

Quality Assurance on Engineering Education

Wilhelm König*

Abstract

The quality assurance system QIBB which is based on European recommendations has been successfully implemented at all Austrian Colleges for Engineering, Arts and Crafts (HTL). Co-operation of educational institutions and industrial enterprises is an important additional feature of quality development, regarding continuous teacher training as well as the needs of the labour market.

Qualitätsmanagement in der Ingenieurausbildung

Zusammenfassung

Das Qualitätsmanagementsystem QIBB wurde an allen technischen Schulen in Österreich erfolgreich eingeführt und stellt ein wichtiges Werkzeug zur Schulentwicklung dar. Die Kooperation der Schulen mit Industrie- und Gewerbebetrieben entspricht dem Ziel der Praxisorientierung der Ausbildung und trägt darüber hinaus zur kontinuierlichen Fortbildung der Lehrenden bei.

Keywords:

Engineering education
QIBB Quality in VET
HTL Diploma thesis
Teacher training

Schlüsselwörter:

Ingenieurausbildung
QIBB Qualitätsinitiative Berufsbildung
HTL Diplomarbeiten
Lehrerfortbildung

1 Engineering Education in Austria

The Austrian system of schools and colleges of engineering, arts and crafts (HTL), a major part of the Austrian Vocational Education and Training (VET) sector, is highly divers and facilitates sound education in every field of engineering. Different programmes cover the needs of students according to their personal emphasis as well as the needs of the labour market. A remarkable share of employees in engineering and the production sector of industry and commerce are graduates from HTL.

These educational programmes include the following [1]:

- 5-year colleges of engineering (HTL), which cover years 9-13, introduce both the theory and practice of the respective subject from the beginning, and provide post-secondary forms of teaching and learning in the final year (comparable to short cycle tertiary courses). HTL-college courses are finalised with a diploma exam, which qualifies graduates either to apply at university or to enter the labour market at diploma-level according to the regulation Art. 11 lit. c 2005/36/EG of the European Union on the recognition of professional qualifications.
- 4-year VET schools of engineering (year 9-12), which are completed with a final examination and are focused on practical skills. These courses are linked to the post-secondary sector via add-on courses.
- 2-year add-on courses, leading graduates of subject-specific VET schools to the educational objective of the related 5-year HTL-college.
- 4-semester post-secondary HTL-courses (years 13-14), which require university/higher education entrance qualifications and are finalised with a diploma exam.

* Inspectorate Colleges for Engineering, Arts and Crafts, Board of Education for Lower Austria
Rennbahnstraße 29, 3100 St. Poelten, Austria

Generally full time education is provided, but evening courses for persons under employment designed in a modular form are offered additionally, which lead to the same educational objective as the respective 5-year HTL-colleges.

2 Quality Assurance in VET-Education

2.1 Leading Principles of QIBB

The assurance and enhancement of quality has always been featured prominently in the Austrian system of schools and colleges of engineering, arts and crafts (HTL). A traditional form of quality assurance (QA) is the counselling, monitoring and feedback through school inspection of the Regional Boards of Education. Besides that formal procedure, all HTL-colleges foster a long lasting tradition of co-operation with the business sector to gather feedback on their educational outcome, e.g. the accordance of employers' expectations and graduates' competences.

During the academic year 2004/05, the VET-Directorate within the Ministry of Education, the Arts and Culture launched the development of a new quality management system, QIBB – *QualitätsInitiative Berufsbildung*, which is designed for the specific requirements of the VET schools and colleges as well as for meeting international quality assurance standards. QIBB meets the criteria set for nationally and internationally recognised quality assurance systems at educational institutions and meets the recommendations adopted by the European Parliament and the Council on the establishment of a European Quality Assurance Framework for Vocational Education and Training in June 2009 in the context of the Copenhagen process [2].

QIBB conforms to the model of the European Reference Framework, Fig.1, in terms of objectives, guiding principles, priorities and structure.

