The Academe and the Field
A Case Study: The Engineering Program at the Ariel University Center of Samaria, Israel

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Abstract

The final project is the final chord in an undergraduate program in engineering. In their final projects, students are required to demonstrate their ability to address an engineering assignment, making maximal use of the practical education acquired during the student's studies, the student's ability to develop and implement a valid engineering solution. Final projects are designed to prepare graduating students for the challenges they will encounter as engineers. Projects require extensive efforts on part of the students and on part of the academic institution, in terms of time and resources. To examine whether the project fulfill's the system's expectations, we developed a detailed feedback questionnaire and asked graduates of the AUC's give engineering departments to address topics such as the effectiveness of project guidance, the need for theoretical background knowledge, and the project's impact on graduates' employability. We analyzed 261 completed questionnaires of graduates by specialty. The vast majority of participants reported that the project made a most positive contribution to their engineering training, and also reported extensive use of theoretical knowledge in the project. Most participants noted that they acquired new skills and that the project helped them find a job.

Introduction

The modern university was founded on the value of "Lernfreiheit" – a German concept that reflects academic freedom ("learning liberty"), and the individual's liberty to study and conduct research according to his own wishes. The German concept, which distinguishes research for research's sake, quickly became a standard adopted in the Western world by the mid-twentieth century (Stallmann, 2002). Over the years, the status of the academe has changed as have attitudes to its products, based on the role and position of the economy, the nation, and religion in social existence. Initially it was the transition to a capitalism economy, and subsequently to a capitalist society, which has a deep impact on the status and conception of universities. These institutions, which stood for decades in their resilience to external events, slowly became a subject of examination and were required to provide an account of their operations. Specifically, interest in the quality of the higher education expanded significantly (Worthington, & Hodgson, 2005). The "ivory tower" which has been free to operate according to its own standards, was now required to define its activities in measurable terms that were amenable to quality control (King, 2007; King, Griffiths, & Williams, 2007).

In the wake of these changes, there has been a growing attempt to define the role of the academe and its quality (Blackmur, 2004; Lieven & Martin, 2006). The global society of plenty and consumerism, which thinks in terms of inputs and outputs (Currie & Newson, 1988), is trying to apply capitalist economic concepts to institutions of higher education (Slaughter & Rhodes, 2004) by quantifying, increasing efficiencies, and carefully delimiting areas of activity which were previously autonomous in the social landscape, self-administrative public organizations, which operated based on self-defined norms and standards. Quality, in its general form, is a broad concept, which is defined differently by different individuals (Harvey & Knight, 1996). In the context of higher education, its complexity is all the greater due to the presence of numerous stakeholders (students, faculty, administrative staff, and government agencies). The multiplicity of stakeholders is the reason for the diversity of views concerning the nature of quality in higher education (Menon, 2003).In their article entitled "Defining Quality," Harvey and Green (1993) present a broad range of definitions for quality in higher education. According to one of the definitions, quality is the extent in which an academic institution fulfills its declared mission. This definition sees quality as a subjective issue, which constitutes a product of the degree of congruence between the mission imposed on academic institutions and its realization. In the present study, we adopt this definition and seek to argue that the academic mission of the twenty-first century is threefold, as it operates in research, teaching, and community service.

The Academe and its Mission

Many researchers have addressed the theoretical sources of universities, their goals, and missions (Iram, 1978, 1987, , 1991, 1998, 1999; Buber, 1981; Yaoz, 1992, 1994; Iram & Shkolnikov, 2001; Maslovati & Itam, 2002: Guri-Rosenblit, 2005; Davidovitch & Iram, 2005: Katz, 2005: Zimmerman, 2005).

In the context of academic institutions, the term "mission" describes the fundamental aim of universities (Allen, 1988), which is the main raison d'etre of the university (Montesinos, Carot, Martinez, & Mora, 2008). Until the 1930s, this mission was an abstract concept that may have been clear to the organization itself but not to outside observers. In the 1930s, US universities began to officially and publically state their mission and goal in their catalogues (Scott, 2006). The shift to a "mission statement" represents a move from theory to practice. This move, which began in the USA, initially spread to institutions in Canada and British, and was subsequently adopted by the majority of academic institution in western countries, where the definition and declaration of the mission became included in the academic agenda (Feldner, 2006).

The mission statement, it has been claimed, is equivalent to organizational concept management: The mission frequently expresses society's aspirations of higher education, aspirations which represent the most general level of hopes and expectations that people have of colleges and universities (Feldner, 2006). The significance of the mission statement is in its translation of ideas into operational terms and may ultimately enhance the behavior and operations of academic institutions (Scott, 2006). In the present day, universities tend to declare missions that embody three facets of operations: teaching, research, and community service (Atkinson, 2008), despite the fact that this triptych does not always exist in practice. Over the years of existence of academic institutions, missions have undergone several transformations that reflect the historical changes in the relationship between universities and evolving state entities (para-nation state, nation state and globalization).

Transformations in the Academic Mission – A Historical Overview

The universities are religious institutions that were originally founded in Europe in the late Medieval period, between 1150-1500. At the same time, many social changes occurred: the rise of mercantalism, accelerated urbanization, expansion of the middle class and bureaucracy, and the blossoming of the renaissance movement, all of which resulted in a more complex European society and created the need for professional and vocational training. The universities operated on the basis of this need, and served as professional teaching institutions. They were organized by guilds of teachers and pupils (the term "university" comes from the Medieval Latin term "universitas" meaning guild) that were administrated as quasi-corporations that sought to protect the guild's interests. University activities were planted deeply in the "soil of efficiency of the Medieval period" (Cobban, 1992, p. 231), which viewed higher education as a functional matter bestowing a professional advantage to its graduates, which is expressed in monetary terms. From this perspective, the medieval university was a school with a modern spirit (Haskins, 1957). Institutions operated as teacher-student collaborations, and governments made no move to intervene in institutional activities, allowing it complete administrative freedom (Shechter, 2006).

