allow interactive teacher–student communication.

2.13. The Concept behind Programmes of Study and Future Reforms

The organisation of the programmes of study of the Faculty is outlined in detail under section 2.1, and the proposal for minor amendments to undergraduate programmes of study is provided under section 2.8.

The Graduate Programmes of Study Reform Plan. In addition to adopting the programmes of two optional university courses in English, Polymer Science and Technology (in the academic year 2010/2011) and Corrosion and Environment (in the academic year 2013/2014), the graduate programmes of study have not been modified or supplemented in the period of nine years since their licenses were issued. The curricula of some courses were amended but the competences and learning outcomes remained the same. The relevant graduate programmes of study were not evaluated under the regulated evaluation procedures in accordance with the Ordinance on the Evaluation Procedure for Undergraduate and Graduate University Study Programmes and Integrated Undergraduate and Graduate Programmes of Study of the University of Zagreb. After the Faculty had submitted its opinion about the above-mentioned to the University, the Committee for Quality Management of the University of Zagreb requested

from the Faculty to draft amendments to the graduate programmes of study by 30th September 2015, starting from the programmes for which the licence was obtained in 2005.[13]

In the process of drafting of the proposal special attention will be dedicated to learning outcomes at the level of the programme of study and the course level, in compliance with the University standards and in accordance with the foregoing Ordinance.

The Faculty also plans to introduce the specialist programme of study with the working title *Applied Chemistry in Industry*.

2.14. Life-long Learning

In engineering professions it is most convenient to structure life-long learning around the Chamber of Chartered Engineers, as it was done for instance by the FSB, one of the comparative institutions in this self-evaluation report. However, in the area of chemical engineering such chamber does not exist, nor is the profession of chemical engineers regulated in Croatia. The Faculty cannot accept such situation and section 1.14 outlines the activities concerning the establishment of the Chamber of Engineers.

Under such, relatively complicated circumstances, the Faculty nevertheless has the prerequisites for the establishment of a permanent life-long learning (LLL) system, taking into account the needs of the industry and employers. The life-long learning programmes are mostly structured without any allocation of ECTS credits, as in fact, there is no formal need for something like that in absence of the professional association. However, there is a clear need for refreshment and improvement of knowledge, skills and competences within the chemical and engineering profession with special emphasis on the following areas: materials characterisation techniques, pharmaceutical technology, instrumental analytical methods, environmental protection, biotechnology and biocatalysis, intellectual property, etc.

The Faculty organises a number of workshops, seminars, lectures, etc. for supplementary training, see Table 2.7. The Ordinance on the Lifelong Learning System at the Faculty was drafted,[14] which determines the framework content and form of the training and the methods of its announcement and implementation.

2.15. Recognition of Previously Acquired Competences and Qualifications

The recognition of previously acquired competences is carried out in compliance with the Ordinance on Studying in Undergraduate and Graduate Programmes of Study of the University of Zagreb[15] and the Ordinance on Studying in Undergraduate and Graduate University Programmes of Study of the Faculty of Chemical Engineering and Technology,[16] according to case-by-case applications. The system of recognition of foreign higher education qualifications is not under competence of the Faculty. In the academic year 2014/2015 the Vice-Dean for Education of the Faculty was appointed to the University Commission for Academic Recognition of Foreign Higher Education Qualifications (IVK – *inozemne visokoškolske kvalifikacije*) of the University of Zagreb, and the first constitutional session was held on 8th December 2014.

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[13] graduate university programme of study *Chemical Engineering*, UP/I-602-04/05-16/680, 533-07-05-2, 2nd June 2005; graduate university programme of study *Environmental Engineering*, UP/I-602-04/05-16/900, 533-07-05-2, 16th June 2005; graduate university programme of study *Materials Chemistry and Engineering*, UP/I-602-04/05-16/681, 533-07-05-2, 2nd June 2005; graduate university programme of study *Applied Chemistry;* UP/I-602-04/05-16/820, 533-07-05-2, 9th June 2005.

[14] *http://www.fkit.unizg.hr/_download/repository/Pravilnik_o_sustavu_cjelozivotnog_obrazovanja.pdf*

[15] *http://www.fkit.unizg.hr/_download/repository/PRAVILNIK_O_STUDIRANJU2008_Sveuciliste.pdf*

[16] *http://www.fkit.unizg.hr/_download/repository/pravilnik_preddiplomski_diplomski_studiji_2010.pdf*

2.16. Self-Accreditation of the Programmes of Study

The Faculty has no possibility for self-accreditation of the programmes of study.

2.17. General Discussion and Proposals

The analysis of the indicators suggested in this self-evaluation report leads to the conclusion that the solutions proposed for the improvement of the current state of affairs resulting from the previous self-analysis report and the measures proposed for the improvement of the programmes of study were largely fulfilled. The Faculty is continuously engaged in ongoing, well-developed promotion by participating in the Fair of the University of Zagreb, organising the Ideas Fair and the planned Open Door Day in February 2015. The course curricula and teaching methods were critically reviewed, and upgraded due to implementation of e-learning through 20 courses of level 3. The Faculty is constantly investing efforts in the development and improvement of the quality of the educational process as a whole. The Faculty is continuously making financial investments in the state-of-the-art instrumental techniques and laboratories in general to educate students by learning and not by teaching as much as possible. The new postgraduate specialist study Petroleum and Petrochemical Engineering was introduced, and the Faculty also plans to introduce a postgraduate specialist study having the working title Applied Chemistry in Industry.

The Faculty definitely needs to continue working on the improvement and genuine adoption of the concept of learning outcomes, which will require time and permanent engagement of teachers, and on the improvement of the pass rate of students in the first year of undergraduate programmes of study. Furthermore, the Faculty also needs to work more on the compliance between ECTS credits and actual workload or the compliance between the course schedule and the real needs for completion of the foreseen course content. The Faculty should intensify its activities on the implementation of e-learning, and ask students for their feedback by student surveys and fora. In this regard, it should also carry out the performance analysis and encourage sharing of (good and bad) experiences between teachers over online workshops.

The biggest issue is the lack of motivation of some students in undergraduate programmes of study. The Faculty therefore constantly takes efforts to encourage and to train teachers how to provide students with comprehensive information on the possibilities offered by the Faculty and how to determine the expectations from students as clearly and as accurately as possible.

2.18. Tables

Table 2.1 The structure of enrolled students and interest in the programme of study in the current and the last two years*

a) Undergraduate programme of study Chemical Engineering

	Full-time students					Part-time students			Total					
									Gymnasium		Vocational school		Other schools	
Year	Applicants	1st choice	2nd choice	Quota	Enrolled in the 1st year	Applicants	Enrolled in the 1st year	Quota	Number	Grade point avg.	Number	Grade point avg.	Number	Grade point avg.
2014/2015	716	81	91	55 + 3 foreigners	55	–	–	–	38	4.48	–	–	17	4.12
2013/2014	999	119	149	55 + 3 foreigners	55	–	–	–	45	4.50	3	4.49	7	4.45
2012/2013	636	73	89	55 + 3 foreigners	55	–	–	–	46	4.36	6	4.02	3	4.04

b) Undergraduate programme of study Materials Chemistry and Engineering

	Full-time students					Part-time students			Total					
									Gymnasium		Vocational school		Other schools	
Year	Applicants	1st choice	2nd choice	Quota	Enrolled in the 1st year	Applicants	Enrolled in the 1st year	Quota	Number	Grade point avg.	Number	Grade point avg.	Number	Grade point avg.
2014/2015	366	47	61	55 + 3 foreigners	55	–	–	–	47	4.17	1	4.69	7	4.26
2013/2014	694	92	85	55 + 3 foreigners	55	–	–	–	36	4.03	14	4.12	5	4.37
2012/2013	687	91	124	55 + 3 foreigners	55	–	–	–	33	4.12	11	4.17	11	3.99

c) Undergraduate programme of study Environmental Engineering

	Full-time students					Part-time students			Total					
									Gymnasium		Vocational school		Other schools	
Year	Applicants	1st choice	2nd choice	Quota	Enrolled in the 1st year	Applicants	Enrolled in the 1st year	Quota	Number	Grade point avg.	Number	Grade point avg.	Number	Grade point avg.
2014/2015	584	67	58	55 + 2 foreigners	55	–	–	–	46	4.23	3	4.10	6	4.28
2013/2014	1324	164	170	55 + 2 foreigners	55	–	–	–	43	4.20	9	3.85	3	4.19
2012/2013	1111	164	129	55 + 2 foreigners	55	–	–	–	33	4.22	10	4.23	12	4.08

d) Undergraduate programme of study Applied Chemistry

	Full-time students					Part-time students			Total					
									Gymnasium		Vocational school		Other schools	
Year	Applicants	1st choice	2nd choice	Quota	Enrolled in the 1st year	Applicants	Enrolled in the 1st year	Quota	Number	Grade point avg.	Number	Grade point avg.	Number	Grade point avg.
2014/2015	471	60	67	55 + 2 foreigners	55		–	–	42	4.53	6	4.61	7	4.67
2013/2014	743	81	94	55 + 2 foreigners	55	–	–	–	45	4.41	4	4.22	6	4.36
2012/2013	476	66	58	55 + 2 foreigners	55	–	–	–	39	4.30	9	4.15	7	4.33

e) Graduate programmes of study

Chemical Engineering	Full-time students			Part-time students			Number of students transferring from another higher education institution	Grade point average
Year	Applicants	Enrolled	Enrolment quota	Applicants	Enrolled	Enrolment quota		
2014/2015	46	35	35	-	-	-	1	3.596
2013/2014	35	33	35	-	-	-	3	3.645
2012/2013	44	36	35	-	-	-	4	3.669

Materials Chemistry and Engineering	Full-time students			Part-time students			Number of students transferring from another higher education institution	Grade point average
Year	Applicants	Enrolled	Enrolment quota	Applicants	Enrolled	Enrolment quota		
2014/2015	16	12	20	-	-	-	0	3.428
2013/2014	17	11	20	-	-	-	2	3.381
2012/2013	24	22	20	-	-	-	4	3.615

Environmental Engineering	Full-time students			Part-time students			Number of students transferring from another higher education institution	Grade point average
Year	Applicants	Enrolled	Enrolment quota	Applicants	Enrolled	Enrolment quota		
2014/2015	20	17	35	-	-	-	4 (students with differential year)	3.231
2013/2014	21	17	35	-	-	-	5 (2 students with differential year)	3.549
2012/2013	28 (1 foreigner)	17 (1 foreigner)	35	-	-	-	2 (1 foreigner)	3.361

Applied Chemistry	Full-time students			Part-time students			Number of students transferring from another higher education institution	Grade point average
Year	Applicants	Enrolled	Enrolment quota	Applicants	Enrolled	Enrolment quota		
2014/2015	27	23	35	-	-	-	0	3.689
2013/2014	31	26	35	-	-	-	4 (3 students with differential year)	3.537
2012/2013	33	29	35	-	-	-	2	3.667

f) Postgraduate programmes

Name of the programme of study	Full-time students			Part-time students*			Number of students transferring from another higher education institution	Grade point average**
Year	Applicants	Enrolled	Enrolment quota	Applicants	Enrolled#	Enrolment quota		
KIPK 2014/2015	-	-	-	17	16	40	5	4.15
IK 2013/2014	-	-	-	6	6	30	5	4.23
KI 2013/2014	-	-	-	3	4	30	0	5.00
IK 2012/2013	-	-	-	8	6	30	1	4.42
KI 2012/2013	-	-	-	10	7	30	2	4.02

*The Faculty specified the students of the postgraduate programme of study as part-time students in accordance with the recommendations given by the Agency for Science and Higher Education (AZVO – *Agencija za znanost i visoko obrazovanje*).

** Grade point average of the previous programme of study, irrespective of the level.

Total number with students transferring to second and third year.

Table 2.2 The pass rate in the programme of study

a) Undergraduate programmes of study

Chemical Engineering

Enrolment year	Number of enrolled students	Number of students who obtained less than 1/3 of possible ECTS credits	Number of students who obtained from 1/3 to 2/3 of possible ECTS credits	Number of students who obtained more than 2/3 of possible ECTS credits	Number of graduates	Number of students who lost their right to studying#	Grade point average of the programme of study
2006/2007	26	2	4	20	18	3 (23)	3.764
2007/2008	35	2	8	25	21	1 (13)	3.642
2008/2009	35	3	7	25	22	2 (21)	3.506
2009/2010	46	4	23	19	18	5 (25)	3.355

Materials Chemistry and Engineering

Enrolment year	Number of enrolled students	Number of students who obtained less than 1/3 of possible ECTS credits	Number of students who obtained from 1/3 to 2/3 of possible ECTS credits	Number of students who obtained more than 2/3 of possible ECTS credits	Number of graduates	Number of students who lost their right to studying#	Grade point average of the programme of study
2006/2007	11	2	0	9	9	1 (21)	3.684
2007/2008	19	1	2	16	11	1 (15)	3.651
2008/2009	18	2	5	11	17	1 (14)	3.574
2009/2010	35	8	8	19	18	3 (15)	3.575

Environmental Engineering

Enrolment year	Number of enrolled students	Number of students who obtained less than 1/3 of possible ECTS credits	Number of students who obtained from 1/3 to 2/3 of possible ECTS credits	Number of students who obtained more than 2/3 of possible ECTS credits	Number of graduates	Number of students who lost their right to studying#	Grade point average of the programme of study
2006/2007	35	3	6	26	24	5 (20)	3.601
2007/2008	47	10	11	26	24	2 (23)	3.326
2008/2009	35	3	15	17	14	4 (24)	3.285
2009/2010	47	10	16	21	22	7 (40)	3.417

Applied Chemistry

Enrolment year	Number of enrolled students	Number of students who obtained less than 1/3 of possible ECTS credits	Number of students who obtained from 1/3 to 2/3 of possible ECTS credits	Number of students who obtained more than 2/3 of possible ECTS credits	Number of graduates	Number of students who lost their right to studying#	Grade point average of the programme of study
2006/2007	29	1	2	26	18	2 (15)	3.812
2007/2008	34	2	3	29	22	0 (3)	3.817
2008/2009	29	1	2	26	21	0 (8)	3.812
2009/2010	44	5	7	32	25	3 (14)	3.608

Note for all undergraduate programmes of study: The number of enrolled students included in the ISVU computer system is the total number of the first time enrolled students in a given academic year, reduced by the number of the same generation students who withdrew from the programme, and without the number of students who transferred from the relevant programme of study to another programme of study. The number of enrolled students may be smaller than the number of enrolled freshmen because some freshmen transferred to other undergraduate programmes of study throughout years. The number of enrolled students may be higher than the number of enrolled freshmen because of enrolled visiting students.

#The brackets include the total number of students who dropped out of the programme of study; in addition to those who lost their right to studying the number also includes the students who withdrew from the programme at their own request and who transferred to another programme of study.

b) Graduate programmes of study

Chemical Engineering

Enrolment year	Number of enrolled students	Number of students who obtained less than 1/3 possible ECTS credits	Number of students who obtained from 1/3 to 2/3 possible ECTS credits	Number of students who obtained more than 2/3 possible ECTS credits	Number of graduates	Number of students who lost their right to studying#	Grade point average
2006/2007	19	0	0	19	19	0	4,125
2007/2008	23	0	0	23	23	0	4,012
2008/2009	27	0	0	27	27	0 (2)#	3.996
2009/2010	17	0	0	17	17	0	3.895

Materials Chemistry and Engineering

Enrolment year	Number of enrolled students	Number of students who obtained less than 1/3 possible ECTS credits	Number of students who obtained from 1/3 to 2/3 possible ECTS credits	Number of students who obtained more than 2/3 possible ECTS credits	Number of graduates	Number of students who lost their right to studying#	Grade point average
2006/2007	5	0	0	5	5	0	4.371
2007/2008	9	0	0	9	9	0	4.024
2008/2009	15	0	0	15	15	0	4.208
2009/2010	16	1	2	13	13	1	3.985

Environmental Engineering

Enrolment year	Number of enrolled students	Number of students who obtained less than 1/3 possible ECTS credits	Number of students who obtained from 1/3 to 2/3 possible ECTS credits	Number of students who obtained more than 2/3 possible ECTS credits	Number of graduates	Number of students who lost their right to studying#	Grade point average
2006/2007	28	0	0	28	28	0	4.152
2007/2008	31	0	0	31	31	0	3.825
2008/2009	16	0	0	16	16	0	3.851
2009/2010	13	0	1	12	13	0 (4)#	3.889

Applied Chemistry

Enrolment year	Number of enrolled students	Number of students who obtained less than 1/3 possible ECTS credits	Number of students who obtained from 1/3 to 2/3 possible ECTS credits	Number of students who obtained more than 2/3 possible ECTS credits	Number of graduates	Number of students who lost their right to studying#	Grade point average
2006/2007	12	0	0	12	10	2	4.120
2007/2008	26	0	0	26	26	0	4.012
2008/2009	25	0	0	25	25	0	4.023
2009/2010	15	1	0	14	14	0	3.845

The brackets include the total number of students who dropped out of the programme of study; in addition to those who lost their right to studying, the number also includes the students who withdrew from the programme of study at their own request and who transferred to another programme of study.

× In the academic years 2006/2007 and 2007/2008 the students did not enrol in the graduate programmes of study yet.

Table 2.3 Testing of learning outcomes (The structure of examinations in undergraduate and graduate programmes of study of the Faculty)

a) Undergraduate programmes of study

Name of the programme of study		Final examination only			Practical work and final examination	Preliminary exams / assignments only	Preliminary exams/ assignments and final examination	Seminar paper	Seminar paper and final examination	Practical work	Other forms
		Written final examination	Oral final examination	Written and oral final examinations							
Chemical Engineering	Number (of 43)	0	0	0	1	23	13	10	0	23	33
	Percentage	0	0	0	2.3	53.5	30.2	23.3	0	53.5	76.7
Materials Chemistry and Engineering	Number (of 42)	0	0	0	1	24	12	6	0	29	37
	Percentage	0	0	0	2.4	57.1	28.6	14.3	0	69	88.1
Environmental Engineering	Number (of 41)	0	0	0	1	24	10	12	1	20	35
	Percentage	0	0	0	2.4	58.5	24.3	29.3	2.4	48.8	85.4
Applied Chemistry	Number (of 51)	0	0	0	1	32	12	15	0	28	46
	Percentage	0	0	0	2	62.7	23.5	29.4	0	54.9	90.2
TOTAL	Number (of 177)	0	0	0	4	103	47	43	1	100	151
	Percentage	0	0	0	2.3	58.2	26.6	24.3	0.6	56.5	85.3

b) Graduate programmes of study

Name of the programme of study		Final examination only			Practical work and final examination	Preliminary exam/ assignments only	Preliminary exam / assignments and final examination	Seminar paper	Seminar paper and final examination	Practical work	Other forms
		Written final examination	Oral final examination	Written and oral final examination							
Chemical Engineering											
Module Chemical Process Engineering (KPI – *Kemijsko procesno inženjerstvo*)	Number (of 63)	0	0	0	1	43	14	21	4	42	63
	Percentage	0	0	0	1.6	68.3	22.2	33.3	6.3	66.7	100
Module Chemical Engineering in Environmental Protection (KIZO – *Kemijsko inženjerstvo u zaštiti okoliša*)	Number (of 62)	0	0	0	1	44	12	16	3	39	60
	Percentage	0	0	0	1.6	71	19.4	25.8	4.8	62.9	96.8
Module Chemical Technologies and Products (KTP – *Kemijske tehnologije i proizvodi*)	Number (of 62)	0	0	0	1	43	15	16	3	42	62
	Percentage	0	0	0	1	69.3	24.2	25.8	4.8	67.7	100
Chemical Engineering Total	Number (of 187)	0	0	0	3	130	41	53	10	123	185
	Percentage	0	0	0	1.6	69.5	21.9	28.3	5.3	65.8	98.9
Materials Chemistry and Engineering											
	Number (of 52)	0	0	0	1	37	12	15	3	41	52
	Percentage	0	0	0	1.9	71.1	23.1	28.8	5.8	78.8	100
Environmental Engineering											
	Number (of 66)	0	0	0	1	47	14	28	4	48	66
	Percentage	0	0	0	1.5	71.2	21.2	42.4	6.1	72.7	100
Applied Chemistry											
Module Environmental Chemistry (A)	Number (of 52)	0	0	0	1	35	14	19	2	34	49
	Percentage	0	0	0	1.9	67.3	26.9	36.5	3.8	65.4	94.2
Module Specific Materials and Advanced Technologies (B)	Number (of 57)	0	0	0	1	39	15	20	2	38	54
	Percentage	0	0	0	1.8	68.4	26.3	35.1	3.5	66.7	94.7
Module Applied Organic Chemistry (C)	Number (of 57)	0	0	0	1	39	15	15	2	40	54
	Percentage	0	0	0	1.8	68.4	26.3	26.3	3.5	70,2	94.7
Applied Chemistry Total	Number (of 166)	0	0	0	3	113	44	54	6	112	157
	Percentage	0	0	0	1.8	68.1	26.5	32.5	3.6	67.5	94.5
Graduate Programmes of Study Total											
	Number (of 471)	0	0	0	8	327	111	150	23	324	460
	Percentage	0	0	0	1.7	69.4	23.6	31.8	4.9	68.8	97.7

Table 2.4 The number of scientific papers published in scientific journals by doctoral students while writing their doctoral dissertations

Name of the doctoral programme of study (main courses of study)	Number of doctoral dissertations defended in the last five years*	Number of published papers required to approach dissertation defence	Number of papers written by doctoral students and published in foreign scientific journals relevant for the election to research ranks	Number of papers written by doctoral students and published in Croatian scientific journals relevant for the election to research ranks
Chemical Engineering	24+7(IDS)**	31	147	53
Engineering Chemistry	52+5(IDS)**	57	267	24

* Defended Ph.D. degrees in the period from 1st October 2009 to 30th September 2014.
** The brackets include the number of doctoral dissertations defended in the part-time doctoral programme of study (not involving regular studying) (IDS – *izvandoktorski studij*).

Table 2.6 Websites

Name of the programme of study	Number of courses with their own website	For courses with their own websites, specify the following elements on such pages (specify the number of websites containing the element indicated in each column)					
		Course objectives and content and a list of references	Online announcements of written and oral examination periods and consultation hours	Results of preliminary exams and written exams for students uploaded online	Assignments included in previous examination periods uploaded online	Auxiliary teaching materials (lectures, Power Point presentations, drawings, visuals, video clips, etc.)	Possibility of interactive teacher–student communication
Undergraduate programmes of study							
Chemical Engineering	60	44	60	60	3	44	60
Materials Chemistry and Engineering	43	42	43	43	2	42	43
Environmental Engineering	53	43	53	53	3	43	53
Applied Chemistry	54	52	54	54	3	52	54
Graduate programmes of study							
Chemical Engineering	257	186	257	257	13	186	257
Materials Chemistry and Engineering	72	52	72	72	4	52	72
Environmental Engineering	88	69	88	88	5	69	88
Applied Chemistry	223	167	223	223	11	167	223

Table 2.7 Life-long learning programmes (less than 60 ECTS credits)

Life-long learning programmes	Duration	Accredited (yes/no) and by which institution	ECTS (if allocated)
One-off programmes (congresses, summer schools)			
6th European Summer School on Electrochemical Engineering (ESEEE)	September 2012 Five day conference within the international cycle	University of Zagreb	2
POLYCHAR Congress and Short Course on Polymer Characterisation	March 2012 Six day conference within the international cycle		
Regular Programmes			
Ion Chromatography School	Every year One day conference		
Meeting of Young Chemical Engineers (SMLKI – *Susret mladih kemijskih inženjera*)	Every two years Two day scientific and professional conference		1
International Symposium on Environmental Management (SEM)	Every four years Multi-day scientific conference		
Implementation of Microreactor Technology in Biotechnology	Every two years Organised in turns with the Faculty of Chemistry and Chemical Technology, University of Ljubljana Four day conference		
AMACIZ Scientific Colloquium	Continuously throughout the academic year (5–15 per annum) One hour lectures		
Ideas Fair	In October every year (since 2013) One day conference		
Applied Biocatalysis	Every year, in turn in Zagreb and in Maribor Scientific meeting of students and professors of the Faculty and the FCCT UM One day conference		
Intellectual Property Workshop	In February every year One day workshop		
Conference for Teachers of Vocational High Schools in the Educational Subsector of Chemical Technologies in Cooperation with the Agency for Vocational Education, 2009	Held in 2009 and 2014 One day conference		
Occasional programmes			
Seminars in the area of pipeline modelling/calculation and design	Occasionally One day		
Seminars and workshops on the topic of corrosion and materials protection	Occasionally One day		
Seminars and workshops in the area of measurements and control	Occasionally One day		

3. STUDENTS

3.1. Input Quality

The interest in the programmes of study can be expressed by the fulfilment of the enrolment quotas and the ratio between the number of applicants and the number of enrolled students. The statistics indicating the number of enrolled students per programmes of study clearly show a very good interest in all programmes of study. Figure 3.1 shows the total number of applicants and enrolled students in the last five academic years. There is a visible upward trend in the programmes of study. In the academic year 2014/2015 the number of applicants decreased as a result of introducing high level mathematics in the national high school graduation exam (*državna matura*) as a compulsory requirement. However, the Faculty hopes such practice will contribute to better quality of students. The effect of the foregoing can be seen in the ratio between the number of enrolled students and applicants indicated in Figure 3.1.b. A leap in the academic year 2014/2015 suggests that the number of applicants dropped whereas the number of enrolled students remained the same, which may be a result of the input quality increase. The analysis of enrolled students by programmes of study (Figure 3.2) shows a rise in the number of enrolled students in the academic year 2011/2012 in comparison with 2010/2011, with the highest upward trend in the programme of study Materials Chemistry and Engineering. From the academic year 2011/2012 the Faculty has been enrolling the full quota.

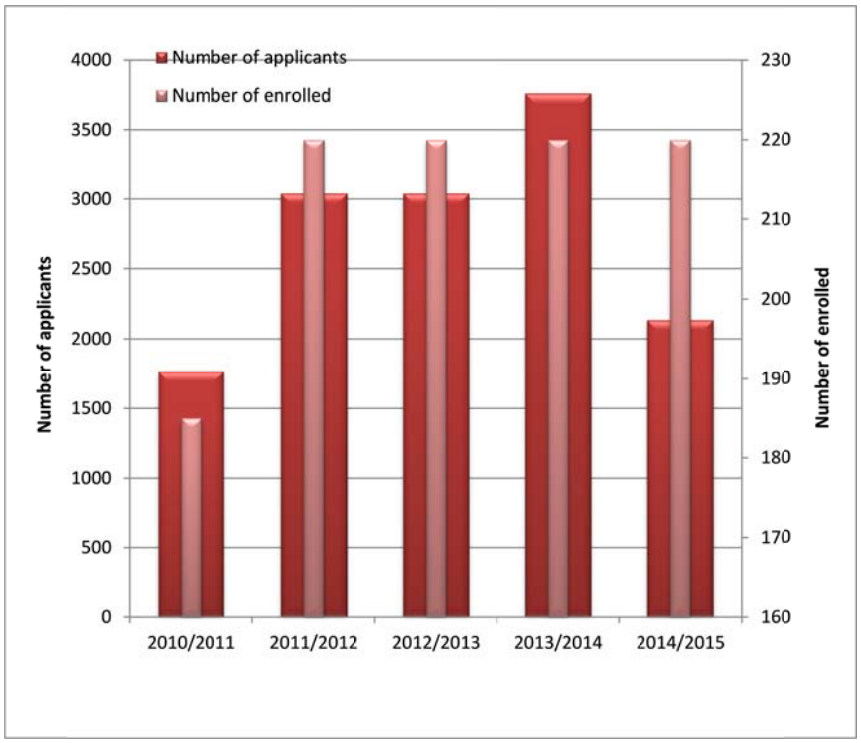

Figure 3.1.a The number of applicants and enrolled students by academic years

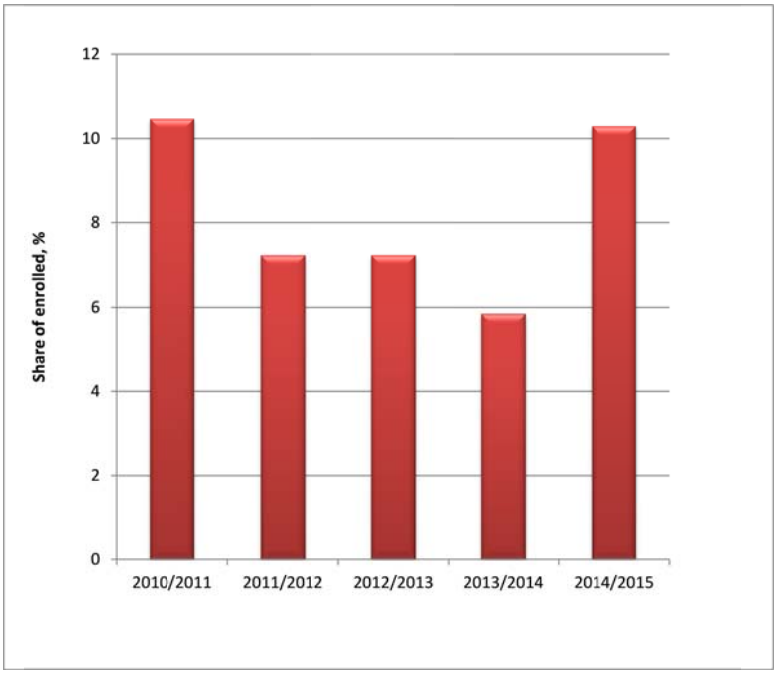

Figure 3.1.b The share of enrolled students (ratio between enrolled students and applicants) by academic years

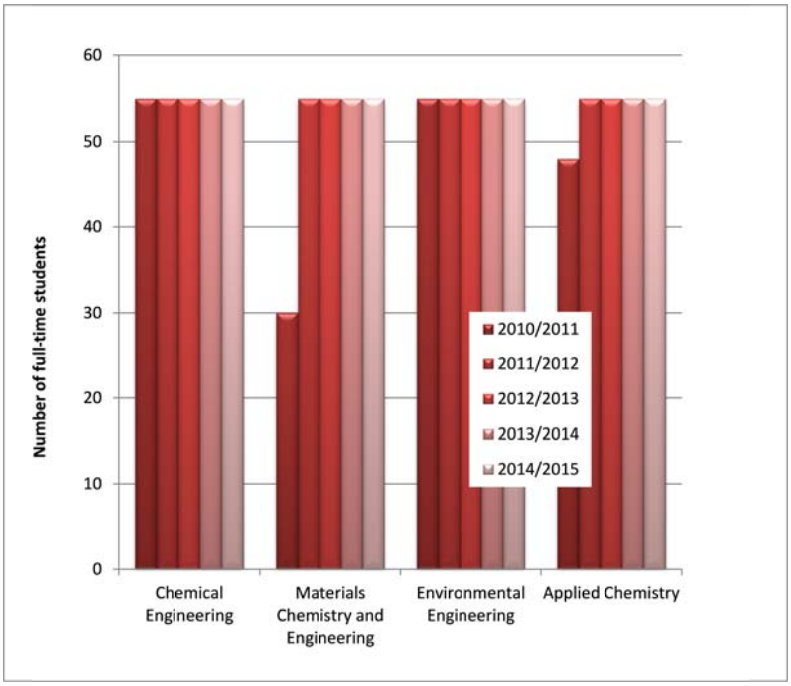

Figure 3.2 The number of enrolled full-time students by programmes of study

The input quality of students is verified by the test of preliminary general chemistry knowledge, in the beginning of the first semester of undergraduate programmes of study. Such test suggests that the average level of input knowledge of enrolled students is not enough for adequate monitoring of chemistry programmes as foreseen. Subsequently, it reflects upon the pass rate of students, as well as on the teaching process quality.

In other words, the Faculty should intensify its efforts to motivate candidates with better preliminary knowledge in the framework of its current and new activities and measures. The introduction of higher level mathematics in the national high school graduation exam has

already been mentioned as a measure used to attract the students who have better preliminary knowledge. The Faculty also tries to promote the programmes of study and the profession and to make them more popular, for instance by participating in the University Fairs in a well-prepared way. The establishment of the Chamber of Engineers would have a significant positive effect on the foregoing. The measures and the activities mentioned should be implemented systematically and continuously as the results only become visible in due time.

Figure 3.3 shows the structure of enrolled students according to their high school education. In line with the indicated statistics it can be seen that more than 60% of enrolled students come from gymnasiums, whereas the share of vocational and other schools is smaller. Throughout the last five academic years the share of enrolled students who come from gymnasiums has been on the rise, whereas the share of students who come from vocational schools has dropped.

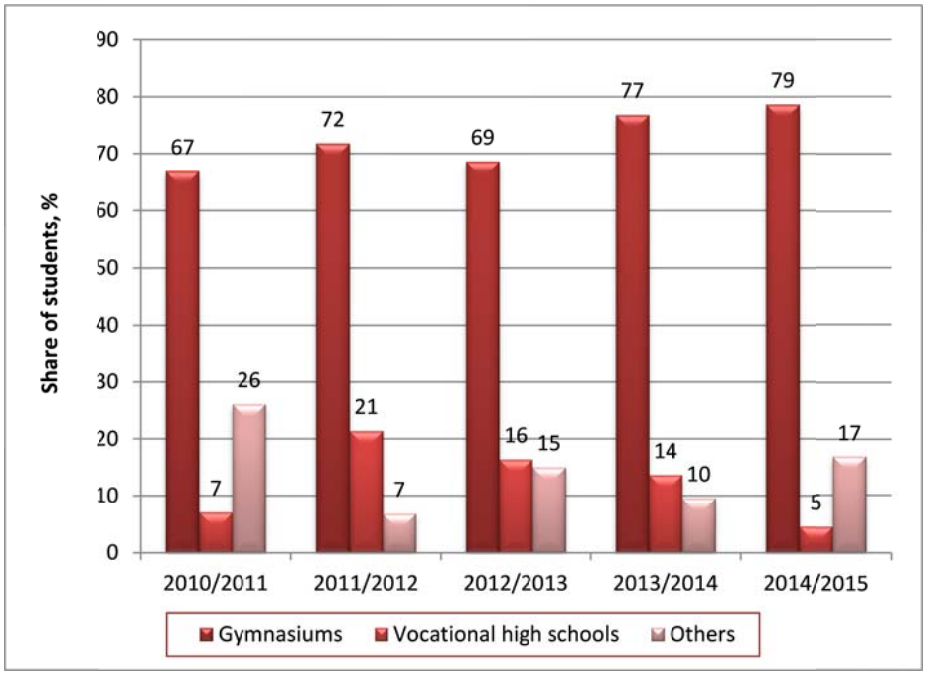

Figure 3.3 The structure of enrolled students according to their high school education

The analysis of the structure of enrolled students by programmes of study (Figures 3.4.a–e) shows the smallest number of enrolled students who come from vocational high schools in the academic year 2014/2015, whereas the programme of study Chemical Engineering has no students who come from vocational high schools. All programmes of study manifest a visible increase in the share of students who come from gymnasiums, which share accounted for more than 70% in the academic year 2014/2015.