QIBB Reference Model

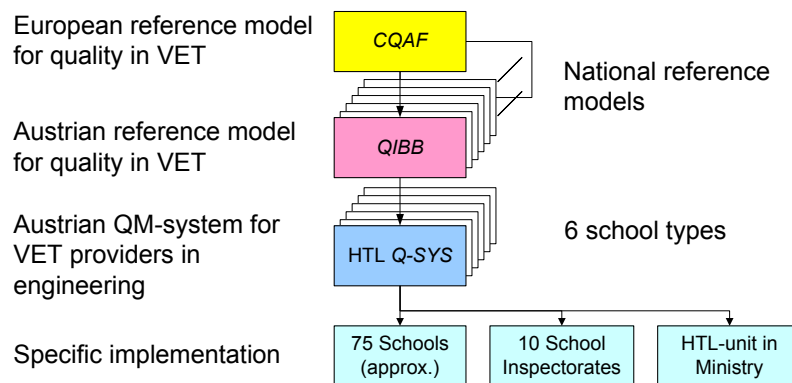


Fig. 1: Quality assurance reference framework in VET

Since the 2006/2007 academic year, QIBB has been implemented at all VET school type locations in almost all of Austria: at part-time vocational schools, at schools and colleges for engineering, arts and crafts (HTL), at schools and colleges of business administration, at schools and colleges of social and services industries, at colleges for agriculture and forestry and also at nursery teacher training colleges and colleges of social pedagogy.

2.2 Core Elements of QIBB

QIBB aims to improve the quality of teaching and of the administration services systematically and continuously. Therefore, both pedagogical action and administrative action are at the focus of attention.

QIBB comprises all institutional levels of the VET system [3]. Processes and instruments for quality assurance and quality development are not only implemented in schools and colleges but the model also provides that school inspection (at regional Boards of Education) and the ministry's general directorate responsible for VET

schools and colleges (national level) are involved in the quality cycle for regular evaluation and continuous improvement, Fig.2.

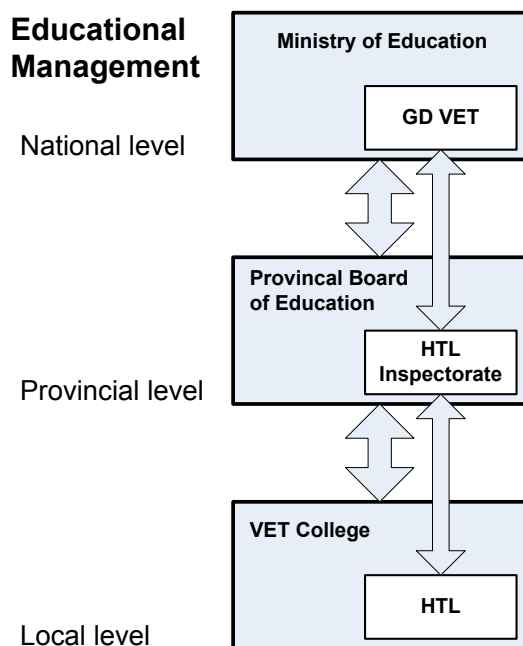


Fig. 2: Management levels in VET

The guiding principles of QIBB are:

- outcome orientation
- transparency
- participation
- use of recognised quality management methods
- economical use of time and financial resources
- ethics in relation to evaluation objectives, measures, and handling of data
- integration of the gender dimension

Core elements of the QIBB system are the mission statement, the quality-matrix, work-programme, a set of indicators and evaluation tools, quality report, management & performance review and follow-up measures as explained below.

The development process follows the continuous four stage quality cycle also well known as “PDCA-cycle”: Plan – Do – Check – Act, Fig. 3.