Research at universities, while existed, was the product of individual endeavors rather than institutional policy. The universities, which considered themselves cooperatives, did not award research degrees or appointments to research positions. The degree "doctor" (from the Latin root docere – to teach) was the highest degree that was awarded, and certified the recipient as qualified for teaching at the highest level. Despite their indirect contribution to society, through the creation of an intellectual elite and a group of alumni who became the pillars of society, universities considered themselves, first and foremost, as professional organizations motivated by the interests of its members (Haskins). This attitude first began to change during the early modern period (1500-1800), which symbolized the rise of independent nation states – sovereign states limited by defined boundaries, whose population had a shared sense of nationalism. The rise of the nation state led to a reduction in academic autonomy as universities worldwide became instruments of the government or sovereign in structuring the institutions of the state. In this role, the academe engaged in teaching, research, and community services outside their walls (Scott, 2006).

The universities, which were controlled by the state at the municipal level, became tools to expand the ruling elite In his volume, The University in Ruins, Readings (1996) defines the mission of universities at that time as a socio-political mission, where universities served as a quasi-ideological arm of the government: the state protected university activities, while the university defended state ideology (Readings). At the beginning of the early modern period, academic institutions blossomed all over Europe. Over 190 universities were established in this period, most out of political and religious reasons, and other based on the struggle between Catholics and Protestants (Scott, 2006). Although they were conducted in an academic setting, research, teaching, and community service did not stand on their own, but rather constituted means to promote the government's national or religion agenda. As a government arm, universities were not free to manage their affairs independently, nor did they enjoy academic freedom. This role of the academe started to wan in the early 19th century, with the founding of the University of Berlin. In 1910, Wilhelm von Humboldt founded the University of Berlin. This university was established in the name of the principles of unifying teaching and research, and the academic freedom of autonomous study and learning.

The autonomous function of higher education was at the heart of the Humboldtian approach, which served as the standard for higher education the world over. Such principles were manifest in an approach that assumed that students would be trained for a life of research, and that students are both intellectually and mentally mature, educated adults. Therefore, instructors were considered research workers first and foremost, rather than teachers or information mediators (Iram, 1983). This model has a strong formative impact on research universities all over the world, including the conception of higher education in Israel (Guri-Rosenblit, 2005; Zimmerman, 2005). Universities all over the world shifted to the dual academic model, defining research and teaching missions as the core of academic activities.

This model was broadly adopted by academic institutions, and represented a consensus over the declared mission of universities. However, after WWII, modern universities were no longer able to afford to focus exclusively on knowledge creation (Wittrock, 1993). Toward the second half of the twentieth century, a demand arose of the academe to reallocate its resources and participate in technological transfer and assimilation to meet the needs of modern society (Clark, 1983). The academe was required not merely to create theoretical knowledge, but to apply it to concrete goals, in the form of "organizing knowledge for action" (Baker, 1983, p. 7). This change occurred as part of the move from nation state to a global state that constitutes an integral part of the world community. This change created the need to rediscover the academe's declared mission (Seaberry & Davis, 1997).

The Academe and its Mission in the Global World

As a result of the changes in community, technology, and social structure, communities developed new expectations of the university. "There was no need to attend university to understand the powerful changes occurring in the entire world: liberalization of markets, globalization of the economy, universalization of culture, growing power of technology, and expansion of human abilities for good and bad, structural geopolitical changes, and empowerment of the individual vis a vis the general public" (Chen, 1999, p. 254). All these led to a reexamination of the purpose of the university: "Was its essential goal knowledge per se, or rather was there a need to consciously extend the goals of the university to social, cultural, and economical services on a community and international level" (p. 262). After the various transformations affecting the university's tasks over the years of its existence — the teaching model, the teaching-research-service community, the dual research-teaching model — the academic community began to contemplate a return to earlier roles: a combination of teaching, research, and community service (Seaberry & Davis, 1997).

Post-modern society is a "knowledge society" that has made the balance between research and teaching ever more complicated by adding a third dimension – community service (Austin & Gamson, 1983). Scott (2006) claims that inclusion of community service into present-day universities is a natural extension of the concept of democratization, which originates in the US colleges of the 19th century. Scott also argues that the concept of community service and its inclusion in universities' mission is "fundamentally American" (p. 23).In the present, this concept developed into the tripartite model known as the "metropolitan university" Bonner (cited in Seaberry & Davis, 1997) described it as not merely a university located in a city but also of the city, with an obligation to meet the diverse needs of the city's population. In his view, the university is the center of research and center of intellectual leadership, which uses the city as its laboratory, clinic, and workshop. It offers people of all social classes' access to higher education and attends to the community in a manner that allows it to maintain contact with its mission and its conscience.

The community service mission of metropolitan universities, both private and public, is yet another stratum of the academe's missions (Ward, 2003). In the post-modern world, universities are considered social organizations whose role is to render higher education services (Scott, 2006). By bringing the academe closer to the community, this approach shatters the "ivory tower" image that was until recently attributed to research institutions (Schechter, 2006). In contrast to teaching and research, the service element tends to be vaguer, and its boundaries more blurred (Boice, 2000; Fear & Sandmann, 1995). Its position is not clear, both on campus and off campus, and it has been likened to "the shortest leg of a three-legged stool (Boyer & Lewis, 1985). Indeed, the indeterminate nature of its mission raises the question of the nature of the community service that the academe should assume. Where does it begin, and where does it end? Does it refer to services on campus, or services off campus? It seems that of all three aspects of the academe's mission, the community service mission is the least comprehensible to academic faculty (Boice, 2000).

Ward (2003) argues that the community service role may be clarified by dividing it into internal and external services. Internal services refer to activities designed to reinforce ties within a disciplinary field, such as participation in conferences and committees, writing reviews for journals, and advising groups of students. Such service activities to the discipline and to the campus are the hidden curriculum of the academe.