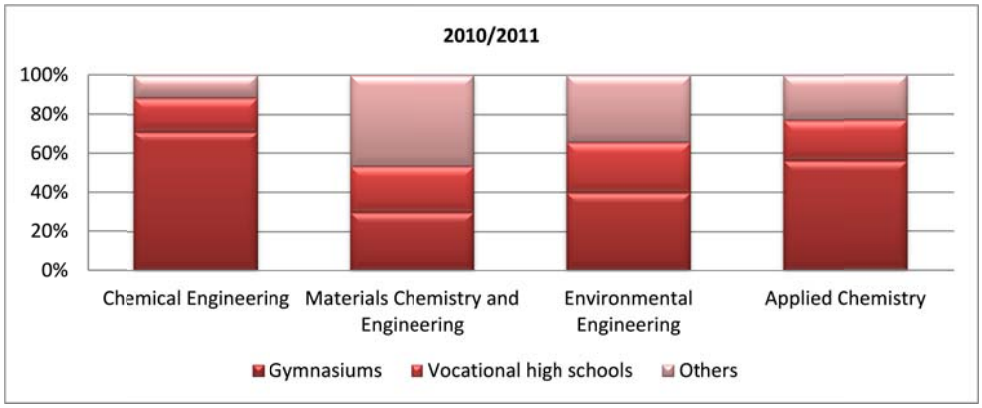

Figure 3.4.a Distribution of students per programmes of study according to their high school education (academic year 2010/2011)

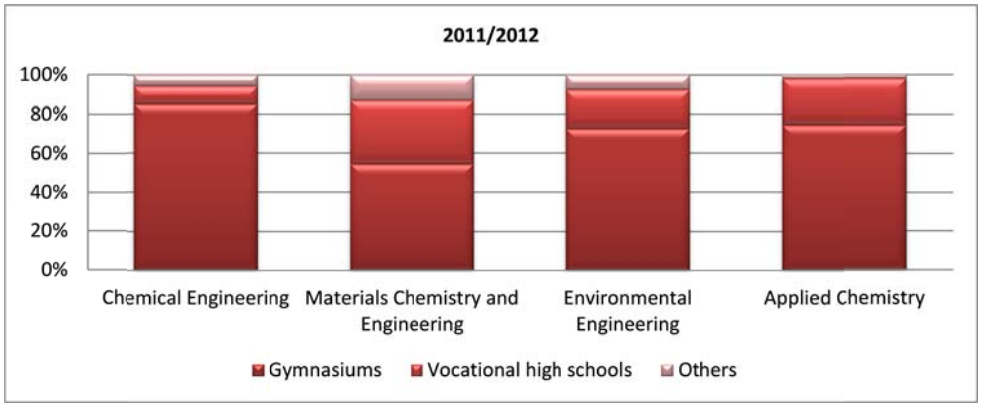

Figure 3.4.b Distribution of students by programmes of study according to their high school education (academic year 2011/2012)

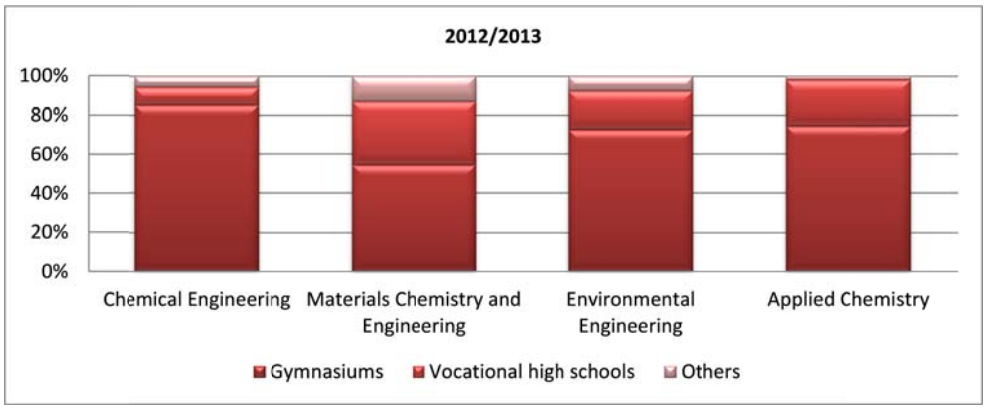

Figure 3.4.c Distribution of students by programmes of study according to their high school education (academic year 2012/2013)

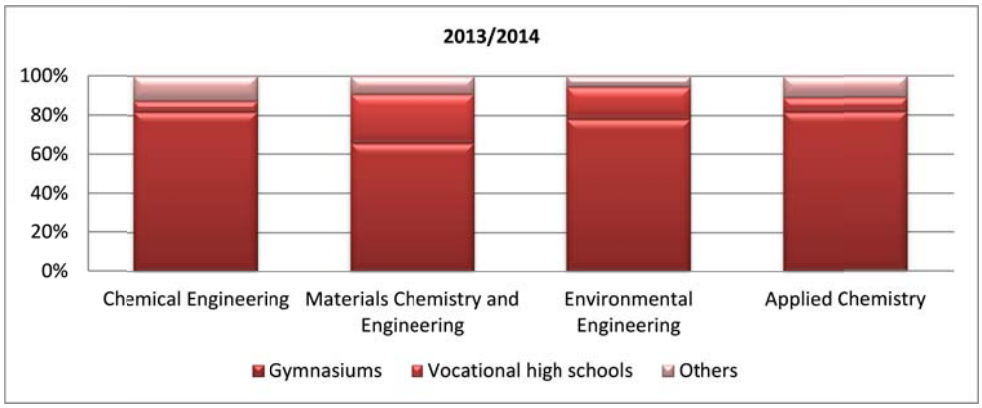

Figure 3.4.d Distribution of students by programmes of study according to their high school education (academic year 2013/2014)

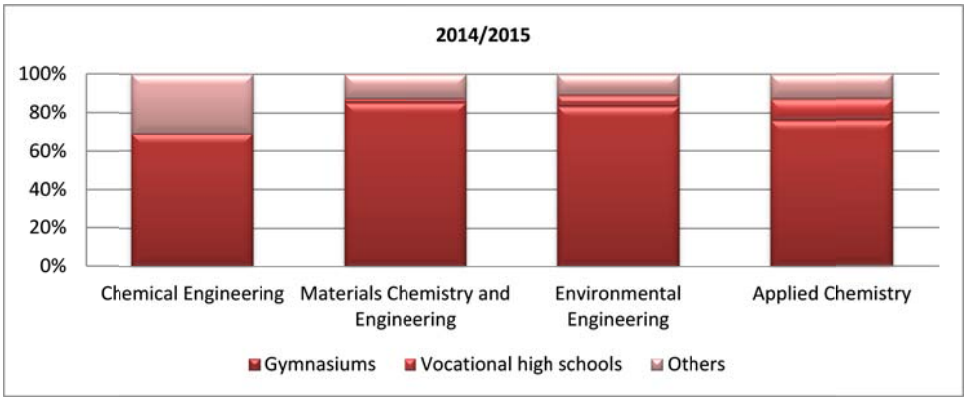

Figure 3.4.e Distribution of students by programmes of study according to their high school education (academic year 2014/2015)

Figure 3.5 shows high school grade point average of enrolled candidates by programmes of study. All programmes of study exhibit an upward trend in grade point average of applicants who enrol in the Faculty programmes of study. The sharpest increase is noticeable in the programmes of study Materials Chemistry and Engineering and Applied Chemistry, which also corresponds with the rise in the share of students with gymnasium education. The programmes of study Chemical Engineering and Environmental Engineering have a somewhat smaller upward trend in the grade point average.

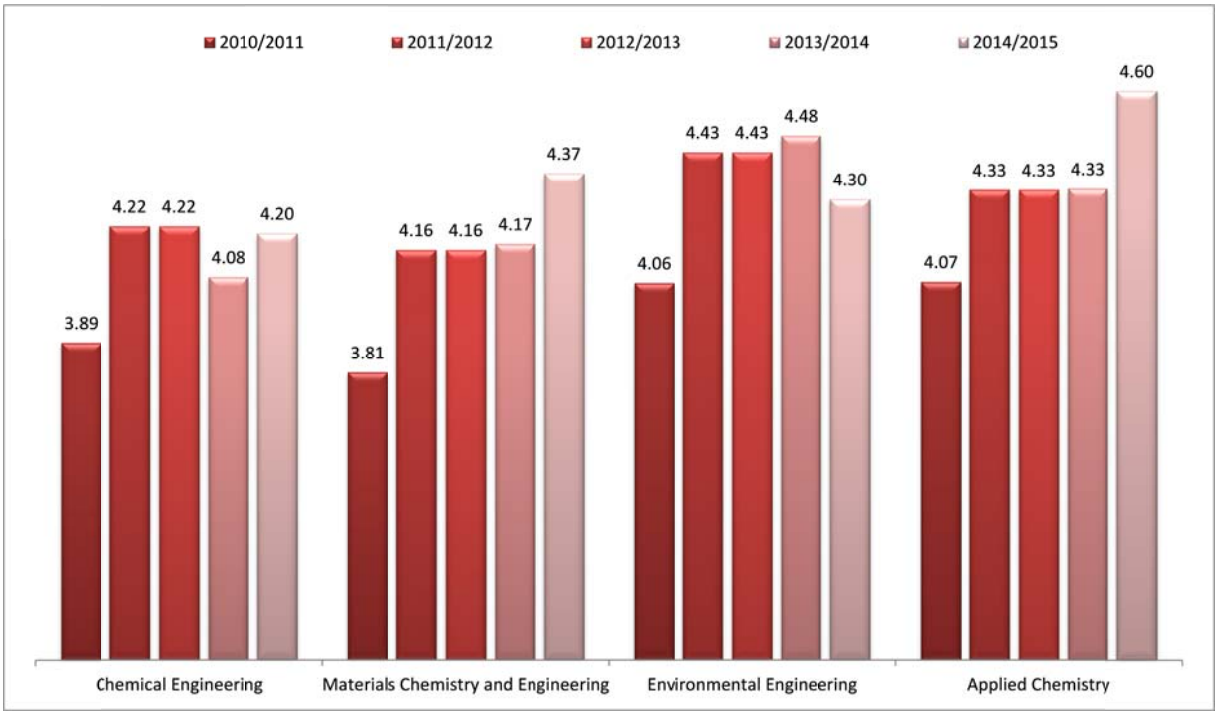

Figure 3.5 The average high school grade point average of enrolled applicants by programmes of study

When the total grade point average by academic years is considered (Figure 3.6), it is evident that the last five academic years showed a 10% increase in the grade point average of applicants enrolling in the Faculty programmes of study.

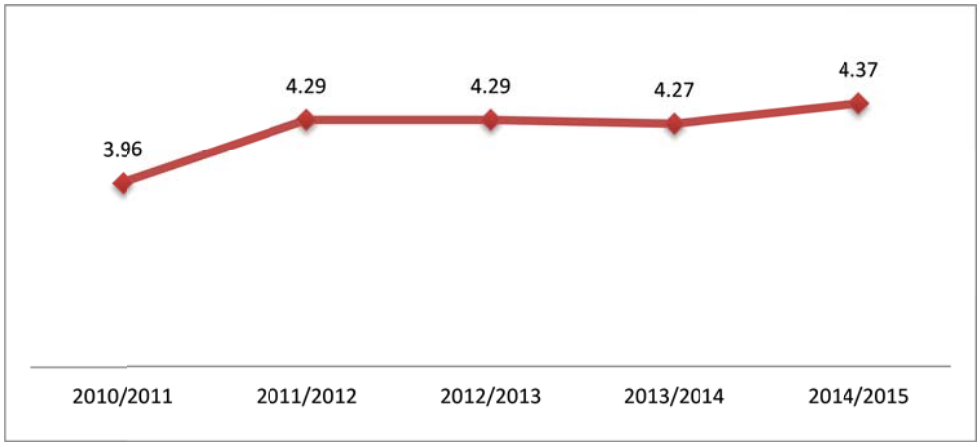

Figure 3.6 The total high school grade point average of enrolled applicants by academic years

3.2. The Pass Rate

Table 2.2 shows the pass rate of students from the first to the second year of undergraduate programmes of study indicated as ECTS credits obtained by the generations of students enrolled from the academic year 2006/2007 to the academic year 2009/2010. Figure 2.4 exhibits the grade point average of courses passed in all programmes of study. For specific undergraduate programmes of study, the grade point average is from 3.2 to 3.9 and for graduate programmes of study between 3.8 and 4.3. The number of students who obtained more than 40 ECTS credits in a given academic year is taken as the indicator of the pass rate for the next year of studying (although the official enrolment criterion for the next year is 50 ECTS credits obtained from possible 60 ECTS credits). It can be concluded that in comparison with the enrolment quota, the pass rate of students who proceed from the first to the second year of studying is relatively high and definitely higher than in the period covered by the previous self-evaluation report. However, it is still smaller than desired, probably as a result of the insufficient preliminary knowledge and inability to follow demanding programmes of study.

3.3. Dissemination of Information to Future Students

The future students can find the information about the Faculty programmes of study and obtain any other information about qualifications, competences and the possibilities of subsequent education and employment in the following ways:

- The potential freshmen can obtain information about the Faculty and the programmes of study from students and junior researchers at the University Fair. Future students can also obtain brochures available both in Croatian and English.
- The Faculty website[17] offers the details concerning enrolment in undergraduate, graduate and doctoral programmes of study. There is a special section on employment analysis.[18]
- The Facebook page of the Faculty Students' Union[19] features video materials and presentations available to future students for dissemination purposes.
- The Faculty Facebook page[20] offers basic information and contacts.
- Promotional brochures written in Croatian and English are distributed during all events organised by the Faculty, and are available on the Faculty website.[21,22]

[17] *http://www.fkit.unizg.hr*
[18] *http://www.fkit.unizg.hr/zaposljavanje*
[19] *https://hr-hr.facebook.com/StudentskiZborFKIT*
[20] *https://hr-hr.facebook.com/pages/FKIT/630414206977964*
[21] *http://www.fkit.unizg.hr/images/50010006/00%20Brosura%20HR%202014_komplet.pdf*

- Every year the Faculty takes part in the Science Festival.
- The employees of the Students' Administration Office respond directly to all inquiries of future students.

3.4. Learning Outcomes and Objectivity of Examinations

Due to different output competences of the courses, learning outcomes are tested in different forms of tests of knowledge, also including continuous knowledge tests (preliminary written exams, oral tests, homework assignments, homework assignments via e-learning, quizzes, preliminary laboratory exercises-related exams), development and presentation of seminar papers, development and presentation of project assignments, drafting of reports relating to field instruction and internship, written exam, oral exam or any combinations of the above. The Faculty website offers detailed information about the courses, including detailed criteria and forms of knowledge tests and examinations determined for each course and established under the curriculum of each course. The shares of specific forms of knowledge tests in undergraduate and graduate programmes of study of the Faculty are specified in Figures 2.5 and 2.6.

The students are given the same or different exams which have equally difficult questions, and are supervised by the teaching assistant or the relevant course teacher to ensure impartiality and objectivity of written examination. The results of written exams and oral exams are public. The student performance on the course which includes preliminary exams is determined according to total points they obtain, and the grading system is determined by the relevant course teacher. If the student is not satisfied with the grade obtained from the test of knowledge, he/she is entitled to appeal and to be re-examined before a commission, provided the motivated request for re-examination is submitted in writing to the Dean 24 hours within the grade announcement. The re-examination is organised three days within the date of receipt of the student's request. The Dean appoints a three-member commission 24 hours within the receipt of the request. The relevant course teacher should be one of the Commission members, and one member should be from another Department. The Commission has an obligation to keep the minutes during the examination and to include the final grading decision in the minutes. The minutes are submitted to the Dean.

If the student approaches the examination before the Commission (for the 4th examination term of a relevant course in the academic year) and is not satisfied with the outcome, he/she is entitled to appeal to the Dean 24 hours within the grade announcement. In accordance with the adopted appeal procedure, the Dean appoints new members of the Commission. In this case, the Commission cannot be chaired by the relevant course teacher.

3.5. The Student Surveys

The Faculty has been carrying out teacher evaluation surveys since the academic year 2005/2006. The surveys are conducted in both semesters for every course and every teacher participating in its execution. The findings of the student surveys for every teacher are only available to the Dean and the Vice-Dean for Education. In compliance with the Decision of the Faculty Council of 14th July 2014[23] the teachers of the Faculty evaluated in the student surveys by the grade lower than good (3.00) during the academic year have an obligation to take part in the workshops of the Centre for Development of Teacher Competences of the University of Zagreb (CeZaN) with the aim of assuring teaching quality and encouraging teaching excellence.

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[22] *http://www.fkit.unizg.hr/images/50010665/00%20Brosura%20ENG%202014_komplet.pdf*
[23] 14th July 2014 (Class: 003-05/14-02/06, Reg. Number: 251-373-5/8-14-01)

The aggregate findings of the student surveys on the teacher evaluation for the academic year 2010/2011 show the teacher grade point average of 4.24 for the winter semester, that is 4.09 for the summer semester. The lowest grade was obtained for the usage of different teaching materials and teaching quality increase (e.g. e-learning, materials prepared in advance – 3.85 in the winter semester, 3.77 in the summer semester). To upgrade instruction by using different teaching methods and increase the quality of instruction, a huge step forward was made in the academic year 2013/2014 when the implementation of e-learning was intensified in all undergraduate and graduate programmes of study at the Faculty (section 2.8). The positive feedback in this regard has already been received from students, and more specific results will be visible after conducting the pen-and-paper survey in both semesters for the academic year 2014/2015, which includes a significantly larger number of students in comparison with the online surveys, the turnout of which accounts for about 23%.

The evaluation surveys for undergraduate and graduate programmes of study have been conducted since the academic year 2008/2009. The relationship between students and teachers in such surveys can be seen from the grades under categories P44 Availability and Friendliness of the Academic Staff to Students and P47 Consultations with the Academic Staff and Out-of-Class Assistance (Table 3.4). The latest available statistics from aggregate surveys of the University of Zagreb for the academic year 2008/2009 show the grades of the Faculty similar to the grade point average at the University level (P44 3.67; P47 3.62). Throughout the years there has been a visible progress in the relationship between students and teachers, as manifested by the upward grading trend, see Table 3.4. The students and the teachers are informed about the evaluation findings of undergraduate and graduate programmes of study in the sessions of the Faculty Council, and over the students' representative in the meetings of the Commission for Education, and the surveys are also available on the Faculty website.[24]

The periodical teaching quality survey was not conducted in the doctoral programmes of study **Engineering Chemistry** (IK) and **Chemical Engineering** (KI). The analyses of 56 (IK), that is 26 (KI) Annual Progress Reports written by doctoral students, which also include the elements relating to the teaching quality for the academic year 2013/2014 (in accordance with the Form DR.SC.04) put forward useful information in this regard. The following grades were obtained: the mentor evaluation 4.9 and the programme of study evaluation 4.5 for IK and 5.0 and 4.6 respectively for KI. The doctoral students evaluated the quality of their own research activity with grade point average 4.25 for both programmes of study. In line with the analysis of Annual Progress Reports written by mentors for the academic year 2013/2014 (in accordance with the Form DR.SC.05), the mentors evaluated the progress of doctoral students' research activity with grades 4.5 and 4.1, and the total quality of the doctoral students' activity with 4.6 and 4.3 for the programmes of study IK and KI respectively.

3.6. The Students' Standard

Table 3.2 shows the data on the students' standard at the Faculty. The space available for learning seats 160 people. The Faculty also provides the premises for the Students' Union and its activities.

The Faculty cannot provide any accommodation for students nor students' canteen, sports or leisure facilities. The Faculty is situated at three locations and all three of them are in the vicinity of the canteen of the Students' Centre. During shorter breaks the students can go to the canteen at Marulić's Square 19. The students' dormitories are also located nearby the Faculty.

Although the Faculty does not offer any sports and leisure facilities, special care is taken of sports and extracurricular activities of students. The Faculty rented a sports hall, where, with

[24] *http://www.fkit.unizg.hr/preddiplomski* i *http://www.fkit.unizg.hr/diplomski*

great support of the Chair of Social Sciences and Humanities, it organises sports and leisure activities. The Tigers Sports Association, founded by the students of the Faculty, has also assumed a great role in the organisation of sports activities for students. The students' sports performance in the previous academic year 2013/2014 is provided below as an example. Taking into account everything that has been done and provided, the teachers and the Faculty have hopefully at least partially contributed to the students' sports achievements. The students of the Faculty won the second place in the team competition in the International Table Tennis University Tournament, EuroZagreb Mladost Open 2014, and came second and fifth as singles. In the World University Karate Championship the student of the Faculty reached the semi-finals (in the category under 60 kg). The female student of the Faculty is a Croatian University Long Jump champion. For third year in a row the students of the Faculty are total winners of *Tehnologijada*, a traditional scientific and sports competition of students in the field of technical sciences and technology.

The Faculty invests ongoing efforts to improve the students' standard, as can mostly be seen by the results of sports, humanitarian and other extracurricular activities of students. In this regard, it could be said that the students' standard is at the satisfactory level. However, there is still a huge problem with the provision of adequate facilities for learning, accommodation and students' canteen. The Faculty is not able to provide these segments of the students' standard in its current premises. The possible solution is migration of the Faculty to the Borongaj Research and Education Campus, the concept of which integrates best experiences worldwide in the organisation of university activities and provides for students' restaurants, canteens, areas for learning, mini-shops, students' fitness clubs and lounges, as well as sports halls, which would improve the students' standard considerably.

3.7. Awards and Certificates of Merit

In order to promote the graduate programmes of study and to encourage students to enrol in and complete such programmes of study, in the academic year 2012/2013 the Faculty established the *Vjera Marjanović-Krajovan* Award. Together with the representatives of the industry (Končar – Institut za elektrotehniku d.d., INA – Industrija nafte d.d., Pliva Hrvatska d.o.o. and Zagrebačke otpadne vode d.o.o.), who finance the award, ever year on the Day of the Faculty this award is given to the students who graduated in the previous academic year as the best students in each of the graduate programmes of study. The same occasion is also used to give Certificates of Merit to the best students of all years of undergraduate and graduate programmes of study, which is financed by the Faculty. The Faculty plans to conclude agreements with a couple of other companies to finance such awards. At the beginning of every academic year the Faculty calls for proposals for student tutors who provide help in instruction and hold consultations with other students. Student tutors are remunerated for their work. The Faculty also supports the activities and projects of the Students' Union.

The effect of such measures is visible in a number of awards received by the students of the Faculty every academic year. For instance, last academic year 2013/2014 ten students won the Rector's Award for six student papers in total. The Dean's Awards (18 for academic year 2013/2014) are given for motivation to those students who competed for the Rector's Award, but were not able to receive it due to fierce competition at the level of the University, and the Commission for the Rector's Award of the Faculty believes their papers to be of very good quality. In the exhibition of innovations of pupils of Zagreb Primary and Secondary Schools and students with international participation, INOVA-Youth 2014, the students of the Faculty won three gold medals and one silver medal for their innovations. One female student of the Faculty won the *Hrvoje Požar* Award, given by the Croatian Energy Association – *Hrvoje Požar* Foundation, in 2014 for the outstanding graduation thesis in the area of energy. Another female student of the Faculty, now already a graduate, received the *Annual Award of Hrvatske vode* for professional and scientific papers in the category best graduation thesis in other areas

concerning water management. In the last four years the students of the Faculty have regularly won the first awards in the competitions for scholarships for the best student projects organised jointly by INA – Industrija nafte d.d. and Jutarnji list.

3.8. The Support for Students

In the academic year 2013/2014 the Faculty established a system of scholarships for good students of poorer social and material status and for the second year in a row provided scholarships for about a dozen students.

Together with the Student Counselling and Support Centre of the University of Zagreb, in the academic year 2013/2014 the Faculty organised workshops to provide help with studying to the students of the first and the second year of undergraduate programmes of study with the topics *How to Get Going and Not Leave Things for Tomorrow* and *How to Learn Continuously*, and the workshops for students of graduate programmes of study with the aim of career counselling.

The student tutors mostly help their colleagues with laboratory exercises in the first and the second year of undergraduate programmes of study with financial support of the Faculty. The Faculty has a teacher who is a coordinator of the student support. The Secretary of the Faculty and the Students' Ombudsperson provide legal aid for studying to students, and the Commission for International Cooperation provides assistance to students applying for international exchange and international scholarships. The Management of the Faculty provides financial support and premises for the activities of the Students' Union of the Faculty, development of the website of the Students' Union in the framework of the Faculty website and implementation of any other planned students' activities.

3.9. The Protection of Students' Rights

The Students' Ombudsperson was first time appointed at the Faculty on 5th October 2010, in the first regular session of the Student's Union of the Faculty. The Students' Ombudsperson receives students' complaints relating to their rights, gives counsel to students concerning the exercise of their rights and together with the Management of the Faculty discusses the issues in the context of the exercise of students' rights. In addition to the Students' Ombudsperson, the students can also consult with the Students' Union of the University of Zagreb with regard to their rights and obligations. The protection of the students' rights is regulated under the Ordinance on Studying in Undergraduate and Graduate University Programmes of Study of the Faculty of Chemical Engineering and Technology of the University of Zagreb,[25] and in accordance with the Dean's decisions.

3.10. *Alumni* Monitoring

The graduates (*alumni*) of the Faculty of Chemical Engineering and Technology are gathered around the AMACIZ Association (Association of Graduate Engineers and Friends of Chemical and Technological Studies), which has been active for 25 years. Many former students are involved in the sections of the Association.[26] Since its foundation the Association includes a choir, hiking, arts and sports sections, regularly issues AMACIZ Bulletin, holds regular lectures in scientific and professional colloquia, and has also recently founded a section of innovators, largely composed of fresh graduates of the Faculty. From the academic year 2013/2014 the Faculty

[25] *http://www.fkit.unizg.hr/_download/repository/pravilnik_preddiplomski_diplomski_studiji_2010.pdf*
[26] *http://www.amaciz.hr/*

signs up all graduates and pays for their one year AMACIZ membership fee, as stimulation for further membership.

The statistics concerning employment of former students is collected on periodical basis. The most recent employment statistics was collected based on a sample of 453 students who graduated from 2009 to 2013 (included). Those were students of the old (Pre-Bologna) undergraduate programme of study and the first four generations of the Bologna programme students, that is graduates from the graduate programmes of study of the Faculty (it turned out that having completed undergraduate programmes of study very few students left the Faculty as bachelors). The findings indicate that the Faculty provides broad education facilitating employment in a large number of versatile industrial companies, public services, institutes and laboratories, depending on the interests and abilities of the candidates. More detailed statistical information can be found on the website of the Faculty.[27]

3.11. General Discussion and Proposals

The Faculty is not completely satisfied with the quality of preliminary knowledge of enrolled freshmen and would like to have freshmen with bigger and similar preliminary knowledge who are more strongly motivated to enrol in the programme of study of their interest. Thus the Faculty will invest even stronger efforts to promote the programmes of study in order to attract candidates of better quality at the University Fair in Zagreb, and to organise the first Open Door Day of the Faculty on 20th February 2015. The Management of the Faculty is encouraged to continue its promotional activities after having received the Certificate of Merit for the best promotional materials received by the Faculty at the 19th University Fair in Zagreb held on 14th and 15th November 2014 at the premises of the Students' Centre.

The Faculty should encourage students to get more engaged in the activities of the *alumni* association while they are still students, to remain more active members later on. In this way the Faculty develops a sense of students' affiliation with the Faculty, which brings long-term benefits to the Faculty.

[27] *http://www.fkit.unizg.hr/zaposljavanje*

3.12. Tables

Table 3.1.a The structure of students (undergraduate and graduate programmes of study)

Programme of study	Full-time students				
	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014
Undergraduate programme of study Chemical Engineering	163	172	187	217	219
Undergraduate programme of study Materials Chemistry and Engineering	95	92	122	134	155
Undergraduate programme of study Environmental Engineering	171	191	205	223	233
Undergraduate programme of study Applied Chemistry	141	137	156	168	185
Graduate Programme of Study Chemical Engineering (three modules)	42	52	45	54	71
Module Chemical and Process Engineering	18	9	12	21	39
Module Chemical and Process Engineering	18	9	12	21	39
Module Chemical and Process Engineering	18	9	12	21	39
Graduate Programme of Study Materials Chemistry and Engineering	14	24	33	38	36
Graduate Programme of Study Environmental Engineering	59	49	38	33	36
Graduate Programme of Study Applied Chemistry (three modules)	38	50	41	45	54
Module Environmental Chemistry	11	15	11	8	8
Module Specific Materials and Advanced Technologies	9	19	14	16	24
Module Applied Organic Chemistry	18	16	16	21	22
Total	723	767	827	912	989

Table 3.1.b The structure of students (postgraduate doctoral programme of study)

Doctoral programme of study Engineering Chemistry

2009/2010	1st year		2nd year		3rd year		Doctoral degree	
	M	F	M	F	M	F	M	F
TOTAL:	3	17	4	12	4	9	2	7

2010/2011	1st year		2nd year		3rd year		Doctoral degree	
	M	F	M	F	M	F	M	F
TOTAL:	4	10	2	18	4	12	2	3

2011/2012	1st year		2nd year		3rd year		Doctoral degree	
	M	F	M	F	M	F	M	F
Teaching assistant	0	0	2	2	0	3	0	1
Junior researcher	1	2	1	3	0	7	2	3
Scholarship	0	0	0	0	0	0	0	1
Costs borne by legal person	2	4	0	2	0	7	1	5
Self-financing	1	2	1	3	2	1	0	0
TOTAL:	4	8	4	10	2	18	3	10

2012/2013	1st year		2nd year		3rd year		Doctoral degree	
	M	F	M	F	M	F	M	F
Teaching assistant	0	1	0	0	2	2	2	2
Junior researcher	0	1	1	2	1	3	1	4
Scholarship	0	0	0	0	0	0	0	0
Costs borne by legal person	1	2	3	4	0	2	2	4
Self-financing	0	2	0	2	1	3	0	1
TOTAL:	1	6	4	8	4	10	5	11

2013/2014	1st year		2nd year		3rd year		Doctoral degree	
	M	F	M	F	M	F	M	F
Teaching assistant/ Junior researcher	0	2	0	2	1	2	3	10
Scholarship	0	0	0	0	0	0	0	0
Costs borne by legal person	1	2	0	1	3	4	0	1
Self-financing	0	0	0	1	0	2	0	2
TOTAL:	1	4	0	4	4	8	3	13

Doctoral programme of study Chemical Engineering

2009/2010	1st year		2nd year		3rd year		Doctoral degree	
	M	F	M	F	M	F	M	F
TOTAL:	4	7	4	1	1	5	3	4

2010/2011	1st year		2nd year		3rd year		Doctoral degree	
	M	F	M	F	M	F	M	F
TOTAL:	6	4	4	7	4	1	1	3

2011/2012	1st year		2nd year		3rd year		Doctoral degree	
	M	F	M	F	M	F	M	F
Teaching assistant/ Junior researcher	0	2	1	1	1	4	0	4
Scholarship	0	0	0	0	0	0	0	0
Costs borne by legal person	0	2	2	0	3	1	2	0
Self-financing	1	1	1	0	0	0	0	0
TOTAL:	1	5	4	1	4	5	2	4

2012/2013	1st year		2nd year		3rd year		Doctoral degree	
	M	F	M	F	M	F	M	F
Teaching assistant/ Junior researcher	0	1	0	2	0	1	2	3
Scholarship	0	0	0	0	1	0	0	0
Costs borne by legal person	1	0	2	2	5	0	0	4
Self-financing	0	1	0	1	1	0	0	1
TOTAL:	1	2	2	5	7	1	2	8

2013/2014	1st year		2nd year		3rd year		Doctoral degree	
	M	Ž	M	Ž	M	Ž	M	Ž
Teaching assistant/ Junior researcher	0	1	0	1	0	2	1	1
Scholarship	0	0	0	0	0	0	0	0
Costs borne by legal person	0	0	1	0	1	2	1	0
Self-financing	0	0	0	0	1	0	0	1
TOTAL:	0	1	1	1	2	4	2	2

Table 3.2 The students' standard

	Area / m²	Number of seats or active seats*
Area for learning	264.76	160
Students' canteen (use of student identity card)	–	–
Other food and eating facilities	40	20
Possibility for students' accommodation	–	–
Sports facilities	–	–
Premises for students' associations and cultural activities	121.9	50
Leisure facilities	–	–

*The number of active seats for learning outside the schedule of lectures and seminars;
area available to students for learning and as lounge area in the premises of the Faculty

Table 3.3 The employment of graduates

Name of the programme of study		Number of students who graduated in the last three years	Number of unemployed according to the statistics of the Croatian Employment Service on 24th November 2014
Graduate programme of study Chemical Engineering	2011/2012	27	17
	2012/2013	16	
	2013/2014	35	
Graduate programme of study Materials Chemistry and Engineering	2011/2012	17	5
	2012/2013	13	
	2013/2014	18	
Graduate programme of study Environmental Engineering	2011/2012	19	19
	2012/2013	12	
	2013/2014	19	
Graduate programme of study Applied Chemistry	2011/2012	25	17
	2012/2013	14	
	2013/2014	29	

Table 3.3.a The unemployment analysis according to the statistics of the Croatian Employment Service on 24th November 2014

Level of Education Educational programme	2011		2012		2013		October 2014	
	Total	Without any work experience	Total	Without any work experience	Total	Without any work experience	Total	Without any work experience
(3.2.2) Undergraduate university programme of study 180 ECTS credits								
(51300/52.003) Environmental Engineering	1	1	3	2	1	1	3	1
(51300/52.012) Chemical Engineering	0	0	1	1	2	0	2	1
(51300/52.010) Materials Chemistry and Engineering	0	0	0	0	0	0	2	1
(4.5.3) Graduate university programme of study 120 ECTS credits								
(51500/44.037) Applied Chemistry; Major course of study: Chemistry in Environmental Protection and Sources of Energy	3	3	7	5	7	4	6	1
(51500/44.038) Applied Chemistry; Major course of study: Applied Organic Chemistry	3	3	6	4	9	6	9	8
(51500/44.039) Applied Chemistry; Major course of study: Specific Materials and Advanced Technologies	1	1	5	5	1	0	11	11
(51500/52.005) Environmental Engineering	20	18	21	15	19	12	24	15
(51500/52.016) Materials Chemistry and Engineering	3	3	7	7	5	3	13	11
(51500/52.018) Chemical Engineering	7	5	17	13	17	15	25	20
(4.1) Faculty, Academy								
(51001/52.020) Chemical Technology	47	12	45	9	42	2	37	3
(4.6.4) Postgraduate university programme of study 180 ECTS credits								
(60900/44.011) Engineering Chemistry	0	0	0	0	0	0	1	0
(60900/52.023) Chemical Engineering	0	0	0	0	0	0	1	0
Sum Total	85	46	112	61	103	43	134	72

Table 3.4 The evaluation of the programmes of study

Acad. year	P44 Availability and Friendliness of the Academic Staff to Students	P47 Consultations with the Academic Staff and Out-of-Class Assistance
2008/2009	3.53	3.74
2011/2012	4.07	4.17
2012/2013	3.97	4.22

4. ACADEMIC STAFF

4.1. The Structure of Teachers and Associates

The structure of the Faculty staff is indicated in Table 4.1. The share of external associates in the academic ranks is 10.4%, and the share of external associates in the teaching assistants and junior researchers accounts for 8.8%.

Figure 4.1 shows the structure of full-time employees. In comparison with 2008 (previous self-evaluation report), the number of teaching assistants (from 6 to 15) has risen considerably, whereas the number of assistant professors (from 24 to 11) and junior researchers (from 55 to 37) has decreased. Some employees were promoted to a higher academic rank, and the employment contract of some junior researchers has expired. The Faculty has employed nine new teachers, and as many as 19 teachers have retired (Table 4.4). Since it was largely full professors who retired, the average age of full professors at the Faculty has decreased. The comparison between the structure of employees at two faculties in Croatia (Faculty of Mechanical Engineering and Naval Architecture of the University of Zagreb, FSB – *Fakultet strojarstva i brodogradnje* and the Faculty of Food Science and Technology of the Josip Juraj Strossmayer University of Osijek, PTF – *Prehrambeno-tehnološki fakultet*) and one foreign faculty (Faculty of Chemistry and Chemical Technology, University of Maribor, FCCT UM) (Figure 4.2), indicates that the structure of employees at the Faculty is not significantly different from the other faculties.

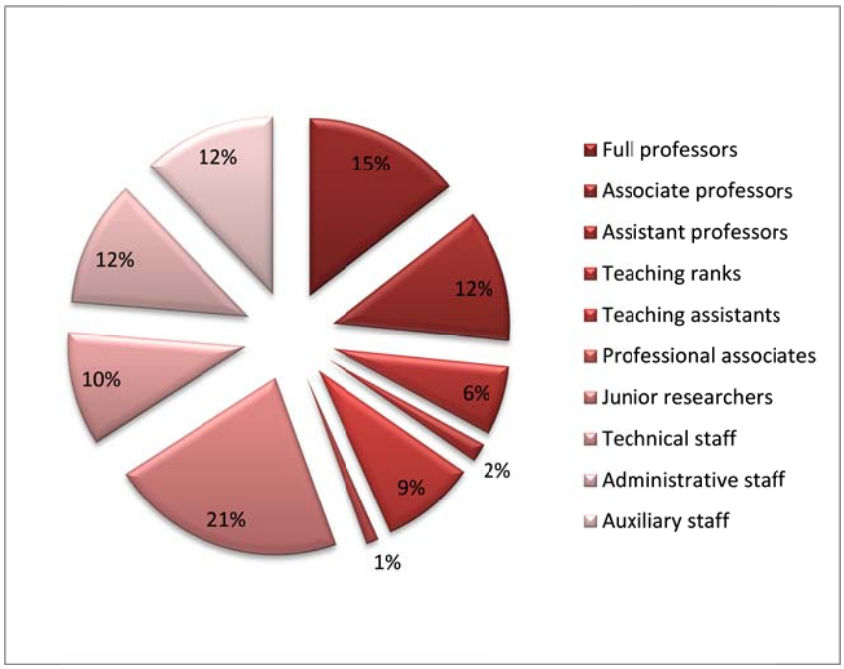


Figure 4.1 The structure of full-time employees of the Faculty

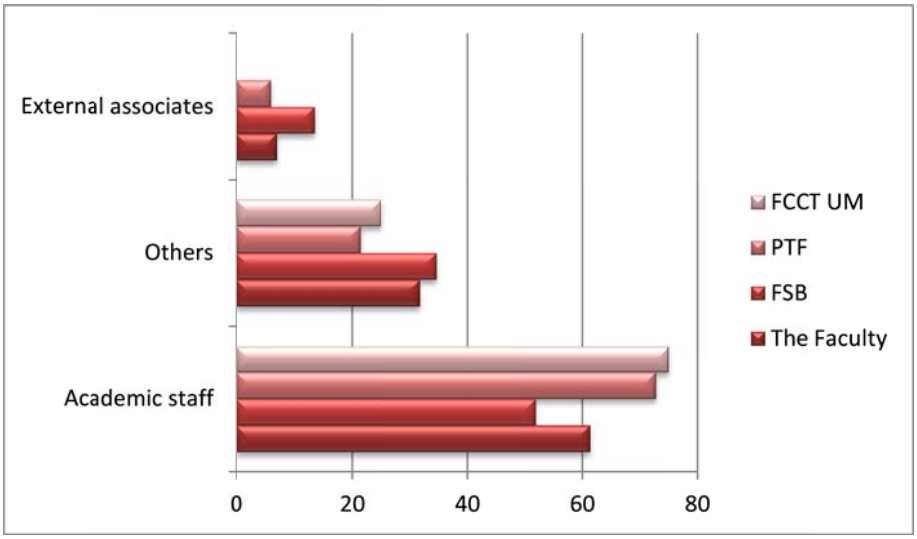


Figure 4.2 The comparison of the structure of employees between the relevant faculties (according to available statistics)

In comparison with the previous Self-Evaluation Report, the staffing situation has changed in the positive direction. The number of teachers has dropped and now complies with the real needs to a large extent (see workload, Table 4.3). As appropriate, junior researchers and teaching assistants and technical staff with insufficient workload in their home Department have also taken part in the instruction (laboratory exercises) in the Departments where such need was expressed. The retirement of full professors does not result in automatic announcement of vacancies for their positions, but the vacancies are announced as needed: if there is a need for teaching assistants, the vacancy is announced for teaching assistants. Nevertheless, the Faculty still has a need for teaching assistants, see section 4.3. It should be indicated here that the Faculty gives due consideration to any decision of this kind, it takes the teacher's competences into account and avoids any adverse effect it may have on the execution of the programmes of study and the competences of graduates. However, the need for further approximation of the workload of the academic staff is still present, see Table 4.a. In accordance with the provisions of the repealed Collective Agreement on Science and Higher Education, the workload of 19.3% of teachers is less than 240 standard working hours, 38.6% of teachers are within the admissible limits, and as many as 42.1% are overloaded. The efforts are made to approximate the workload by determining more mentorship of final and graduation theses for teachers with smaller workload. The accurate division in turn depends on the number of students in final years of undergraduate and graduate programmes of study and it changes every academic year.