PDCA - Cycle

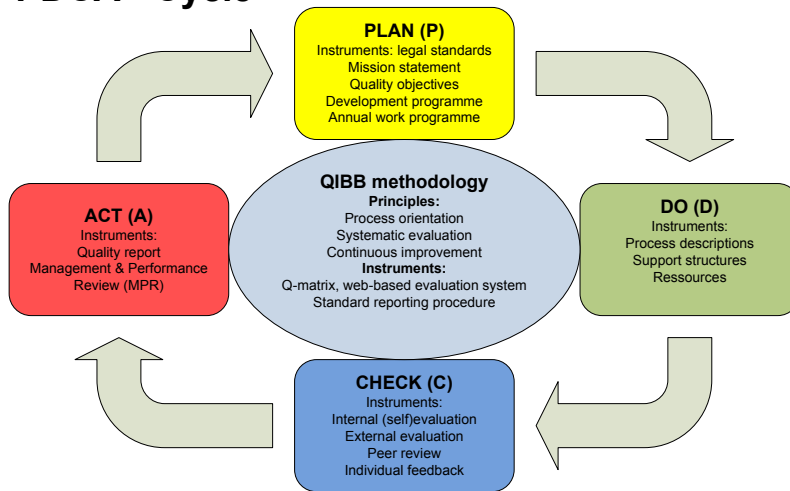


Fig. 3: Quality cycle in VET

The core goals are established by the mission statement, e.g. teaching according to the state of the art of engineering and the requirements of the labour market as well as of tertiary education. The mission statement introduces seven domains of quality relevant to engineering education. The quality matrix points out objectives (“Plan”), measures (“Do”), indicators and evaluation tools (“Check”), Fig. 4.

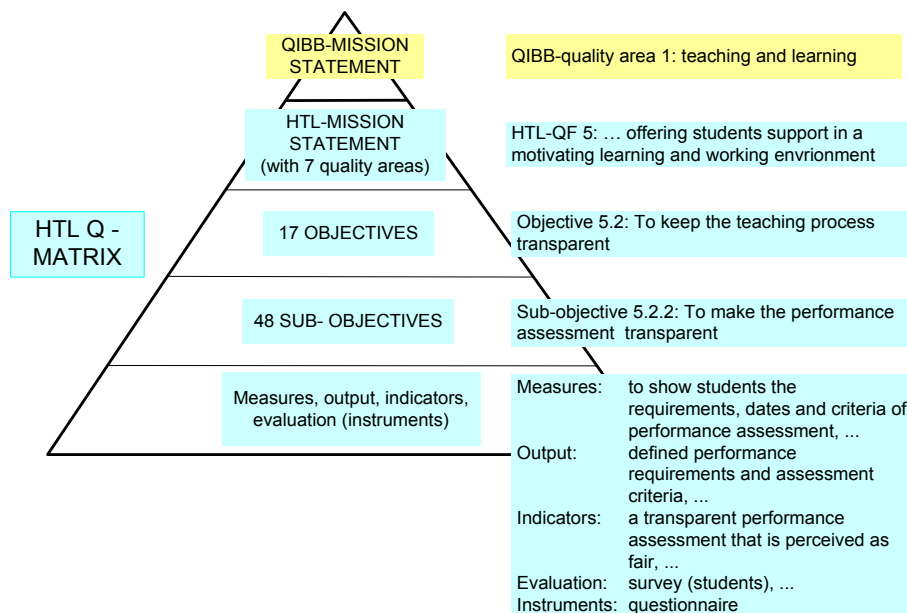


Fig. 4: QIBB Quality matrix

Identification of the need for change is based on the results of the evaluation process and a follow-up programme has to be developed (“Act”).

A set of goals and relevant indicators has been committed to all stakeholders nationwide, but every college is obliged to define its individual goals also to meet its local demands.

2.3 Evaluation and Reports in QIBB

The objectives are evaluated regularly and systematically. The evaluation is normally performed in the form of an internal self-evaluation. In addition, national priorities are specified as external evaluation objectives.

QIBB Web-application for evaluation

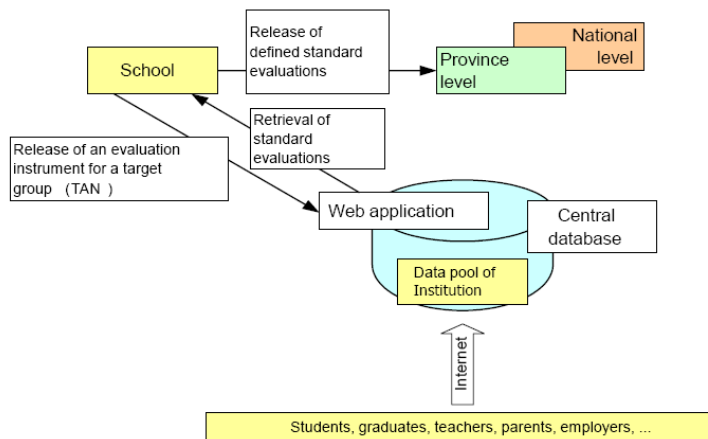


Fig. 5: QIBB Evaluation platform

The evaluation system is web-based and offers a great variety of evaluation instruments (questionnaires, survey grids, etc.) and tools for standardised data analysis, Fig. 5. As a means of external evaluation, peer-review is going to be implemented regularly based on several pilot projects.