External services refer to services used by the institution as a means to communicate with the public outside the academe. External services may take various forms, including consulting, teaching, civic and community activities. The common ground of all these aspects is that they occur outside the context of the campus.

In the present study we sought to focus on the external service mission of universities, the dimension of practice that does not constitute part of the professional or institutional context of practice, but is rather social practice per se, which cuts through personal, research, or institutional interests. Community service is conducted in the name of broader values that include Israeli society, and the Jewish society in the Diaspora. Israel – the state of the Jews – was established and developed on the basis of the Zionist vision. The academe, and the community service role imposed on it, was one of the means to realize this vision. Academe in Israel was established even before the establishment of the State of Israel and its institutions. The vision of Israel's first university was the vision of national renewal and an aspiration to renew Jewish creativity in the Land of Israel. The founders believed in the significance of a cultural and spiritual center that would serve as a magnet for Jewish scientists and scholars from all over the world, following 'let them settle and contribute an original contribution to human civilization" (from: The Lexicon of Israel's Culture).

The Academe in Israel – Academe in the Service of Society

In his volume "The State of the Jews," Benjamin Zeev Herzl outlined a detailed plan for the establishment of a Jewish state. The entire plan was fundamentally simply – sovereignty would be granted in some territory on earth to provide the justified needs of our nation: "We will take care of the all the rest ourselves…" (1978, p. 21). "All the rest" included, among other things, the establishment of higher education institutions. In his detailed vision, Herzl considered the academe as a nation-building instrument, and assigned it a special role in the realization of Zionism.

The Zionist Movement that Herzl led joined this approach when it gave scientific research a central role in the Zionist revolution. In the First Zionist Congress, Professor Zvi Herman Shapira presented his program, "A Letter to the Future," discussion the establishment of a research university in the Land of Israel (Yurtner, 1999). The First Zionist Congress, which convened in 1897 almost fifty years before the establishment of the State, supported an integral connection between the establishment of higher education institutions in Israel and the realization of the Zionist dream. In 1918, at the cornerstone ceremony of the Hebrew University of Jerusalem, Chaim Weizmann stated, "The Jewish nation was aware that only by developing its spiritual attributes would we be able to realize our material needs" (ibid, p. 51).

The first two academic institutions in Israel (the Technion and the Hebrew University of Jerusalem) were established 23 years before the State won its independence. For the pioneers, their establishment represented roots in Israel, roots that were designed to blossom into the flowering tree of the State of Israel. The role assigned to the Hebrew University of Jerusalem in the Zionist Movement may explain the Zionist significance that the pioneers attributed to higher education. More than the universities came to meet the practical needs of the settlement in Israel, it was designed to play a role in the revival of the Jewish spirit and to serve as the focus of the study of Judaism sciences in the national-spiritual center of the Jewish nation (Iram, 1978).

Thinkers such as Weizmann and Buber considered the establishment of the Hebrew University as a manifestation of Ehad Ha'am's program: the establishment of a world center of Jewish science and research. Realization of society's economic and political goals, and the educational needs of individuals in the future society were considered subordinate to the major goal of creating a center of science and research in the Humboldtian tradition, in the spirit of Ehad Ha'am.

The history of the Hebrew University largely reflects the sources of higher education in Israel. The institution was established by the Zionist Movement, and served as a symbol of national revival in the Land of Israel. The establishment of the university was accompanied by tension between the research character and the national orientation of the Hebrew University (Hed & Katz, 1978). Ever since the establishment of the institution was envisioned by Jewish circles in the 1870s, it was afflicted with another source of tension between a general Jewish orientation and a Zionist organization, tension between caring for the needs of the Jewish people and care for the needs of the Jewish settlement in Israel. It has been argued that the Hebrew University was not a catalyst for the national movement, and played no focal role in creasing a national culture (Shapira, 1978). Contrasting these arguments is a body of research literature which demonstrates the centrality of national considerations in the election of the circles and individuals known as the "Rishonim" (Hed &Katz, 1978). Rather than an expression of a Zionist version of Jewish nationalism, other viewed it as a Jewish institution of higher learning. This dimension was, in the eyes of Jabotinsky and others, an additional motive to establish the institution, in view of the needs of Jewish students in Eastern Europe and their minority status (Lebsky, 2005). Weizmann and his supporters believed that reinforcing the Jewish settlement in Israel was a primary motive.

This approach was adopted by the majority and became the guiding element in outlining the program to establish the university. This approach found expression in various aspects of the institution, including its attempts to absorb new immigrants from Germany, the language of study, and the physical features of the building. All these placed the institution between east and west, and closely connected to the Jewish settlement in Israel. Notwithstanding the role assigned to the university in the Zionist vision, it was not taken for granted that the university would conduct itself in the Hebrew language, grounded in Hebrew culture. The establishment of the institution was accompanied by a "language war" – a struggle over the official language of studies (Yiddish, Hebrew, or German), and arguments were heard on all sides regarding the language worthy of being the official language of the academe (Schweid, 1995). Ultimately the battle was decided and Hebrew rather than any other foreign language was designated as the official language. Language is the identifying feature of any national culture. All nations distinguish themselves first and foremost by language, and the Jewish nation's language is Hebrew. Due to the ideological sources on which the Hebrew University was grounded, it has a unique dimension that was a conceptual breakthrough (Yurtner, 1999). It was argued that the Humboldtian model never actually existed in Israel: "We began with the tripartite model: higher education; scientific research; serving the needs of the economy, society, and the state" (p. 54).