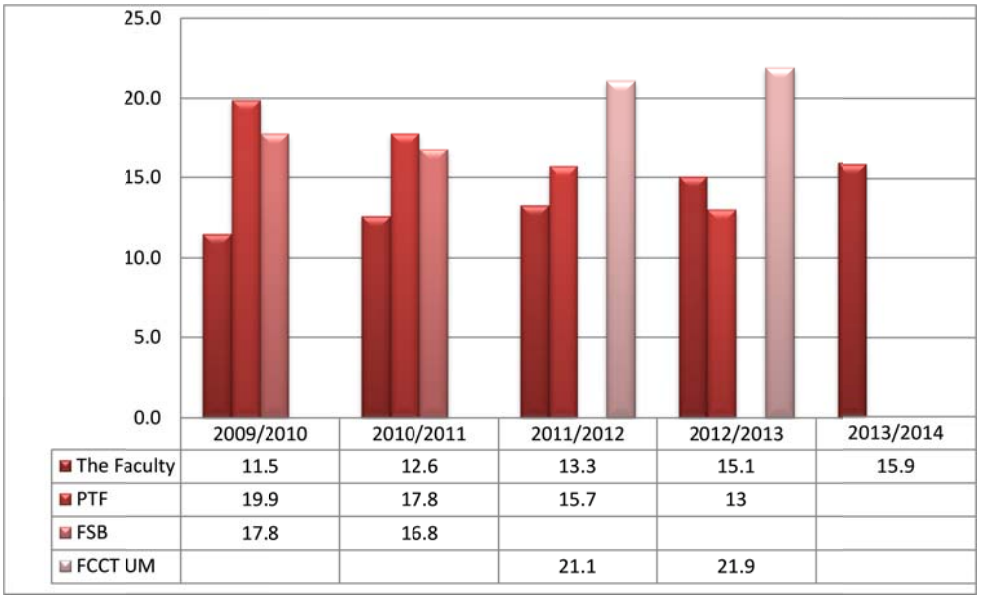
Table 4.a The workload of the academic staff in the academic year 2013/2014

Standard working hours	Full professor		Associate professor		Assistant professor	
	Number	%	Number	%	Number	%
< 240	2	8.0	4	19.0	5	45.5
240 – 360	12	48.0	8	38.1	2	18.1
< 240	2	8.0	4	19.0	5	45.5

4.2. The Ratio between the Number of Teachers and the Number of Students

To calculate the number of students per teacher the students of all undergraduate and graduate programmes of study executed at the Faculty were taken into account, as well as the doctoral students in the first three years of studying, without the final year students. The teachers include full and associate professors, assistant professors and lecturers – the employees of the Faculty. The statistics for the last five years (Figure 4.3) shows a growing number of students per teacher (from 11.5:1 to 15.9:1). On the one hand, it results from a drop in the number of teachers (due to

retirement which is not followed by new recruitment, see Table 4.4), and on the other, from an increasing number of students. According to the analysis of the Agency for Science and Higher Education[28], which includes the statistics of the best higher education institutions worldwide, the number is within the range from 9:1 to 22:1, whereas the maximum allowed ratio is 30:1. That is to say, the Faculty is within the admissible limits on the ratio between the number of students and the number of teachers, in which way the teaching quality is assured because the foregoing ratio is taken as the quantitative indicator for the quality of the teaching component of higher education institutions worldwide. Figure 4.3 also shows the relevant indicators for FSB, PTF and FCCT UM, according to which the comparison of the ratio between the institutions taken into account does not suggest any significant deviations.



	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014
The Faculty	11.5	12.6	13.3	15.1	15.9
PTF	19.9	17.8	15.7	13	
FSB	17.8	16.8			
FCCT UM			21.1	21.9	

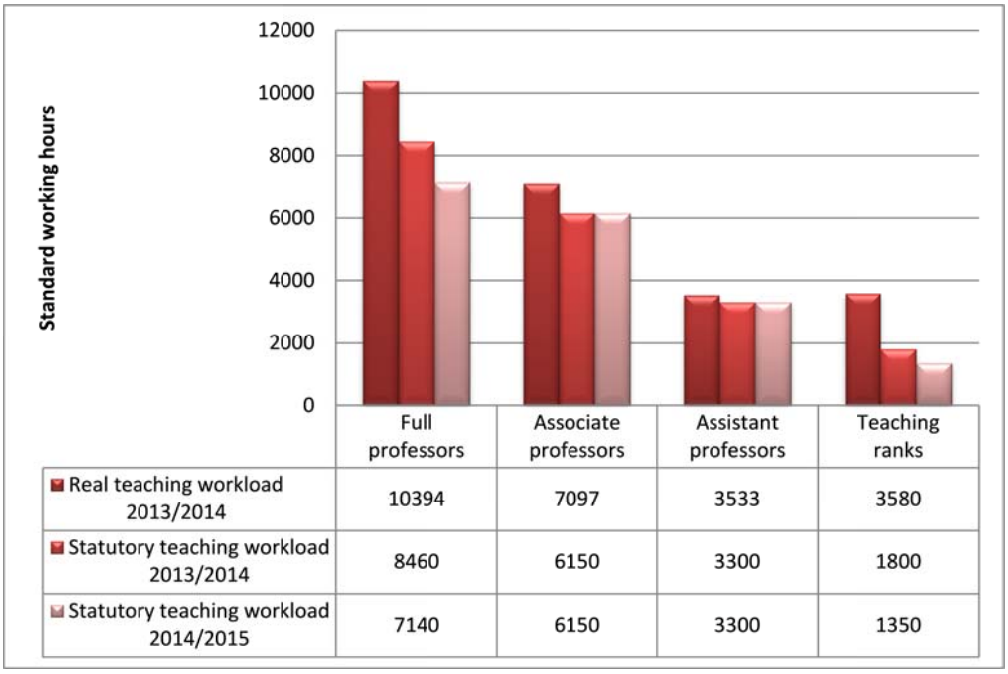
Figure 4.3 The comparison of the student/teacher ratio between the relevant faculties (according to available statistics)

4.3. The Teaching Workload

Table 4.2 shows the statistics on the total teaching workload (in standard working hours) of teachers and external associates in the execution of lectures, seminars and laboratory exercises for all undergraduate and graduate programmes of study conducted at the Faculty. The statistics concerns the academic year 2013/2014.

Figures 4.4 and 4.5 show the teaching workload of the Faculty staff (without external associates) participating in the execution of the instruction. The comparison includes the statistics on the statutory and real teaching workload for the academic year 2013/2014. It can be seen that the real workload in total is bigger than the workload regulated under the repealed Collective Agreement on Science and Higher Education. The situation is much more different from the academic year 2007/2008, when there was a certain surplus of the academic staff. Table 4.3 provides a list of employees (on 31st October 2014) participating in the execution of instruction with their teaching workload for the academic year 2013/2014. Some employees holding the academic ranks participate in all forms of instruction (lectures, seminars, exercises). The reason behind it is primarily a lack of teaching assistants who would be responsible for laboratory exercises. On the other hand, in addition to laboratory exercises, some junior researchers and teaching assistants also take part in the execution of seminars.

[28] *http://www.azvo.hr/hr/kvaliteta-je-neodvojiva-od-niskog-omjera-nastavnik-student*



Slika 4.4. The statutory and real teaching workload of the academic staff in the academic year 2013/2014

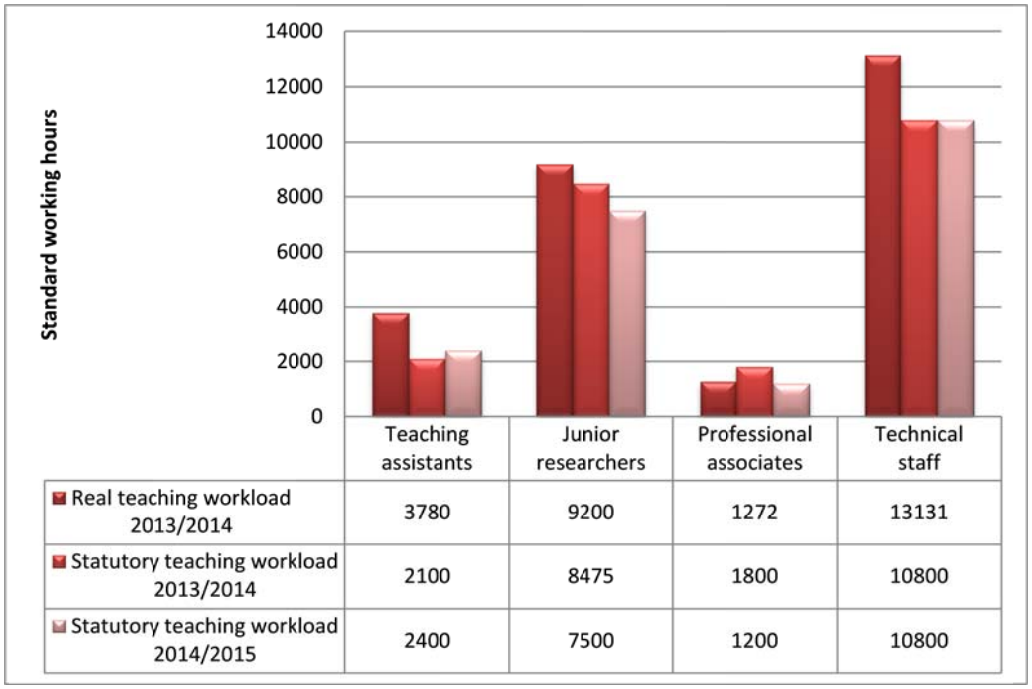


Figure 4.5 The statutory and real teaching workload of junior researchers, teaching assistants, professional associates and technicians in the academic year 2013/2014

The analysis of the situation in specific Departments of the Faculty shows that there are some Departments whose index of workload is too small, but also Departments whose index of workload is too big as a result of a lack of teaching assistants and junior researchers (Figure 4.6). The situation is resolved in different ways. For instance, the Department of General and Inorganic Chemistry hires external associates, and the Management deploys teaching assistants and junior researchers from under-loaded Departments to participate in the execution of instruction in overloaded Departments.

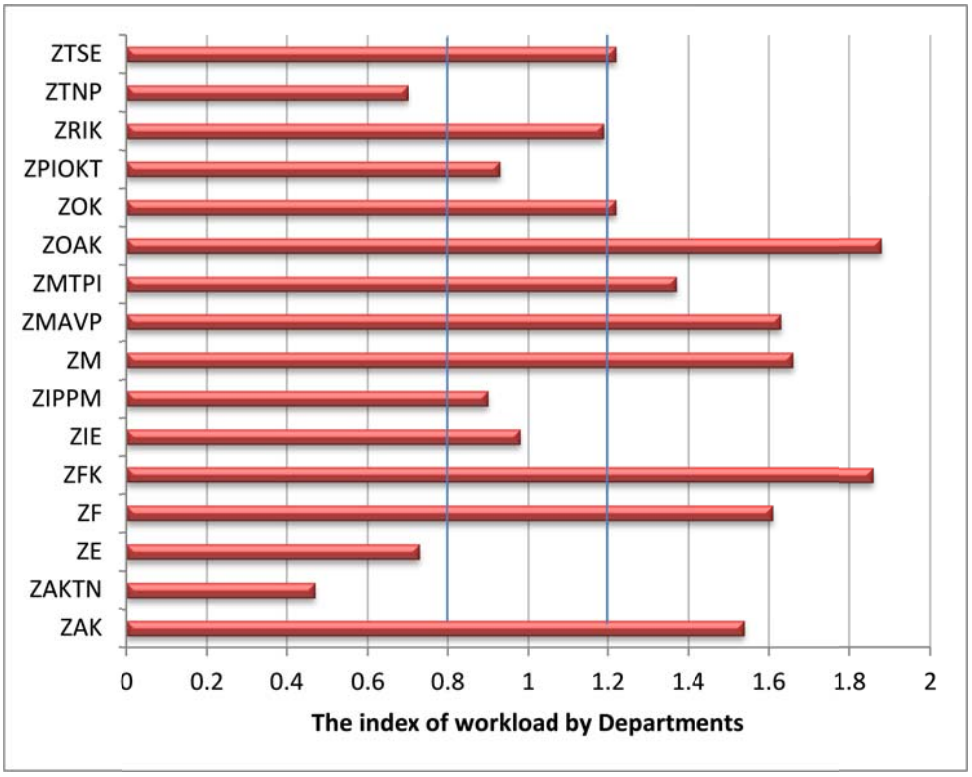


Figure 4.6 The index of workload by Departments (in accordance with the materials of the 179th session of the Faculty Council of 26th May 2014). The acronyms are defined in Figure 1.1.

4.4. Monitoring of External Engagement of the Academic Staff

For every teacher whose engagement was requested by another scientific and educational institution, the Faculty Council issues the approval for the execution of instruction with consent of the relevant teacher. As a rule, the Faculty Council renders a positive decision provided the teacher has less than 360 standard working hours per year at the Faculty. Where the workload exceeds 360 standard working hours, the Faculty gives additional consideration to the justification of such request. In this way, it prevents the overload of teachers resulting from additional engagement in external institutions. Table 4.b shows external engagements of teachers of the Faculty in the previous five-year period.

It is visible that 11 teachers of the Faculty, of 60 teachers in total, participated in the instruction given in other scientific and educational institutions in the last five years. The teachers engaged by external institutions had mostly one course per year, and only one teacher had two courses. It is also visible that only five teachers had such activity continuously in the period of two or more years.

Table 4.b External engagement of the academic staff of the Faculty in the execution of instruction in other external higher education institutions

Teacher	Academic year/ Course	Name of external higher education institution	Number of hours per semester or per year
Ivana Baranović, Ph.D., junior researcher	2009/2010 Mathematics 2	Faculty of Electrical Engineering and Computing of the University of Zagreb	90 hours of seminar in summer semester
Prof. Felicita Briški, Ph.D.	2012/2013 Environmental Science and Design	Faculty of Graphic Arts of the University of Zagreb	30 hours of lectures and 15 hours of seminar in winter semester
	2012/2013 Design and Environment	Faculty of Graphic Arts of the University of Zagreb	30 hours of lectures and 15 hours of seminars in summer semester
	2013/2014 Environmental Science and Design	Faculty of Graphic Arts of the University of Zagreb	30 hours of lectures and 15 hours of seminar in winter semester
Assoc. Prof. Vladimir Dananić, Ph.D.	2009/2010 Physics 1	Faculty of Electrical Engineering and Computing of the University of Zagreb	75 hours of instruction
Prof. Hrvoje Ivanković, Ph.D.	2009/2010 Fundamentals of Chemical Engineering	Faculty of Science of the University of Zagreb	30 hours of lectures and 15 hours of exercises in summer semester
	2010/2011 Fundamentals of Chemical Engineering	Faculty of Science of the University of Zagreb	30 hours of lectures and 15 hours of exercises in summer semester
	2011/2012 Fundamentals of Chemical Engineering	Faculty of Science of the University of Zagreb	30 hours of lectures and 15 hours of exercises in summer semester
	2012/2013 Fundamentals of Chemical Engineering	Faculty of Science of the University of Zagreb	30 hours of lectures and 15 hours of exercises in summer semester
	2013/2014 Fundamentals of Chemical Engineering	Faculty of Science of the University of Zagreb	30 hours of lectures and 15 hours of exercises in summer semester
Assoc. Prof. Alka Horvat, Ph.D.	2010/2011 Environmental Chemical Analysis	Faculty of Science of the University of Zagreb	13 hours of lectures in winter semester
Prof. Zlata Hrnjak-Murgić, Ph.D.	2012/2013 Packaging and Environment	Faculty of Graphic Arts of the University of Zagreb	30 hours of lectures and 15 hours of seminar in winter semester
	2013/2014 Packaging and Environment	Faculty of Graphic Arts of the University of Zagreb	30 hours of lectures and 15 hours of seminar in winter semester
Prof. Krešimir Košutić, Ph.D.	2010/2011 Physical Chemistry	Faculty of Textile Technology of the University of Zagreb	30 hours of lectures and 30 hours of seminars
Prof. Stanislav Kurajica, Ph.D.	2010/2011 Introduction into Inorganic Materials	Undergraduate programme of study: Restoration of Wood, Paper and Textile of the University of Dubrovnik	30 hours of lectures in winter semester
	2013/2014 Materials Technology (Metal and Ceramics)	Undergraduate study of Restoration and Conservation of the University of Dubrovnik	30 hours of lectures in winter semester
Assist. Prof. Hrvoje Kušić, Ph.D.	2013/2014 Industry and Environment	Faculty of Graphic Arts of the University of Zagreb	30 hours of lectures and 15 hours of seminars in winter semester
Assoc. Prof. Ana Lončarić Božić, Ph.D.	2012/2013 Industry and Environment	Faculty of Graphic Arts of the University of Zagreb	30 hours of lectures and 15 hours of seminars in winter semester
Prof. Laszlo Sipos, Ph.D.	2009/2010 Wastewater Technology	Faculty of Science of the University of Zagreb	30 hours of lectures and 30 hours of exercises in summer semester
	2010/2011 Environmental Chemical Analysis	Faculty of Science of the University of Zagreb	15 hours of lectures and 45 hours of exercises in winter semester
	2011/2012 Environmental Chemical Analysis	Faculty of Science of the University of Zagreb	15 hours of lectures and 45 hours of exercises in winter semester
	2011/2012 Wastewater Technology	Faculty of Science of the University of Zagreb	30 hours of lectures and 30 hours of laboratory practice in summer semester
	2012/2013 Environmental Chemical Analysis	Faculty of Science of the University of Zagreb	15 hours of lectures and 45 hours of exercises in winter semester

Teacher	Academic year/ Course	Name of external higher education institution	Number of hours per semester or per year
	2012/2013 Wastewater Technology	Faculty of Science of the University of Zagreb	30 hours of lectures and 30 hours of exercises in summer semester
	2013/2014 Environmental Chemical Analysis	Faculty of Science of the University of Zagreb	15 hours of lectures and 45 hours of exercises in winter semester
	2013/2014 Wastewater Technology	Faculty of Science of the University of Zagreb	30 hours of lectures and 30 hours of exercises in summer semester

4.5. The Sizes of Student Groups

In accordance with the Ordinance on the Bases for Financing of Higher Education at Public Higher Education Institutions, the size of the student group for lecture amounts to 150 students, for seminars not more than 30 students and for exercises not more than 10 students.

The instruction at the Faculty is executed in groups created in accordance with available premises (size and number of lecture rooms, number of available seats in laboratories, number of seats in IT classrooms). The Faculty considers the work efficiency in the current groups as satisfactory. Any effort to make some improvements by reducing the size of groups is limited by space availability.

The student surveys are conducted online, every semester for every course and teacher individually, and the findings are published at the end of every semester, for every teacher individually and for the Faculty as a whole. On occasional basis, the surveys are also carried out by using pen-and-paper method (academic year 2011/2012). Given the fact that the survey findings for courses are not public, this analysis includes publicly available surveys of students who completed their undergraduate or graduate programmes of study in the given years. Although such surveys do not include questions directly relating to the size of student groups in lectures, seminars and exercises, the analysis highlights the results of questions pertaining to work efficiency in student groups (Table 4.c). For the academic years 2009/2010 and 2010/2011 only aggregate survey was conducted for 22 components of the University of Zagreb in total, including this Faculty. The findings indicated in the Table for the academic years 2011/2012 and 2012/2013 are taken from the surveys of students who completed one of the undergraduate that is graduate programmes of study at the Faculty in the foregoing academic years.

Table 4.c The findings of student surveys concerning the quality of teachers in lectures, exercises and seminars (*M* – arithmetic mean, *sd* – standard deviation, *N* – number of assessments)

	Programme of study, academic year	*M*	*sd*	*N*
Usefulness of lectures for understanding of relevant course units	*Undergraduate programmes of study 2009/2010 and 2010/2011	3.35	0.88	2933
	Undergraduate programmes of study 2011/2012	3.96	0.77	89
	Undergraduate programmes of study 2012/2013	3.68	1.09	73
Usefulness of lectures for understanding of relevant course units	*Graduate programmes of study 2009/2010 and 2010/2011	3.75	0.77	2009
	Graduate programmes of study 2011/2012	4.13	0.77	69
	Graduate programmes of study 2012/2013	4.29	0.72	52
Practical training during exercises and possibility of practical testing of acquired knowledge and skills	*Undergraduate programmes of study 2009/2010 and 2010/2011	3.20	1.02	2920
	Undergraduate programmes of study 2011/2012	3.90	0.91	90
	Undergraduate programmes of study 2012/2013	4.06	0.75	72
Practical work during exercises (seminars) and possibility of practical testing of acquired knowledge and skills	*Graduate programmes of study 2009/2010 and 2010/2011	3.51	0.88	2006
	Graduate programmes of study 2011/2012	3.91	1.01	69
	Graduate programmes of study 2012/2013	4.19	0.86	52

*The findings of the surveys for the academic years 2009/2010 and 2010/2011 from the aggregate surveys in 22 components of the University of Zagreb in total, including the Faculty of Chemical Engineering and Technology. The findings for the academic year 2011/2012 were obtained by using pen-and-paper method.

In comparison with the findings of the surveys conducted in the academic years 2009/2010 and 2010/2011 for 22 components, the teaching quality at the Faculty for 2011/2012 and

2012/2013 was assessed with higher grades. There is also a noticeable upward grading trend both in undergraduate and graduate programmes of study of the Faculty in the academic year 2012/2013 in comparison with 2011/2012. In accordance with the foregoing survey findings, the execution of instruction can be evaluated as very good in general.

4.6. The Competency of the Academic Staff

The evaluation of competency of teachers and external associates includes the following criteria: scientific activity (publishing of scientific papers and participating in scientific projects), professional activity (publishing of professional papers and participating in professional projects), teaching activity (developing, publishing and availability of teaching materials) and student surveys.

In the field of natural sciences, the Faculty consistently enforces the provisions of the Ordinance of the National Council for Science on the Criteria for the Election to Research Ranks and the Criteria of the Rectors' Conference for the Election to Academic and Teaching Ranks, as approved by the competent Council of the Field of Natural Sciences of the University of Zagreb. In the field of technical sciences, the Criteria of the Rectors' Conference and the foregoing Ordinance are also applied, but the promotion criteria are made additionally stringent in accordance with the internal document: Recommendations of the Faculty of Chemical Engineering and Technology for the Election to Academic, Teaching and Associate Ranks. The Faculty also has another internal document: the Scoring System for Applicants Elected to the Academic Rank of Assistant Professor. This document is used for unequivocal scoring and evaluation of the scientific, teaching and professional activity, inaugural lecture, scientific and professional competency in the area of the group of courses to which the assistant professor is elected. According to the curriculum vitae, bibliography, professional references, presentation and interview with the applicant, the expert commission evaluates the overall potential of the applicant, including the following elements: organisational and planning skills, initiative (e.g. the commission recognises the mobility experience, short-term trainings, ability to work in multidisciplinary areas, etc.), communication skills, managerial skills/teamwork, and other elements chosen by the commission.

The external associates engaged at the Faculty are elected to academic ranks at their home institutions.

To be able to make a comparison of competency of the academic staff of the Faculty at the national level, Table 4.d shows the criteria for the election to academic ranks (which also includes a comprehensive evaluation of the teacher's competency) of the Faculty and of the FSB and the PTF. The statistics for the FCCT UM, which could be used to make a comparison at the international level, is not available. According to the criteria listed in Table 4.d, it is visible that the Faculty criteria used to evaluate the competency of teachers in the process of election to the academic ranks exceeds the criteria used by other relevant institutions.

The scientific and professional activity, as an important element for evaluation of the academic staff competency, is analysed under section 5, and can be evaluated as excellent at the national level.

The teaching competency is monitored according to development, publication and availability of teaching materials (lectures in the form of Power Point presentations, other teaching references, handbooks and textbooks), which is evaluated under section 4.9.

The students' opinion of the competency of the academic staff is outlined in accordance with the student surveys conducted in winter and summer semesters of the academic year 2011/2012 in all programmes of study executed at the Faculty (Table 4.e).

Table 4.d The criteria for the election to academic ranks

Institution	Election criteria
Faculty	- Criteria of the Rectors' Conference for the Election to Academic and Teaching Ranks - Criteria of the Academic Area Council of the University of Zagreb for the Election to Academic and Teaching Ranks - Recommendations of the Faculty of Chemical Engineering and Technology for the Election to Academic, Teaching and Associate Ranks - The Scoring System for Applicants Elected to the Academic Rank of Assistant Professor
FSB	- Criteria of the Rectors' Conference for the Election to Academic and Teaching Ranks - Criteria of the Academic Area Council of the University of Zagreb for the Election to Academic and Teaching Ranks
PTF	- Criteria of the Rectors' Conference for the Election to Academic and Teaching Ranks - The applicant elected for the first time to the academic rank, artistic and teaching and teaching rank, except applicants who completed teaching-oriented profiles of the programmes of study, must have a certificate of the certified higher education institution on the completed programme of general pedagogical, psychological and didactic-methodical education.

Table 4.e The grades of the survey questions for the academic year 2011/2012 concerning competency of the academic staff (*M* – arithmetic mean, *sd* – standard deviation, *N* – number of assessments)

Survey question	Semester	*M*	*sd*	*N*
The teacher clearly determines learning outcomes and expectations from the student.	Winter	4.24	0.61	215
	Summer	4.09	0.59	119
The teacher presents thematic units of the course clearly and intelligibly.	Winter	4.12	0.68	215
	Summer	4.03	0.60	119
Methods, examples and exercises facilitate achievement of learning outcomes.	Winter	4.02	0.66	215
	Summer	3.89	0.57	119
The teacher is motivated and conscientiously fulfils his/her obligations.	Winter	4.41	0.51	215
	Summer	4.23	0.57	119
What overall assessment would you give to this teacher?	Winter	4.24	0.61	215
	Summer	4.09	0.59	119

According to the statistics in Table 4.e it is evident that students have a very high opinion of the competency and performance quality of the academic staff.

The results of the comprehensive analysis, including all relevant criteria (scientific, teaching and professional activity and student surveys) suggest high competency of the academic staff of the Faculty for the execution of teaching assignments. There is space for some improvements, which are expected in publishing of refereed teaching materials and writing of textbooks.

4.7. Professional Training and Development of Teacher Competences

In cooperation with the University of Zagreb (mostly) or other specialised institutions or agencies, the Vice-Dean for Education of the Faculty organises, coordinates and ensures professional training and development of general and methodological teachers' competences, which is carried out occasionally in the form of lectures and workshops. The focus has recently been on determination of learning outcomes for programmes of study and courses, and nowadays learning outcomes of all courses have been determined.[29] The Faculty has also invested efforts to promote e-learning, especially to increase the number of e-courses of higher levels, as a result of which all courses of undergraduate and graduate programmes of study have been raised to the first or the second level, and 20 e-courses – 13 in undergraduate and 7 in

[29] *https://www.fkit.unizg.hr/predmet/*

graduate programmes of study – have a high third level of e-learning.[30] The Faculty has also undertaken activities to improve mentoring skills.

The examples of workshops and courses held in the second half of 2014 are as follows:

- D. Pašić: Learning Outcomes, Centre for the Development of Teacher Competences, CeZaN of the University of Zagreb / Faculty of Chemical Engineering and Technology, 30th October 2014
- Panel: International Mobility for the Development of Teacher Competences, CeZaN of the University of Zagreb, 23rd October 2014
- E-Course Development Projects, Office for E-Learning of the University of Zagreb, 30th June 2014

In terms of content, teachers improve their skills independently, by following scientific and professional references, participating in scientific and professional conferences, implementing scientific and professional projects, for which the Faculty provides any required infrastructure (laboratories, equipment) and services (accounting, procurement).

The academic staff of the Faculty is responsible for management or participates in a number of projects within the academic exchange programme for students and teachers of Central and East Europe CEEPUS (Central European Exchange Programme for University Studies), Table 4.f. The scope of such cooperation is satisfactory, especially having in mind the prominent scientific activity as the primary form of development of university teachers' competences in the context of content of their courses.

Table 4.f The academic staff of the Faculty as project leaders of projects within the CEEPUS programme

Project Leader **Title of the project**	**Duration**
Sanja Martinez *Education of modern analytical and bioanalytical methods*	3/4/2014–2/4/2015
Tomislav Bolanča *Determination of xenobiotics by using separation and hyphenated techniques for environment, food and human health purposes*	1/10/2011–30/9/2016
Zvjezdana Findrik Blažević *Chemistry and chemical engineering*	1/10/2011–30/9/2014
Nenad Bolf *Cybernetics and modern methods of control*	1/10/2011–30/9/2016
Ivana Steinberg *Education of modern analytical and bioanalytical methods*	1/10/2007–30/9/2012
Alka Horvat *Education in separation and identification of organic xenobiotics in environmental samples and food product*	1/10/2007–30/9/2012
Nenad Bolf *International study in automatic control*	1/6/2005–1/6/2010

In addition to the foregoing findings of the student surveys, the assessment and achievements in terms of teachers' competency also reflect upon relatively prompt employment of graduates (58% within six, and 78% within 12 months after graduation), as well as upon a large share of graduate who continue their education in doctoral programmes of study (5.7% and 7.5% in foreign, that is in Croatian higher education institutions respectively).[31]

According to the forms, scope and achievements in the area of professional training and development of teacher competences, the Faculty is at the forefront in comparison with other

[30] The Decision of the Dean of 10th September 2014, Class: 602-04/14-01/01, Reg. Number: 251-373-1/1-14-05.
[31] *http://www.fkit.unizg.hr/zaposljavanje*

higher education institutions in Croatia (FSB, PTF; no such projects are listed) and is close to those in developed neighbouring countries (FCCT UM; six projects listed in 2013).

In this context it is important to mention that on 24th September 2014 the Centre for Development of Teacher Competences of the University of Zagreb, CeZaN, was officially opened with the aim of coordinating and providing support to university teachers and assuring teaching quality and encouraging teaching excellence.[32] In the forthcoming years the Faculty expects close cooperation with the CeZaN and the use of services under their scope of activity.

4.8. Motivation of Teachers

To encourage textbook publishing, the Dean's College rendered a decision whereby the Faculty will support financially the publication of any textbook adopted as a university textbook with the gross amount of HRK 10,000.00.[33] The amount, at discretion of the author, may be used for graphic design, printing or as the author's fee. To date the Faculty has also paid for the refereeing process and bought a specific number of the textbook copies, depending on demand for such textbooks. The Faculty has not directly evaluated the effect of this measure, but the measure is definitely not crucial when it comes to motivating teachers to write a textbook. The number of published textbooks and books is still relatively small (from one to three textbooks) at the annual level, and a large number of authors of the textbooks published in the last five years are today retired (Gomzi, Janović, Kaštelan-Macan, Mintas, Lopac, Koprivanac, Table 4.g). It is recommended that the Commission for Education and the Commission for Quality Management and as appropriate other bodies consider this issue and introduce additional measures to encourage and motivate teachers to publish university textbooks and to integrate such measures into the relevant Ordinance.

In order to motivate teachers to develop e-courses of the third level in the academic year 2013/2014, the authors of adopted courses were paid a fee in net amount of HRK 500.00 (20 courses in total).[34]

Moreover, to date the Faculty Council and the Management of the Faculty have not considered it necessary to introduce other special measures such as awards and certificates of merit to motivate teachers additionally in this context. One exception, marginally relating to this subject matter, is the *Franjo Hanaman* Award, given for overall activity on the promotional activities relating to the Faculty visibility.[35] The award may be given to teachers and students (professors, assistant professors, lecturers, teaching assistants), junior researchers, and students, who compete in a special category.

4.9. Teaching Materials

The academic staff of the Faculty develops the following types of teaching materials: lectures in the form of Power Point presentations, non-refereed teaching references (books of exercises, lecture notes or handbooks), refereed teaching references, refereed books or university textbooks.

A large majority of courses is covered by minimum one type of teaching materials (see Table

[32] *http://www.unizg.hr/studiji-i-studiranje/cjelozivotno-obrazovanje-i-usavrsavanje/podrska-nastavnicima/*
[33] Report of the Dean from the 140th regular session of the Faculty Council held on 29th March 2010.
[34] Decision of the Dean of 6th February 2014, Class: 602-04/14-01/01, Reg. Number: 251-373-1/1-14-01; Decision of the Dean of 10th September 2014, Class: 602-04/14-01/01, Reg. Number: 251-373-1/1-14-05.
[35] *https://www.fkit.unizg.hr/_news/35248/Pravilnik_Nagrada_FranjoHanaman-procisceni_tekst.pdf*, Ordinance on the Criteria and the Awarding Procedure for *Franjo Hanaman* Award of the Faculty of Chemical Engineering and Technology of the University of Zagreb – consolidated version.

4.5). The fundamental courses in undergraduate programmes of study, especially those executed at other faculties such as mathematics, physics, general, inorganic and organic chemistry, are covered by textbooks, whereas graduate programmes of study and optional courses have other type of teaching materials. Only a smaller portion of teaching references is refereed (lecture notes and handbooks of 25 courses in total), but practically all materials will be refereed during the procedure of re-elections to teaching ranks, which shall be implemented in the next five years because this is one of the re-election criteria.[36]

In accordance with the afore mentioned, the curriculum can be considered covered by professional references to a satisfactory extent in terms of scope, but it should be highlighted that the Faculty cannot be satisfied with a relatively low quality of teaching materials in the majority of courses in graduate programmes of study. The fundamental courses in undergraduate programmes of study largely have relatively old textbooks according to their original publication date (General and Inorganic Chemistry: 1992; Physical Chemistry: 1969; Organic Chemistry: 1984), although in such areas it is difficult to speak of obsolete textbook nature. In the forthcoming period the quality of teaching materials should be improved. In the process, it should be taken into account that the refereeing process should be rigorous and entrusted to competent experts from the Faculty or external institutions, whether from Croatia or abroad (who understand the Croatian language and who would be adequately remunerated for their effort). It is recommended that the Commission for Education and the Commission for Quality Management consider and as appropriate, introduce additional encouraging measures to increase the quality of teaching materials, on top of those required for re-election. For instance, the Faculty could integrate the criteria into the Faculty regulations for the election to the ranks, increase financial remuneration or decrease the teaching workload for a specific period of time while the textbook is being written or during use of a sabbatical leave facility. Table 4.g lists the textbooks published in the last five years. It is noticeable that the teachers of the Faculty traditionally nourish Croatian nomenclature and terminology, as exemplified by published dictionaries, but some books were also published in English.

Table 4.g A selection of books and textbooks published by the academic staff of the Faculty in the last five years

Author **Title of the book / textbook**	**Publisher, place and year of publication, number of pages**
Marija Kaštelan-Macan Enciklopedijski rječnik analitičkoga nazivlja (*Encyclopaedic Dictionary of Analytical Terminology*)	Faculty of Chemical Engineering and Technology and Mentor d.o.o., Zagreb, 2014, 254
Marija Kaštelan-Macan, Mira Petrović (editors) Analitika okoliša (*Environmental Analytics*)	HINUS and Faculty of Chemical Engineering and Technology, Zagreb, 2013, 435
Mladen Mintas, Silvana Raić-Malić Medicinska kemija protutumorskih lijekova (*Medicinal Chemistry of Antitumor Drugs*)	Medicinska naklada, Zagreb, 2013, 227
Zoran Mandić (editor) *Physico-Chemical Methods in Drug Discovery and Development*	IAPC Publishing, Zagreb, 2012, 482
Zvonimir Janović Naftni i petrokemijski procesi i proizvodi (*Petroleum and Petrochemical Processes and Products*)	Croatian Society for Fuels and Lubricants, Zagreb, 2011, 518
Zoran Gomzi Kemijski reaktori (*Chemical Reactors*)	HINUS, Zagreb, 2009, 520
Mladen Mintas, Silvana Raić-Malić Medicinska kemija (*Medicinal Chemistry*)	Medicinska naklada, Zagreb, 2009, 415
Vjera Lopac Leksikon fizike (*Dictionary of Physics*)	Školska knjiga, Zagreb, 2009, 299
Natalija Koprivanac, Hrvoje Kušić *Hazardous Organic Pollutants in Colored Wastewaters*	Nova Science Publishers, Inc., New York, 2009, 81

[36] Decision on the Essential Criteria for Teaching and Professional Activity Assessment in the Procedure of Election to the Academic Rank – OG 106/06.

4.10. General Discussion and Proposals

The structure, the number and competency of the academic staff are considered to be very good, as well as the ratio between the number of teachers and the number of students, and the general human resources policy of the Faculty. In the context of promotion, the Faculty encourages the criteria which exceed the national statutory criteria, and takes the teaching, scientific and professional activity into account. The grades given to the academic staff in student surveys are above the average of the University of Zagreb.

The improvements can be made in the following aspects:

- The teaching workload is not completely approximated, despite significant progress made in 2008. Further distribution of workload is recommended to allow transferring of a portion of the teaching workload from overloaded teachers to those teachers, whose number of standard working hours has been insufficient for a number of years, following the practice used with junior researchers for laboratory exercises. The teachers who assume new obligations should have sufficient time to prepare for instruction.
- The issue of unequal workload among departments will be resolved by adopted restructuring of the Faculty to a large extent.
- The survey should be conducted in order to evaluate the satisfaction among the academic staff and other staff of the Faculty with the work of the Management, associates, working conditions, administrative and auxiliary staff.

The number of published textbooks, both original and translated, should be increased. The Faculty should evaluate the effect of measures taken to date and improve such measures. The desirable number of new textbooks should be determined for a specific period of time.