Every institution has to submit its quality report to the respective higher level of management annually. The report contains a review of the year-end situation, taking into account evaluation results and a follow-up plan with strategic and operational objectives. The management & performance review, Fig. 6, in the form of a discussion between the managerial personnel of the two responsible management levels concerned is the method to agree on the goals and measures for the future development of the institution.

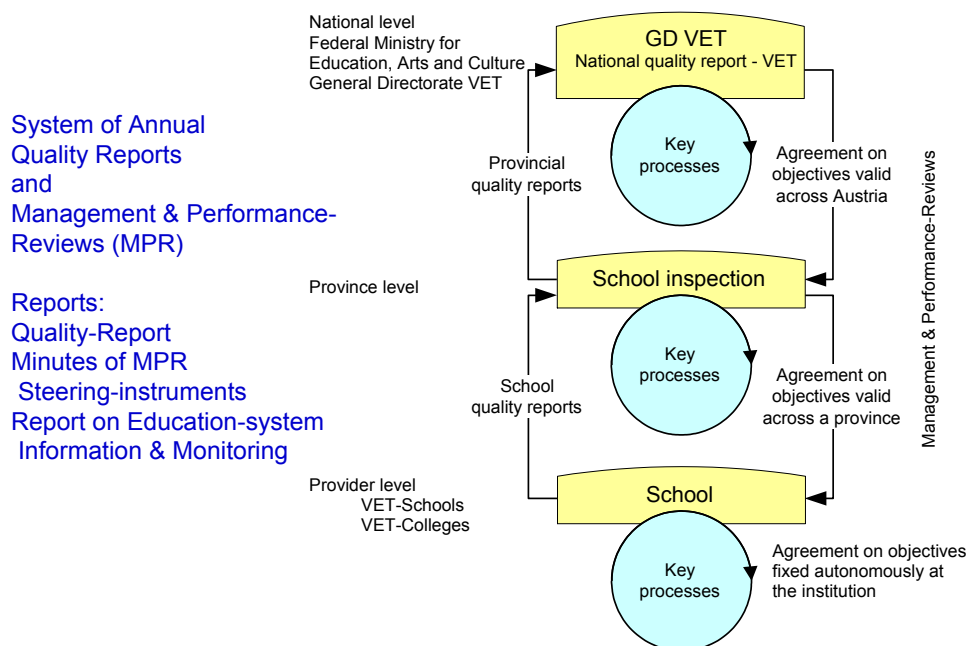


Fig. 6: QIBB Reports and Management & Performance Review

3 How to keep Engineering Teachers up to date

The QIBB-HTL Quality Manual defines the requirements regarding curricula and educational work for the sector of colleges and schools for engineering, arts and crafts:

- Curriculum for every engineering course is state of the art
- Syllabus for every subject is state of the art
- Teaching according to pedagogical and engineering standards and availability of appropriate environment (e.g. industrial machinery etc.)
- Implementation of new technologies and developments according to the needs of the labour market
- Implementation of new methods of teaching and learning
- Regular consultations on the graduates' competences by the of stake holders from educational institutions, enterprises and educational authorities
- Continuous further development of pedagogical and technical competences of teachers

In order to support the quality development processes several institutional measures have been set up, e.g.

- Further education courses provided by the University College of Teacher Education in Lower Austria
- Regular professional conferences of teachers on technical, pedagogical or legal issues organised by educational authorities at regional and national level
- Professional & Scientific Network of HTL (FWN) based on co-operation with the University College of Teacher Education in Lower Austria. Representatives of Schools and Colleges, Inspectorate and University College of Teacher Education contribute to the network.
- Teachers attend courses on special topics provided by companies (manufacturers etc.)

An essential element in every quality assurance system is "continuous improvement" by means of feedback from stakeholders of industrial and business institutions. Formal surveys by means of questionnaires for employers and graduates provide some information on the degree of satisfaction of both groups of persons at a certain point in time. The more continuous mode of keeping in touch with latest developments in the field of technology and the needs of the labour market is that of cooperation between educational institutions (at all levels) and enterprises.