Over the years, academic institutions in Israel, and in the world over, were forced to address their declared missions. Despite (or perhaps because of) its young age, the state of Israel placed higher education high on its priorities. Nonetheless, despite the brief history of Israel's higher education system, its past is replete with fundamental changes that were expressed in changes in the declared goals of the institutions of higher education (Yaoz & Iram, 1987). The history of higher education in Israel is a microcosmos of global trends. The academe, which was conceived even before the independence of the state, underwent significant transformations (Davidovitch, & Iram, 2005) from conveying higher education per se, to teaching a vocation; from viewing education as an end, to viewing education as a means; from valuing learning for its own sake and for the sake of general knowledge and discovery, to technological studies of a pragmatic, applicative nature; from learning based on a principle of excellence, to learning whose major value is equality (Shemida, 1987).

The dynamic nature of the mission of Israel's academe did not undermine the academe's significance in serving Zionism. The university was assigned a role in reviving the Jewish spirit in Israel (Iram, 1978; Davidovitch & Iram, 2005), and promoting science and education, values that were deeply rooted in Jewish heritage. Berl Katzenelson stated of the Hebrew University (Levinson, 1948) that it was one of the senior tools of realizing the national idea. Chaim Nahman Bialik joined this view when he declared in 1936 that science (developed in the academe) should be the purpose of settlement, in order to enhance and improve life.

The academic institutions that developed after independence continued in the path outlined by the pioneers. In the first years after independence, community service was an agenda in its own right. For example, the Technion focused on agricultural research to help improve the national economy; the Hebrew University operated a Laboratory Corps on campus that contributed to the war effort and also joined the British war effort in WWII. In the 1960s, the Hebrew University began to operate pre-academic preparatory programs in order to reduce sectarian disparities in Israel. Other universities followed suit. In the 1970s, Bar Ilan University accepted new immigrants to the Faculty of Social Work, and the Ben Gurion University of the Negev invested efforts in the social and industrial development of the Negev.

All these activities had a distinct social nature, and represented the academe's community mission. In those years, social action assumed an ideological character that, as noted, stemmed mainly from the history of the development of higher education in Israel. Over time, community service changed from a key priority (as the pioneers viewed it) to a means to the institutions' survival, a means to raise funds, and exploit economic opportunities. Programs that were initially conceived as a community service gradually were assimilated into the various disciplines, becoming instruments of fund raising. Preparatory programs, for example, which targeted a specific public (released soldiers of a low-SES Mizrahi background), were transformed into programs that were available to all for a fee. Assistance programs for new immigrants offered by Social Science Faculties became external programs that were funded by ex-academic sources and became an additional channel for fund raising. The ideology of community service as an activity that was distinct from academic operations became assimilated into the various faculties, and lost its ideological status.

In Israel of the twenty-first century, community service continues in a different form and motivation. Higher education institutions in Israel operate programs that have a social character mainly as a means for the institutions' economic survival, and they are activated by outside funding that transforms them into an economic endeavor for all intents and purposes.

Engineering Studies in Academic Institutions

In the late 18th century, with the beginning of technological development, the first institutions for technical education were opened. The first, a school for construction technicians, was established in 1765 in Hamburg, Germany, and was followed by schools in France, Germany, and Holland, which mainly taught construction and mechanical subjects (Educational Encyclopedia, 1961, Ministry of Education, Jerusalem). The curriculum in Germany was a two-year high school program. In 1878 in Vienna, three years were added to the original two-year high school program, for a total of five years, similar to the education of technicians in Israel today. With the rapid technological development that began in the late 19th century, technological subjects began to be taught in post-secondary settings. The German universities were not suitable for structured vocational studies and therefore these programs were taught in institutions known as "hochschule" rather than within the universities.

In England, the approach to technological studies was very different. The technical schools were founded in the 19th century on the basis of existing colleges. In contrast to the German approach, in English engineering students were required to acquire a broad general education similar to all university students. In the United States, a dramatic transformation occurred in all areas of higher education following WWII. The enormous expansion of higher education also affected the field of engineering. In addition to the quantitative scope of the programs, the curricula were also modified. Engineering programs were offered in two types of institutions: technological institutions such as those in Massachusetts, California, and Illinois, and engineering faculties in universities. Both settings offered students an education that exceeded what was required solely for professional training. For over thirty years, the sole institution that offered a technological education in Israel was the Technion in Haifa. Numerous battles had preceded the establishment of the Technicom, which was also known as the Haifa Technion in 1925.

In addition to a battle over the language of study, a battle also ensued between the advocates of the German school who called for the establishment of a "middle school" (rather than higher school) for professional training, while other demanded that technological programs be incorporated in the universities. This corresponded to the differences of opinion in the Zionist Congresses at the beginning of the twentieth century. Jabotinsky demanded to establish a university institution based on the US model, which would also include an engineering program. Weizmann, however, supported the idea of establishing a university in Jerusalem and a technological institution in Haifa, which would function as a middle/high school based on the German conception. Wiezmann's plan was ultimately accepted. In 1921, the 12th Zionist Congress decided on the steps to establish the Technicom rather than a school of higher education. It was the prevalent opinion among professionals in Mandatory Palestine, and the majority of the Technion's executive board at the time concurred, with the intention of training technicians and foremen. Some even proposed that the new institution would admit graduates of 10 years of schooling.

Only at the 17th Zionist Congress in 1930 was it decided that the institution would be a school of higher education. Opponents believed that this step was a waste of public funds and the entire demand for engineers in Palestine could be met by training three engineers overseas… In 1922, Albert Einstein wrote to a colleague, also a physicist, who was considering joining the Technion. He stated that he could not recommend joining the Technion because the institution merely training auxiliary workers for secondary building tasks in Palestine. Weizmann stated, when he visited the Technion in the institution's first years of operation, that its equipment did not meet the standards of the poorest institution in the world (testimony of a graduate of the first class, doctoral thesis by Ruth Lavie, Haifa University, 1999). Although the Technion's Articles of Association stated that the institution would engage in research, and the institution was granted authority to promote technical research and build appropriate laboratories, the Technion was the object of discrimination and did not receive the research budgets awarded to the Hebrew University.As time passed, faculty members of the Technion began to receive an increasing number of invitations to conduct research.