4.11. Tables

Table 4.1 The structure of the staff*

The staff	Full-time employees		Part-time employees		External engagement of full-time teachers	External associates	
	Number	Average age	Number	Average age	Number	Number	Average age
Full professors	25	52				2	61
Associate professors	21	45				2	45
Assistant professors	11	40				2	53
Teaching ranks	3	47				1	65
Teaching assistants	15	27				3	30
Professional associates	2	41				1	51
Junior researchers	37	32				2	30
Technical staff	18	43			-------		
Administrative staff	20	48			-------		
Auxiliary staff	21	51			-------		
Total	173	42.2				13	47.9

*The statistics obtained from the Human Resources Office on 31st October 2014

Table 4.2 The workload of teachers and external associates

	Lectures		Seminars and auditory exercises		Other forms of instruction	
Name of the programme of study	Teachers of higher education institution	External associates	Teachers of higher education institution	Name of the programme of study	Teachers of higher education institution	External associates
KI-u	2820	-	1890	20.25	3120	18
KIM-u	2040	-	945	20.25	2727	15.6
EI-u	2460	120	1912.5	73.35	3330	114
PK-u	2370	60	1192.5	20.25	3085.5	16.8
KI-g	1920	90	270	90	1455	-
KIM-g	1200	60	180	45	677.4	-
EI-g	810	-	292.5	-	950	-
PK-g	1830	60	225	-	1095	180
DS	924					
Total	16374	390	6907.5	269.1	16439.9	344.4

Table 4.3. The list of teachers

Teacher	Rank	Academic degree	Higher education institution which issued the qualification	Academic area	Date of last election to rank	Employment percentage	Workload at home institution in standard working hours	Workload at external institutions in standard working hours
BRIŠKI, FELICITA	Full professor – permanent rank	Ph.D.	Faculty of Technology	Chemical Engineering	11/06/2013	100	341.00	45.00
GUSIĆ, IVICA	Full professor – permanent rank	Ph.D.	Faculty of Science	Mathematics	12/07/2012	100	510.00	
IVANKOVIĆ, HRVOJE	Full professor – permanent rank	Ph.D.	Faculty of Technology	Chemical Engineering Fundamental Technical Sciences	12/04/2011	100	240.00	45.00
IVANKOVIĆ, MARICA	Full professor – permanent rank	Ph.D.	Faculty of Technology	Chemical Engineering Fundamental Technical Sciences	21/12/2010	100	306.00	
KURAJICA, STANISLAV	Full professor – permanent rank	Ph.D.	Faculty of Technology	Chemical Engineering Fundamental Technical Sciences	12/02/2013	100	273.00	30.00
SERTIĆ-BIONDA, KATICA	Full professor – permanent rank	Ph.D.	Faculty of Technology	Chemical Engineering	22/11/2011	100	152.50	
VASIĆ-RAČKI, ĐURĐA	Full professor – permanent rank	Ph.D.	Faculty of Technology	Chemical Engineering	16/09/1997	100	375.00	
BABIĆ, SANDRA	Full professor – first election	Ph.D.	Faculty of Chemical Engineering and Technology	Chemistry	11/07/2013	100	397.25	
BOLANČA, TOMISLAV	Full professor – first election	Ph.D.	Faculty of Chemical Engineering and Technology	Chemistry	11/06/2013	100	298.50	
FILIPAN, VELJKO	Full professor – first election	Ph.D.	Faculty of Mechanical Engineering and Naval Architecture	Mechanical Engineering	12/10/2010	100	537.50	
GOVORČIN-BAJSIĆ, EMI	Full professor – first election	Ph.D.	Faculty of Technology	Chemical Engineering	18/09/2012	100	370.70	
HRNJAK-MURGIĆ, ZLATA	Full professor – first election	Ph.D.	Faculty of Technology	Chemical Engineering	10/02/2009	100	320.00	45.00
JUKIĆ, ANTE	Full professor – first election	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	12/03/2013	100	277.41	
KOŠUTIĆ, KREŠIMIR	Full professor – first election	Ph.D.	Faculty of Technology	Chemical Engineering	18/01/2011	100	622.50	
LESKOVAC, MIRELA	Full professor – first election	Ph.D.	Faculty of Technology	Chemical Engineering	18/09/2012	100	410.64	

Teacher	Rank	Academic degree	Higher education institution which issued the qualification	Academic area	Date of last election to rank	Employment percentage	Workload at home institution in standard working hours	Workload at external institutions in standard working hours
LUČIĆ BLAGOJEVIĆ, SANJA	Full professor – first election	Ph.D.	Faculty of Technology	Chemical Engineering	18/09/2012	100	270.64	
MARTINEZ, SANJA	Full professor – first election	Ph.D.	Faculty of Science	Chemical Engineering	18/09/2012	100	135.00	
MATIJAŠEVIĆ, LJUBICA	Full professor – first election	Ph.D.	Faculty of Technology	Chemical Engineering	16/11/2010	100	243.75	
PAPIĆ, SANJA	Full professor – first election	Ph.D.	Faculty of Technology	Chemical Engineering	10/05/2011	100	405.00	
RAIĆ-MALIĆ, SILVANA	Full professor – first election	Ph.D.	Faculty of Chemical Engineering and Technology	Chemistry	17/01/2012	100	510.00	
ROGOŠIĆ, MARKO	Full professor – first election	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	14/07/2009	100	467.50	
SANDER, ALEKSANDRA	Full professor – first election	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	13/09/2011	100	488.75	
TOMAŠIĆ, VESNA	Full professor – first election	Ph.D.	Faculty of Technology	Chemical Engineering	10/05/2011	100	337.50	
VOLOVŠEK, VESNA	Full professor – first election	Ph.D.	Faculty of Science	Physics	16/11/2010	100	267.50	
ZELIĆ, BRUNO	Full professor – first election	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	13/03/2012	100	251.25	
AŠPERGER, DANIJELA	Associate Professor	Ph.D.	Faculty of Chemical Engineering and Technology	Chemistry	22/10/2013	100	463.50	
BOLF, NENAD	Associate Professor	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	22/11/2010	100	587.50	
DANANIĆ, VLADIMIR	Associate Professor	Ph.D.	Faculty of Science	Physics	22/12/2009	100	405.00	
FINDRIK BLAŽEVIĆ, ZVJEZDANA	Associate Professor	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	22/10/2012	100	193.75	
GLASNOVIĆ, ZVONIMIR	Associate Professor	Ph.D.	Faculty of Electrical Engineering	Electrical Engineering	14/02/2011	100	335.00	
HRANJEC, MARIJANA	Associate Professor	Ph.D.	Faculty of Chemical Engineering and Technology	Chemistry	18/12/2012	100	357.50	
KOSAR, VANJA	Associate Professor	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	19/03/2012	100	271.50	
LONČARIĆ-BOŽIĆ, ANA	Associate Professor	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	17/01/2011	100	240.00	
MACAN, JELENA	Associate Professor	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	18/06/2012	100	268.50	
MANDIĆ, ZORAN	Associate Professor	Ph.D.	Faculty of Technology	Chemical Engineering	10/05/2010	100	336.00	

Teacher	Rank	Academic degree	Higher education institution which issued the qualification	Academic area	Date of last election to rank	Employment percentage	Workload at home institution in standard working hours	Workload at external institutions in standard working hours
MATIJAŠIĆ, GORDANA	Associate Professor	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	21/11/2011	100	345.50	
MILARDOVIĆ, STJEPAN	Associate Professor	Ph.D.	Faculty of Technology	Chemistry	21/12/2010	100	421.50	
MUTAVDŽIĆ PAVLOVIĆ, DRAGANA	Associate Professor	Ph.D.	Faculty of Chemical Engineering and Technology	Chemistry	19/03/2013	100	409.50	
PRLIĆ-KARDUM, JASNA	Associate Professor	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	19/09/2011	100	556.00	
SUTLOVIĆ, IGOR	Associate Professor	Ph.D.	Faculty of Mechanical Engineering and Naval Architecture	Fundamental Technical Sciences	18/04/2011	100	367.50	
ŠIPUŠIĆ, JURAJ	Associate Professor	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	14/12/2009	100	171.00	
ŠKORIĆ, IRENA	Associate Professor	Ph.D.	Faculty of Chemical Engineering and Technology	Chemistry	28/06/2011	100	377.50	
VIDOVIĆ, ELVIRA	Associate Professor	Ph.D.	Rheinisch-Westfälische Technische Hochschule Aachen, Federal Republic of Germany	Chemical Engineering	22/04/2013	100	137.76	
VRBOS, NEVENKA	Associate Professor	Ph.D.	Faculty of Technology	Chemical Engineering	17/12/2012	100	201.00	
VRSALOVIĆ PRESEČKI, ANA	Associate Professor	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	23/09/2013	100	361.63	
VUKOVIĆ DOMANOVAC, MARIJA	Associate Professor	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	22/10/2012	100	343.50	
FOGLAR, LUCIJA	Assistant Professor	Ph.D.	Faculty of Technology	Chemical Engineering	11/07/2011	100	105.00	
GAZIVODA KRALJEVIĆ, TATJANA	Assistant Professor	Ph.D.	Faculty of Science	Chemistry	17/05/2011	100	385.00	
JERKOVIĆ, MIROSLAV	Assistant Professor	Ph.D.	Faculty of Science	Mathematics	19/06/2012	100	675.00	
KRALJIĆ ROKOVIĆ, MARIJANA	Assistant Professor	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	18/06/2009	100	237.75	
KRIŠTAFOR, SVJETLANA	Assistant Professor	Ph.D.	Faculty of Science	Chemistry	24/09/2013	100	527.10	
KUŠIĆ, HRVOJE	Assistant Professor	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	18/03/2013	100	145.00	45
OTMAČIĆ ĆURKOVIĆ, HELENA	Assistant Professor	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	12/04/2010	100	216.00	

Teacher	Rank	Academic degree	Higher education institution which issued the qualification	Academic area	Date of last election to rank	Employment percentage	Workload at home institution in standard working hours	Workload at external institutions in standard working hours
STEINBERG, IVANA	Assistant Professor	Ph.D.	Karl-Franzens-Universität Graz	Chemistry	17/06/2014	100	334.50	
UKIĆ, ŠIME	Assistant Professor	Ph.D.	Faculty of Chemical Engineering and Technology	Chemistry	19/06/2012	100	396.00	
VRSALJKO, DOMAGOJ	Assistant Professor	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	18/02/2013	100	197.25	
ŽIŽEK, KRUNOSLAV	Assistant Professor	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	20/05/2013	100	314.50	
DEŠPALJ, NAĐA	Senior Lecturer		Faculty of Humanities and Social Sciences	Philology	25/04/2012	100	960.00	
FURAČ, LIDIJA	Senior Lecturer	Ph.D.	Faculty of Chemical Engineering and Technology	Chemistry	24/09/2013	100	924.55	
MARKIĆ, MARINKO	Lecturer	M.Sc.	Faculty of Electrical Engineering	Electrical Engineering	16/12/2013	100	585.00	
HRKOVAC, MARTINA	Senior Teaching Assistant	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	01/03/2013	100	417.00	
UJEVIĆ ANDRIJIĆ, ŽELJKA	Senior Teaching Assistant	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	01/03/2013	100	0.00	
BEGOVIĆ, ERNA	Teaching Assistant		Faculty of Science	Mathematics	01/03/2010	100	495.00	
ĆOSIĆ, IVANA	Teaching Assistant		Faculty of Chemical Engineering and Technology	Chemistry	01/03/2009	100	182.15	
DRAŽEVIĆ, EMIL	Teaching Assistant	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	15/01/2008	100	326.40	
HAJDARI, ZANA	Teaching Assistant		Faculty of Chemical Engineering and Technology	Chemical Engineering	01/12/2012	100	0.00	
HORAK, EMA	Teaching Assistant		Faculty of Chemical Engineering and Technology	Chemistry	01/02/2012	100	348.30	
KASSAL, PETAR	Teaching Assistant		Faculty of Chemical Engineering and Technology	Chemical Engineering	01/06/2010	100	348.30	
KUČIĆ, DAJANA	Teaching Assistant		Faculty of Chemical Engineering and Technology	Chemical Engineering	01/04/2011	100	174.65	
MARGETA, DUNJA	Teaching Assistant		Faculty of Chemical Engineering and Technology	Chemical Engineering	01/04/2011	100	163.95	
PALJAR, KLAUDIA	Teaching Assistant		Faculty of Chemical Engineering and Technology	Chemical Engineering	01/03/2010	100	394.50	
PANDURIĆ, NIKOLA	Teaching Assistant		Faculty of Chemical Engineering and Technology	Chemical Engineering	01/03/2011	100	84.00	
ROGINA, ANAMARIJA	Teaching Assistant		Faculty of Chemical Engineering and Technology	Chemical Engineering	01/09/2010	100	360.00	
ŠABIĆ, MONIKA	Teaching Assistant		Faculty of Chemical Engineering and Technology	Chemical Engineering	01/12/2013	100	0.00	

Teacher	Rank	Academic degree	Higher education institution which issued the qualification	Academic area	Date of last election to rank	Employment percentage	Workload at home institution in standard working hours	Workload at external institutions in standard working hours
VIDAK, ANDREJ	Teaching Assistant		Faculty of Science	Physics	01/02/2012	100	450.00	
LASIĆ, LUKA	Professional Associate	M.Sc.	Faculty of Science	Mathematics	25/09/1995	100	495.00	
MATIJAŠEC, DORA	Professional Associate		Faculty of Science	Chemistry	01/02/2009	100	777.18	
BUHIN ŠTURLIĆ, ZRINKA	Junior Researcher – Postdoctoral scholar	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	01/12/2013	100	0.00	
FARAGUNA, FABIO	Junior Researcher – Postdoctoral scholar	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	01/10/2014	100	217.90	
MEŠČIĆ, ANDRIJANA	Junior Researcher – Postdoctoral scholar	Ph.D.	Faculty of Chemical Engineering and Technology	Chemistry	01/04/2014	100	262.50	
MILOVAC, DAJANA	Junior Researcher – Postdoctoral scholar	Ph.D.	Faculty of Chemical Engineering and Technology	Fundamental Technical Sciences	01/03/2014	100	116.25	
PERIN, NATAŠA	Junior Researcher – Postdoctoral scholar	Ph.D.	Faculty of Chemical Engineering and Technology	Chemistry	01/04/2014	100	228.25	
ŠAGUD, IVANA	Junior Researcher – Postdoctoral scholar	Ph.D.	Faculty of Chemical Engineering and Technology	Chemistry	01/04/2014	100	235.00	
ZRNČIĆ, MIRTA	Junior Researcher – Postdoctoral scholar	Ph.D.	Faculty of Chemical Engineering and Technology	Chemistry	01/11/2013	100	320.00	
ALEKSIĆ, MAJA	Junior Researcher – Senior Teaching Assistant	Ph.D.	Faculty of Chemical Engineering and Technology	Chemistry	01/08/2013	100	237.50	
GRČIĆ, IVANA	Junior Researcher – Senior Teaching Assistant	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	01/06/2011	100	290.00	
KATANČIĆ, ZVONIMIR	Junior Researcher – Senior Teaching Assistant	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	01/04/2013	100	182.25	
KATIĆ, JOZEFINA	Junior Researcher – Senior Teaching Assistant	Ph.D.	Faculty of Chemical Engineering and Technology	Chemistry	01/01/2013	100	233.25	
KEREKOVIĆ, IRENA	Junior Researcher – Senior Teaching Assistant	Ph.D.	Faculty of Chemical Engineering and Technology	Chemistry	01/11/2010	100	448.32	
KOPČIĆ, NINA	Junior Researcher – Senior Teaching Assistant	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	01/08/2011	100	252.15	
KRATOFIL KREHULA, LJERKA	Junior Researcher – Senior Teaching Assistant	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	01/08/2010	100	216.95	

Teacher	Rank	Academic degree	Higher education institution which issued the qualification	Academic area	Date of last election to rank	Employment percentage	Workload at home institution in standard working hours	Workload at external institutions in standard working hours
MANDIĆ, VILKO	Junior Researcher – Senior Teaching Assistant	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	01/08/2012	100	88.50	
MOVRE ŠAPIĆ, IVA	Junior Researcher – Senior Teaching Assistant	Ph.D.	Faculty of Science	Physics	01/08/2011	100	450.00	
OCELIĆ BULATOVIĆ, VESNA	Junior Researcher – Senior Teaching Assistant	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	01/06/2013	100	204.70	
ORLIĆ, SEBASTIJAN	Junior Researcher – Senior Teaching Assistant	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	01/05/2012	100	122.25	
SOVIĆ, IRENA	Junior Researcher – Senior Teaching Assistant	Ph.D.	Faculty of Chemical Engineering and Technology	Chemistry	01/12/2012	100	242.50	
UKRAINCZYK, NEVEN	Junior Researcher – Senior Teaching Assistant	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	01/08/2009	100	51.00	
VALEK ŽULJ, LIDIJA	Junior Researcher – Senior Teaching Assistant	Ph.D.	Faculty of Chemical Engineering and Technology	Chemistry	01/02/2010	100	157.50	
VRANJEŠ PENAVA, NINA	Junior Researcher – Senior Teaching Assistant	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	01/01/2009	100	0.00	
VUK, DRAGANA	Junior Researcher – Senior Teaching Assistant	Ph.D.	Faculty of Chemical Engineering and Technology	Chemistry	01/02/2010	100	238.25	
WITTINE, OZREN	Junior Researcher – Senior Teaching Assistant	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	01/08/2013	100	306.58	
DUPLANČIĆ, MARINA	Junior Researcher – Teaching Assistant		Faculty of Chemical Engineering and Technology	Chemical Engineering	01/05/2007	100	181.27	
IVANKOVIĆ, ANTONIO	Junior Researcher – Teaching Assistant		Faculty of Chemical Engineering and Technology	Chemical Engineering	10/01/2011	100	150.75	
JURETIĆ, DARIA	Junior Researcher – Teaching Assistant		Faculty of Chemical Engineering and Technology	Chemical Engineering	01/04/2012	100	240.00	
MARAČIĆ, SILVIJA	Junior Researcher – Teaching Assistant		Faculty of Chemical Engineering and Technology	Chemistry	10/01/2011	100	0.00	
MINGA, IVA	Junior Researcher – Teaching Assistant		Faculty of Chemical Engineering and Technology	Chemical Engineering	10/01/2011	100	90.00	
MOHLER, IVAN	Junior Researcher – Teaching Assistant		Faculty of Chemical Engineering and Technology	Chemical Engineering	01/05/2009	100	143.50	

Teacher	Rank	Academic degree	Higher education institution which issued the qualification	Academic area	Date of last election to rank	Employment percentage	Workload at home institution in standard working hours	Workload at external institutions in standard working hours
NOVAK, MIRJANA	Junior Researcher – Teaching Assistant		Faculty of Chemical Engineering and Technology	Chemistry	01/06/2011	100	210.00	
PENOVIĆ, TOMISLAV	Junior Researcher – Teaching Assistant	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	01/02/2009	100	210.75	
PERIŠA, MARTINA	Junior Researcher – Teaching Assistant		Faculty of Chemical Engineering and Technology	Chemistry	01/03/2009	100	243.75	
SOPČIĆ, SUZANA	Junior Researcher – Teaching Assistant	Ph.D.	Faculty of Chemical Engineering and Technology	Chemical Engineering	01/03/2009	100	158.25	
STIPKOVIĆ BABIĆ, MAJA	Junior Researcher – Teaching Assistant		Faculty of Chemical Engineering and Technology	Chemistry	01/02/2009	100	209.00	
SUDAR, MARTINA	Junior Researcher – Teaching Assistant		Faculty of Food Technology Osijek	Biotechnology	10/01/2011	100	250.00	
ŠALIĆ, ANITA	Junior Researcher – Teaching Assistant		Faculty of Food Technology and biotechnology	Biotechnology	01/03/2009	100	340.88	

Table 4.4 Employment dynamics for teachers in the last 5 years

Year	Number of newly employed teachers	Number of teachers who retired
2009/2010	1	3
2010/2011	2	2
2011/2012	2	4
2012/2013	3	3
2013/2014	1	7

Table 4.5 Teaching materials used in the previous academic year (2013/2014)

Name of the programme of study	Undergraduate				Graduate			
	KI	KIM	EI	PK	KI	KIM	EI	PK
Number of textbooks written in Croatian	20	8	21	22	23	1	5	9
Number of foreign textbooks translated into Croatian	1	2	4	6	-	-	-	2
Number of scientific publications related in content with instruction	A great majority of scientific publications can be considered related in content with instruction, especially for graduate programmes of study.							
Number of handbooks	20	8	10	12	16	11	6	5
Number of courses with refereed handbook on the website of the higher education institution	3	1	1	-	5	7	5	3
Number of courses having website with auxiliary teaching materials	29	34	40	40	44	26	24	42
Number of courses executed as e-courses (o-compulsory (*obvezni*); i-optional (*izborni*)	5-o	3-o	4-o	3-o	2-o, 1-i	2-o	0	2-i
Total number of courses in the programme of study	34	39	42	42	58	30	25	48

5. SCIENTIFIC AND PROFESSIONAL ACTIVITY

5.1. The Scientific Research Strategy

The Faculty is active in the field of technical sciences, academic areas of chemical engineering, fundamental technical sciences and interdisciplinary technical sciences, and in the field of natural sciences, academic area of chemistry.

The research strategy is already highlighted in the mission of the Faculty, determined under the Faculty Development Strategy for Period 2008–2013 and concerns promotion of chemical engineering and applied chemistry as scientific disciplines by establishing a link between science and technology and businesses, industry and public activities.

The following scientific research guidelines of the Faculty are emphasised:

- To analyse and improve the current and to develop new chemical processes and products and their industrial application,
- To develop new materials and aspects of introducing new materials into industrial production, that is, application,
- To analyse environmental processes resulting from interaction with the human being as a social being, that is with the human being as a technological being with different environmental elements: soil, waters, air and other living beings.

The foregoing guidelines touch upon the fields of nano- and biosciences; they link chemistry and physics with materials engineering, and develop environmentally friendly technologies and energy efficient industrial processes. They include provision of services to chemical and pharmaceutical industries, state and public services, and development of projects in the area of synthesis, analysis, measurements, modelling, diagnostics and chemical process control.

5.2. The Most Important Scientific Journals

For recognisability of the Faculty it is most important **to publish scientific papers in journals** in the areas within the scope of Faculty activity, especially in those journals indexed in the bibliographic databases of *Current Contents*, *Science Citation Index* that is *Science Citation Index Expanded*. This is also recognised under the Ordinance of the National Council for Science on the Election Criteria for Research Ranks. Therefore, the majority of scientific productivity of the Faculty consists of precisely such papers in journals cited in the foregoing tertiary databases.

In other words, the Faculty proves its scientific excellence by publications in prestigious international journals. In the period from 2009 to the end of October 2014, the teachers and scholars of the Faculty published their scientific findings in 224 journals in total according to the *Web of Science* database, 72 journals of which are listed under the first quartile journals in the given category (Q1). The largest number of journals mostly covers the topics concerning chemical engineering, materials, chemistry and environmental protection. Table 5.a shows ten journals with publications of the Faculty academic staff, selected according to the first quartile of the given subject category and including minimum three published papers. The statistics indicated in the Table suggests that in the last five years the average impact factors of the selected ten journals (five year IF) are much higher than the median impact factor (median IF) of

a given category. In the ten selected journals the academic staff of the Faculty published 70 papers in total in the period from 2009 to the end of October 2014.

The Faculty teachers most commonly publish their papers in the following journals (more than ten papers were published in the period 2009–2014):
Chemical and Biochemical Engineering Quarterly, IF=0.911 (30)
Chemical Engineering Journal, IF=4.058 (26)
Journal of Hazardous Materials, IF=4.331 (24)
Corrosion Science, IF=3.686 (20)
Journal of Alloys and Compounds, IF=2.726 (14)
Desalination, IF=3.960 (12)
Journal of the European Ceramic Society, IF=2.307 (12)
Sensors and Actuators B–Chemical, IF=3.840 (12)
Journal of Molecular Structure, IF=1.599 (11)
Journal of Photochemistry and Photobiology A–Chemistry, IF=2.291 (11)
European Journal of Medicinal Chemistry, IF=3.432 (11)

Eight (8) of the foregoing 11 journals are the first quartile (Q1) journals, that is among the best ranked journals in a given category. The first journal is *Chemical and Biochemical Engineering Quarterly*, which became the official journal of the Faculty in 2014.

The Faculty employees most often publish their papers in the following national journals: *Kemija u industriji: časopis kemičara i tehnologa Hrvatske (Chemistry in Industry: Journal of Croatian Chemists and Engineers)*, *Goriva i maziva (Fuels and Lubricants)* and *Polimeri: časopis za plastiku i gumu (Polymers: Journal of Plastics and Rubber)*.

Table 5.a Ten renowned international scientific journals with publications of the Faculty teachers, classified according to the 5-year IF and including minimum 3 published papers

	Journal	Five-year IF (2013)	Categories	Quartile	Median IF	Number of published papers
1	WATER RESEARCH	6,092	ENGINEERING, ENVIRONMENTAL	Q1	1.649	3
			ENVIRONMENTAL SCIENCES	Q1	1.640	
			WATER RESOURCES	Q1	1.231	
2	JOURNAL OF MEDICINAL CHEMISTRY	5,504	CHEMISTRY, MEDICINAL	Q1	2.390	4
3	JOURNAL OF HAZARDOUS MATERIALS	5,123	ENGINEERING, CIVIL	Q1	0.956	8
			ENGINEERING, ENVIRONMENTAL	Q1	1.649	
			ENVIRONMENTAL SCIENCES	Q1	1.640	
4	ELECTROCHIMICA ACTA	4,433	ELECTROCHEMISTRY	Q1	2.089	10
5	CORROSION SCIENCE	4,329	MATERIALS SCIENCE, MULTIDISCIPLINARY	Q1	1.380	10
			METALLURGY & METALLURGICAL ENGINEERING	Q1	0.605	
6	CHEMICAL ENGINEERING JOURNAL	4,181	ENGINEERING, CHEMICAL	Q1	1.313	13
			ENGINEERING, ENVIRONMENTAL	Q1	1.649	
7	SENSORS AND ACTUATORS B-CHEMICAL	4,101	CHEMISTRY, ANALYTICAL	Q1	1.900	4
			ELECTROCHEMISTRY INSTRUMENTS	Q1	2.089	
			INSTRUMENTATION	Q1	1.286	
8	EUROPEAN JOURNAL OF MEDICINAL CHEMISTRY	4,071	CHEMISTRY, MEDICINAL	Q1	2.390	11
9	CHEMOSPHERE	3,867	ENVIRONMENTAL SCIENCES	Q1	1.640	4
10	FOOD CHEMISTRY	3,867	CHEMISTRY, APPLIED	Q1	1.316	3
			FOOD SCIENCE & TECHNOLOGY	Q1	1.206	
			NUTRITION & DIETETICS	Q2	2.444	

5.3. The Number of Citations and Scientific Journal Analysis

According to the *Web of Science* citation database, from 2009 to the end of October 2014 the Faculty scholars published 523 scientific papers in total (586 according to *Scopus* database), 501 papers of which in journals cited in the *Current Contents* database (Table 5.5). The ongoing upward trend in the number of published papers in the last five years can be seen in Figure 5.1. The total number of published papers includes a considerable share (more than 50%) of papers resulting from cooperation with other foreign or national higher education institutions and scientific organisations (Table 5.5). The number of papers published in national journals is not negligible either. In comparison with the large number of published scientific papers and a satisfactory number of book chapters, the number of books, especially of books published in foreign countries, is small.

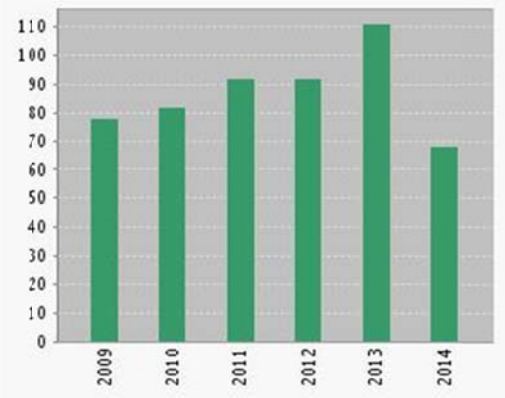


Figure 5.1 The number of papers published per year, *Web of Science* database

As above mentioned, the Faculty is active in the field of technical sciences, the academic areas of chemical engineering, fundamental technical sciences (branch of materials) and interdisciplinary technical sciences (branch of environmental engineering) and in the field of natural sciences, academic area of chemistry. Consequently, the Faculty teachers publish their scientific research findings in the academic areas of chemical engineering, chemistry, materials and environmental protection. Many papers are published in journals which include two or more specified academic areas. Figure 5.2 shows the distribution of papers by academic areas for period 2009–2014.

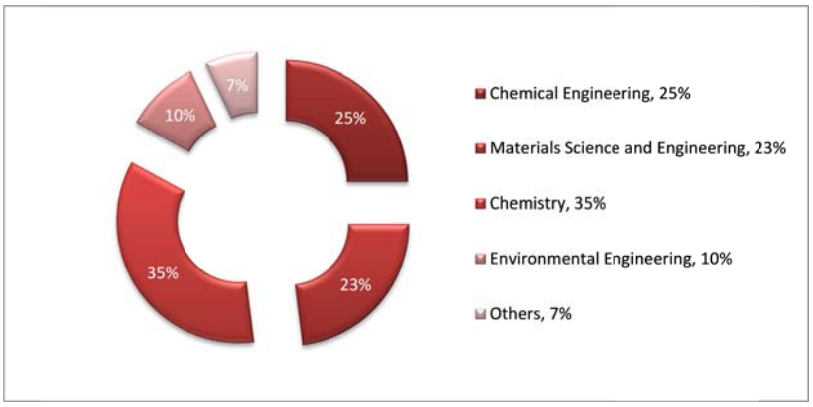


Figure 5.2 The distribution of papers by academic areas

The most important scientific papers of the Faculty are selected for every academic area, according to the high average number of citations per year (in line with the *Web of Science* database). The papers in the academic area of environmental protection and environmental science are classified under the field of technical or natural sciences according to the subject matter investigated in the paper. The papers are listed in Table 5.b.

Table 5.b Ten scientific papers selected according to high average number of citations per year in three areas within the scope of activity of the Faculty

Chemical Engineering			
	Average Nr. of Citations per Year	**Total citation count**	**Paper**
1	20.80	104	I. Dejanović, Lj.Matijašević, Ž. Olujić, Dividing wall column – A breakthrough towards sustainable distilling, CHEMICAL ENGINEERING AND PROCESSING, **49**(6) (2010) 547-558.
2	7.00	35	M. Aleksić, H. Kušić, N. Koprivanac, D. Leszczynska, A. Lončarić Božić, Heterogeneous Fenton type processes for the degradation of organic dye pollutant in water – The application of zeolite assisted AOPs, DESALINATION, **257** (2010) 22-29.
3	7.00	35	P. Kralik, H. Kušić, N. Koprivanac, A. Lončarić Božić, Degradation of chlorinated hydrocarbons by UV/H_2O_2: The application of experimental design and kinetic modeling approach, CHEMICAL ENGINEERING JOURNAL, **158** (2010) 154-166.
4	6.25	25	I. Dejanović, Lj. Matijašević, I. J. Halvorsen, S. Skogestad, H. Jansen, B. Kaibel, Ž. Olujić, Designing four-product dividing wall columns for separation of a multicomponent aromatics mixture, CHEMICAL ENGINEERING RESEARCH & DESIGN, **89** (2011) 1155-1167.
5	6.00	24	I. Dejanović, Lj. Matijašević, H. Jansen, Ž. Olujić, Designing a packed dividing wall column for an aromatics processing plant, INDUSTRIAL & ENGINEERING CHEMISTRY RESEARCH, **50** (2011) 5680-5692.
6	5.50	33	S. Papić, D. Vujević, N. Koprivanac, D. Šinko, Decolourization and mineralization of commercial reactive dyes by using homogeneous and heterogeneous Fenton and UV/Fenton processes, JOURNAL OF HAZARDOUS MATERIALS, **164** (2009) 1137-1145.
7	5.00	30	H. Kušić, B. Rasulev, D. Leszczynska, J. Leszczynski, N. Koprivanac, Prediction of rate constants for radical degradation of aromatic pollutants in water matrix: A QSAR study, CHEMOSPHERE, **75** (2009) 1128-1134.
8	4.75	19	H. Kušić, I. Peternel, Š. Ukić, N. Koprivanac, T. Bolanča, S. Papić, A. Lončarić Božić, Modeling of iron activated persulfate oxidation treating reactive azo dye in water matrix, CHEMICAL ENGINEERING JOURNAL, **172** (2011) 109-121.
9	4.17	25	M. Tišma, B. Zelić, Đ. Vasić-Rački, P. Žnidaršić-Plazl, I. Plazl, Modelling of laccase-catalyzed L-DOPA oxidation in a microreactor, CHEMICAL ENGINEERING JOURNAL, **149** (2009) 383-388.
10	4.00	12	D. Dolar, M. Gros, S. Rodriguez-Mozaz, J. Moreno, J. Comas, I. Rodriguez-Roda, D. Barcelo, Removal of emerging contaminants from municipal wastewater with an integrated membrane system, MBR-RO, JOURNAL OF HAZARDOUS MATERIALS, **239/240** (2012) 64-69.
Materials			
	Average Nr. of Citations per Year	**Total citation count**	**Paper**
1	9.80	49	W. Brostow, V. Kovačević, D. Vrsaljko, J. Whitworth, Tribology of polymers and polymer-based composites, JOURNAL OF MATERIALS EDUCATION, **32** (2010) 273-290.
2	5.40	27	S. Jurmanović, Š. Kordić, M. D. Steinberg, I. Murković Steinberg, Organically modified silicate thin films doped with colourimetric pH indicators methyl red and bromocresol green as pH responsive sol-gel hybrid materials, THIN SOLID FILMS, **518** (2010) 2234-2240.
3	4.80	24	H. Otmačić Ćurković, E. Stupnišek-Lisac, H. Takenouti, The influence of pH value on the efficiency of imidazole based corrosion inhibitors of copper, CORROSION SCIENCE, **52** (2010) 398-405.
4	4.60	23	L. Bistričić, G. Baranović, M. Leskovac, E. Govorčin Bajsić, Hydrogen bonding and mechanical properties of thin films of polyether-based polyurethane-silica nanocomposites, EUROPEAN POLYMER JOURNAL, **46** (2010) 1975-1987.
5	4.25	17	M. Metikoš-Huković, R. Babić, Z. Grubač, Ž. Petrović, N. Lajci, High corrosion resistance of austenitic stainless steel alloyed with nitrogen in an acid solution, CORROSION SCIENCE, **53** (2011) 2176-2183.
6	4.00	24	H. Otmačić Ćurković, E. Stupnišek-Lisac, H. Takenouti, Electrochemical quartz crystal microbalance and electrochemical impedance spectroscopy study of copper corrosion inhibition by imidazoles, CORROSION SCIENCE, **51** (2009) 2342-2348.
7	3.83	23	H. Ivanković, G. Gallego Ferrer, E. Tkalčec, S. Orlić, M. Ivanković, Preparation of highly porous hydroxyapatite from cuttlefish bone, JOURNAL OF MATERIALS SCIENCE-MATERIALS IN MEDICINE, **20** (2009) 1039-1046.
8	3.83	23	Z. Matusinović, M. Rogošić, J. Šipušić, Synthesis and characterization of poly(styrene-co-methyl methacrylate)/layered double hydroxide nanocomposites via in situ polymerization, POLYMER DEGRADATION AND STABILITY, **94** (2009) 95-101.
9	3.33	20	M. Ivanković, I. Brnardić, H. Ivanković, M. Huskić, A. Gajović, Preparation and properties of organic-inorganic hybrids based on poly(methyl methacrylate) and sol-gel polymerized 3-glycidyloxypropyltrimethoxysilane, POLYMER, **50** (2009) 2544-2550.
10	3.33	20	M. Šiljeg, S. Cerjan Stefanović, M. Mazaj, N. Novak Tušar, I. Arcon, J. Kovač, K. Margeta, V. Kaučič, N. Zabukovec Logar, Structure investigation of As(III)- and As(V)-species bound to Fe-modified clinoptilolite tuffs, MICROPOROUS AND MESOPOROUS MATERIALS, **118** (2009) 408-415.

Chemistry			
	Average Nr. of Citations per Year	**Total citation count**	**Paper**
1	9,83	59	I. Ćaleta, M. Kralj, M. Marjanović, B. Bertoša, S. Tomić, G. Pavlović, K. Pavelić, G. Karminski-Zamola, Novel cyano- and amidinobenzothiazole derivatives: Synthesis, antitumor evaluation, and X-ray and quantitative structure-activity relationship (QSAR) analysis, JOURNAL OF MEDICINAL CHEMISTRY, **52** (2009) 1744-1756.
2	6,83	41	J. Piljac-Žegarac, L. Valek, S. Martinez, A. Belščak, Fluctuations in the phenolic content and antioxidant capacity of dark fruit juices in refrigerated storage, FOOD CHEMISTRY, **113** (2009) 394-400.
3	6,20	31	M. Hranjec, G. Pavlović, M. Marjanović, M. Kralj, G. Karminski-Zamola, Benzimidazole derivatives related to 2,3-acrylonitriles, benzimidazo[1,2-a]quinolines and fluorenes: Synthesis, antitumor evaluation in vitro and crystal structure determination, EUROPEAN JOURNAL OF MEDICINAL CHEMISTRY, **45** (2010) 2405-2417.
4	5,60	28	S. Babić, D. Mutavdžić Pavlović, D. Ašperger, M. Periša, M. Zrnčić, A. J. M. Horvat, M. Kaštelan-Macan, Determination of multi-class pharmaceuticals in wastewater by liquid chromatography-tandem mass spectrometry (LC-MS-MS), ANALYTICAL AND BIOANALYTICAL CHEMISTRY, **398** (2010) 1185-1194.
5	5,17	31	Z. Mandić, M. Kraljić Roković, T. Pokupčić, Polyaniline as cathodic material for electrochemical energy sources: The role of morphology, ELECTROCHIMICA ACTA, **54** (2009) 2941-2950.
6	4,80	24	J. Piljac-Žegarac, L. Valek, T. Stipčević, S. Martinez, Electrochemical determination of antioxidant capacity of fruit tea infusions, FOOD CHEMISTRY, **121** (2010) 820-825.
7	4,50	18	M. Hranjec, K. Starčević, S. Kraljević Pavelić, P. Lučin, K. Pavelić, G. Karminski Zamola, Synthesis, spectroscopic characterization and antiproliferative evaluation in vitro of novel Schiff bases related to benzimidazoles, EUROPEAN JOURNAL OF MEDICINAL CHEMISTRY, **46** (2011) 2274-2279.
8	4,50	9	S. Babić, M. Periša, I. Škorić, Photolytic degradation of norfloxacin, enrofloxacin and ciprofloxacin in various aqueous media, CHEMOSPHERE, **91** (2013) 1635-1642.
9	3,75	15	I. Jarak, M. Marjanovic, I. Piantanida, M. Kralj, G. Karminski-Zamola, Novel pentamidine derivatives: Synthesis, anti-tumor properties and polynucleotide-binding activities, EUROPEAN JOURNAL OF MEDICINAL CHEMISTRY, **46** (2011) 2807-2815.
10	3,60	18	L. Racané, M. Kralj, L. Šuman, R. Stojković, V. Tralić-Kulenović, G. Karminski-Zamola, Novel amidino substituted 2-phenylbenzothiazoles: Synthesis, antitumor evaluation in vitro and acute toxicity testing in vivo, BIOORGANIC & MEDICINAL CHEMISTRY, **18** (2010) 1038-1044.

The number of citations. Figure 5.3 shows the number of papers published per year from 1992 to October 2014 and the number of their citations. The statistics is obtained from the *Web of Science* database, according to which in the period specified 1,424 papers were published, cited 15,080 times in total with the average number of citations per paper amounting to 10.59 and the institutional h-index of 49. A high number of citations indicates that the scientific activity of the Faculty teachers has been recognised by the international scientific community.