Regarding to this the FWN mentioned above is to collect information on main engineering branches (e.g. mechanical-, electrical-, electronics-, mechatronics- and civil engineering, industrial engineering and ICT), to provide dissemination of relevant data, to summarize experience and to make it useful for all members of the network. As most significant outcomes, well-designed programmes of further education courses and a reliable procedure for implementation of new issues (curricula, final exams etc.) have to be mentioned.

The Austrian schools and colleges of engineering feature a long lasting tradition of co-operation with companies and public institutions and thus industrial stakeholders know about the skills and competences of HTL-graduates.

An appropriate means of co-operation is the composition of diploma theses on industrial topics. A lot of challenging projects have been realised and valuable results have been achieved for students as well as for companies and teachers.

Every year about 250 projects are realized by Colleges in Lower Austria and often awarded in national and international competitions for young engineers and scientists, e.g. EU-Contest for Young Scientists, WIPO World Intelligence Property Organisation Geneva, Sparkling Science (Vienna), International Exhibition Of Young Inventors (Tokyo), IENA International Inventors Fair, Nürnberg, Taipeh International Invention Show.

A typical project deals with problems like the development and testing of prototypes, design studies, optimization of production processes according to technological or commercial criteria etc. The goal of the project is to be defined by the project partners, a team of up to five students, the representatives of the company and a supervisory teacher. The students being in their fifth (last) year of the college compose their diploma thesis within the framework of the project.

4 Examples of projects

4.1 “Flexible alligator forceps for minimal invasive surgery” [4]

Institution: HTL Moedling
 Project team: M. Brezowar, M. König, I. Schmidt
 Project partner: Univ. Doz. (H) OA Dr. Peter Metzger, Department of Surgery, Donauespital in Vienna
 Supervisory teacher: Prof. Dipl.-Ing. Dr. Andreas Matzner, HTL Moedling

One advantage of our flexible alligator forceps is that contusion of tissue is minimized. Another advantage is that precise movement of the gripper is improved thus facilitating contact to relevant areas in the operation field. The result of the project has been filed as a patent application (Application No A 745/2009) with the Austrian Patent Office on May 14, 2009 to achieve legal protection. The prototype is particularly suitable for laparoscopic procedures. However, the invention can also be adapted to other types of grippers and for other working areas, for example in the motor industry or for working with radioactive material.



Fig. 7: Flexible Alligator forceps [3]

4.2 “Manufacturing of condenser microphones - Automatic Tuning Device for Membranes of Condenser Microphones” [5]

Institution: HTL Moedling
 Project team: Gerhard Schöny, Martin Knöbel, Florian Grössbacher
 Project partner: AKG Acoustics GmbH, Vienna
 Supervisory teacher: Prof. Dipl.-Ing. Dr. Michael R. Diglio, HTL Moedling

The production step of adjusting the membrane of condenser microphones is the most important part of the microphone production. During the whole manufacturing procedure there is a high noise pollution caused by the stimulating loudspeaker. Furthermore, this manufacturing step can only be performed by experienced personnel. The target of the project is the automation of the manufacturing process, which means it is necessary to find an adequate measuring principle. The automation should minimize the tolerances and should make the process independent of the operating personnel. The engineering and manufacturing of the automatic device required skills in the field of CAD, CIM, manufacturing, selection and design of electronic circuits and programming of microcontrollers.

4.3 “Gripper for Energy Wood Harvesting” [6]

Institution: HTL Waidhofen an der Ybbs
 Project team: Mario Gspörer, Markus Maurerlehner, David Smutny
 Project partner: HaCo Engineering, Ybbsitz
 Supervisory teacher: Prof. Dipl.-Ing. Klaus Riedler, HTL Waidhofen an der Ybbs

Aim of the project was the development of a gripper device that enables economic and safe harvesting of energy wood. The device is mounted on a hydraulic hoisting system, easy application; reliability and operational safety are most important requirements. The task comprised the design of components, stress and deformation analysis and 3D-simulation.