When Kaplansky became director in 1930, the Technion was recognized as a school of higher education. Kaplansky made great strides in promoting the Technion's status as an institution that combines teaching and research.In the matter of community service, "the Technion, since its inception, considered itself as an institution designed to serve the needs of the nation and the land" (Ruth Lavie, p. 105). The Technion extended assistance to the settlement project and the industry in general, and to the defense industry in particular, during WWII and the country's subsequent wars. Yuval Dror, in his article "The beginning of the Hebrew Technion in Haifa, 1902-1950: From a plan for a "Jewish school of higher education" (Iyunim B'hinuch, 1996, pp. 330-357) to the end of Shlomo Kaplansky's administration" stated that work on the national-settlement project came at the expense of the Technion's academic foundation.

In the pre-independence period, the Technion played an important role in admitting students from overseas, with the support of the Zionist Executive, which expedited the issue of entry permits into Palestine. For over 40 years, the Technion was the sole academic institution where students could acquire an undergraduate degree in engineering. In 1967, the Ben Gurion University of the Negev opened masters programs in chemical engineering and mechanical engineering and several years later, an undergraduate program was also added. Tel Aviv University began to offer engineering studies as an independent program in 1971 and in the following decade, Bar Ilan University joined the institutions that offered an undergraduates degree in engineering. As a result of the significant growth of colleges in the 1990s, an increasing number of engineering departments were opened in colleges. Consequently, the ratio of engineering students in university as opposed to college programs steadily. One-half of all engineering students currently study in a college.

Case Study – The Engineering Program at the Ariel University Center

In this study, we present an academic activity that functions as a community service, in the interface between the academe and the field. The authors sought to follow employment integration of graduates of the Faculty of Engineering at the Ariel University Center (AUC) between 2004 and 2009, and their satisfaction with their training, their profession, and their jobs. In Israel as in many other countries, engineering students are required to complete a comprehensive design project at the final stage of their studies. Although students attend numerous and diverse laboratory classes throughout their studies, they gain limited practical experience. In completing their final project, however, students work independently under the guidance of an academic advisor. Projects are designed to integrate students' theoretical studies and practical experience. Final projects demand special efforts of students and of the academic institution. Students are awarded many credit points for their project, typically more points than for any other course in the program. Frequently, students devote most of their final year to the project. On its part, the academic department must appoint a member of the faculty or outside engineer as advisor. Frequently, projects entail a considerable financial expense. In view of all this, the question arises as to whether these resources bear fruit? Are the academic and administrative efforts justified? To answer these questions, we decided to turn to our graduates and examine how they assess their work on their final project from a mature, practical engineering perspective. We developed a questionnaire which we distributed among our graduates in order to receive their impressions.

Structure of the Project

The structure of projects changes from one discipline to another. In specific departments, the structure is relatively inflexible, which means that students are assigned a defined task. Other departments grant students greater freedom: Students may suggest a topic or select from a number of topics proposed by the advisor. Students work individually or in pairs. In other cases, students participate in a departmental project, in which each sub-group works on a different part of the project. Alternatively, the department may define a master goal, and each group addresses it as it sees fit. Advance projects of a research nature constitute a group unto itself. In such projects, the most talented students work directly with a faculty member and play a role in his or her ongoing research project.

Students begin their work on the project with in-depth analysis of the project goals, and review of alternative approaches. Students must attend to budgetary constraints and decide which instruments, equipment, and materials to use. They must draft a detailed work plan, including schedule, which they use as a base for their initial proposal. After exhaustive discussions with their advisor, students receive a "green light" to begin working on the project. As they make progress, they are required to draft and submit monthly progress reports. Finally, after completing their work, they must submit a final report including technical drawings, computer programs, technical specifications, collected data, and any other relevant information. After receiving their advisor's comments and incorporating the necessary corrections, students are tested by several faculty members. Frequently, students present their work at a departmental colloquium or public "project fair" organized by the department to showcase the results of its students' work.

Academic Guidance

The extent of academic involvement in advising and supervising students' work may differ drastically in different project types. In all cases, a faculty member serves as advisor. The advisor meets with the students on a regular basis, approves the topic and the work plans, monitors students' progress, reads and correct students' reports, approves project completion, functions as one of the examiners in the final exam, and determines the students' final grade. Mature students, mainly students who select the project topic by themselves, tend to work very independently, and require minimum supervision. Some students work on their project in a work setting, where a qualified engineer serves as the advisor, after having received the department's approval. In many departments, experienced engineers propose topics for projects and supervise their execution.

In these cases, a faculty member serves as the project team's academic coordinator. Obviously, faculty members' involvement is greater when they propose an idea and supervise the work on the project.

The Questionnaire

The questionnaire comprises 27 items, which are divided into four groups. The first group of eight items addresses technical details including the graduate's department and specialty; the topic of the final project, the advisor and the advisor's position, the source of the idea (student or advisor, or jointly proposed). The second group of items concerns graduates' assessment of their projects: their satisfaction with the topic, the work plan, did the project meet the original schedule and program, the scope of the advisor's supervision and guidance, how effective was the advisor.

The third group of items concerns the association between students' prerequisite theoretical courses and students' work on their project, and the project's role in contributing to students' training as a future engineer. Graduates were requested to rate the extent to which they used the knowledge from their theoretical courses in their work on their project, and the extent to which they learned new skills from working on the project.

Finally, we asked graduates to state their overall impression from their project work. We specifically asked whether implementation met their expectations. As engineers, we asked about their evaluation of the role of the project in their training, and the extent to which the experience they gained from working on the project helped them resolve engineering issues in their jobs. Graduates responded to the items using a Likert-type scale from 1 (not at all) to 5 (very much).