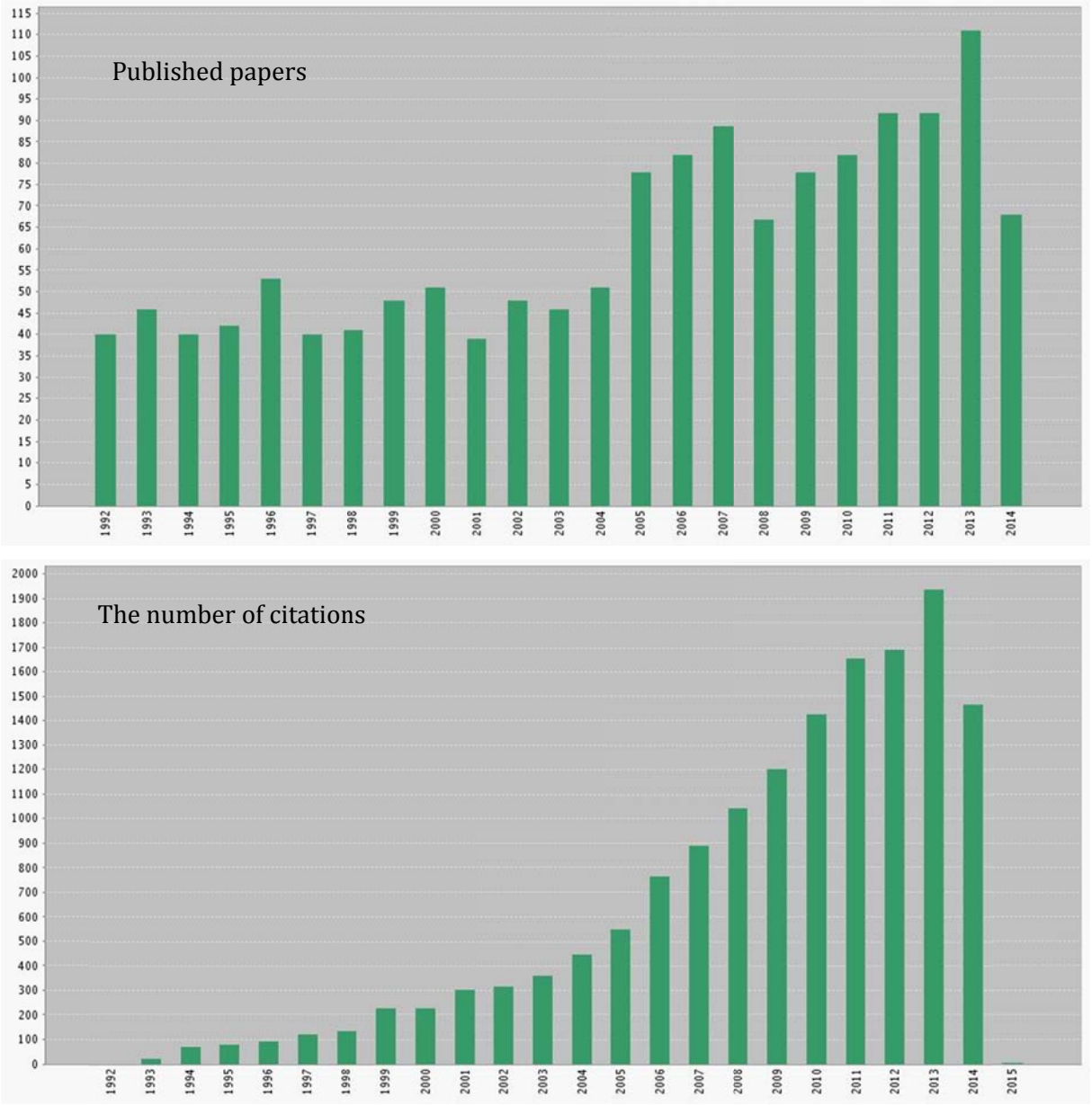


Figure 5.3 The number of published papers and the number of their citations for the period 1992–2014 according to the *Web of Science* database

The comparison with other higher education institutions. To compare the scientific achievements of the Faculty with other higher education institutions, two national institutions were selected: the Faculty of Mechanical Engineering and Naval Architecture of the University of Zagreb (FSB – *Fakultet strojarstva i brodogradnje*) and Faculty of Food Science and Technology of the Josip Juraj Strossmayer University of Osijek (PTF – *Prehrambeno-tehnološki fakultet*), and one foreign higher education institution, the Faculty of Chemistry and Chemical Technology, University of Maribor (FCCT UM). Figure 5.4 shows a graphical comparison between the Faculty and the selected institutions, which includes the ratio between the number of published papers (*Web of Science*) and the number of teachers in the academic and teaching ranks. According to the Figure, the scientific productivity of the Faculty teachers (523/60/5=1.744) is considerably higher than the scientific productivity of the FSB teachers (253/134/5=0.378[37]) and the PTF

[37] Self-Evaluation Report of the Faculty of Mechanical Engineering and Naval Architecture of the University of Zagreb, 2007–2011.

teachers (142/45/5=0.632[38]), but it is lower than the scientific productivity of the FCCT UM (290/16/3=6.043[39]). However, the scientific productivity also directly depends on the funds allocated for science and research. According to the statistics of Eurostat for 2013[40], such allocations in Croatia (0.81% of GDP) are considerably lower than in Slovenia (2.59%). Nevertheless, the difference in comparison with the FCCT UM still remains very high, which indicates that in comparison with the Faculty, the latter institution is much better organised in terms of its scientific activity and absorbs much more financial resources from the funds of national and international projects, that is, from cooperation with the industry.

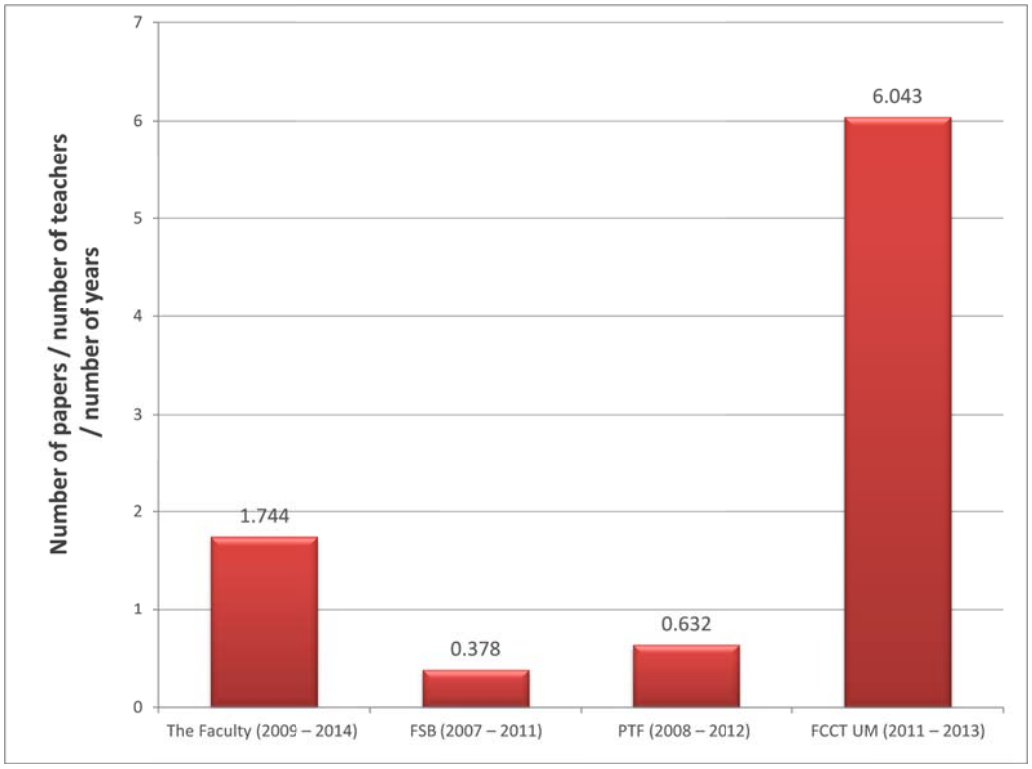


Figure 5.4 The comparison of scientific productivity between the Faculty and FSB, PTF and FCCT UM

5.4. Doctoral Dissertation Mentors

The mentors of doctoral dissertations in the doctoral programmes of study of the Faculty **Chemical Engineering and Engineering Chemistry** (executed in accordance with 2008 licences), that is the new doctoral programme of study **Chemical Engineering and Applied Chemistry** substituting the two previous programmes (2014 licence), should be **active researchers** and fulfil the requirements of the Ordinance on Doctoral Programmes of Study at the University of Zagreb (Article 9), enforced by the Faculty from the academic year 2011/2012. Any teacher holding the academic rank and having a concluded employment contract with the Faculty may be selected as a mentor. The university teachers of other higher education institutions and scholars holding adequate research ranks may be selected as mentors with preliminary approval of the Council of the Doctoral Programme of Study and the Faculty Council

[38] Self-Evaluation Report of the Faculty of Food Science and Technology of the Josip Juraj Strossmayer University of Osijek, 2008–2012.
[39] Self-Evaluation Report of the Faculty of Chemistry and Chemical Technology of the University of Maribor, Slovenia, 2011–2013.
[40] *http://epp.eurostat.ec.europa.eu/tgm/graph.do?tab=graph&plugin=1&language=en&pcode=t2020_20&toolbox=type)*

on case-by-case basis. The decision on the mentor's competences is based on the papers published by the potential mentor in the last five years qualifying him/her as a mentor (minimum one paper of which should concern the subject matter of the doctoral dissertation) specified in the application for the doctoral dissertation topic (Form DR.SC.01). As appropriate, additional criteria may be taken into account such as: mentor's workload, mentor's experience and organisational skills, mentor's involvement in management / participation in project research and attendance in mentoring workshops for first-time mentors. In order to assure doctoral dissertation quality, dual mentorship is also allowed, if needed (interdisciplinary research, research conducted in several scientific institutions, etc.). Table 5.1 outlines the total number of papers published by mentors in national and international scientific journals with peer-review in the last 5 years, which indicates that the mentors are very active scientifically and highly ranked according to the scientific activity and excellence at the University of Zagreb. In line with the total scientific productivity indicated by the number of papers published in journals listed in tertiary databases their scientific productivity is comparable with the scientific productivity of the FCCT UM employees. In accordance with the Annual Performance Report for Doctoral Programmes of Study for 2011/2012, 2012/2013 and 2013/2014, it can be seen that the mentors of doctoral dissertations aggregately publish from 96 to 218 scientific papers per calendar year (depending on the academic area: natural sciences – chemistry or technical sciences – chemical engineering), of which between 69 and 163 papers per year are published in foreign journals. In co-authorship with doctoral students, mentors publish from 43 to 64 scientific papers per calendar year.

According to the available statistics, the mentors of FSB published 52 papers in Croatian journals in the last five years, and 95 papers in foreign journals, whereas the mentors of PTF published 90 papers in Croatian journals and 114 papers in foreign journals. In the period from 2011 to 2013 the staff of the FCCT UM published 95 original scientific papers on the average (*Web of Science* database) per calendar year.

5.5. The Scientific Development of Young Scholars

The guidelines for the scientific development of doctoral students and potential assistant professors are *inter alia* based on the enforcement of the Ordinance on Doctoral Programmes of Study at the University of Zagreb and internal documents of the Faculty: Recommendation for the Election to Academic, Teaching and Associate Ranks and the Scoring System for Applicants Elected to the Academic Rank of Assistant Professor.

In accordance with the University Ordinance on Doctoral Programmes of Study, the doctoral student, when enrolling in the doctoral programme of study, is assigned a *study counsellor* who helps him/her during studying and monitors his/her work and progress throughout studying or until the appointment of the mentor. *The mentor* has an obligation to guide the doctoral student while he/she is writing the doctoral dissertation, to monitor the quality of his/her work, to encourage him/her to publish papers and to facilitate scientific research within scientific projects. The mentor submits the Annual Doctoral Student's Progress Report to the Faculty Council that is to the Council of the Doctoral Programme of Study in the Form DR.SC.05. The doctoral student submits his/her Annual Progress Report in the Form DR.SC.04, wherein he/she makes evaluation of his/her mentor. The counsellor of the programme of study also submits the Annual Progress Report of the Doctoral Programme of Study as a whole (Form DR.SC.09), adopted by the Faculty Council, and where appropriate, a decision is rendered concerning further activities in order to improve the quality.

With the help of the **Council of the Doctoral Programme of Study** (also comprising representatives of junior researchers and doctoral students) and other competent bodies, the Faculty constantly encourages young scholars to adopt the need for ongoing development, to expand their skills and knowledge and to engage in mobility. The scientific development is also achieved by referring young researchers to attend university workshops with the aim of

acquiring transfer skills (developing communication, managerial and business skills), stimulating conference participation, getting involved in developing and applying different forms of e-learning within the teaching process, participating in instruction of different Departments and laboratories, engaging in the work on scientific and professional projects, stimulating internationalisation through participation in bilateral projects, etc. On regular basis, the Faculty informs all employees, including young scholars, about the cooperation agreements signed with specific institutions, notifies them of the possibilities for financing of research, mobility, etc. For some of the foregoing activities the doctoral students in the integrated doctoral programme of study **Chemical Engineering and Applied Chemistry** (from the academic year 2014/2015) obtain additional ECTS credits. The Faculty encourages individual scientific and research projects of doctoral students and their applications for calls for proposals for doctoral students (HRZZ (Croatian Science Foundation/*Hrvatska zaklada za znanost* – Fellowship Programme for Doctoral Students, calls for proposals of the Croatian Academy of Sciences and Arts (HAZU – *Hrvatska akademija znanosti i umjetnosti*), inclusion in the projects of CEEPUS, Erasmus+, fellowships within the *Marie Curie* programme for doctoral programmes of study, established exchange networks and fellowships for doctoral students).

5.6. International Cooperation

In the period from 2009 to the end of October 2014 the teachers of the Faculty published 523 papers in total (*Web of Science*), 298 papers of which were published in cooperation with other foreign and national higher education institutions and scientific organisations (Table 5.5), which accounts for a share of 57% in the total number of published papers and 4.97 (298/60) papers per teacher. The number of papers resulting from international cooperation in the foregoing period amounts to 135 that is 25.8% and 2.25 papers per teacher.

In comparison with similar institutions, the ratio between the number of published papers and the number of teachers shows considerably higher results of the Faculty (Figure 5.5).

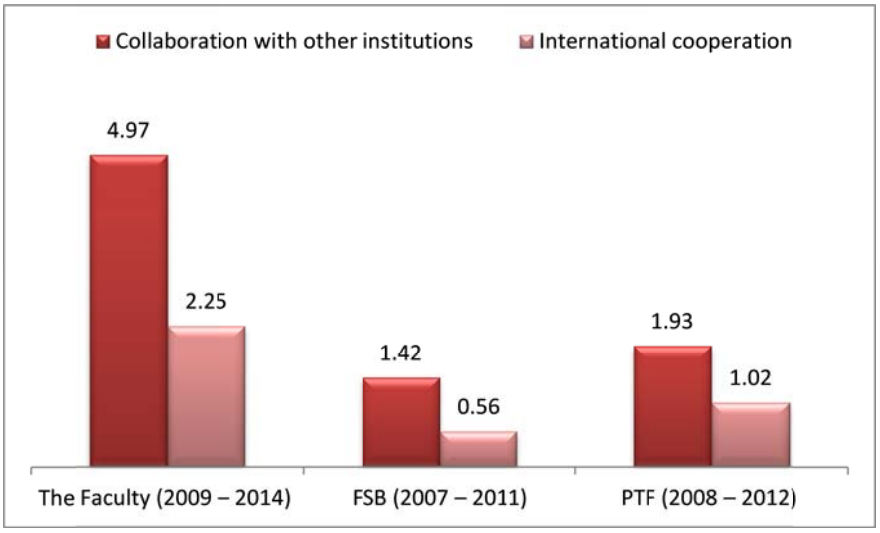


Figure 5.5 The comparison of scientific productivity of the Faculty resulting from cooperation with other national and international institutions

5.7. The Mentors' Availability and mentor – doctoral student relationship

The information about the relationship between the mentor and the doctoral student is obtained from the regular Annual Progress Report written by the doctoral student (DR.SC.04, of the academic year 2011/2012) and the Annual Doctoral Student's Progress Report written by the

mentor (DR.SC.05, of the academic year 2013/2014). Before the academic year 2013/2014 the Faculty had two doctoral programmes of study and therefore made two separate analyses. The mentors were evaluated under the categories: clear setting of objectives and expectations from the doctoral student, assistance in research planning and professional training, mentoring on regular basis, stimulation to publish research findings and the overall mentor's relationship to the doctoral student. The doctoral students were evaluated under the categories: level of preparedness for consultations, planning and implementation of annual research activities and participation in professional trainings, progress in adopting scientific research methodology, writing and publishing of scientific papers and the doctoral student's relationship to the programme of study.

For the academic year 2013/2014 (26 reports written by doctoral students), the doctoral students of the doctoral programme of study **Chemical Engineering** evaluated the quality of their own research activity with grade point average 4.3, the mentors were evaluated with 5.0, and the doctoral programme of study as a whole with 4.6. The teachers/mentors evaluated the quality of progress of the doctoral student's research activity with 4.1, and the total quality of the doctoral student's activity with 4.3. It was also concluded that all doctoral students were allowed to continue with the doctoral programme of study. The doctoral students were evaluated with the lowest grade under the category *writing and publishing of scientific papers*, for which they received 3.5. In the context of the doctoral programme of study **Engineering Chemistry** (56 reports written by doctoral students), the doctoral students evaluated the quality of their own research activity with grade point average of 4.2. The mentors were evaluated with grade point average of 4.9, and the doctoral programme of study with 4.5. The mentors evaluated the quality of progress of the doctoral student's research activity with 4.52. The total quality of doctoral student's activity was evaluated with grade point average of 4.6. All doctoral students were allowed to continue the doctoral programme of study. In this programme of study the doctoral students also received the lowest grade under the category *writing and publishing of scientific papers*. In accordance with the above mentioned, in the forthcoming period the doctoral students of the Faculty will be encouraged to attend workshops in which they will be able to improve their competences required for writing and publishing of scientific papers. They can also join the workshops on the same topic organised at the University of Zagreb or, as appropriate, similar workshops can be organised at the level of the Faculty.

The reports have also shown that the average age of doctoral students who defended their doctoral dissertations is dropping, as well as the average studying duration, which *inter alia* can be explained by better instructions given to the doctoral students concerning scientific research methods, increasingly better monitoring system and encouragement of doctoral students and a good quality assurance system for mentors. For instance, the average duration of studying for the doctoral programmes of study *Chemical Engineering* and *Engineering Chemistry* in the academic year 2013/2014 amounted to 5.5, that is, 5.40 years respectively, whereas in accordance with the Report on the Thematic Evaluation of Doctoral Programmes of Study in the Republic of Croatia of February 2014 the same number amounts to 7.5 years for 71% of the doctoral programmes of study in Croatia.

The doctoral students may enrol in the doctoral programmes of study of the Faculty full-time or part-time. The full-time programme of study largely concerns junior researchers and teaching assistants who dedicate most of their working time to fulfilling obligations required by the programme of study. Other doctoral students, who are part-time students and largely do not belong to the scientific and research system, due to their other obligations do not have the same possibilities for learning about the scientific research methods, as their engagement mostly depends on their employers. It is believed that this issue should be resolved within the system under legislation and national educational policies.

5.8. Scientific and Research Projects

This section provides a short description of 10 most important scientific and research projects of the Faculty. The statistics is outlined in Table 5.2.

The project *Reduction of environmental risks posed by pharmaceuticals and their degradation products in process wastewaters, through RO/NF membrane treatment* is funded by the Unity through Knowledge Fund. The scientific and technological objectives of the project were focused on the investigation of advance membrane technologies based on reverse osmosis (RO) and nanofiltration (NF) in laboratory and pilot scale water treatment. The procedure was developed for the removal of antibiotics from wastewater of veterinary pharmaceuticals manufacturing plants by RO/NF device. A portable pilot membrane device, including pretreatment units, was installed in the equalisation ponds of Veterina d.d., Kalinovica, and its efficiency was tested by using developed and validated analytical methods. The complete removal of veterinary antibiotics and other contaminants was achieved by carefully selected and preliminarily tested RO/NF membranes. In addition, the investigations resulted in new insights into environmental toxicity and potential biotransformations of pharmaceuticals in the environment and during the wastewater treatment procedure. Different *in vitro* methods were developed for monitoring of pharmaceuticals, as well as the measurement procedures for acute and chronic toxicity of complex mixtures in the environment, including pharmaceuticals and their degradation products, whereby all project objectives were achieved. The project resulted in 11 scientific papers published in journals and 32 abstracts and congress talks.

The project *Microreactor technology for continuous enzymatic reactions catalyzed by C–C-bond forming enzymes* is the project of the ERA-IB network of the FP-6 European Framework Programme. The investigations were conducted in cooperation with *Forschungszentrum Jülich GmbH*, Germany and *Institute of Advanced Chemistry of Catalonia* (*IQAC*) / *Spanish Council for Scientific Research* (*CSIC*), Spain. The basic objective of the project was the application of environmentally friendly biocatalysis in designing and synthesis of new chiral 2-hydroxy ketones and iminocyclitols with high potential for pharmaceutical application using enzymes and microreactor technology. The project included evaluation of the microreactor application for enzymatic carboligase reactions using thiamine diphosphate (ThDP)-dependent enzymes (TDEs) and D-fructose-6-phosphate aldolase from *E. coli* (FSA). Process intensification based on micro-device is a new concept in chemical engineering used with the aim of reducing the costs of investment and energy, which is environmentally friendly. The main advantage of the foregoing concept is the first time application of the microreactor technology for TDEs and FSA dependent enzymes in this project. The project investigations resulted in six scientific papers and two patent applications.

The project *Pseudomonas 2.0: Industrial biocatalysis using living cells* is the project of the ERA-IB network of the FP-6 European Framework Programme. The project implementation included eight partners, seven of which were European higher education and research institutions (*Technical University Dortmund*, Germany; *University of Stuttgart*, Germany; *The Helmholtz Centre for Environmental Research*, *UFZ Leipzig*, Germany; *Technical University Delft*, The Netherlands; University of Zagreb, Croatia; *Spanish Council for Scientific Research* (*CSIC*), Spain; *RWTH Aachen*, Germany) and one company (EvonikRexim S.A.S, France). The objective of investigations conducted at the Faculty was to develop efficient stereospecific styrene epoxidation into (*S*)-styrene-oxide using whole cells of genetically modified strains of *Pseudomonas* and *Pseudomonas* 2.0. For such purpose, a sustainable and cost-effective fermentation process was developed whereby the shortcomings occurring in the implementation of this process on the industrial scale were removed. The experiments in the laboratory reactor determined the minimum process conditions required for the growth of *Pseudomonas* and its full biocatalytic activity and dynamics of glucose consumption required for sustainable production of (*S*)-styrene-oxide. Based on findings of investigations in this project, three papers are in the refereeing process and eight papers were presented in international and national scientific and professional conferences as verbal and poster reports.

The project *Nanostructured and functional polymer materials* is a research project of the HRZZ. The project was implemented in cooperation with the industrial partner Končar – Institut za elektrotehniku. In the framework of the project the preparation procedures as well as the nanocomposite materials characterisation methodology based on methacrylate and functional polymers and multi-walled carbon nanotubes were investigated. To achieve miscibility of the components at the molecular level and thus also a homogenous structure of the polymer nanocomposite, chemical modification of carbon nanotubes was carried out using different functional groups. The materials with improved and prestigious properties were obtained for the targeted area of application. In this way, one of the main objectives was achieved – to acquire own scientific and technological know-how on the production and characterisation of nanostructured and functional polymeric materials for special applications in the energy sector and electric vehicle manufacturing. The project contributions include new insights into the area of nanotechnology, novel prepared materials with improved properties, possibility for research expansion and follow-up within international projects, possibility for protection and commercialisation of project findings, as well as a great opportunity to continue research cooperation with the partner institution – Končar Institut za elektrotehniku.

The project *Sustainable bioseparation processes* is a research project of the HRZZ. Due to their selectivity, mild implementation conditions and environmental friendliness, in the last two decades biotransformations have become particularly interesting to pharmaceutical and food industry, and to agriculture. Therefore, the development of bioseparation processes, their optimisation as well as the design of production processes with fully integrated product separation is especially important. In addition, due to availability of raw materials, mild process conditions for implementation, and low tonnage production of products, bioseparation processes are environmentally friendly, sustainable, and thus convenient for application to small enterprises. Taking into account the foregoing, and a huge scientific and professional interest in the development of fully integrated biotransformation processes, the Laboratory for Bioseparation Processes was established and equipment-furnished at the Department of Reaction Engineering and Catalysis of the Faculty. During investigations the L-malic acid production process was developed and optimised, the hexanoic acid production process fully integrated, as well as the polyphenol extraction process and the processes of isolation, purification and characterisation of enzyme fumarase, ADH and ligninolytic enzymes. To date the findings of such investigations have generated ten scientific, professional and review papers, and more than forty papers were presented in international and national scientific and professional conferences as plenary talks, invited lectures, verbal and poster reports.

The project *Environmental friendly protection of metallic structures exposed to seawater* is a research project of the HRZZ. The main objective of the project is to find effective protection of copper and nickel alloys and steel, which will not have any adverse effect on the marine ecosystem. Nowadays the corrosion protection still includes toxic and environmentally hazardous substances, which should be substituted by new formulations. For such purpose, different compounds are evaluated which are presumed to be good corrosion inhibitors in seawater, and which are not environmentally hazardous. They should decrease the corrosion rate of copper-nickel alloys and carbon steel and localised corrosion of stainless steels. The first group of compounds the inhibiting activity of which is investigated are long chain carboxylic acids and phosphonic acids that can form thin films arranged on the metallic surface – self-assembled monolayers. The protective properties of such films are evaluated using electrochemical methods, and their structure and arrangement are determined by spectroscopic methods. The other type of inhibitors investigated is combinations of lanthanide salts with different organic compounds (gluconates, phosphonates). The evaluations are carried out in cooperation between researchers of the Faculty, HAZU Institute for Corrosion Research and Desalinization in Dubrovnik and researchers of the Pliva Company. The project has resulted in three papers published in the scientific journal and four reports prepared for one international and two national congresses.

The project *High power–high energy electrochemical supercapacitor for hybrid electric vehicles* is a research project of the HRZZ. The project comprises scientific and research activity with the aim of improving and manufacturing a high power–high energy supercapacitor for application in hybrid electric cars. The project belongs to the interdisciplinary area and combines fundamental and applied investigations in the academic areas of chemical engineering, materials engineering and electrical engineering. The new type of a supercapacitor will be based on hybridisation of two types of electrodes: electrodes that store energy within the electrochemical double layer and pseudocapacitive electrodes. For such purpose, different forms of carbon in binary and ternary composites with transition metal oxides and/or conducting polymers will be evaluated. The project was implemented by joined human and material resources of the Faculty and the "Ruđer Bošković" Institute, the Faculty of Electrical Engineering and Computing and the Dok-ing d.o.o. Company.

The project *Synthesis and cytostatic evaluations of novel nitrogen heterocycles library* is a research project of the HRZZ. The project is an interdisciplinary project with a specific main objective to develop novel lead compounds with prominent and selective antitumor activity which could be used further on in higher phases of development of antitumor drugs. In order to achieve the main objective the following tasks will be carried out: (*i*) synthesis of a small compound library (A-H Class), novel pseudo-purine, coumarin and quinoline conjugates with 1,2,3-triazole core, *N*-acyclic 5-unsaturated pyrimidine derivatives, amino-, amido- and amidino-substituted derivatives of benzimidazoles, benzothiazole and benzo[*b*]thieno-2-carboxamide derivatives; (*ii*) anticipation of potential biological targets and pharmacological activity by application of chemoinformatic and *in silico* analysis; (*iii*) antitumor evaluations based on which molecules will be selected with prominent biological activity for structure optimisation; (*iv*) evaluations of mechanism of action for most efficient compounds from which the candidate could be derived for further application in higher phases of development of antitumour drugs.

The project *Development of photocatalytic polymer nanocomposites for wastewater treatment* is a research project of the HRZZ. The objective of the project is to develop novel polymer nanocomposites with enhanced photocatalytic activity moved to the visible region of the UV/Vis spectra of solar radiation, whereby innovative technologies will be developed for water purification. Conducting polymers in combination with photocatalyst nanoparticles show synergistic activity and increase photocatalyst efficiency. Consequently, conducting polymers will be synthesized: polyaniline (PANI), polypyrrole (PPy) and poly(3,4-ethylene-dioxythiophene) (PEDOT) in combination with metal oxide (TiO_2, ZnO) nanoparticles and polymer nanocomposite photocatalysts (CPNPs) will be developed with enhanced photocatalytic activity. The efficiency of the new CPNPs will be evaluated during photocatalytic degradation of organic azo dyes (reactive red 45 and methyl orange), selected as targeted wastewater contaminants. During preparation of photocatalysts and synthesis of conducting polymers as nanoparticle carriers, fly ash will be used as waste material, which will additionally contribute to environmental pollution reduction. The integrated approach to the process efficiency assessment is proposed and any negative implications of the novel photocatalysts (CPNPs) in application will be considered.

The project *Environmental implications of the application of nanomaterials in water purification technologies* is an installation research project of the HRZZ. The main objective of the project is to develop sustainable technologies based on advanced oxidation processes using nanocomposite photocatalysts for purification of waters which contain pharmaceuticals. In order to minimise restrictions of the technologies based on application of nano-TiO_2, such as: (i) tendency of nanoparticles to form agglomerates during treatment and (ii) the need for their post-treatment removal, as well as (iii) a relatively low activity under the impact of solar radiation, new photocatalysts will be developed based on nano-$TiO_2$and synthetic iron modified zeolites and SnS_2, and their application in treatment of waters which contain pharmaceuticals will be evaluated. The efficiency of novel water treatment processes will be assessed in accordance with the integrated approach which concurrently includes monitoring of removal of

the targeted pharmaceutical and common water quality indicators, energy consumption for the targeted level of treatment, and assessment of potentially adverse environmental effects. Additionally, pre- and post- water treatment characterisation of developed photocatalytic materials is planned to gain insight into their mathematical and chemical stability, which will be additionally investigated by their sequential use in water treatment.

5.9. Transfer of Scientific Research Findings to Instruction and Industry

The investigations carried out within national and international scientific projects contribute to the development of Croatian industry, strengthening of cooperation between the industry and the Faculty, and to enhanced recognisability of the Faculty in its wider surroundings. The findings are inbuilt into the curricula and have direct impact on learning outcomes and acquisition of competences of our students – future experts. The Faculty encourages scientific excellence and most successful students, junior researchers and teachers are nominated for prestigious awards and certificates of merit.

In the last five-year period the students of the Faculty won many awards including: twenty Rector's Awards, fifty-four Dean's Awards for Scientific and Research Papers, two Annual Awards of Hrvatske vode and one *Hrvoje Požar* Annual Award for outstanding professional and scientific papers in the category of the best graduation thesis, as well as a number of scholarships awarded to the best student projects given by INA – Industrija nafte d.d. and Jutarnji list. In the National Exhibitions of Innovations (*INOVA Youth*), as well as in the Exhibition of Innovations with international participation organised by the Croatian Association of Innovators and the Zagreb Association of Innovators, the students of the Faculty won a number of gold and silver medals for their innovations, developed under the mentorship of the Faculty teachers. During the formal session of the Senate of the University of Zagreb held in November 2013 a student of the Faculty was awarded a Special Certificate of Merit of the University of Zagreb for the Achievement of International Importance in Competitions and Exhibitions of Young Researchers.

In the last five-year period the junior researchers and teachers of the Faculty also won many awards, of which the following are particularly important to be mentioned: two National Science Awards, two *Fran Bošnjaković* Awards of the University of Zagreb, special certificate of merit for improvement and promotion of doctoral education quality of the University of Zagreb, four awards of the Society of University Teachers, Scholars and other Scientists in Zagreb, three *Vera Johanides* Awards of the Croatian Academy of Engineering, *Vladimir Prelog* Award of the Croatian Chemical Society and Pliva, *Young Chemical Engineer Award* of the Croatian Society of Chemical Engineers and *Women in Science* Award of the L'ORÉAL Adria Company and the Croatian Commission for UNESCO of the Ministry of Culture.

Two employees of the Faculty participated in the development of strategic documents of the University of Zagreb (Student Support Development Strategy and University of Zagreb Internationalisation Strategy), and one employee participated in the development of the National Education, Science and Technology Strategy.

The findings of the scientific research in the last five-year period also resulted in six patents.

At the Ideas Fair held in October 2014 nine final and graduation theses of students were presented with topics resulting from cooperation with the industry in the region (INA – Industrija nafte d.d., Končar – Institut za elektrotehniku d.d., Pa-El d.o.o., Belupo d.d., Multi Natura d.o.o., Holcim Hrvatska, Čateks d.d., Moderator d.o.o. and Pliva Hrvatska d.o.o.). The investigations carried out in cooperation with the industry mostly concern the following topics: cathodic protection systems, properties of mineral motor fuels, nanolubricants, product formulations and environmental protection, improvement of process efficiency and process scale-up.

The findings of the scientific activity of the Faculty employees are published in scientific journals and presented in national and international scientific conferences, with a noticeable activity of the Faculty in organisation of such conferences. In the last five years such conferences were: *20th POLYCHAR World Forum on Advanced Materials,* Dubrovnik, 2012, *6th European Summer School on Electrochemical Engineering*, Zadar, 2012 in a sequence of triennial conferences, *SEM, International Symposium on Environmental Management*, Zagreb, 2011, *Meeting of Young Chemical Engineers*, Zagreb, 2010, 2012 and 2014, *International School of Ion Chromatography*, Zagreb, 2010, 2011, 2012, 2013 and 2014, etc. In addition to the foregoing, the teachers of the Faculty occasionally feature as members of the scientific committees of conferences organised by other national and international scientific organisations.

Moreover, mention should also be made of the promotional activities of the Faculty closely connected with scientific research, which include organisation of the Ideas Fair, occasionally organised workshops, etc. Since 2008 the employees of the Faculty have actively participated in the Science Festival by organising and holding workshops, presentations and lectures with the aim of making science more popular in the public at large, primarily among children and youth, to arouse their interest in science and scientific research. The workshops always have a good turnout, and the public interest increases year after year.

5.10. Journals of the Higher Education Institution

The scientific journal *Chemical and Biochemical Engineering Quarterly* (CABEQ), published in English, is an official journal of the Croatian Society of Chemical Engineers, as well as *Slovenian Chemical Society* and *Austrian Association of Bioprocess Technology*, the official journal of the Faculty from May 2014. The journal represents the international forum for presenting original scientific papers, professional and review papers, written conference reports and discussions concerning state-of-the-art developments in chemical and biochemical engineering. The contributions to the journal include technological news, book reviews and the regional scientific and professional news. The thematic content of the journal is very wide and without any special limitations, except the fact that the content should always give special contribution to chemical and biochemical engineering. The criteria for paper eligibility are originality, paper quality and style clarity. All papers are subject to minimum two international peer-reviews.

The journal CABEQ has been published online since 2000[41], and has been printed regularly on quarterly basis for 28 years. It is cited in most important tertiary databases of *Current Contents a*nd *Web of Science*. According to the statistics provided by *Journal Citation Reports* in 2013 the impact factor (IF) of the journal amounted to 0.911, which classifies it among the leading scientific journals issued in the Republic of Croatia, and recognised by this database. The editor-in-chief of the journal is Ž. Kurtanjek, and the junior assistant editor is T. Jurina, whereas associate editors are: M. Narodoslawsky (Austria), M. Grassi (Italy) and I. Plazl (Slovenia). The international members of the Editorial Board are: R. Marr and M. Koller (Austria), G. Greco and P. Alessi (Italy), P. Glavič, Z. Kravanja and P. Žnidaršič-Plazl (Slovenia). The Editorial Board members from the Republic of Croatia are: E. Bauman, Đ. Vasić-Rački, D. Sinčić, B. Šantek, M. Rogošić and B. Zelić.

In compliance with the Decision of the Faculty Council a paper published in the CABEQ journal cannot be evaluated as a criterion to approach defence of the doctoral dissertation in the framework of doctoral programmes of study of the Faculty, in order to ensure independent (external) evaluation of the scientific contribution of the doctoral dissertation.

[41] *http://pierre.fkit.hr/hdki/cabeq/*

5.11. Development and Professional Projects and their Community Impact

Some research groups of the Faculty have intensive cooperation with the industry, as well as with relevant small companies through professional projects (Table 5.3).

Thus for instance the professional projects in cooperation with INA – Industrija nafte d.d., Rafinerija nafte Rijeka and Rafinerija nafte Sisak included optimisation of light naphtha isomerisation process and extractive desulphurisation of FCC gasoline and investigation into the process of obtaining polymeric materials for their use as mineral lubricating oils additives. In cooperation with Lab Air Media d.o.o., a company for instrument and software development, laboratory apparatuses were developed for conducting batch and column homogenously and heterogeneously catalysed chemical reactions and separation processes, as well as devices for evaluations of fuels, polymers and chemical reactions of mixtures. All the foregoing has a strong impact on the development of the leading national petroleum company INA – Industrija nafte d.d., which is still a largely state-owned company.

Of many professional and development projects, the long standing and successful cooperation with engineering design offices and companies (Vodovod Osijek d.o.o., Vodotehnika d.d., Đakovački vodovod, Komunalac d.o.o. Županja, Hidroing d.o.o.) perhaps has the strongest community impact in the context of development of preliminary designs, that is, technological designs for water treatment, which also extends to include placing in operation and start-up procedure for constructed plants. The ground water in Eastern Croatia contains high concentrations of iron, manganese, ammonia and arsenic and has to be purified to be used as drinking water. Thus there is a need for a simple procedure with the simultaneous removal of such impurities. The pilot plant was employed to develop the original single-step biological procedure for ground water treatment, convenient for use with high filtration rates. Furthermore, the treatability coefficients were determined, and the fast biofilter start-up procedure for removal of iron, manganese and ammonia from ground waters was developed as well. A number of laboratory-scale and field evaluations of typical groundwater across Eastern Croatia were carried out, including evaluations of groundwater treatment procedure in pilot plants. The methods for efficient process of arsenic removal from water were developed, and the procedure itself is also simply implemented in the current drinking water treatment facilities.

The corrosion evaluations for large state-owned companies also have a wide social impact. Thus in the last five year period professional projects in the area of materials corrosion and protection were implemented in cooperation with the companies HŽ infrastruktura d.o.o. and Jadranski naftovod d.d. Laboratory and field evaluations were also carried out to determine the intensity and cause of corrosion activity and pipeline damage. Following the analysis of corrosion damages, the corrosion mechanism was determined and the proposals given for preventive measures and ways of removing corrosion effects.