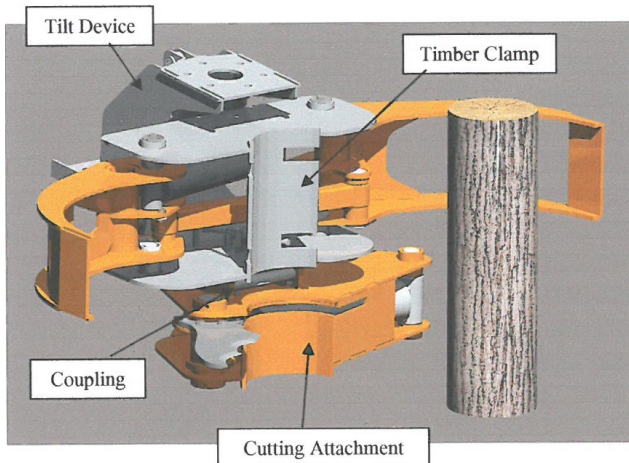


Fig. 8: Gripper for wood harvesting

4.4 “Test Rig for Transmission Shafts” [7]

Institution: HTL Moedling
Project team: Stefan Fuchs, Lorenz Sauerzopf
Project partner: Zoerkler Gears, Jois, Austria
Supervisory teacher: Prof. Dipl.-Ing. Johann Köberl, HTL Moedling

Aim of the project was the development of a test that enables economic and safe fatigue testing of transmission shafts for helicopters (for full cross section as well as hollow shafts) The task comprised the design of components, stress and deformation analysis and 3D-simulation, instrumentation and construction of the prototype. By means of the new system, it possible to reduce the necessary time for the test down to 22 days compared to more than 3 months applying traditional methods.

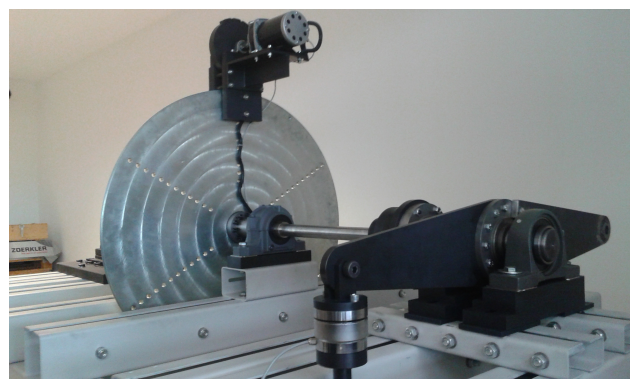


Fig. 9: Test rig for transmission shafts [6]

5 Conclusion

The quality management system QIBB has been successfully implemented at all Austrian Colleges for Engineering, Arts and Crafts (HTL). Co-operation of HTL-Colleges and industrial enterprises as well as Universities is an important measure to keep up with the state of the art in engineering education and to meet the needs of the labour market. A win-win-process may be established for all stakeholders, students (who possibly propose unconventional ideas to solve a problem), industrial partners (additional recruiting sources) and educational institutions. The Professional & Scientific Network of HTL (FWN) has been established in co-operation with the University College of Teacher Education in Lower Austria as a means of implementation of new topics in engineering education and further teacher training.

References

- [1] Recommendation of the European Parliament and of the Council of 18 June 2009 on the establishment of a European Quality Assurance Reference Framework for Vocational Education and Training (Text with EEA relevance) 2009/C 155/01
- [2] Schools and Education in Austria, Austrian Federal Ministry for Education and Women's Affairs, Vienna, November 2015; Internet: www.bmbwf.gv.at/enfr/school/bw_en/index.html
- [3] Information on QIBB; Internet: www.qibb.at
- [4] M. Brezowar, M. König, I. Schmidt, „Flexible Fasszange für minimal-invasive Chirurgie“, diploma thesis, HTL Moedling 2009, unpublished
- [5] G. Schöny, M. Knöbel, F. Grössbacher, „Automatische Stimmvorrichtung für Membrane von Kondensatormikrofonen“, diploma thesis, HTL Moedling 2004, unpublished
- [6] M. Gspörer, M. Maurerlehner, D. Smutny, „Entwicklung einer Energieholzzange“, diploma thesis, HTL Waidhofen an der Ybbs, 2015, unpublished
- [7] S. Fuchs, L. Sauerzopf, „Dauerfestigkeitsprüfstand für Hohl- und Vollwellen“, diploma thesis, HTL Moedling, 2015, unpublished