Findings

In this study, respondents were 261 graduates who completed a final project during their studies.

Table 1: Distribution of graduates' Demographics

		N	%
Department	Electrical and Electronic Engineering	161	61.7
	Mechanical Engineering	56	21.5
	Industrial Management Engineering	25	9.6
	Chemical Engineering, Biotechnology	10	3.8
	Civil Engineering	9	3.4
Program specialty	High voltage	57	27.8
	Communications and Computers	47	22.8
	Robotics	32	15.6
	Information systems	22	10.7
	Communications and signal processing control	18	8.8
	Communications and optics	17	8.3
	Electricity and electronics	7	3.4
	Production management	3	1.5
	Construction	2	1.0
Registered in the Engineers Registry	YES	27	10.3
	NO	234	89.7
Holds Engineer's License	YES	12	4.6
	NO	249	95.4
Advisor's rank	Faculty member (research)	132	58.4
	Department engineer	64	28.3
	Engineer in the industry	30	13.3
Project method	Individual work	162	63.8
	In a pair	89	35
	In a group of three	3	1.2
Project topic selection method	Proposed at a meeting with other students	33	13.1
	Proposed by advisor	57	22.7
	Student's own idea	161	64.1

Table 1 indicates that the f graduates who completed the questionnaire graduated from Electrical and Electronics Engineering (61.7%), Mechanical Engineering (21.5%), Industrial Management Engineering (9.6%), Chemical Engineering and Biotechnology (3.8%), and Civil Engineering (3.4%). The main specialties were high voltage (27.8%), communications and computers (22.8%), robotics (15.6%), and information systems (10.7%). 10.3% of the graduates are registered in the Engineers' Registry, 4.6% have an engineer's license.

Over one-half (58/4%) of the graduates had an advisor who was a faculty member, 28.3% had an advisor who was a departmental engineer, and 13.3% had an advisor who was an engineer working in the industry. 63.8% of the graduates worked on their project independently, 35% worked in pairs, and 1.2% worked in groups of three. Finally, 64.1% of the graduates selected the topic for the project independently, 22.7% accepted a topic proposed by the advisor, and 13.1% selected a topic proposed in a classroom meeting.

We constructed several measures of graduates' assessment of their final projects:

Graduates' satisfaction with their advisor:

Graduates responded to four items concerning their satisfaction with their advisor:

Item 11 – Help and guidance from your advisor in selecting your topic.
Item 13 – Your satisfaction with your advisor's involvement in the project.
Item 14 – Your advisor monitored your progress.
Item 15 – Guidance included regular meetings?

Students rated their satisfaction on a scale of 1 (very little) to 5 (very much). Measure average was 3.84 and SD was 0.96. Measure reliability according to Cronbach's alpha was 0.78. Figure 1 presents the proportion of graduates who awarded high ratings (4 or 5) to the above items.

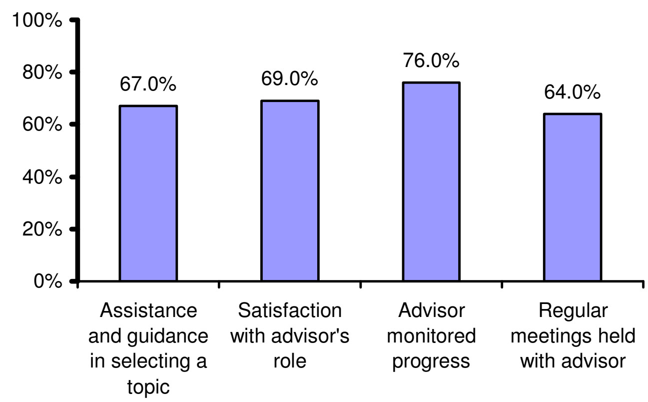

Figure 1: Share of graduates who awarded high ratings to their advisor's involvement

Satisfaction with advisor's guidance: Graduates were asked a summary item on this issue, which was Item 12: To what extent were you satisfied with the guidance process? M = 3.81, SD = 1.09. Figure 2 presents satisfaction with the guidance process.

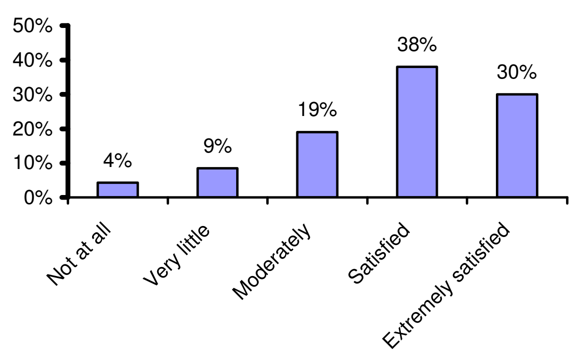

Figure 2: Distribution of satisfaction with the guidance process

Figure 2 indicates that the vast majority (87%) of the graduates expressed various degree of satisfaction with the guidance process.

Congruence between theoretical knowledge and final project. Graduates responded to two items on this issue:

Item 19: To what extent did your project entail use of the theoretical knowledge you acquired in your studies?
Item 20: To what extent was the theoretical knowledge you acquired in your studies connected to your project?

We constructed a measure of congruence between theoretical knowledge and practical implementation. Scores ranged from 1 to 5. The higher the score, the greater the congruence. M = 4.05, SD = 0.81. Reliability according to Cronbach's alpha was 0.90. Figure 3 presents the share of graduates who noted a high or very high degree of congruence between the theoretical knowledge and project execution.