In the context of the Faculty and its impact on the social community, the development of the Environmental Impact Studies has an important role, as well as determination of integrated environmental protection (IPPC) conditions and technical and technological company solutions (Muraplast d.o.o., ABS Sisak, Metalska industrija Varaždin, Keramika Modus d.o.o., Lipovica, C.I.A.K., Adria čelik, Finag d.d.).

Some employees of the Faculty are also trained for energy performance certification of buildings and authorised by the Ministry of Environmental Protection, Physical Planning and Construction to carry out energy inspections and issue energy performance certificates. Hence in the last five years they conducted energy inspections, made energy consumption analyses and issued energy performance certificates for buildings with simple and complex technical systems (e.g. Braće Radić Primary School, Koprivnica, Gradski bazeni (indoor swimming pool), Koprivnica).

The *Proof of Concept Programme* of the Croatian Business and Innovation Agency (BICRO) in cooperation with small enterprises was used to develop novel compounds with strong anti-inflammatory activity. The innovative project included two patent applications for the

protection of preparation and potential application of novel biologically active molecules. The implementation of the professional project with the Pliva Hrvatska d.o.o. Company is undergoing, which includes development of the activated sludge quality control protocol for aerobic reactor of the wastewater treatment plant on the Pliva site in Savski Marof.

In addition to the foregoing, the Faculty employees continuously carry out analyses of materials structures and properties using the methods of X-ray powder diffraction, infrared spectroscopy and thermal analysis, feasibility studies and analyses of new technologies for waste management and wastewater treatment.

The knowledge acquired in development and professional projects is transferred to others in seminars held on ongoing basis by the employees of the Faculty. Thus in the last five-year period six seminars were held in the area of pipeline calculation and design, attended mostly by the engineers from designing companies in Croatia, Bosnia and Herzegovina and Slovenia. Six seminars and workshops were also organised on the topic of corrosion and materials protection, with the aim of bringing the corrosion issues closer to a wide circle of experts. They were organised for designers of metal structures, owners that is investors in metallic structure construction or maintenance, experts who are contractors for maintenance and anti-corrosion protection, supervisory engineers and inspectors and everybody else who, within their scope of activity, encounters the issues of corrosion and corrosion protection with coatings in industrial or other aggressive corrosion environments. The seminars and the workshops included attendants from different industrial branches, from Croatia, Bosnia and Herzegovina, Slovenia and Serbia.

The IPA project *Technology Mapping at the University of Zagreb* in 2013 included mapping of the technology potential and expertise of the Faculty. The objective of the project was to strengthen the technology transfer and commercialisation capacities of the components of the University of Zagreb in order to contribute to sustainable regional development and industry competitiveness of high value added sectors of the economy and knowledge-based SMEs. The Recommendations for Strategic Planning recognised the technology potential and a spectrum of expertise the research groups of the Faculty could offer to the industry, primarily in terms of service provision to chemical industry, and in terms of transfer and exploitation of new technologies, methods, products and projects. They particularly recognise a moderate and high potential for technology transfer in the research areas of catalysis, organic chemistry and chemical and process engineering and control.

The establishment of the spin-off company of the Faculty CoTech d.o.o. is undergoing, which is expected to have an increased impact on the development of the national economy due to findings of professional projects of the Faculty. The establishment of such company will fulfil the prerequisites for stimulation of multidisciplinary research cooperation, which will lead to specific collaborative research projects with the industry, and which in turn will be better adapted to suit the needs of the industry. The largest targeted market for the spin-off company CoTech d.o.o. will be the mentioned technological projects concerning the current drinking water and wastewater treatment plants, water treatment industrial plants and cooperation with designing companies.

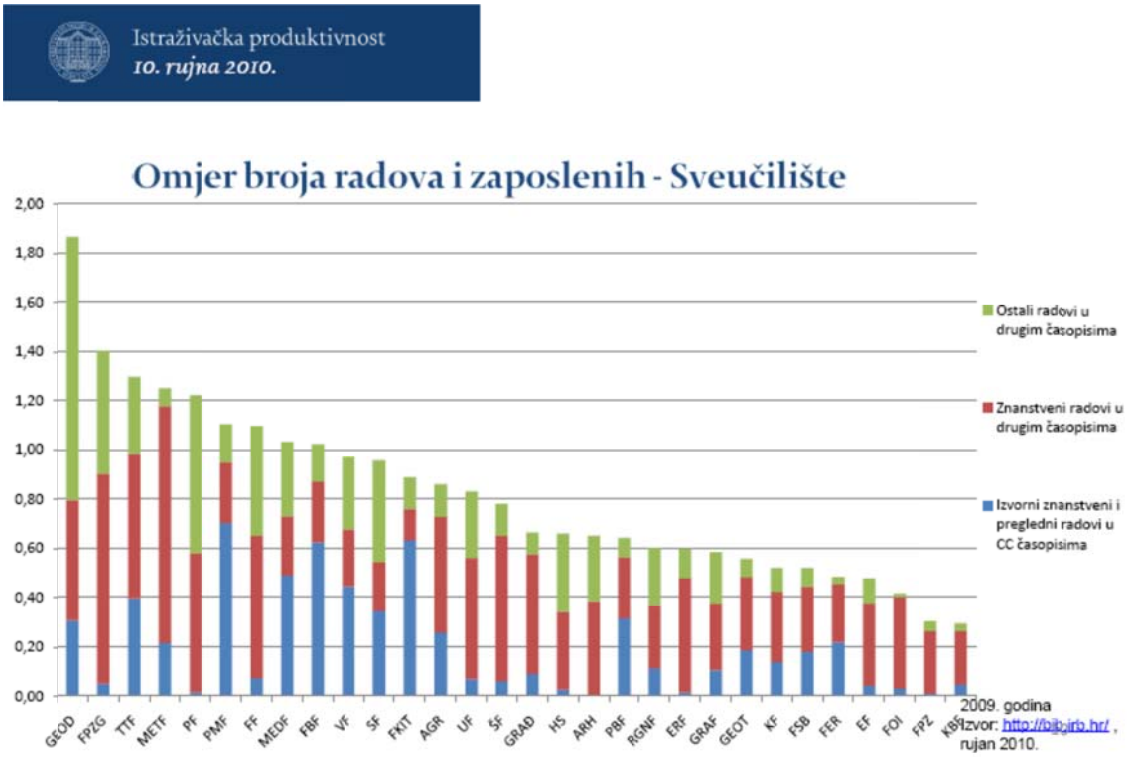
5.12. The Evaluation of the Scientific Activity and the System of Awarding

The Faculty continuously monitors the research activity of its employees and evaluates their scientific productivity, primarily by means of different annual reports submitted to the University of Zagreb, that is, to the Ministry of Science, Education and Sports. The other method of evaluation is the promotion system. In the field of natural sciences, the Faculty consistently enforces the provisions of the Ordinance of the National Council for Science on the Criteria for the Election to Research Ranks and the Criteria of the Rectors' Conference for the Election to Academic and Teaching Ranks, as approved by the competent Council of the Field of Natural

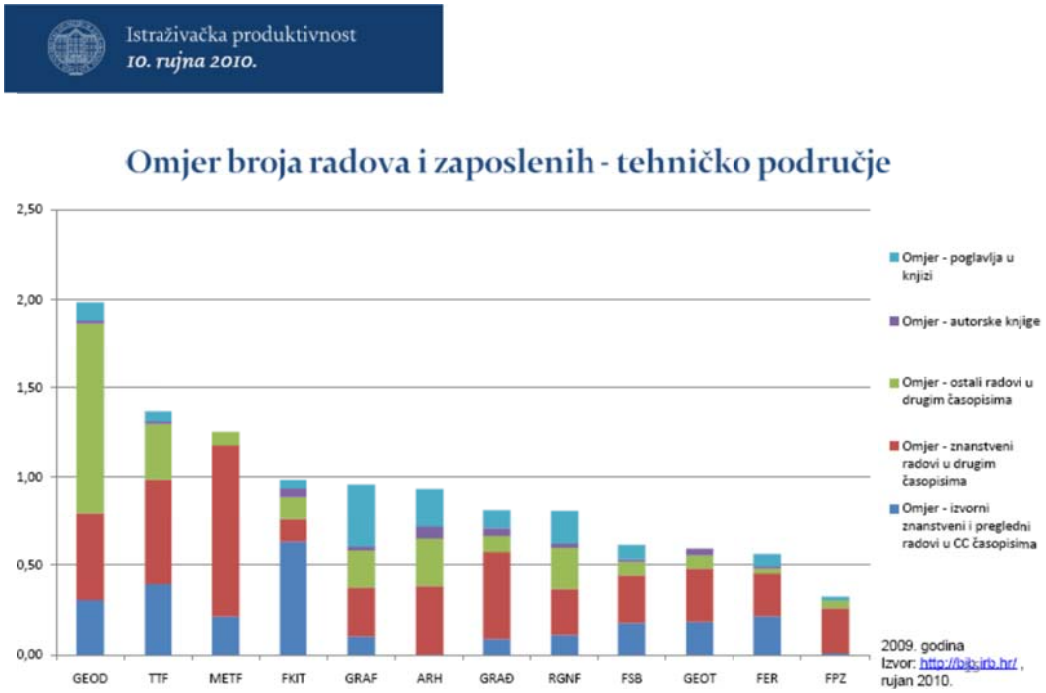
Sciences of the University of Zagreb. In the field of technical sciences, the Criteria of the Rectors' Conference and the foregoing Ordinance are also applied, but the promotion criteria are made additionally stringent in accordance with the internal document: Recommendations of the Faculty of Chemical Engineering and Technology for the Election to Academic, Teaching and Associate Ranks. The Faculty also has other internal documents, which are especially important: the Scoring System for Applicants Elected to the Academic Rank of Assistant Professor as well as the Decision on the Criteria for the Ranking List of Mentors for Junior Researchers which motivate junior researchers and teaching assistants and teachers to engage in the scientific and research activity and to publish the findings of such activity.

Such approach has resulted in an increase in the research productivity and quality of scientific publications. In turn, it has had an impact on the increase in positive evaluations of the Faculty candidates, that is, their scientific projects, in national calls for proposals for financing. The implications are general progress of scientific and research infrastructure, procurement of new scientific equipment, employment of junior researchers, doctoral students and postdoctoral scholars.

The indicators of the research activity of all components of the University of Zagreb were used to evaluate the research performance of the components of the University in 2010. According to the most relevant scientific indicator, the number of papers cited in tertiary publications indexed by the number of scholars, the Faculty was classified among the best at the University and thus contributes significantly to international recognisability of the University of Zagreb. In comparison with other components of the University, the Faculty came second, and in the field of technical sciences, it holds the convincing first position (Figures 5.6 and 5.7).



Slika 5.6. The research productivity of the components of the University of Zagreb according to the ratio between the number of papers and the number of employees (Source: presentation of the then Vice-Rector for Science and Technology, Prof. M. Kovačević, Ph.D. in the meeting of Vice-Deans for Science of the components of the University of Zagreb and in the sessions of the Councils of the Field of Natural Sciences and the Field of Technical Sciences)



Slika 5.7. The research productivity of the components of the University of Zagreb in the field of technical sciences according to the ratio between the number of papers and the number of employees (Source: presentation of the then Vice-Rector for Science and Technology, Prof. M. Kovačević, Ph.D. in the meeting of Vice-Deans for Science of the components of the University of Zagreb and in the sessions of the Councils of the Field of Natural Sciences and the Field of Technical Sciences)

According to the results, it seems that the promotion system was a sufficient stimulation whereby the quality of research activity was raised to the national level. The international level requires more work to be done.

According to our estimate, the introduction of the internal stimulation and awarding system would not make too much sense for the component which belongs to the minority within the home university, and moreover is among the most productive components in terms of scientific productivity. The Faculty *Franjo Hanaman* Award is given for promotional activities relating to the Faculty visibility (in wide social community) as the Faculty estimates that this would bring more benefits than internal promotion of scientific excellence. On the other hand, the Faculty strongly supports nominations of its employees for the awards given by "external" institutions, such as the above mentioned *Fran Bošnjaković* Award of the University of Zagreb, the Award of the Society of University Teachers, Scholars and other Scientists in Zagreb, *Rikard Podhorsky* and *Vera Johanides* Awards of the Croatian Academy of Engineering, *Vladimir Prelog* Award of the Croatian Chemical Society and Pliva Company and the *Women in Science* Award and the most important among them – *National Science Awards,* received by many employees of the Faculty in the last fifteen-odd years.

The scientific productivity of the employees of the Faculty has been at a considerably high level for years, there is a long standing strong feeling of affiliation with the international research community, a large majority of teachers can speak English adequately as a main language of international communication in science, and thus publications in foreign countries are not encouraged by additional measures such as engagement of external translators. The employees of the Faculty instead are particularly engaged in the promotion of Croatian as a language of their profession, as verified by national projects such as *Creation of Croatian chemical terminology* or *Creation, selection and harmonisation of Croatian terminology in physics* within the scope of umbrella project StruNa (Croatian Special Field Terminology), dictionaries such as *Leksikon fizike* (Dictionary of Physics) or Enciklopedijski *rječnik analitičkoga nazivlja*

(Encyclopaedic Dictionary of Analytical Terminology) and regular Croatian translations of documents on IUPAC (*International Union for Pure and Applied Chemistry*) terminology in the national journal *Kemija u industriji*, in which both current and former teachers of the Faculty participate. The Faculty also encourages publication of university teaching references by covering the costs of the refereeing process for the proposed textbook and participating in the costs of textbook publication (in the amount of HRK 10,000).

5.13. Ethics in Scientific Research / Human Resources Policy

In their research activity and recruitment of best research human resources the employees of the Faculty observe the recommendations (general principles and requirements) specified under the documents *The European Charter for Researchers* and *The Code of Conduct for the Recruitment of Researchers*, the crucial elements of the EU policy for stimulation of growth in economy and employment. The recruitment of researchers leads to open, transparent and internationally comparative procedure whereby the best human resources are selected. The process of recruitment of junior researchers, doctoral students and postdoctoral scholars includes public and international announcements of vacancies. They are published in one of the public newspapers and in English on the website of the *Euraxess* portal. The selection process takes into account bibliometric indicators, evaluation and assessment of academic and professional qualifications and the entire range of the candidate's experiences. As indicated in the section above, the selection of new assistant professors is carried out according to the Scoring System for Applicants Elected to the Academic Rank of Assistant Professor. In addition to evaluation of scientific, teaching and professional activity of the applicant, the selection process also comprises evaluation of the presentation of the current activity and the proposal for scientific and research activities and an interview with the applicant in which the overall potential of the applicant is assessed, including his/her organisational and planning skills and abilities, initiative, communication skills, managerial skills/teamwork, etc.

The researchers observe the recognised ethical practices and fundamental ethical principles adequate for relevant academic areas. It however should be mentioned that the research activities carried out by the Faculty very seldom feature as the subject matter of ethical discussions, only in individual cases in which chemistry has interdisciplinary connections with medicine. The Faculty has an active Ethical Commission comprising three members and active as needed, in accordance with any reports on unethical conducts. The provisions of the Code of Ethics of the University of Zagreb are applied. Moreover, the University of Zagreb developed a system which allows anonymous reporting of unacceptable conduct in the academic community or other potential violations of the provisions of the Code of Ethics. The website of the Faculty includes a reference to such system. In addition, the Ethical Commission of the University of Zagreb takes care of potential unethical procedures concerning the approval of topics of doctoral dissertations.

5.14. General Discussion and Proposals

In the last five-year period the Faculty retained its leading position as a scientific and educational institution in the academic areas of chemical engineering, materials science and engineering, applied chemistry and environmental engineering in the national context. The employees of the Faculty achieved very high scientific results in the foregoing period.

The scientific and research activity was mostly financed through projects of the Ministry of Science, Education and Sports. However, this project cycle finished at the end of 2013, and slowly the Faculty is turning to other sources of financing: international, national and university, public and private. The applications for national and international calls for proposals resulted in a number of projects of the Croatian Science Foundation, bilateral projects, projects of the

Environmental Protection and Energy Efficiency Fund, projects of the FP6 Framework Programme, projects within the systems COST, NEWFELPRO and SCOPES. The Faculty provided financial support for such applications. Despite the hard effort invested in winning the projects within FP7 Framework Programme for Research and Development, the projects of the Faculty were not approved. The two applications submitted within Horizon 2020 Programme have not been approved, but the activities will be continued.

The implementation of the Faculty Development Strategy and the continuous development of the quality assurance system at all levels of activity represent a huge challenge to all Faculty employees, especially given the difficulties with financing of the scientific activity as a result of suspension of research financing by the Ministry of Science, Education and Sports. The new lines of research financing by the Croatian Science Foundation and other project lines also suffer from a lack of funds which significantly slows down international project evaluation. It is all a result of low allocations for science in Croatia. They accounted for 0.81% of GDP in 2013, which is significantly lower than the EU average of 2% of GDP (according to the Draft Proposal for Innovation Strategy of the Republic of Croatia 2014–2020).

The Strategic Objective 4, provided under the Faculty Development Strategy for Period 2008–2013, which concerned verification and improvement of favourable indicators for scientific and research and professional productivity of the Faculty was partially achieved, as well as its associated measures 4.1–4.3. More specifically, the Faculty maintained the previous level, but did not make any significant step forward in scientific productivity, as it was not more intensively involved in international projects. Nevertheless, the maintenance of the currently high level of scientific productivity (at the national level) can be considered as a success if the reduction of budgetary allocations for research and development is taken into account.

The indicators for the current situation, which *inter alia*, include working in inadequate premises (migration to the Borongaj University Campus is still questionable), the problems connected with servicing of the current research equipment and impossibility to procure new equipment, difficulties with recruitment of young teachers and researchers and difficulties with promotion on account of new legislative solutions could weaken the motivation of employees for scientific and research and professional work in the forthcoming period.

Possible improvements could be made in the following areas:

- Reduction of research fragmentation and thematic integration of smaller research groups working on similar topics,
- Focus on research in less represented areas (process engineering, process measurements and control, etc.) with the aim of creating a better starting position for knowledge transfer to local and national industry, in compliance with the Recommendations for Strategic Planning (IPA project *Technology Mapping at the University of Zagreb*),[42]
- Focus on research in traditionally strong areas (synthesis of drugs, corrosion protection, water treatment, materials etc.) with the aim of intensifying the current connections with the environment,
- Strengthening of new research areas in compliance with the priorities determined under the Strategy of Education, Science and Technology (nanotechnology, advanced materials, advanced production systems, etc.),
- Strengthening of applied research, professional projects and studies in cooperation with the industry, including the area of environmental protection,
- Strengthening of administrative support for international project applications,

[42] *http://unizg.euroart93.net/ea/wp-content/uploads/2014/06/Preporuke_fkit.pdf*

- Strengthening of administrative support for incoming mobility of foreign scholars to fulfil the prerequisites for a larger number of international projects,
- Increase in the number of doctoral students and students in postgraduate specialist programmes of study through systematic promotional and advertising activities for such programmes, also including neighbouring, linguistically similar countries,
- Raising awareness of the need to allow part time doctoral students to have more time for research activity,
- Finding of new sources of financing for doctoral research.

5.15. Tables

Table 5.1 Mentors

Name of the doctoral programme of study	Number of mentors having doctoral degree defences in the last 5 years	Number of mentor's papers published in national scientific journals with peer-review in the last 5 years*	Number of mentor's papers published in foreign scientific journals with peer-review in the last 5 years*
Chemical Engineering	27	*Web of Science*: 48 *SCOPUS*: 72	*Web of Science*: 349 *SCOPUS*: 365
Engineering Chemistry	53	*Web of Science*: 92 *SCOPUS*: 135	*Web of Science*: 928 *SCOPUS*: 966

Table 5.2 The sources of financing for scientific projects

Starting year	Project (title)	Project duration (months)	State budget (MZOS)	State budget (other)	Budget of local units	EU funds	Industry – private sector	Industry – public companies	Other	**TOTAL (HRK)**
NATIONAL										
2007	Application of biological immobilization for nitrate removal from surface water	84	236,002							236,002
2007	Research, development and evaluation of polymeric composites for use in civil engineering	84	289,000							289,000
2007	Inhibiting corrosion by nature derived compounds: from molecular scale models to application	84	459,000							459,000
2007	New heterocycles as antitumor and antiviral ("smart") drugs	84	565,250							565,250
2007	Development of new prodrugs and drugs against viruses and cancer	84	1,117,808							1,117,808
2007	Development of new tracer molecules for positron emission tomography (PET)	84	566,663							566,663
2007	New materials and catalysts for sustainable technologies	84	809,998							809,998
2007	Heteropolycycles, scaffolds to bioactive compounds. Synthesis and photochemistry	84	906,665							906,665
2007	Software sensors and analysers for process monitoring and control	84	362,664							362,664
2007	Aerobic composting of solid waste in reactor system	84	260,666							260,666
2007	Process characteristics in disperse systems	84	527,000							527,000
2007	Chemical reactor analysis and modelling	84	498,666							498,666
2007	Optimization of copolymer properties using controlled radical polymerizations	84	595,000							595,000
2007	Application of catalysis in environmental protection	84	623,334							623,334

Starting year	Project (title)	Project duration (months)	State budget (MZOS)	State budget (other)	Budget of local units	EU funds	Industry – private sector	Industry – public companies	Other	**TOTAL (HRK)**
2007	Advanced processes of hydrocarbon fuels desulfurization	84	595,000							595,000
2007	Biocatalysts and biotransformations	84	386,337							386,337
2007	Sol-gel derived ceramic nanocomposites	84	272,000							272,000
2007	Development of hydration process model	84	561,000							561,000
2007	Bioceramic, polymer and composite nanostructured materials	84	657,335							657,335
2007	Surface and interface engineering of nanoparticles in adhesive nanomaterials	84	538,335							538,335
2007	Modification and stability of multiphase polymer systems 84	84	600,665							600,665
2007	Vibration dynamics and structure of multifunctional polymeric systems	84	198,327							198,327
2007	Development of innovative multifunctional polymer blends	84	413,669							413,669
2007	New non-toxic metal corrosion inhibitors	84	623,334							623,334
2007	Fundamental and applied research of conducting polymers	84	459,000							459,000
2007	Development of advanced analytical methods for tracing of pharmaceuticals in the environment	84	340,000							340,000
2007	Water purification and stabilization in large water supply systems	84	453,334							453,334
2007	Membrane and adsorption processes for organics removal in water treatment	84	538,336							538,336
2007	Wastewater treatment by advanced oxidation technologies	84	580,000							580,000

Starting year	Project (title)	Project duration (months)	State budget (MZOS)	State budget (other)	Budget of local units	EU funds	Industry – private sector	Industry – public companies	Other	**TOTAL (HRK)**
2007	Ion exchange processes in industrial water quality system	84	487,333							487,333
2007	Reducing specific energy consumption in industrial processes	84	324,755							324,755
2007	Croatian terminology in analytical chemistry	84	123,665							123,665
2008	Development of new sensors for determination of biologically important analytes	72	152,500							152,500
2008	Chemical sensors with luminescent semiconductor nanocrystals (*Quantum Dots*)	72	150,000							150,000
2009	Sustainable bioseparation processes	48		931,596 HRZZ						931,596
2010	Nanostructured and functional polymer materials	48		960,000 HRZZ			500,000 Končar, Institute za elektrotehniku d.d.			1,460,000
2011	Creation, selection and harmonisation of Croatian terminology in physics, HRZZ	24		100,000 HRZZ						100,000
2013	Environmental friendly protection of metal structures exposed to seawater, HRZZ	36		1,267,123 HRZZ						1,267,123
2014	High power-high energy electrochemical supercapacitor for hybrid electric vehicles, HRZZ	48		955,800 HRZZ						955,800
2014	Synthesis and cytostatic evaluations of novel nitrogen heterocycles library, HRZZ	48		934,036 HRZZ						934,036
2014	Development of photocatalytic polymer nanocomposites for wastewater treatment, HRZZ	48		915,300 HRZZ						915,300
2014	Environmental implications of the application of nanomaterials in water purification technologies, HRZZ	36		948,965 HRZZ						948,965

Starting year	Project (title)	Project duration (months)	State budget (MZOS)	State budget (other)	Budget of local units	EU funds	Industry – private sector	Industry – public companies	Other	**TOTAL (HRK)**
INTERNATIONAL										
2007	Reduction of environmental risks posed by pharmaceuticals and their degradation products in process wastewaters, through RO/NF membrane treatment (REPHAD)	36	1,596,465 UKF							1,596,465
2008	Cascade chemoenzymatic processes – New synergies between chemistry and biochemistry	48				46,787 COST				46,787
2008	Natural zeolites in water quality system, EUREKA	36	1,096,372 Eureka							1,096,372
2009	Development of novel C-5 fluoroalkyl *N*-acyclic pyrimidine nucleoside analogs as PET tracer for in situ monitoring of gene and cell-based therapies using HSV1-TK as a reporter gene	44							398,995 SCOPES, SNF	398,995
2009	Photophysics and photochemistry of transition metal polypyridine and porphyrin complexes; their application in the photocatalytic oxygenation of selected heteropolycycles	24	14,700 bilateral (Hungary)							14,700
2009	Study on biotransformations of industrial interest in aqueous and non-conventional media	24	14,700 bilateral (Hungary)							14,700
2009.	New catalytic system for wastewater purification	24	18.770 bilateral (France)							18,770
2009	Air and water pollutants abatement on mesoporous silicates modified by oxide particles using advanced oxidation technologies	24	18,770 bilateral (France)							18,770
2009	Applied biocatalysis – Integrated biocatalytical processes	24	23.340 bilateral (Slovenia)							23,340

Starting year	Project (title)	Project duration (months)	State budget (MZOS)	State budget (other)	Budget of local units	EU funds	Industry – private sector	Industry – public companies	Other	**TOTAL (HRK)**
2010	Natural zeolites in water nanotechnology	24	7,920 bilateral (Slovenia)							7,920
2010	Development of environment friendly techniques for protection of bronze artefacts	24	7,920 bilateral (Slovenia)							7,920
2011	Synthesis, photochemical synthesis, DNA binding, antitumor activity and QSAR analyses of novel condensed quinolones and quinolines	24	12,268 bilateral (France)							12,268
2011	Cybernetics and modern methods of control	60	202 CEEPUS							202
2011	Microreactor technology for continuous enzymatic reactions 106unctiona by C-C-bond forming enzymes	36				728,624 FP6				728,624
2011	Pseudomonas 2.0: Industrial biocatalysis using living cells	36				709,434 FP6				709,434
2012	Conceiving wastewater treatment in 2020 – energetic, environmental and economic challenges (Water 2020)	48				~513,000 COST				
2012	Determination of toxicity and physical-chemical properties of pharmaceuticals	24	16,717 bilateral (Slovenia)							16,717
2012	Chemistry and chemical engineering	48	6,000 CEEPUS							6,000
2013	Determination of xenobiotics by using separation and hyphenated techniques for environment, food and human health purposes	60	7,500 CEEPUS							7,500
2013	Systems biocatalysis, CMST COST Action CM1303	48				~150,000 COST				~150,000
2013	Plasma technologies for catalytic wastewater treatment, bilateral (France)	24	38,690 bilateral (France)							38,690

Starting year	Project (title)	Project duration (months)	State budget (MZOS)	State budget (other)	Budget of local units	EU funds	Industry – private sector	Industry – public companies	Other	**TOTAL (HRK)**
2014	Preparation and Characterization of Zeolite Based Catalysts for Phenolic Wastewater Treatment (Zcat4Water) FKIT and Åbo Akademi University, Finland	36				1,003,415 NEWFELPRO				1,003,415
2014	NMR characterisation of aluminium sec-butoxide modified by ethyl acetoacetate in various ratios	24	7,660 bilateral (Slovenia)							7,660
2014	Synthesis and cytostatic activity of new pyrrolo[2,3-d]pyrimidine derivatives	24	7,660 bilateral (Slovenia)							7,660
2014	Nanostructured TiO_2 for photocatalytic degradation of organic pollutants in water with solar radiation and ultrasound-aided photocatalysis	24	7,660 bilateral (Slovenia)							7,660
2014	Development of high-power and high-energy supercapacitors based on lithium anode materials and pseudocapacitive cathodes	24	7,660 bilateral (Slovenia)							7,660
2014	Improvement of carbon nanotubes dispersivity in polymer composites through chemical 107unctionalization, bilateral	24	30,000 bilateral (China)							30,000
2014	Education of modern analytical and bioanalytical methods	24	21,789 CEEPUS							21,789
	Total		**19,235,404**	**7,012,819**		**3,151,260**	**500,000**		**398,995**	**30,298,479**

Table 5.3 Sources of financing for professional projects

Starting year	Project (title)	Project duration (months)	State budget	Budget of local units	International funds	Industry – private sector	Industry – public companies	Other	**TOTAL (HRK)**
2010	Vodotehnika, Topolje	24				130,000			130,000
2010	Development of new chemotherapeutics, project IRCRO	24						500,000	500,000
2010	Metakem, Ludbreg	1				37,500			37,500
2011	HŽ Infrastruktura, JANAF	3					235,000		235,000
2011	HŽ Infrastruktura, PLINACRO	3					235,000		235,000
2011	ELKA d.o.o. Zagreb 2	1				9,225			9,225
2011	Dalekovod d.d., Zagreb	1				26,000			26,000
2011	SAIPEM, Rijeka	2				100,000			100,000
2011	Muraplast d.o.o., Kotoriba	1				10,000			10,000
2011	INA d.d., Development of new technologies in production of environmentally friendly fuels	1				171,746			171,746
2011	Naftalan, Ivanić-Grad	3				30,000			30,000
2011	Komunalac d.o.o., Drenovci	11					60,000		60,000
2011	Komunalac d.o.o., Pakrac	11					65,000		65,000
2011	Vodovod, Osijek	2					69,575		69,575
2011	Schaefer Kalk, Diez, Njemačka	2				74,883			74,883
2011	Lipovica d.o.o., Popovača	36				75,000			75,000
2011	Inciner8 d.o.o., Varaždin	1				23,200			23,200
2012	ABS Sisak	24				19,800			19,800
2012	Metalska industrija Varaždin	3				25,000			25,000
2012	Keramika Modus d.o.o.	24				25,000			25,000
2012	Adria čelik, Kaštel Sućurac	24				92,000			92,000
2012	Grad Koprivnica, OŠ Braće Radić	1		27,500					27,500
2012	Grad Koprivnica, Gradski bazeni	1		32,000					32,000
2012	Metalska industrija Varaždin 1	1				13,499			13,499
2012	Alma Mons, Novi Sad, Srbija	24			121,562				121,562
2012	Zagrebačka županija	4		19,895					19,895

Starting year	Project (title)	Project duration (months)	State budget	Budget of local units	International funds	Industry – private sector	Industry – public companies	Other	**TOTAL (HRK)**
2012	CPS d.o.o. Jastrebarsko	2				27,485			27,485
2012	Metalska industrija Varaždin 1	1				30,000			30,000
2012	HŽ infrastruktura, Plinacro II	7					49,500		49,500
2012	HŽ infrastruktura, JANAF II	7					49,500		49,500
2012	JANAF 2012	12					175,000		175,000
2012	Hidroing Osijek – Čepin	3				120,000			120,000
2012	Hidroing Osijek – Đurđenovac	12				120,000			120,000
2012	Hidroing Osijek – rijeka Drava	1				120,000			120,000
2012	Hidroing Osijek –Dalj	1				12,195			12,195
2013	JANAF 2013	3					195,000		195,000
2013	Metalska industrija Varaždin 2	2				16,000			16,000
2013	Metalska industrija Varaždin 3	2				14,000			14,000
2013	Metalska industrija Varaždin 4	2				25,000			25,000
2013	ELKA d.o.o. Zagreb 1	1				20,000			20,000
2013	IMGD Samobor	9				40,000			40,000
2013	Đakovački vodovod	2					50,000		50,000
2013	C.I.A.K.	Undergoing				80,000			80,000
2013	FINAG d.d.	10				30,000			30,000
2013	Pliva Hrvatska d.o.o.	3				80,000			80,000
2014	CEMEX Hrvatska d.d.	1				33,798			33,798
2014	AEKS d.o.o. Ivanić-Grad	24				121,250			121,250
2014	SINTEF group	1				55,547			55,547
2014	JANAF	1					15,000		15,000
2014	Calucem Pula d.o.o.	1				25,798			25,798
2014	Pliva Hrvatska d.o.o.	12				210,000			210,000
2014	Hrvatski zavod za javno zdravstvo	3					46,315		46,315
2014	Weltplast d.o.o. Posušje, BiH	1				14,000			14,000
2014	Biodizel Vukovar	1				33,640			33,640
2014	Chemical Newtech SPA, Italija	3				18,163			18,163

Starting year	Project (title)	Project duration (months)	State budget	Budget of local units	International funds	Industry – private sector	Industry – public companies	Other	**TOTAL (HRK)**
2014	Keramika Modus d.o.o., Orahovica	48				25,000			25,000
2014	Fakultet strojarstva i brodogradnje Sveučilišta u Zagrebu	1					10,000		10,000
2014	Calucem d.o.o. Pula	6				18,000			18,000
2014	JANAF	12					98,000		98,000
2014	Pliva Hrvatska d.o.o.	2				47,000			47,000
2014	ELKA d.o.o. Zagreb	4				33,000			33,000
	Total		0	79,395	121,562	2,232,729	1,352,890	500,000	4,286,576

Table 5.4 The list of scientific and development projects

a) The list of active scientific and development projects assigned by MZOS with the names of project leaders
The financing of 34 scientific projects of MZOS finished at the end of 2013. The bilateral projects indicated under the category of scientific projects funded by international sources (5.4.c: 4–9) are also partially financed by the MZOS.

b) The list of scientific and development projects funded by other national sources (UKF, HRZZ, other national institutions or national industry) with the names of project leaders
1. High-power-high energy electrochemical supercapacitor for hybrid electric vehicles, HRZZ (Zoran Mandić)
2. Synthesis and cytostatic evaluations of novel nitrogen heterocycles library, HRZZ (Silvana Raić-Malić)
3. Development of photocatalytic polymer nanocomposites for wastewater treatment, HRZZ (Zlata Hrnjak Murkić)
4. Environmental implications of the application of nanomaterials in water purification technologies, HRZZ (Hrvoje Kušić)
5. Environmentally friendly protection of metallic structures exposed to seawater, HRZZ (Helena Otmačić Ćurković)

c) The list of active scientific and development projects funded by international sources with the names of project leaders
1. Preparation and Characterization of Zeolite Based Catalysts for Phenolic Wastewater Treatment (ZCat4Water) FKIT and Åbo Akademi University, Finland, NEWFELPRO (Karolina Maduna Valkaj)
2. Conceiving wastewater treatment in 2020 – energetic, environmental and economic challenges (Water 2020), COST (Ivana Grčić)
3. Systems biocatalysis, CMST COST Action CM1303, COST (Đurđa Vasić-Rački)
4. Plasma technologies for catalytic wastewater treatment, bilateral (France) (Ivana Grčić)
5. NMR characterisation of aluminium sec-butoxide modified by ethyl acetoacetate in various ratios, bilateral (Slovenia) (Stanislav Kurajica)
6. Synthesis and cytostatic activity of new pyrrolo [2,3-d]pyrimidine derivatives, bilateral (Slovenia) (Tatjana Gazivoda Kraljević)
7. Nanostructured TiO_2 for photocatalytic degradation of organic pollutants in water with solar radiation and ultrasound-aided photocatalysis, bilateral (Slovenia) (Ivana Grčić)
8. Development of high-power and high-energy supercapacitors based on lithium anode materials and pseudocapacitive cathodes, bilateral (Slovenia) (Zoran Mandić)
9. Improvement of carbon nanotubes dispersivity in polymer composites through chemical functionalisation, bilateral (China) (Elvira Vidović)
10. Education of modern analytical and bioanalytical methods, CEEPUS (Sanja Martinez)
11. Determination of xenobiotics by using separation and hyphenated techniques for environment, food and human health purposes, CEEPUS (Tomislav Bolanča)
12. Chemistry and chemical engineering, CEEPUS (Zvjezdana Findrik Blažević)
13. Cybernetics and modern methods of control, CEEPUS (Nenad Bolf)

Table 5.5 Bibliography (in the last 5 years)

Types of papers*	Total number of papers**	Number of papers resulting from cooperation with other higher education institutions and scientific organisations	Ratio: number of papers/number of teachers**
Scientific papers in journals in CC, WoS (SSCI, SCI-expanded and A&HCI) and Scopus databases	*CC*: 501	*CC*: 281	501/60=8.35
	WoS: 523	*WoS*: 298	517/60=8.62
	Scopus: 586	*Scopus*: 338	586/60=9.77
Other refereed papers present in databases recognised for the election to research ranks	-	-	-
Authorship of books published in foreign countries	1	0	½=0.50
Authorship of Croatian books	11	4	11/16=0.69
Papers in national journals with international peer-review	0	0	0
Foreign and international scientific conference papers with peer-review***			
Papers in national journals with national peer-review	40	12	40/40=1.00
Professional papers			
Refereed book chapters	11	4	11/16=0.69
National scientific conference papers with peer-review***			
Editorship of foreign books***			
Editorship of Croatian books***			
Number of papers in your institution's journals			

* Please specify the types of papers written in bold and other types of papers at your own discretion.
** Please include the same teacher in calculation only once.
***Please do not include the conference papers without the refereeing and the selection procedure.
The statistics was calculated with the total of 57 employees holding the academic rank and 3 employees holding the teaching rank.