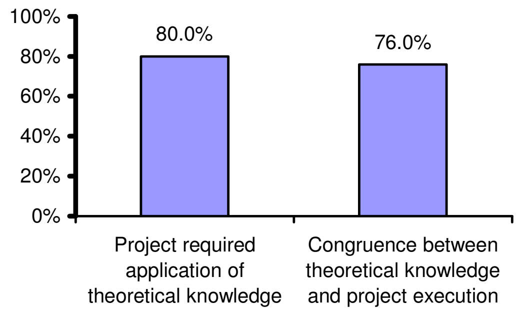

Figure 3: Graduates who noted a high or very high degree of congruence between their theoretical knowledge and project execution

Figure 3 indicates that 80% of the graduates noted a high or very degree of congruence between theoretical knowledge and project execution.

Association between the graduate's project and practical engineering work. Graduates responded to four items on this issue:

Item 22: Work on the project exposed you to procedures that are necessary in practical engineering work?
Item 24: Your final project gave you an opportunity to cope with the challenges and performance required of engineers in the ordinary course of their work.
Item 26: Work on the final project is important in the overall academic training of engineers.
Item 27: Your project helped you find employment as an engineer.
We constructed a measure of the association between the final project and practical engineering work. The measure was constructed as the average of the first three items listed above. Scores range from 1 to 5. The higher the score, the stronger the association. M = 4.00, SD = 0.71, Cronbach's alpha was 0.72. Figure 4 presents the proportion of graduates who strongly or very strongly agreed with each of the elements of association between the project and practical engineering work.

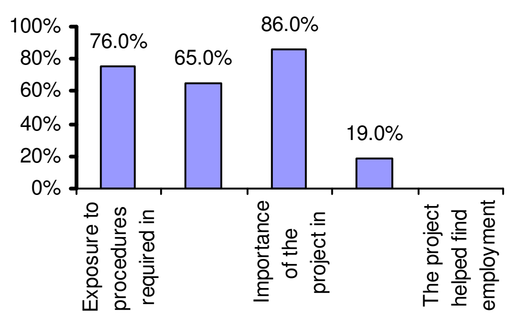

Figure 4. Proportion of graduates who noted a high or very high degree of congruence between their project and practical engineering work

Figure 4 indicates that most graduates noted that their project was connected to their practical work as engineers, although only 19% noted that their project helped them gain employment as an engineer.

Exposure to new skills. This measure comprises a single item (Item 21): To what extent did work on your project expose you to skills that you were not familiar with from your frontal lectures? M = 4.05, SD = 0.84. Figure 5 presents the distribution of graduates' exposure to new skills.

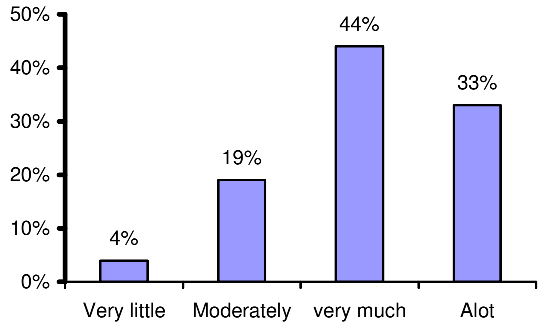

Figure 5. Distribution of graduates' exposure to new skills.

Figure 5 indicates that almost all graduates (96%) agree that work on their project exposed them to skills with which they were not familiar from their frontal lectures.

Technological equipment. This measure comprises a single item (Item 23): To what extent did the available equipment help you? M = 2.99, SD = 1.33. Figure 6 presents the distribution of the extent to which the available technological equipment assisted students.

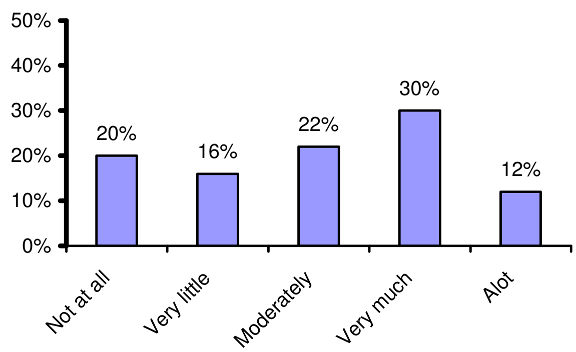

Figure 6. Distribution of the extent to which the available technological equipment assisted students.
Figure 6 indicates that 64% of the graduates noted that the available equipment helped them in their work on their project.

Expectations. This measure comprises a single item (Item 25): To what extent did the project meet your expectations? M = 4.06, SD = 0.80. Figure 7 presents the distribution of the extent in which the project met graduates' expectations.

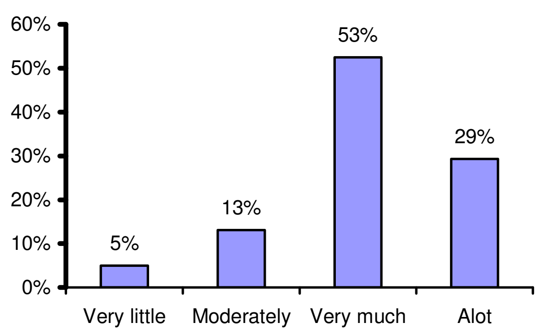

Figure 7. Distribution of the extent in which the project met graduates' expectations
Graduates' responses indicate that for almost everyone without exception (95%), their project met their expectations, as presented in Figure 7.

In summary, Figure 8 presents the averages of the various measures.

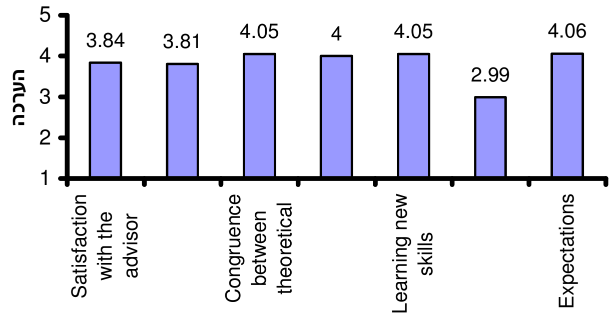

Figure 8. Averages of the project assessment measures.