Table 5.6 The scientific productivity by organisational units of the higher education institution

Type of papers*	Total number of papers	Ratio for every organisational unit: number of papers/number of teachers**															
		ZAK	ZAKTN	ZE	ZFK	ZF	ZIE	ZIPPM	ZM	ZMTPI	ZMAVP	ZOAK	ZOK	ZPIOKT	ZRIK	ZTNP	ZTSE
Scientific papers in journals in CC, WoS (SSCI, SCI-expanded and A&HCI) and Scopus databases	CC: 501	61/8= 7.63	39/5= 7.80	58/5= 11.60	51/6= 8.50	6/3= 2.00	17/3= 5.67	12/3= 4.00	5/2= 2.50	20/6= 3.33	22/2= 11.00	25/4= 6.25	89/7= 12.71	74/8= 9.25	70/9= 7.78	24/3= 8.00	9/4= 2.25
	WoS: 523	62/8= 7.75	41/5= 8.20	60/5= 12.00	52/6= 8.67	6/3= 2.00	17/3= 5.67	12/3= 4.00	9/2= 4.50	21/6= 3.50	22/2= 11.00	26/4= 6.50	89/7= 12.71	75/8= 9.38	75/9= 8.33	24/3= 8.00	11/4= 2.75
	Scopus: 586	65/8= 8.13	48/5= 9.60	62/5= 12.40	58/6= 9.67	8/3= 2.67	22/3= 7.33	13/3= 4.33	8/2= 4.00	27/6= 4.50	26/2= 13.00	28/4= 7.00	91/7= 13.00	81/8= 10.13	79/9= 8.78	24/3= 8.00	15/4= 3.75
Other refereed papers present in databases recognised for the election to research ranks	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Authorship of books published in foreign countries	1	0	0	0	0	0	0	0	0	0	0	0	0	1/2= 0.50	0	0	0
Authorship of Croatian books	11	2/7= 0.29	0	0	1/1= 1	1/1= 1	0	0	0	0	0	0	2/2= 1	0	2/2= 1	2/2= 1	3/1= 3
Papers in national journals with international peer-review	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Foreign and international scientific conference papers with peer-review***																	
Papers in national journals with national peer-review	40	6/7= 0.86	4/3= 1.33	1/2= 0.50	6/5= 1.2	0	2/2= 1	0	0	1/1= 1	5/2= 2.5	0	0	6/6= 1	3/4= 0.75	7/4= 1.75	4/2= 2
Professional papers																	
Refereed book chapters	11	2/4= 0.5	0	2/2= 1	1/2= 0.50	0	1/1= 1	0	0	0	3/2= 1.5	0	0	0	2/2= 1	0	1/1= 1
National scientific conference papers with peer-review***																	
Editorship of foreign books***																	
Editorship of Croatian books ***																	
Number of papers in your institution's journals																	

* Please specify the types of papers written in bold and other types of papers at your own discretion.
** Please include the same teacher in calculation only once.
***Please do not include the conference papers without the refereeing and the selection procedure.
The statistics was calculated with the number of teachers holding the academic and the teaching rank (excluding junior researchers and teaching assistants) + *emeriti* + currently retired professors who were not retired in 2009.
The acronyms are given in Figure 1.1.

6. MOBILITY AND INTERNATIONAL COOPERATION

6.1. Internal Mobility

The fundamental determinants of the Faculty, *inter alia*, are internal student mobility and transfer of students between similar programmes of study, as verified under the Faculty Development Strategy for Period 2008–2013. The students of undergraduate and graduate programmes of study of the Faculty are allowed to use horizontal mobility, that is, to transfer from one programme of study to another provided they fulfil the essential prerequisites determined under the Ordinance on Studying in Undergraduate and Graduate University Programmes of Study of the Faculty of Chemical Engineering and Technology. They can also use vertical mobility, and for the time being students may transfer from any undergraduate programme of study of the Faculty to any graduate programme of study without any restrictions, although according to current experiences, the Faculty is considering a possibility of introducing differential courses for transferees to facilitate achievement of essential competences. In the framework of vertical mobility, students who complete undergraduate university programmes of study in the field of technical, natural and biotechnical sciences the programmes of which do not include the essential prerequisites determined under the foregoing Ordinance may enrol in the graduate programmes of study, but they have to take differential exams. The differential exams are determined by the Commission for Education of the Faculty in accordance with the submitted documentation. In the context of horizontal mobility, when students transfer to the postgraduate (doctoral and specialist) programmes of study of the Faculty, such transfers are considered by the Council of the Doctoral Programme of Study, that is the Council of the Specialist Programme of Study, which, if needed, determine differential exams and other differential requirements. The transfers are approved if justified by proper argumentation.

In the last five academic years (2009/10–2013/14) 161 the Faculty registered 161 (and another 36 in 2014/15) horizontal transfers of students between different undergraduate programmes of study of the Faculty, and this number is considerably stable. The analysis, however, suggests that the transfers do not result from a change of interest in the subject matter of the programme of study or from motivation to achieve multiple competences, but from the possibility offered by the Faculty to students with poor performance to enrol in a new programme of study and have some of their exams recognised. The Faculty is much more satisfied with the figure of 24 horizontal transfers from other higher education institutions, that is, from similar programmes, which accounts for 14 transfers in 2013/14 (and another 20 in 2014/15), indicating how attractive the Faculty is becoming, particularly in the last two years. In this context, as many as 100 horizontal transfers should be added (with another 20 in 2014/15), which account for the admission procedure, that is the results of the national high school graduation exam (*državna matura*), which includes the candidates who, after having studied somewhere else, enrol in the first year at our Faculty.

The graduate programmes of study are a bit shorter, and thus only vertical transfers should be considered here during enrolment in the first year of graduate programmes of study. There were 42 transferees in total inside the Faculty, that is, students who completed another kind of the undergraduate programme of study in the last five academic years (2009/10–2013/14). The graduate programme of study of Chemical Engineering attracted more transferees (20), as well as Materials Chemistry and Engineering (13), whereas the programmes of study of

Environmental Engineering attracted less students (5, due to somewhat worse employability), as well as Applied Chemistry (4, because this is the only programme of study in the field of natural sciences and therefore less similar to others). There were 47 transferees from other institutions, three of whom were foreign students. By programmes of study, 11 students transferred to the programme of study of Chemical Engineering, 12 to the programme of study of Materials Chemistry and Engineering, 16 to the programme of study of Environmental Engineering, and 8 to the programme of study of Applied Chemistry. The programmes of study do not show considerable differences in this context, but on the whole, these numbers are not substantial.

There were also 13 horizontal transfers to the doctoral programmes of study of the Faculty from other doctoral programmes of study in the Republic of Croatia.

6.2. The Objectives of Cooperation

One of the most important tasks of the Faculty is to develop international scientific and teaching cooperation. The cooperation between the Faculty of Chemical Engineering and Technology and foreign universities, scientific and research institutions and international associations is of utmost importance for the achievement of fundamental development objectives of the Faculty and its vision. Openness and contact with foreign institutions enable ongoing comparison between our curricula and scientific achievements and global trends, and adoption of international evaluation criteria for science and university education. The Vice Dean for Science and International Cooperation, with help of the ECTS Coordinator and the Commission for International Cooperation, which in addition to the two foregoing persons also comprises another five distinguished professors, try to facilitate international cooperation and to enhance efficient implementation of international project activities.

6.3. The Forms of Cooperation

The international cooperation of the Faculty is organised on bilateral and multilateral basis, through individual cooperation of specific teachers with adequate international institutions and associations, through teacher and student exchange and through organisation of international conferences in Croatia and abroad.

The partnerships of the University of Zagreb: The University of Zagreb has 161 active bilateral and 3 multilateral agreements with worldwide universities. As a University component, the Faculty has its share in some of such agreements, largely through student exchange, which, however, is not substantial. The Faculty teachers are actively involved in the implementation of the signed strategic agreement between the University of Zagreb and the University of Pennsylvania, USA.

The partnerships of the Faculty: In September 2014 the Faculty and the Polymer Technology College, Slovenj Gradec, Slovenia signed the General Cooperation Agreement to formalise their current scientific cooperation.

Bilateral agreements in the framework of Erasmus+ Programme: The student and the academic staff exchanges (for teaching purposes and internship) are most easily carried out under the signed Erasmus+ bilateral agreements. The Faculty has signed such agreements with the following institutions:

Austria – *Management Center Innsbruck*
Belgium – *Catholic University Leuven*
Bulgaria –*Technical University Gabrovo*
Czech Republic – *Technical University Brno*
Czech Republic – *Technical University Prague*

France – *National Polytechnic Institute Toulouse*
Italy – *University of Perugia*
Hungary – *University of Pannonia*, *Veszprem*
Portugal – *Polytechnic Institute of Beja*
Slovenia – *University of Ljubljana*
Slovenia – *University of Maribor*
Slovenia – *Visoka šola za varstvo okolja*, Velenje
Spain – *University of Castilla–La Mancha*, Toledo
Spain – *Polytechnic University of Valencia*
Turkey – *Kocaeli University*

Joint master degree programmes: The Faculty of Chemical Engineering and Technology participates as an associated partner in the framework of the programme of study *Excellence in Analytical Chemistry* (EACH). It is the so-called joint master degree programme, financed under EU Erasmus+ programme. The first call for proposals for student enrolment has been published.

Erasmus Mundus: The University of Zagreb is active in six mobility programmes: Experts4Asia, Silkroute, Euro-Asian CEA-2, BE Mundus, Basileus V and EU-METALIC. The programmes have been initiated only recently, and the Faculty has only one currently visiting doctoral student from Algeria in the framework of the foregoing programmes. The other calls for proposals are pending.

CEEPUS: The faculty is active in four CEEPUS mobility programmes for student and academic staff exchange with the neighbouring countries. The programmes include: *Education of modern analytical and bioanalytical methods, Determination of xenobiotics by using separation and hyphenated techniques for environment, food and human health purposes, Chemistry and chemical engineering* and *Cybernetics and modern methods of control*.

International projects: The two latest FP6-projects in which the Faculty participated expired in February 2014. In the context of active international projects mention should be made of COST-projects *System biocatalysis* (COST Action CM1303) and *Conceiving wastewater treatment in 2010 – energetic, environmental and economic challenges* (Water 2020).

NEWFELPRO: This is the programme of the Republic of Croatia to support mobility of young researchers. The project is also co-financed by the EU, through the Marie Curie FP7-PEOPLE-2011-COFUND Programme. The Faculty staff won one such project, *Preparation and Characterization of Zeolite Based Catalysts for Phenolic Wastewater Treatment Zcat4Water*, partially carried out at the Åbo Akademi University, Finland.

Bilateral projects: These are small-scale projects which financially cover the costs of mutual visits organised to work jointly on the proposed subject matters. The Faculty and its teachers are very active in their implementation (15 in the last five years, five still pending), and in the projects currently undergoing with the following institutions: the National Institute of Chemistry, Ljubljana, Slovenia (4) and the Institute of Chemistry, Chinese Academy of Sciences (ICCAS), Beijing, China.

Organisation of conferences and summer schools: The Faculty organises conferences and summer schools of international character on regular basis. In the last five years it organised e.g. *20th POLYCHAR World Forum on Advanced Materials* held in 2012 in Dubrovnik as one in a row of identical annual congresses, together with the associated course *Short Course on Polymer Characterization* and *6th European Summer School on Electrochemical Engineering (ESEEE)* held in 2012 in Zadar, in a series of triennial conferences. The Faculty features as an organiser of such conferences on occasional basis. The conferences initiated and organised by the Faculty on ongoing basis are *SEM, International Symposium on Environmental Management*, a conference held in 2011 for the third time, and organised every four years in Zagreb, as well as the *Meeting of Young Chemical Engineers*, held every even year at the Faculty, and organised by the Faculty and the Croatian Society of Chemical Engineers. Every year the Faculty and the Faculty of Chemistry and Chemical Technology of the University of Maribor alternatively organise the

conference called *Applied Biocatalysis*, a one day scientific meeting of students and professors from the foregoing Faculties. The Faculty and the Faculty of Chemistry and Chemical Technology of the University of Ljubljana initiated a biennial conference cycle entitled *Implementation of Microreactor Technology in Biotechnology* with participation of top-notch scholars from all over the world. In June 2014 the *15th International School of Ion Chromatography* was held, a one day conference organised at the Department of Analytical Chemistry of the Faculty every summer. The scholars and teachers of the Faculty regularly feature as chairs or members of scientific and organising committees of the conferences *Croatian Meeting of Chemists and Chemical Engineers* (with international participation, held every odd year, in 2015 for the 24th time) and *Ružička Days* (an international conference, held every even year in Vukovar, in 2014 for the 15th time). In addition to the above-mentioned, the Faculty staff occasionally take part as members of scientific committees of conferences organised by national and international scientific organisations.

6.4. International Associations

Since the Faculty is a leading Croatian scientific and educational organisation in the field of chemical engineering, the Croatian representative of the European associations relating to chemical engineering most frequently comes from the Faculty. Consequently, the Faculty teachers have participated in the work of international associations as follows:

- Representative of the Croatian Society of Chemical Engineers in the *European Federation for Chemical Engineering*,
- Croatian representative in the *European Polymer Federation*,
- Representative of the Croatian Society of Chemical Engineers in the *Working Party on Electrochemical Engineering* in the *European Federation for Chemical Engineering*,
- Representative of the Croatian Society for Materials Protection in the *International Corrosion Council*,
- Member of the *Scientific Committee, European Section on Applied Biocatalysis*,
- Permanent member of the *Board of the Central European Group for Separation Science*,
- Members of the working group for the sustainable network development: *European Environment and Sustainable Development Advisory Councils*,
- Members of the *Scientific Committee, PolyChar, World forum on Advanced Materials*.

6.5. Academic Staff Mobility

The study visits of the Faculty teachers to foreign institutions, as well as of foreign teachers to the Faculty, are organised most commonly in the framework of signed bilateral agreements. The largest number of study visits includes short-term one week to one month long study visits, and partially one year long study visits. The information on the number of visits of the Faculty teachers and associates to foreign countries is shown in Table 6.1. The statistics in the Table and the analysis of specific cases suggest that the study visits are largely comprised of short-term visits of younger staff (teaching assistants and junior researchers) to foreign institutions, where as a rule they work on new experimental techniques which are not available at their home institution, integrate the measurements and findings into their doctoral dissertations, i.e. scientific papers. The only longer stay concerns the recently initiated project within the NEWFELPRO programme. The Faculty practically does not have any long-term visits of foreigners, but some progress is expected, primarily through the Erasmus Mundus programme (the first one year long visit of a doctoral student from Algeria was registered).

In the last three years senior teachers did not go for any long-term visits to foreign countries. However, throughout their career, most of them did visit foreign scientific institutions. The

experiences acquired at such institutions had a very positive effect not only on their scientific and teaching activity, but also on the Faculty as a whole.

There is a more substantial number of shorter than a month visits. For the academic years 2011/2012–2013/2014 the international cooperation database of the University of Zagreb, evidently incomplete, registered one cooperation agreement, two study visits, four scientific visits, four project meetings and one visit under the category "other" to Slovenia, Italy, France and Hungary. The database does not include conferences. The CROSBI database (Croatian Scientific Bibliography) is much more relevant for such information, which in the calendar years 2011–2013 *inter alia* registered seven conference reports – abstracts in CC-journals, five conference reports in other journals, two plenary and two invited lectures in international conferences, 110 published conference papers with international peer-review, etc.

In terms of arrivals, one cooperation agreement, three project meetings, one study and one scientific visit were registered, with visitors coming from the USA, Kosovo, Poland, Germany and Slovenia. The asymmetry is evident as the foreigners scarcely pay a visit to the Faculty, which is not to imply a lack of cooperation – especially because of the age of Internet when physical distance does not represent a serious obstacle.

The direct consequence of scientific visits to foreign countries is more intensive scientific activity, which results in an increased number of scientific papers published in journals with international peer-review. The contacts established in foreign countries are maintained and contribute to the intensified scientific activity of teachers, but also of Departments on the whole, which creates an opportunity for international project applications. It is corroborated, for instance, by the fact that 135 WoS-papers of the total of 523 papers published in the calendar years from 2009 to October 2014 were written in co-authorship with international scholars.

As indicated in Table 6.1, there are no regular academic staff mobility programmes. The attempts to have occasional lectures in the framework of the CEEPUS project have subsided, or the teachers forget to make a record of such lectures in the International Cooperation Database. At the level of graduate or doctoral programmes of study occasional participation of foreign teachers is registered, who come as members of the commission for the graduation thesis or the doctoral dissertation defence. On a brighter note, the teachers from Switzerland, Australia, Canada and Spain participate in the doctoral programmes of study of the Faculty. Such instruction, due to high costs, is exclusively organised in the form of distance learning, where also lectures given occasionally by foreign teachers in summer schools organised by the Faculty in Croatia can be included. Students largely give positive feedback about such visiting lectures given by foreign teachers and scholars, which shows that there is a need for more intensive mobility.

6.6. Student Mobility

The International student mobility is largely organised through the established exchange programmes such as CEEPUS, Erasmus LLE (expired), Erasmus+, Erasmus Mundus etc., and the internship also organised by student associations like IAESTE (**The International Association for Exchange of Students for Technical Experience)**. At foreign universities students engage in scientific and research activities, attend courses, perform the experimental part of the graduation thesis or carry out their internship. The statistics is indicated in Table 6.2.

The outgoing student exchange is supported by the CEEPUS programme (for Central and East-European countries) and Erasmus+ (for entire EU and associated countries). Outgoing students are not so common. The first experiences show a lack o students' interest in outgoing mobility within the Erasmus Mundus programme (excluding Basileus programme), as it mostly concerns the countries with poorer scientific and research infrastructure in comparison with Croatia. The exchange in accordance with bilateral agreements is a considerably seldom occurrence. The

exchange is organised by managers of specific CEEPUS programmes, the Erasmus coordinator at the Faculty, supporting services of the Office for International Cooperation of the University of Zagreb, the Vice Dean for Science and International Cooperation of the Faculty and the Office for International Cooperation of the Faculty. The outgoing mobility statistics is still very low, and such occurrences are resolved on case-by-case basis. However, there is a growing interest, and a lack of a database on available student internships in Europe represents a burning issue. Due to insufficient overlap between the programmes of study, the exchange is practically not executed at the undergraduate level, and is carried out in the fourth semester at the graduate level, when students go abroad to perform the practical part of the graduation thesis there, which they defend when they return to their home institution. Thus such type of exchange does not account for allocation of ECTS credits. The first call for proposals for student internship through Erasmus+ programme is undergoing. The statistics of the student internship through the IAESTE suggests maximum 10 applications per every of the last five academic years, and two internships were carried out in 2009/10 (Brazil, Germany), three in 2010/11 (Argentina, Czech Republic, Finland), one in 2011/12 (Poland), two in 2012/13 (Brazil, the USA) and none in 2013/14.

The incoming student exchange is supported through the programmes CEEPUS and Erasmus+ and bilateral agreements of the University of Zagreb. The Erasmus Mundus programme, according to the first experiences, is going to function better, as Croatia is better prepared in comparison with source countries. At the level of undergraduate and graduate programmes of study, the arrivals are supported by courses held in English, 21 of which are offered in total:

- *Analytical Chemistry*
- *Chemometrics*
- *Chemical Engineering Thermodynamics*
- *Organic Chemistry*
- *Molecular Spectroscopy*
- *Introduction to Nanotechnology*
- *Mass and Energy Balances*
- *Analysis and Modelling of Environmental Processes*
- *Integrated Chemical Systems*
- *Surface Engineering*
- *Bioseparation Processes*
- *Formulation Engineering*
- *Adhesion and Adhesive Products*
- *Polymer Science and Technology*
- *Structure Determination of Organic Compounds*
- *Corrosion and Environment*
- *Engineering Thermodynamics*
- *Thermal Process Engineering*
- *Petroleum Refining and Petrochemical Processes*
- *Biochemical Engineering*
- *Process Measurements and Control*

Due to a low total number of arrivals, the instruction for such students is mostly organised through consultations. In the last four academic years two students from Singapore had one semester organised in such way and passed all their exams successfully. The example of a student from South Korea should be highlighted who failed to take her student obligations seriously and thus was not able to fulfil them. The cases like the one of a student who came from Germany to the Faculty of Mechanical Engineering and Naval Architecture are also possible, who attends only one course in our institution. There are rare cases of foreign students doing the experimental part of the final or the graduation thesis at the Faculty, like the case of a student from Spain. During the summer of 2014, for the first time three students (from Poland and France) came to do their student internship, and thus the Faculty was able to acquire its first experiences. In September 2014, three students from Kosovo came to the Faculty together with

their teacher to acquire knowledge in the area of corrosion. The comparison between the experiences of our students in foreign countries and incoming students indicates that foreign students at our Faculty receive much better treatment than vice-versa.

The courses in the doctoral programme of study Chemical Engineering and Applied Chemistry, i.e. the specialist programme of study Petroleum and Petrochemical Engineering can be declaratively and completely held in English. This academic year one foreign student (from Kosovo) enrolled in the doctoral programme of study, who will be able to receive complete education, through consultations, in English.

6.7. Non-Academic Staff Mobility

The statistics in Table 6.3 clearly shows absence of this type of exchange, as a result of inadequate knowledge of exchange programmes, insufficient knowledge of foreign languages and partly of overload of some members of the non-academic staff.

6.8. International Student Cooperation

The international student cooperation is mostly limited to the neighbouring countries, which will be shown on a couple of examples below.

The first such example is *Tehnologijada*, a traditional scientific and sports competition of students of technological faculties in the Republic of Croatia with participation of students from foreign universities, the tradition of which dates back to the 1950s. The sports event organised for the first time was recorded in 1956 at the Interfaculty Student Conference in Zagreb. The first Croatian *Tehnologijada* (Croatian Technology Scientific and Sports Competition) was held in 1997 and organised by the Faculty of Food Science and Biotechnology from Zagreb, with participation of the Faculty of Chemical Engineering and Technology, the Faculty of Food Science and Technology from Osijek, and the Faculty of Chemistry and Technology from Split. The Faculty of Metallurgy from Sisak, the Faculty of Textile Technology from Zagreb and the Faculty of Graphic Arts from Zagreb also joined in later on, and the number of guests from foreign universities, Bosnia and Herzegovina and Macedonia predominantly, is on the increase. In 2010 the students from the Faculty of Chemistry and Chemical Technology, University of Ljubljana also participated in the sports and the scientific part of the competition. Nowadays the *Tehnologijada* competition includes the following disciplines: chess, futsal, volleyball, swimming, shooting sport, basketball, running and table tennis. In addition to the sports disciplines, the competition also comprises the scientific part, in which the students give short verbal reports on their scientific activity. The commission for the evaluation of scientific papers is composed of a representative of each participating faculty.

The second example is *International Conferences of Technology Students*, held at the Faculty of Technology in Novi Sad, in which our students participate on occasional basis.

The third is a recent example of the *Membrain Concept* project, in the framework of which two students from the Faculty, together with another 70 colleagues from 13 components of the University of Zagreb, participated in the prestigious international competition *Solar Decathlon Europe 2014*, held in the vicinity of Paris, in the park of the Versailles castle for more than one month. The project included construction of an energy self-sufficient, self-sustainable, highly-technology-based prefabricated house and a two-week exhibition where interested parties could learn about the systems designed, programmed and packaged as end-products by the students themselves.

The fourth example is the visit paid to our Faculty by the students from the Faculty of Chemistry and Chemical Technology, University of Ljubljana, in December 2014.

It is important to mention that all the foregoing cases feature students as initiators and organisers, whether as part of the Students' Union of the Faculty or independently, and the Faculty sometimes provides financial support for some aspects of the project, like travelling expenses, etc.

6.9. General Discussion and Proposals

The analysis of the data provided under sections 6.1.–6.8. indicates that the Faculty has achieved substantial progress in the academic staff and student mobility in comparison with the period described in the previous self-evaluation report, which concerns both internal mobility relating to transfer of students between similar university programmes of study and international mobility. The most considerable progress has been achieved in the context of international mobility as a result of the activity carried out by the Commission for International Cooperation and an increasing number of bilateral agreements made between the Faculty and other international scientific and scientific and educational institutions in Europe and worldwide. The largest number of such agreements was implemented within the Erasmus+ and CEEPUS programmes and by implementation of bilateral projects with scientific institutions from all over the world.

The benefits derived from mobility for the academic staff and students of the Faculty, and for the Faculty itself, are visible in multiple ways. The scientific activity at the Faculty is intensified both during cooperation but also after its completion, as indicated by an increase in the number of scientific papers published in journals with international peer review.

Nevertheless, despite the upward trend in international academic staff and student mobility of the Faculty, the satisfactory level of cross-institutional cooperation has not been achieved. Additionally, the current academic staff mobility has largely concerned stimulation and development of scientific cooperation and activities whereas other forms of international exchange, for instance teaching cooperation and exchange, have failed to take part in total mobility. Therefore, the Faculty still cannot be completely satisfied with the results and the progress of the Faculty achieved in the area of international cooperation.

The analysis of the indicators specified in this self-evaluation report leads to the conclusion that the solutions proposed in order to improve the current situation resulting from the former self-evaluation report and the measures proposed in order to improve the international activities under the Development Strategy of the Faculty of Chemical Engineering and Technology for Period 2008–2013 have only partially been implemented. As indicated above, the Faculty can be satisfied with an increase in the international activity of the Faculty as well as with a rise in the academic staff and student mobility. Nonetheless, the involvement of teachers in international, particularly EU, projects is not satisfactory. To date Measure 5.2 of the Faculty Development Strategy, providing for a staffing increase in the Office for International Cooperation recruiting competent personnel who would be in charge of financial and logistic support, has not been implemented. Such personnel would facilitate the flow of technical and administrative information indispensible for the inclusion of our teachers in European projects and simplify such project applications. However, a question should be raised whether the totally expected scientific cooperation of the Faculty through European projects is sufficient to justify the investments of this type, or whether it would be more cost-effective to use the services of the University of Zagreb or perhaps the services of external consultants and financial and accounting offices. A slight progress has also been achieved in the activities relating to Measure 5.3 of the Faculty Development Strategy for Period 2008–2013, which concerns systematic monitoring of international cooperation quality. Such activities and their improvement are crucial to raise teacher and student awareness of the importance of this type of cooperation and of their inclusion in the international mainstream.

Generally speaking, a number of weaknesses could be identified, which the Faculty and its

teachers should overcome and remove in the forthcoming period. They are as follows:

1. Low outgoing and incoming student mobility, both of which, however, show a positive trend. To be able to increase incoming mobility, the current activities should be continued to increase the number of courses available in English and to enhance the willingness of teachers to receive students for internship and graduation theses. A list should be made of small projects available for internship and graduation theses. In order to increase outgoing mobility, first of all the information on available internships should be collected. The limiting factor for outgoing students is the financial situation concerning grants (scholarships), for which the Faculty is not able to do much.
2. Low incoming and outgoing academic staff mobility. In this context, the Faculty has recently adopted the Ordinance on the Sabbatical Leave Facility. A visit to a foreign country is also one of the promotion requirements, which is, admittedly, optional, and given the limited promotion opportunities, also inefficient.
3. Poor EU project involvement. The EU projects build institutional research capacities, contribute to faster and uninterrupted flow of information and improve the institutional inclusion in the European research community. Poor involvement of our Faculty in such projects can be explained by a number of reasons, such as:
    a) Insufficient incoming and outgoing academic staff mobility (see previous item), which establishes strong contacts as a basis for joint project applications
    b) A lack of knowledge about project availability and ways of how to get involved
    c) Complexity of technical and administrative application procedure for such projects
    d) A lack of motivation of teachers

    In accordance with the above-mentioned it is imperative to analyse the justification of the establishment of the Office for International Cooperation in the forthcoming period. The analysis might result in recruitment of a person for such office who will have experiences in project applications of such kind, and will be employed for full- or part-time, or perhaps a link might be established with an external institution or agency, without having our own office established. It is also essential to motivate and encourage the teachers to become more involved in project applications.
4. Insufficient dissemination of current outcomes resulting from international academic staff and student mobility. Effective dissemination of knowledge and experiences acquired during academic staff and student exchange is very important from the perspective of improving the quality of the scientific and research activity and of intensifying current international contacts. In this regard, it is essential to ensure that every teacher participating in international mobility writes a publicly available report about his/her stay and activity in a foreign country and holds a lecture to share his/her experiences, which is already partially carried out through colloquia organised by the AMACIZ (Association of Graduate Engineers and Friends of Chemical and Technological Studies). As a result, a proposal is expected to be given on how the Faculty will be able to use the acquired knowledge and experiences and how, based on current contacts, it will ensure exchange of other teachers and international project applications.

In the end, it should be said that the fundamental objective of international cooperation is to establish international "climate" at the institution in order to accept "global" way of thinking, to evaluate one's own results by international benchmarks and similar, not for the sake of statistics as such but for the sake of students and their preparation for international competition. And although it may seem that the Faculty, on account of mere figures, is not sufficiently involved in the international cooperation trends, it nevertheless manages to teach students how to think globally, that is, to prepare them how to approach the international labour market as testified by our graduates who completed their programmes of study in the last five academic years, and either began to work in foreign countries (16 of them, largely for renowned companies) or continued their education abroad (26 of them) at the following institutions:

- *King Abdullah University of Science and Technology*, Saudi Arabia
- *Pukyong National University*, South Korea
- *Virginia Polytechnic Institute and State University*, USA
- *Pritzker Institute of Biomedical Science and Engineering*, *Illinois Institute of Technology*, *Center for Molecular Study of Condensed Soft Matter*, USA
- *Leopold Franzens University Innsbruck*, *Institute of Organic Chemistry*, Austria
- *University of Leoben*, Austria
- *Technical University Dortmund*, Germany
- *Saarland University Saarbrücken*, Germany
- *Helmholtz-Zentrum Dresden-Rossendorf*, Germany
- *University of Basel*, Switzerland
- *Swiss Federal Institute of Technology*, *Lausanne*, Switzerland
- *University of Geneva*, Switzerland
- *Technical University of Denmark*, Denmark (3 candidates)
- *Chalmers University of Technology*, Göteborg, Sweden
- *University of Oslo*, *Chemical Institute*, Norway
- *University of Göteborg*, *Department of Chemistry and Molecular Biology*, Sweden
- *Institute of Macromolecular Chemistry Prague*, Czech Republic
- *Technical University Delft*, The Netherlands (3 candidates)
- *University of Amsterdam*, The Netherlands
- *University of Florence*, Italy
- *The Centre for Cooperative Research in Biomaterials*, *CIC Biomagune*, San Sebastian, Spain
- *Institute of Environmental Assessment and Water Research*, Barcelona, Spain
- *INSA Toulouse*, France
- *McGill University*, Montreal, Canada

6.10. Tables

Table 6.1 Academic mobility in the last three years

	Number of visits of teachers and associates of this high education institution to foreign institutions			Number of visits of foreign teachers to this higher education institution		
	1–3 months	3–6 months	6 months and more	1–3 months	3–6 months	6 months and more
Scientific	8	2	1	2	1	0
Teaching	0	0	0	0	0	0
Study	0	0	0	0	0	0

The statistics according to the International Cooperation Database of the University in Zagreb for the academic years 2011/12–2013/14 and the materials from the sessions of the Faculty Council in the foregoing period.

Table 6.2 Student mobility in the last three years

	Number of students in international exchange		
	1–3 months	3–6 months	6 months and more
Students of this higher education institution	4	2	0
Foreign students	7	9	0

The statistics according to the International Cooperation Database of the University of Zagreb for the academic years 2011/12–2013/14. The statistics does not include student internship organised by the IAESTE.

Table 6.3 Non-academic staff mobility in the last three years

Number of study visits of non-academic staff of this higher education institution to foreign institutions		
1–3 months	3–6 months i	6 months and more
0	0	0

7. RESOURCES: ADMINISTRATIVE OFFICES, PREMISES, EQUIPMENT AND FINANCES

7.1. Administrative, Technical and Auxiliary Staff

Table 7.a shows that the number of administrative, technical and auxiliary staff from 2009 to 2014 slightly decreased, the most substantial drop being recorded for employees in teaching and associate ranks, and especially in the academic year 2013/2014, see also section 4.1. Different curricula and scientific and research activities require a considerably large number of technical staff, see Table 7.b.

The share of administrative, technical and auxiliary staff in the last five years was slowly growing, primarily as a consequence of more prominent reduction in the number of teachers, and especially junior researchers. In the academic year 2013/2014 it accounted for 35.3%, which is still smaller than for the FSB (39.9%), but significantly higher than for the PTF (22.7%), and thus it seems there is still space to reduce their share. The Faculty policy to date, which will not change in the future, has been to carefully consider the real needs for recruitment of new personnel after any of the employees under this category retires or changes his/her job.

It is very difficult to give any comment on the ratio between the number of administrative, technical and auxiliary staff and the equipment. More specifically, the scientific and research equipment at the Faculty is highly sophisticated, and should be operated by teachers, teaching assistants and junior researchers, that is, scholars.

In the context of financing of the administrative, technical and auxiliary staff, any such employees at the Faculty are financed exclusively from the budget and thus do not encumber the Faculty's own revenues.

Table 7.a The number of employees by categories and the comparison with the number of students in the last five academic years

The rank category	Academic year				
	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014
Academic ranks	62	62	61	61	57
Teaching ranks	5	5	3	3	3
Associate ranks	13	14	15	15	15
Junior researchers	54	53	51	44	37
Teachers and associates in total	134	134	130	123	112
Administrative, technical and auxiliary staff	63	66	64	61	61
Total	197	200	194	184	173
The rank category	**Academic year**				
	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014
The number of students	772	817	873	945	1010
The number of employed teachers and associates / the number of administrative, technical and auxiliary staff	2,1	2,0	2,0	2,0	1,8
The number of students / the number of administrative, technical and auxiliary staff	12.3	12.4	13.6	15.5	16.6

7.2. Qualification Structure of the Non-Academic Staff and their Professional Development

The qualification structure of the non-academic staff of the Faculty, Table 7.b is determined by the position of the employee and as such is mostly in compliance with the needs of the Faculty given its size and activity. However, it should be highlighted that the non-academic staff largely does not speak English or any other foreign language for that matter and is not able to provide any assistance in those activities relating to activities in the international surrounding. In other words, the Students' Administration Office is not able to work independently with foreign students, the Accounting Office cannot handle European projects, the Human Resources Office is not able to make agreements with foreigners, etc. Furthermore, their IT knowledge is relatively low and they are not ready to leave their place of residence to go for professional training, especially to foreign countries. The Faculty does not have adequate administrative support for the affairs concerning international cooperation and cooperation with the industry.

Nevertheless, professional training of the non-academic staff is carried out continuously at all levels. The Accounting Office has ongoing professional trainings in the areas of accounting, finances and public procurement; the Secretariat participates in professional trainings in the areas of public procurement, archives and access to higher education information; IT Administration Office takes part in professional trainings in the area of IT system maintenance; the maintenance staff attend courses relating to occupational health and safety, as well as other employees who work with dangerous substances and are faced with increased workplace hazards. Special attention is given to professional training of the employees working at the Library and Information Centre (as the foregoing activity is closely connected with the core activity of the Faculty) and it is important to highlight here the attendance of the part-time graduate programme of study: Information Sciences – Library Science.

Table 7.b The list of non-academic staff by positions and professional qualifications

Rank	University degree	Associate degree	Secondary school degree	Highly skilled worker	Skilled worker	Primary school degree	Total
Professional associate	2						2
Senior technician/Senior laboratory technician		3					3
Technical associate/Laboratory technician			15				15
Expert officers	5	2	2				9
Technical support		1	2	1			4
Administrative staff in the Dean's Office and Secretariat	2	4	6				12
Auxiliary staff (doormen, cleaning women)			3			13	16
Total by professional qualifications	9	10	28	1	0	13	61
Share of specific professional qualifications	14.8 %	16.4 %	45.9 %	1.6 %	0 %	21.3 %	100 %

7.3. Premises for Teaching Activities

The Faculty has premises in four buildings (see Figure 7.2 and Table 7.1) situated at the locations of Marulićev trg 19 and 20 and Savska cesta 16 and 16/5A. The buildings **are not owned** by the Faculty. The Faculty shares the building at Marulićev trg 20 with the Department of Botany of the Faculty of Science (PMF) of the University of Zagreb and the Department of Pharmacognosy of the Faculty of Pharmacy and Biochemistry of the University of Zagreb. The building at Marulićev trg 19 is shared with the Department of Geography of the PMF and the "Ivo Pilar" Institute of Social Sciences. The building at Savska cesta 16 also has private tenants. The physical communication between the buildings is rather fast due to their relative proximity.

However, the premises at different locations lead to considerable consequences which can be seen in the scientific, teaching and professional activity of the Faculty to a great extent.

The Faculty has 11 lecture rooms which cover the total area of **669.82 m²** (Table 7.1), two IT classrooms (**117.6 m²**) (Table 7.1) and 44 laboratories of the total area of **2,289.73 m²** (Table 7.3). All lecture rooms have computers, LCD projectors and internet connection. In the last three years three smaller lecture rooms were reconstructed, older lecture rooms were renovated and adapted to the teaching needs, and now provide minimum usage and working standards.

A large number of (undergraduate, graduate and postgraduate) programmes of study have not led to unsustainable congestion of the available capacities yet although some parts of instruction are held at inappropriate times (late afternoon and evening hours).

In conclusion, in compliance with available finances, the Faculty invests maximum efforts to renovate and retrofit the premises, but the investment dynamics does not follow (nor will it be able to follow according to real projections for the forthcoming period) the needs and standards determined by dynamics of knowledge development and its transfer, that is, the desirable dynamics of teaching activity improvement.

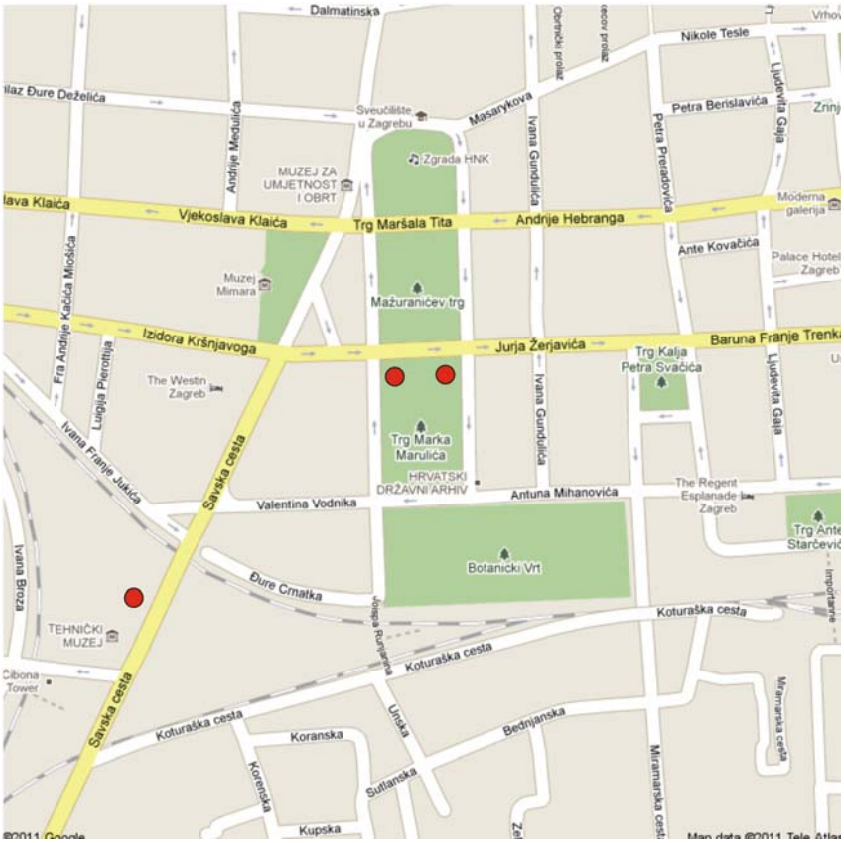


Figure 7.2 The locations where the Faculty carries out its activities (red dots)

7.4. IT Equipment for Educational Purposes

There are two IT classrooms for students. The number of computers available to students is not sufficient (Table 7.5); the computers have the standard operating system (Windows) and a basic group of office tools (MS Office), internet browsers, etc. They also have special software packages installed for students' education, used in different programmes of study (MatLab, Mathematica, Statistica, ChemCad, SuperProDesigner, Scientist, etc.). In the larger classroom (Savska cesta 16) the classes are held intensively, whereas in the smaller classroom (Marulićev trg 20), the classes are only held on occasional basis and it is used primarily for individual work

of students. Unfortunately, the computers installed in the classrooms date back to the end of 2008. Therefore, on the average the computers are more than 7 years old, that is from 6 to 9 years old. By February 2015 a third of computers in the larger classroom will be replaced by new computers, and by the end of the academic year 2015/2016 all computers will be replaced. After enrolment, every student receives his/her electronic identity within the AAI@EduHr system. When the classrooms are not occupied for instruction, between 8.00 a.m. and 7 p.m., both IT classrooms are available to students for their individual needs. The students can also stay in some lecture rooms when they are not occupied. The lecture rooms, like many other premises at the Faculty, have quick wireless internet connection via eduroam™ (*education roaming*) which can be accessed over the electronic identity within the AAI@EduHr system. It can thus be concluded that the students always have access to the information they may need. The students largely use the foregoing IT classrooms where in groups they can resolve the issues concerning homework assignments and seminar papers.

In the last 3–4 years old computers in lecture rooms were replaced by new ones, and today their average age is 3 years, but on the whole they are from 1 to 7 years old.

7.5. IT Equipment Procurement and Usage Policy

For many years the common policy relating to the procurement of new computers for educational purposes relied on donations of the Ministry of Science, Education and Sports, but such donations were completely suspended due to the economic crisis and recession. The Faculty plans to buy new computers for educational purposes, but is not able to buy any more substantial number of new IT equipment at affordable prices on its own.

In terms of other equipment, the computers in lecture rooms, administrative and teachers' offices are, as appropriate, replaced by new or newer computers in order to sustain good quality of instruction, administrative, scientific and professional activities. In compliance with the public procurement regulations, every other year, that is, every year for the procurement of printer toners, the Faculty issues a public tender to select the most favourable IT equipment bidder. After the selection of the bidder, it is relatively easy to buy everything needed, naturally in accordance with the available financial resources. For such purposes, the Faculty uses the resources from its own fund or resources of specific projects as provided under the financial plan and eligible costs.

All IT equipment at the Faculty, including servers, computer network, and largely the website of the Faculty are regularly maintained by senior IT officers of the Faculty.

7.6. The Teachers' Offices

There are 97 offices available to teachers and associates at the Faculty (Table 7.6), of the total 1,509.27 m^2 in area and 13.7 m^2 in average area. The offices have personal computers and internet connection, telephone and adequate, although considerably old, furniture. Most offices also have air-conditioning. In most of Departments junior researchers share a joint office. It is relatively difficult to work in the offices situated in inadequate and humid basement areas, as well as in the offices in the attic, unless they have air-conditioning. In general, it can be concluded that in other offices, the scientific and teaching activities can be carried out in adequate conditions.

7.7. Scientific and Research Laboratories

The Faculty has 56 laboratories in total. Table 7.3 shows 45 laboratories having the total area of 2,289.73 m^2 used on ongoing or occasional basis for instruction and other purposes (scientific,

research and professional activities). Such situation has its good sides, as there is evident interaction between the scientific and the professional activity and instruction, but spatial interaction as well. Very bad sides are exposure of some very valuable equipment to non-qualified persons who can damage it. There is also an increasing risk of unintentional and completely useless exposure of students and teachers to hazardous substances always present in the research or professional laboratory, but not welcome in students' laboratories (according to the Dean's Decision, it is forbidden to use mutagenic, teratogenic and carcinogenic substances during practical exercises with students).

Table 7.7 lists eight laboratories having the total area of 174.11 m^2 used only for the scientific and research activity. Table 7.8 specifies three laboratories used only for the professional activity, having the total area of 109.15 m^2. The laboratories are furnished with adequate instruments and most of them are largely used minimum eight hours a day (for chromatographic analyses also 24 hours a day, seven days a week), which shows how actively such premises are used for their intended purpose.

There is considerable disproportion in correlation between the scientific and research contribution and the space available in scientific and research laboratories. Although it is clear that enviable scientific results can also be achieved in available premises, one could justly raise an issue of what results would be achieved if the Faculty had adequate premises.

7.8. The Library and Information Centre

The Library and Information Centre (BIC – *Bibliotečno-informacijski centar*) of the Faculty was founded in 1984. Its materials cover the academic areas of chemical engineering, chemistry, thermodynamics, physics, mathematics and environmental science. The BIC is open for all users from 8.00 a.m. to 4.00 p.m. every week day.

The BIC has the main room of 102 m^2 in area, where textbooks, other references and journals have been stored since 1974. The current periodicals are shelved separately. The main room includes a reading room with 14 seats, also used as a study room and two offices for the BIC employees. The storage section (55 m^2 of which are on the third floor and 39 m^2 in the basement) houses the entire fund of journals older than 1974 and books. The location is inadequate due to a lack of favourable microclimates required for storing library materials. The main room on the third floor is situated in close proximity to the laboratory digester, which makes it difficult to ventilate this room. In addition, the noise coming from the digester disturbs the employees and the students while they work. The basement rooms are humid, without enough windows and any heating.

The BIC, in addition to the materials for general use (the library fund, lending of materials to students) also buys the library materials for the Faculty employees, catalogues the materials and forwards them to the relevant persons who placed such orders. Due to a lack of space, most books in specialised areas are stored in Departments (15,520), but not the journals, which are integrated and stored in the library premises only. The BIC itself stores 3,411 books. Final theses (549), graduation theses (5,679), master theses (1,102) and doctoral dissertations (711) are catalogued and stored separately, in the Archives of the Faculty. The qualification theses can only be borrowed from the library.

In terms of equipment, the BIC has three desk computers and one laptop, three printers, one of which can be used by students, a photocopying machine, a scanner, a bar code reader and printer, and a magnetic card reader.

On the average the BIC buys 70 books (titles) per year, whereas the number of printed journals which are bought decreased dramatically in the last couple of years. Consequently, the number of titles bought in the academic year 2013/2014 was reduced to merely eight (four of which were foreign and four national journals), for which HRK 53,423.00 were spent (in comparison

with for instance 2008, when 29 journal titles were bought – 24 foreign and 5 national – and HRK 185,813.62 spent). This is a result of suspension of the financial support provided by the Ministry of Science, Education and Sports (MZOS), the funds of which used to account for 80% of the total costs.

On the average the BIC receives user's 250 requests per year, most of which concern scientific and professional papers, of which number about 40% of requests are forwarded to similar libraries as the BIC does not have the requested references (mostly when more recent issues of journals are in question). For the needs of students the BIC also carries out thematic search of references. The interlibrary exchange also includes the exchange of our own publications, as well as of journals, books of proceedings or copies of the library materials, which increases the library fund. Depending on the financial resources available, the procurement plan and needs, the BIC buys new publications from the list of basic references for all courses. Some titles were acquired throughout the years through exchange, donation and the Faculty's own publications. The Bologna process imposed high requirements for libraries concerning the number of copies of compulsory references, and thus in the last two academic years the Faculty has been working intensively on meeting such requirements in full and obtaining the required number of copies of compulsory and supplementary references corresponding with the number of students.

7.9. Electronic Databases

Since 2011 the BIC has been utilising the integrated Aleph library management system, used for university, academic and national libraries. The system was preceded by the conversion and adjustment (upgrading) of the entire book database in the previously used software (CDS/ISIS-DOS), which was completed very professionally by the team of the National and University Library (NSK – *Nacionalna i sveučilišna knjižnica*) in Zagreb.

The records on journals are kept in the functional software SAND, and the BIC plans to enter journals gradually (433 titles in total) in the Aleph, as direct conversion is unfortunately not possible. The catalogue of journals is uploaded online[43], but includes only the data before 2004. Therefore, the internal catalogue of journals is available on the website of the BIC[44] in PDF format, which is updated at the beginning of every calendar year. The catalogue updating allows other similar institutions to see availability of specific papers for interlibrary loan.

The access to sources of information is relatively satisfactory, as by licensing of a large number of electronic journals the MZOS facilitated direct access to papers in journals never received by the BIC or the receipt of which stopped in a specific year (as a rule it was 2005), and which are of great importance for research and teaching processes at the Faculty. The journals available on the publishers' websites have largely improved availability of sources of information outside the library premises and working hours.

Irrespective of the foregoing, it cannot be said that the Faculty is satisfied with the number of electronic journal titles, as there is a noticeable shortage of some which were of great assistance to our Faculty for years. The library compensates for the lack of access to such titles by excellent interlibrary cooperation with the libraries of similar faculties and institutes in Croatia and the region, as well as by borrowing the necessary references from foreign countries over the NSK. The Library of the Ruđer Bošković Institute developed a free of charge online application for interlibrary loan of books and journals in electronic or printed format and in a way integrated all libraries signed up in the system. The access is available over the electronic identity within the AAI@EduHr system and the system automatically recognises affiliation with a specific institution.

[43] *http://lib.irb.hr/preskok/*
[44] *http://www.szi.irb.hr/knjiznice/?libid=62*

The BIC does not have a computer for its users, but one of the two IT classrooms is situated in its vicinity. The computers in the classroom provide access to all databases over the Centre for Online Databases[45], as well as to the portal of the Croatian scientific journals (hrČAK)[46], and users can ask the librarian for help during their search at any moment. On the library website the users can find links to databases and the electronic journals with full articles available free of charge.

The data on the frequency of use of the databases, that is, the number of accesses, is unfortunately not available.

7.10. The Premises of Administration Offices

The Administration Offices have enough workspace to meet the conditions required for their work and receiving clients, and are situated in the vicinity of the Office Manager and the Management of the Faculty. The offices have all the required office and IT equipment at their disposal, including specific software support (e.g. WinTASK for accounting, ordering and procurement, working time and attendance tracking, travelling orders, payroll and financial planning; ARHiNET – software support for archives; SAP – software support for development of financial plans and planning of material costs, Registry of Public Services and COP (*centralni izračun plaća*) – central calculation of wages for human resources management and payroll expenses, software support for the Registrar's Office, software support for the work of the IT specialist, etc.). Some rooms where clients are received are fitted with the multimedia system. Overall, it can be concluded that in the context of Faculty resources on the whole, the premises of the Administration Offices are at the satisfactory level, and will be improved by timely upgrading of the IT equipment.

7.11. Autonomy and Flexibility of Financial Management

In 2012 the total revenue of the Faculty amounted to approximately HRK 44.69 million, and in 2013 to HRK 42.30 million, of which about 82% accounted for the revenue from the state budget. The Faculty's operating revenue amounts to about 10% of the total revenues on the average (11.30% for 2012 and 8.95% for 2013), whereas the rest is the revenue resulting from special needs, primarily the revenue from tuitions for undergraduate and graduate programmes of study. The level of autonomy in financial management is determined relatively, by ratio between the budgetary revenue and the marketing revenue, whereas the level of flexibility (in addition to the foregoing) is also determined by the amount of the Faculty's operating revenue, which was HRK 5.06 and 3.73 million in 2012, that is 2013 respectively. The Faculty should invest more effort to increase the absolute amount, as well as the share of its operating revenue in total revenues, which will primarily lead to an increase in the operating flexibility and only to a small extent to autonomy in financial management, which requires more radical system changes.

7.12. The Structure of Marketing Revenues

As above mentioned, the total marketing revenue amounted to about HRK 5.06 million in 2012 that is HRK 3.73 million in 2013. The foregoing deficit of about HRK 1.30 in 2013 is a direct result of suspension of financing of scientific projects (Z-projects (scientific projects) in the amount of HRK 1.40 million). Of the total revenue, about 20% accounts for tuitions from postgraduate programmes of study, 20% for revenue resulting from cooperation with the

[45] *http://www.online-baze.hr/*
[46] *http://hrcak.srce.hr/*

industry, 30% for organisation of scientific and professional conferences and workshops, and 30% for scientific projects outside the general budget. The foregoing structure of the Faculty's own revenues is satisfactory, but the revenues from commercial projects and other forms of cooperation with the industry should be increased. For such purpose, in December 2014 the Faculty founded a spin-off company owned 100% by the Faculty and the University of Zagreb. It is believed that the outsourcing of new technologies and intellectual property, which were inadequately and insufficiently used by the Faculty (due to its business policy and climate, but undoubtedly having a market value) in the form of a spin-off company will lead to them becoming the core business activities. The future progress of the Faculty will be based on their development and exploitation. In global, this should lead to an increase in the total volume of business activities in the favourable business climate at the Faculty, which will offer the advantages of highly competitive and economically potent business activities.

7.13. Marketing Revenue Management

The revenue from marketing services is used to improve the activities of the Faculty, either directly or indirectly.

The direct improvement of the activities of the Faculty is manifested through:

- Co-financing of procurement (as a rule) of minor equipment used in the teaching process
- Servicing of major equipment available to all employees (and students)
- Procurement of specific software packages
- Assistance in organisation of conferences and activities within the life-long learning system
- Procurement of (literature) references
- Co-financing of scientific and professional projects

The indirect improvement of the business activity of the Faculty involves financing of material and similar costs connected with efficient functioning of the core business activity of the Faculty (such as procurement of dispensables: reagents, gases, etc.), excluding overheads and similar running costs.

By implementing the business policy based on integrated management of direct and indirect costs the Faculty strives to enhance the achievement of objectives and improve its business activity to the maximum extent possible.

7.14. The Spending Structure of Marketing Revenues

The spending structure of marketing revenues is in compliance with the objectives and the governance with the aim of improving the business activity, and is described in more detail under the section above. A lack of such funds cannot have a considerable effect on the operation of the Faculty, especially having in mind the fact that a large share of revenues (about 82%) come from the state budget, whereas the revenues for science were reduced to the minimum in 2013 (cancellation of the Z-projects (scientific projects) generated a deficit of about HRK 1.40 million). In such unfavourable financial climate the Faculty managed to achieve the educational objectives in their full volume, the scientific objectives were also achieved, but in a smaller volume. Irrespective of the smaller volume of scientific objectives, an increase in the marketing revenues resulting from cooperation with the industry would not significantly improve the scientific activity, as scientific research in the field of technical sciences, academic area of chemical engineering and in the field of natural sciences, academic area of chemistry, require extremely substantial investments, which cannot be achieved by a mere increase in marketing revenues.

7.15. The Priorities in Case of Increased State Budget Financing of the Faculty

In the event of an increase in the budgetary financing of the Faculty, the priorities will firstly depend on the absolute amount of the increase. If the increase in financing is small, the priorities will have to be carried out in the framework of modernisation and retrofitting of current laboratories, training courses for the academic and non-academic staff, maintenance of premises, furnishing of premises for associations (students, *alumni*, teachers' club), the Faculty's promotional activities and quality system improvement. If the increase in financing is more substantial, in addition to the foregoing priorities, the objectives such as construction and furnishing of new premises could be achieved, which would facilitate upgrading of the teaching process to suit the trends (such as independent work of students on projects) and procurement of the equipment the Faculty cannot afford today because of its price, which in the end would create new opportunities for applications for European funds for science and research.

The migration of the Faculty to the location of the Borongaj Research and Education Campus can also be expected, which is in compliance with the Spatial and Functional Development Strategy of the University of Zagreb, adopted on 8th July 2014, and the preliminary design of the building for the Faculty of Chemical Engineering and Technology of the University of Zagreb on the Borongaj Research and Education Campus adopted on 24 March 2014 during the session of the Faculty Council. Despite the good intentions, the outcome of such endeavour directly depends on external financing, including the one coming from the budget.

7.16. General Discussion and Proposals

The current situation with resources cannot be characterised as satisfactory.

Primarily it concerns the operation of the Faculty at several locations and the fact that practically a third of the available premises are situated in inadequate basements and attics. The buildings are old, leaking, humid and rapidly falling into disrepair, and any intervention to improve the situation is largely encumbered and becomes more expensive due to the fact that the premises are protected culture monuments (excluding the yard building at Savska cesta 16/5A). The Faculty does not have a sufficient number of offices for the needs of its employees holding academic, teaching and associate ranks, and there is a visible shortage of research laboratories as a large majority of the laboratory premises are used for teaching, research and professional activities at the same time. The foregoing fact was recognised by the Faculty, but also by the University of Zagreb, and migration of the Faculty to the location of the Borongaj Research and Education Centre is planned. The migration would improve the general conditions for students' attendance in courses and integration of information-communication technologies and audiovisual aids in lecture rooms and laboratories. The new premises would primarily provide adequate level of occupational health and safety and the essential conditions for storing of reagents and dangerous substances, which is in compliance with the holistic orientation of the Faculty. As a result, the competitiveness and competency of the scientific and research activity would increase.

In addition to the premises, mention should also be made of the competent Ministry of Science, Education and Sports (MZOS) which fails to allocate sufficient resources for normal and regular operation of the Faculty. It is a consequence of the generally poor economic situation in the country, which at the same time also affects reduction of the Faculty's own revenues resulting from cooperation with the industry. The financial situation is also additionally aggravated by the claims filed by some employees for non-payment of bonuses for special working conditions they are entitled to receive in accordance with the Collective Agreement, and which payments the MZOS fails to remit. The unfavourable financial situation represents an ongoing barrier to normal operation of the Faculty, and is a threat to its survival in the long-run.

The number of administrative, technical and auxiliary staff should be reduced to a certain extent, but not in a way to threaten the functioning of such offices at any moment. In other words, this is a long term process. The current policy of staff professional development should be continued, and when employing substitutes, considerations should be made to recruit new employees who would be able to work in the international environment.

7.17. Tables

Table 7.1 The buildings in which the Faculty operates (not owned by the Faculty)

Building identification	Building location	Year of construction	Year of extension or reconstruction	Total area for higher education activity (m^2)	Total area for scientific research (m^2)	
					Laboratory	Library
Faculty of Chemical Engineering and Technology, Marulićev trg 19	Marulićev trg 19	1918.		2,451.17	614.79	
Faculty of Chemical Engineering and Technology, Marulićev trg 20	Marulićev trg 20	1918.		4,441.50	1,416.88	204.01
Faculty of Chemical Engineering and Technology, Savska cesta 16	Savska cesta 16	1910.		2,803.31	571.99	
Faculty of Chemical Engineering and Technology, Savska cesta 16/yard	Savska cesta 16/5A, yard	1950.	1980.	197.10	91.28	

Table 7.2 Lecture rooms and IT classrooms

Building identification	Lecture room number or designation	Area (m^2)	Number of seats for students	Number of hours of use per week	Evaluation of equipment (1 – 5)
Marulićev trg 19/basement	MKM 19/3001	70.48	45	Winter sem. 33 Summer sem. 38	4
Marulićev trg 19/basement	P1KM 19/3008	37.32	24	Winter sem. 30 Summer sem. 38	5
Marulićev trg 19/basement	P2KM 19/3007	19.20	12	Winter sem. 30 Summer sem. 38	5
Marulićev trg 19/ground floor	MKV 19/3002	192.20	150	Winter sem. 40 Summer sem. 40	5
Marulićev trg 20/basement	1514	34.98	24	Winter sem. 20 Summer sem. 20	4
Marulićev trg 20/ground floor	MKV 20/3102	82.00	120	Winter sem. 37 Summer sem. 40	4
Marulićev trg 20/I	MKM 20/3101	61.57	40	Winter sem. 37 Summer sem. 26	4
Savska 16/basement	S-P/3201	41.13	32	Winter sem. 37 Summer sem. 41	3
Savska 16/basement	S-P2/3210	23.48	6	Winter sem. 35 Summer sem. 40	3
Savska 16/ground floor	S-0/3214	36.77	24	Winter sem. 36 Summer sem. 26	5
Savska 16/I	S-1/3204	70.69	80	Winter sem. 45 Summer sem. 51	4
Total		**669.82**	**581**		
IT classrooms					
Marulićev trg 20/III	UR/3112	55.51	6	Winter sem. 40 Summer sem. 40	2
Savska 16/ground floor	UR/3202	62.09	24	Winter sem. 47 Summer sem. 40	2
Total		**117.6**	**44**		

Table 7.3 Laboratories used for educational purposes

Building identification	Internal room designation (of laboratory)	Area (m^2)	Number of seats for students	Number of hours of use per week	Evaluation of equipment (1 – 5)
Marulićev trg 19/ basement	Students' Laboratory III (2304)	51.73	12	34	5
Marulićev trg 19/ basement	Preparation/Sterilisation Room (2305)	15.31			5
Marulićev trg 19/ground floor	Students' Laboratory (1109)	96.53	32	30	3
Marulićev trg 20/basement	Students' Laboratory III (1320)	160.57	24	20	3
Marulićev trg 20/basement	Laboratory IV (1616)	37.09	6	14	2
Marulićev trg 20/basement	Laboratory II (1509)	74.41	24	20	3
Marulićev trg 20/ground floor	Laboratory I (1210)	164.84	48	40	2
Marulićev trg 20/ground floor	Laboratory II (1209)	164.85	32	20	2
Marulićev trg 20/ground floor	Instrumental and Process Analysis Laboratory (1202)	78.91	10	30	3
Marulićev trg 20/ground floor	Environmental Chemical Analysis Laboratory (1205)	53.12	5	50	4
Marulićev trg 20/ground floor	Laboratory I (1306)	56.30	8	40	4
Marulićev trg 20/I	Scientific and Research Laboratory III (1605)	33.30	6	32	4
Marulićev trg 20/I	Chemical Laboratory II (1604)	47.50	10	32	4
Marulićev trg 20/I	Laboratory for Structural Materials Characterisation I (1602)	24.57	6	175	4
Marulićev trg 20/I	Reverse Osmosis Laboratory (1404)	34.04	2	24	4
Marulićev trg 20/I	Polymers Laboratory I(1402)	34.13	6	26	3
Marulićev trg 20/I	Laboratory I (1502)	96.12	24	28	3
Marulićev trg 20/III	Laboratory II (1314)	84.90	12	40	4
Marulićev trg 20/III	Physical Chemical Laboratory III (1409)	115.27	24	20	3
Marulićev trg 20/III	Corrosion Laboratory (1413)	66.79	12	8	2
Marulićev trg 20, III floor	Laboratory II (1314)	84.90	12	40	4
Savska cesta 16/basement	Laboratory for Petroleum Products Characterisation III (2010)	26.26	8	30	1
Savska cesta 16, basement	Laboratory II (1706)	72.83	10	10	4
Savska cesta 16/ basement	Laboratory V (1717)	18.00	16	10	4
Savska cesta 16/basement	Laboratory IV (1709)	18.07	6	10	3
Savska cesta 16/ ground floor	Laboratory I (1702)	38.70	10	20	4
Savska cesta 16/ground floor	Laboratory VI (1718)	20.00	6	10	3
Savska cesta 16/ ground floor	Laboratory I (1702)	38.70	10	20	4
Savska cesta16/ground floor	Laboratory (3501)	7.61	2	*20*	2
Savska cesta 16/I	Laboratory I (1802)	24.50	2	40	4
Savska cesta 16/I	Laboratory for Semi-Conductors II (1807)	19.55	2	20	5
Savska cesta 16/I	Laboratory of Electrochemistry III (1819)	52.20	15	40	3
Savska cesta 16/I	Laboratory of Engineering IV (1821)	52.85	15	40	4
Savska cesta 16/II	Laboratory for Polymers and Polymerisation Processes I (1909)	51.09	18	20	2
Savska cesta 16/II	Laboratory for Dyes and Coatings II (1911)	49.46	15	20	3
Savska cesta 16/II	Laboratory for Environmental Engineering III (1916)	17.27	5	40	4

Building identification	Internal room designation (of laboratory)	Area (m^2)	Number of seats for students	Number of hours of use per week	Evaluation of equipment (1 – 5)
Savska cesta 16/II	Laboratory for Petrochemical Engineering I (2008)	22.86	5	40	3
Savska cesta 16/III	Laboratory for Sono-Oxidation Processes VII (1930)	12.40	2	20	4
Savska cesta 16/III	FTIR-TGA Laboratory IV (1928)	12.03	2	40	4
Savska cesta 16/III	Physical Laboratory for Polymeric Materials VI (1923)	11.54	2	25	5
Savska cesta 16/III	Physical Laboratory for Polymeric Materials V (1922)	10.54	2	25	5
Savska cesta 16/III	Laboratory for Petroleum Process Engineering II (2009)	34.21	5	40	3
Savska 16/III	Laboratory for Adhesion and Adhesives I (2406)	12.60	6	25	5
Savska cesta 16/5A	Laboratory II (2107)	34.48	4	4	4
Savska cesta 16/5A	Students' Laboratory I (2101)	56.80	12	10	4
Total		**2,289.73**			

Table 7.4 Educational sites (work-sites) for practical classes

Building identification	Name of the teaching site (work-site)	Number of students attending specific teaching site	Number of classes (per week) held at specific teaching sites
-	0	0	0

Note: The Faculty does not have any educational sites (work-sites) for practical trainings.

Table 7.5 Equipment in IT classrooms

Building identification	Number of new computers (younger than 3 years)	Number of computers older than 3 years	Functionality evaluation (1 – 5)	Maintenance evaluation (1 – 5)	Possibility of use outside classes
Savska 16/ground floor	0	25	3	5	2
Marulićev trg 20/III	0	6	3	5	5

Table 7.6 Teachers' Offices

Building identification	Number of teachers' offices	Average area (m^2)	Evaluation of equipment (1 – 5)	Average area (m^2) per full-time teacher/associate
Marulićev trg 19/ basement	7	18.56	3	14.43
Marulićev trg 19/ground floor	17	16.79	4	11.89
Marulićev trg 20/I	14	15.26	4	12.56
Marulićev trg 20/III	10	13.95	3	11.63
Savska cesta 16/ basement	1	25.29	4	12.65
Savska cesta 16/ ground floor	13	14.75	4	11.28
Savska cesta 16/I	9	15.39	3	15.39
Savska cesta 16/II	13	17.24	3	14.94
Savska cesta 16/III	10	14.71	5	13.37
Savska cesta 16/5A	3	14.86	4	14.86
Total	**97**	**15.56**	**4**	**13.05**

Table 7.7 The premises used only for scientific and research activity

Building identification	Internal room or laboratory designation	Area (m^2)	Number of hours of use per week	Evaluation of equipment (1 – 5)
Marulićev trg 19/basement	Microbiological Laboratory I (2302)	14.19	40	4
Marulićev trg 19/ basement	Laboratory for Waters II (2303)	18.62	25	3
Marulićev trg 19/ basement	Laboratory for Composting IV (2308)	17.82	20	5
Marulićev trg 19/ basement	Laboratory for Mass Spectrometry (1120)	21.34	40	5
Marulićev trg 20/basement	Laboratory 3 (1512)	20.85	10	3
Marulićev trg 19/ ground floor	Research Laboratory (1105)	52.56	40	3
Marulićev trg 20/III	Instrumental Laboratory II (1315)	11.75	40	2
Marulićev trg 20/III	Instrumental Laboratory III (1316)	16.95	40	2
Total		**174.11**		

Table 7.8 The premises used only for professional activity

Building identification	Internal room or laboratory designation	Area (m^2)	Number of hours of use per week	Evaluation of equipment (1 – 5)
Marulićev trg 19/basement	Laboratory III (1115)	54.29	40	3
Marulićev trg 19/basement	Laboratory II (1116)	18.58	40	2
Marulićev trg 19/basement	Laboratory I (1117)	36.28	40	2
Total		**109.15**		

Table 7.9 Major equipment

Name of instrument (equipment)	Purchase price, HRK	Age (in yrs)
Inductively coupled plasma mass spectrometer (ICP-MS)	1,445,936.00	11
Fourier Transform Infrared Spectrophotometer – Thermogravimetry-Differential Scanning Calorimetry/Differential Thermal Analysis-Evolved Gas Analysis – FTIR-TG-DSC/DTA-EGA analysis	973,752.00	6
X-ray diffractometer	600,000.00	2
Gas adsorption – desorption analysis instrument (Micromeritics, ASAP 2000)	242,552.00	25
Laser Diffraction Particle Size Analyzer (Shimadzu, SALD-3101)	490,000.00	4
Spray dryer (Büchi, B-290)	250,000.00	6
High-performance liquid chromatography (HPLC)	812,238.00	3
Ion chromatograph	407,566.00	6
High-performance liquid chromatography with mass spectrometry system (HPLC-MS/MS)	1,000,000.00	5
High-performance liquid chromatography / analytical-preparative system (HPLC)	309,208.00	8
Gas chromatography-mass spectrometer system (GC/MS)	540,292.00	11
Electron microscope (Tescan)	1,000,000.00	2
Gas chromatography system (GC)	209,321.00	2
Instrument for electrochemical measurements – PAR	405,305.51	24
Instrument for electrochemical measurements – Solartron	254,345.00	10
Instrument for electrochemical impedance spectroscopy	228,400.35	11
Wave dispersive x-ray spectrometer	496,540.00	7
Size-exclusion chromatography system (SEC)	280,196.00	11
Fourier Transform Infrared Spectrophotometer (FTIR)	254,269.00	6
Organic halide content analyser	311,958.00	11
Dynamic-mechanical analyser (DMA)	288,765.00	13
Thermogravimeter	270,000.00	5
Differential scanning calorimeter (DSC)	210,100.00	8
Differential scanning calorimeter (DSC)	210,100.00	7
Goniometer	241,540.00	10
Thermographic diagnosis system	449,963.00	11

Table 7.10 Library equipment

Total area (m^2)		Number of employees	Number of seats	Number of students using the library		Does your library have an electronic database of your books and journals	
204.01		1	14	Majority		Yes	
Number of book titles	**Number of textbooks**	**Evaluation of up-to-date quality of books and textbooks (1 – 5)**	**Number of titles of foreign journals**	**Number of titles of national journals**	**Evaluation of functionality of the catalogue of books and journals**	**Evaluation of equipment (1 – 5)***	**Evaluation of quality and availability of electronic content (1 – 5)****
18,931	157 titles, 577 copies	4	5 in 2013, total number of titles is 383	4 in 2013, total number of titles is 50	18,931	157 titles, 577 copies	4

* Possibility of photocopying for teachers and students, obtaining copies from other libraries, catalogues of teachers' papers, etc.
** Electronic content includes e-editions of books, journals, databases, but also catalogues of the Faculty's and external libraries.

Table 7.11 Financial evaluation

	REVENUES	2012 Calendar year (HRK)	2013 Calendar year (HRK)
1.	REVENUES FROM THE STATE BUDGET (AOP 114 PR-RAS)	**36,715,173**	**34,545,801**
1.1	Wages	**30,534,923**	**29,510,014**
1.2.	Operating costs (including field instruction)	**1,894,463**	**1,501,348**
1.3.	External teaching cooperation	**0**	**0**
1.4.	National scientific projects	**2,656,023**	**2,074,469**
1.5.	International scientific projects	**366,151**	**586,938**
1.6.	International cooperation	**12,079**	**10,967**
1.7.	Organisation of scientific conferences	**23,500**	**35,940**
1.8.	Procurement of journals	**0**	**0**
1.9.	Regular maintenance	**0**	**0**
1.10.	Construction and investment maintenance	**150,000**	**0**
1.11.	Equipment	**0**	**0**
1.12.	Total of other types of revenues (transportation costs, doctoral dissertation graphic design, systematic medical check-ups, subsidy returns, jubilee awards, students' programmes)	**1,078,034**	**826,125**
			0
2.	REVENUES FROM THE BUDGETS OF OTHER PUBLIC SOURCES	**755,311**	**0**
2.1.	Revenues and aid from local self-government units (city, county, etc.)	**0**	**0**
2.2.	Revenues and aid from other entities (for instance Croatian Science Foundation)	**755,311**	**0**
2.3.	Total of other types of revenues (please specify)	**0**	**0**
3.	INTEREST REVENUES (AOP 067 PR-RAS, Group 64)	**27,560**	**30,141**
3.1.	Revenues from bilateral and EU projects (AOP 047, Group 63)	**386,022**	**608,295**
3.2.	Revenues from repayment of apartments (AOP 264, Group 72)	**8,558**	**23,371**
4.	OPERATING REVENUE (AOP 108 PR-RAS)	**5,055,267**	**3,729,517**
4.1.	Tuitions – postgraduate specialist	**417,900**	**228,800**
4.2.	Tuitions – postgraduate doctoral	**547,300**	**873,705**
4.3.	Scientific projects – outside general budget	**1.401,342**	**0**
4.4.	Professional projects – project co-financing	**561,249**	**97,299**
4.5.	Rental revenue	**0**	**0**
4.5.1	Total of other types of revenues (workshops and other operating revenue)	**554,978**	**1,145,389**
4.5.2	Revenue from course materials bookshop	**10,433**	**6,304**
4.5.3	Revenue from participation fees	**659,054**	**373,544**
4.9.	Cooperation revenue	**903,015**	**1,004,476**
5.	REVENUES IN ACCORDANCE WITH SPECIAL REGULATIONS (AOP 090, Group 65)	**2,179,978**	**3,335,575**
5.1.	Tuitions – undergraduate, graduate, professional	**888,840**	**1,427,109**
5.2.	Additional testing of special knowledge, skills and abilities (if carried out in addition to the national high school graduation exam (*državna matura*))	**0**	**0**
5.3.	Enrolment fees	**104,650**	**96,100**
5.4.	Publishing activity	**0**	**0**
5.5.	Fees from student's application forms, certificates, diplomas, index (grade record books), etc.)	**64,680**	**20,720**
5.6.	Total of other types of revenues (revenue for implementation of objectives and other earmarked revenues)	**453,010**	**287,355**
5.7	Participation fees Tuitions University	**773,343**	**1,504,291**
6.	OTHER (UNSPECIFIED) REVENUES (donations)	**325,293**	**29,877**
	Donations (AOP 111 PR-RAS, Sub-group 663)	**325,293**	**29,877**
A	OPERATING REVENUES TOTAL (AOP 598 PR-RAS)	**44,697,672**	**42,302,577**

	EXPENSES	2012 Calendar year (HRK)	2013 Calendar year (HRK)
1.	EMPLOYEE EXPENSES (Group 31)	31,775,388	30,291,232
1.1	Wages (AOP 134 PR-RAS, Subgroup 311)	26,892,733	26,188,277
1.2.	External teaching cooperation	195,994	289,297
1.3.	Total of other expenses (wage contributions, taxable subsidies, severance pays)	4,686,661	3,813,658
1.3.1.	Material costs (Group 32)	10,473,665	10,598,514
1.3.2.	Financial expenses (Group 34)	272,627	88,110
1.3.3.	Fees and other expenses (Groups 37 and 38)	136,481	72,248
2.	EXPENSES FOR SUPPLIES, DISPENSABLES AND ENERGY (Subgroup 322)	2,664,119	2,368,015
2.1.	Office supplies and other material costs	302,077	217,763
2.2.	Laboratory supplies –(reagents, columns and dispensables)	638,850	554,862
2.3.	Energy	1,245,104	1,159,877
2.4.	Supplies and parts for regular and investment maintenance	133,103	125,399
2.5.	Small inventory costs	286,221	298,127
2.6.	Total of other costs (Account 3227 work apparel and protective clothing)	58,758	11,897
3.	EXPENSES FOR SERVICES (Subgroup 323)	4,435,490	4,091,355
3.1.	Telephone, post, transportation	197,930	151,017
3.2.	Services of regular and investment maintenance	800,635	1,176,296
3.3.	Promotion and dissemination	83,450	107,458
3.4.	Utilities	760,983	513,220
3.5.	Lease, rent	144,655	70,503
3.6.	Intellectual and personal services (temporary service contracts, fees, legal and other services) - (Account 3237 AOP 166)	2,107,360	1,675,803
3.7.	IT services	123,738	170,208
3.8.	Total of other costs (healthcare and other services, Accounts 3236 and 3239)	216,739	226,824
4.	EXPENSES FOR NON-FINANCIAL ASSETS (Groups 42 and 45)	1,172,136	2,487,735
4.1.	Premises	0	0
4.2.	IT equipment	186,379	245,221
4.3.	Laboratory equipment	720,000	2,026,347
4.4.	Office equipment	167,268	112,407
4.5.	Communication equipment	0	0
4.6.	Other equipment	0	0
4.7.	Literature (references)	48,023	77,821
4.8.	Investment in plants, machinery and other equipment	0	0
4.9.	Additional investments in construction facilities (Group 45)	50,000	0
4.10.	Total of other expenses (investments in computer software)	0	25,939
5.	REIMBURSEMENT OF COSTS TO EMPLOYEES (AOP 139 and 146 , Subgroups 312 and 321 PR-RAS)	2,637,820	1,856,137
5.1.	Business trips	668,538	464,177
5.2.	Professional trainings	324,443	214,044
5.3.	Total other costs including transportation costs	1,040,518	1,177,916
6.	OTHER NON-SPECIFIED OPERATING EXPENSES (AOP 171 PR-RAS, Subgroup 329 – (6.1 to 6.3.))	1,021,103	2,246,320
6.1.	Insurance premiums	78,748	60,254
6.2.	Representation costs	90,835	130,635
6.3.	Membership fees, charges and benefits and other costs (Accounts 3295 and 3299)	49,617	47,553
6.4.	Banking and financial transaction services	37,511	24,909
6.5.	Interests	2,522	3,266
6.6.	Other financial expenses (negative rate of exchange differentials and other expenses AOP 194 and 196)	232,594	59,935
6.7.	Reimbursement of costs to non-employees (AOP 169 PR-RAS, Subgroup 324)	317,193	166,462
B	TOTAL OPERATING EXPENSES (AOP 599 PR-RAS)	43,830,297	43,537,839
	Deficit 31/12/2013 (AOP 601)		-1,235,262
C	Balance transferred from the previous year	-143,694	723,681
	TOTAL BALANCE 31.12. (A-B+C) = AOP 604 PR-RAS Form	723,681	-511,581

Note: The positive financial result on 31st December 2012 reduced the total deficit generated in 2013. The revenues reduced by expenses + transferred surplus of 723,681 = total balance, that is the deficit generated on 31st December 2013, which was covered by the operating revenues of the Faculty in 2014.