Figure 8 indicates that satisfaction with all elements of the project was high, with the exception of satisfaction with the extent in which the project was assisted by available technological equipment. The highest degree of satisfaction was from exposure to new skills (4.05), high expectations (4.06), and congruence between the project and theoretical knowledge (4.05).

Examining differences in project assessment by demographics

Differences in project execution method

162 graduates completed their project individually, while 92 worked in pairs or groups of two or three. We used bilateral t-tests for independent samples to examine differences in the various measures by method of execution. We found statistically significant differences in satisfaction with advisor ($t(252)=4.56$, $p<.001$). We found that graduates who worked independently on their project were more satisfied with their advisor ($M=4.02$, $SD=0.89$) than graduates who worked on their projects in pairs. Differences were also found in graduates' satisfaction with the guidance process ($t(250)=6.66$, $p<.001$): Graduates who worked on their projects independently were more satisfied with the guidance process ($t(250)=6.66$, $p<.001$) than graduates who worked on their projects in pairs ($M=3.24$, $SD=1.08$). No differences were found in the remaining measures by method of project execution.

Differences by registration in the Engineers' Registry

27 graduates are registered in the Engineers' Registry, while 233 are not registered. We used bilateral t-tests for independent samples to examine differences in the various measures by registration in the Engineers' Registry. No differences were found.

Differences by licensing

12 graduates are licensed engineers, while 248 do not hold an engineering license. We used bilateral t-tests for independent samples to examine differences in the various measures by licensing. No differences were found.

Differences by advisor's rank

The advisor of 132 graduates was a member of the (research) faculty; 64 graduates had an advisor who was an engineer with the department; and 30 had an advisor who was an engineer employed in the industry. We used bilateral t-tests for independent samples to examine differences in the various measures by advisor's rank. No differences were found.

Differences by project topic selection method

Project topics are selected using one of three methods: project topics are presented to the students in the classroom (33), topics are proposed by the advisor (57), and students propose topics (161). We used bilateral t-tests for independent samples to examine differences in the various measures by project topic selection method.We found differences in satisfaction with the guidance process ($F(2,248)=5.93$, $p<.01$). When advisors proposed the project topic, satisfaction was greater ($M=4.17$, $SD=0.83$) than when topics were suggested to students in the classroom ($M=3.67$, $SD=0.88$). No differences were found when topics were proposed by students ($M=3.70$, $SD=0.95$).Differences in satisfaction with the advisor were found ($F(2,246)=9.11$, $p<.001$). When advisors proposed the project topic, satisfaction was greater ($M=4.26$, $SD=1.01$) than when topics were suggested to students in the classroom ($M=3.33$, $SD=0.96$). No differences were found when topics were proposed by students ($M=3.72$, $SD=1.10$). No differences in the remaining measures were found by project topic selection method. Differences by department. We used bilateral t-tests to examine differences in the various project assessment measures by department.

Table 2
Averages, standard deviations, and F values for measures by department

		Electricity and electronics	Mechanical engineering	Industrial management	Chemistry, Biotechnology	Civil Engineering	F
Satisfaction with advisor	Average	4.08	3.46	3.01	3.95	4.06	***10.72
	SD	0.92	0.85	0.99	0.67	0.67	
	N	160	56	25	10	9	
Satisfaction with the guidance process	Average	4.18	2.89	3.29	4.40	3.89	***21.88
	SD	0.96	0.85	1.12	0.52	1.17	
	N	159	56	24	10	9	
Congruence between theoretical knowledge and practice	Average	4.11	4.02	3.68	3.85	4.33	2.00
	SD	0.82	0.67	0.83	1.03	0.97	
	N	159	56	25	10	9	
Connection between project and practical engineering work	Average	4.10	4.00	3.47	4.17	3.48	***6.09
	SD	0.69	0.60	0.70	0.98	0.65	
	N	159	56	25	10	9	
The extent to which the project exposes students to new skills	Average	4.10	4.04	3.88	3.90	4.00	0.49
	SD	0.81	0.76	0.83	1.37	1.12	
	N	159	56	25	10	9	
The extent to which technological equipment in the laboratories assisted students	Average	3.11	3.38	1.71	3.22	1.67	***10.83
	SD	1.37	0.85	1.00	1.64	0.71	
	N	154	55	24	9	9	
The extent to which the project fulfilled students' expectations.	Average	4.18	3.88	3.88	4.00	3.67	*2.69
	SD	0.75	0.83	0.83	0.82	0.87	
	N	159	56	25	10	9	
The extent to which the project helped gain employment	Average	2.43	2.16	1.83	2.83	1.33	*2.75
	SD	1.37	1.27	0.96	1.60	0.71	
	N	140	51	24	6	9	
Project grade	Average	88.32	87.30	92.71	89.33	89.44	*2.44
	SD	7.39	7.39	4.53	5.77	11.30	
	N	161	53	24	9	9	
Final degree grade	Average	81.38	79.86	83.12	83.77	80.30	1.79
	SD	5.82	5.98	4.76	7.18	5.53	
	N	160	54	24	9	9	

* $p<0.05$ *** $p<0.001$

Table 2 indicates significant differences by department in the following variables:

Satisfaction with advisor: Lowest satisfaction was noted by graduates of Industrial Management, and highest satisfaction was noted by Electrical and Electronics Engineering, Civil Engineering, Chemical Engineering, and Biotechnology.

Satisfaction with the guidance process: Lowest satisfaction was noted by graduates of Mechanical Engineering and Industrial Management, and highest satisfaction was noted by Electrical and Electronics Engineering, Chemical Engineering, and Biotechnology.

Connection between project and practical engineering work: Lowest satisfaction was noted by graduates of Civil Engineering and Industrial Management, and highest satisfaction was noted by Electrical and Electronics Engineering, Chemical Engineering, and Biotechnology, and Mechanical Engineering.

Assisted by technological equipment: Lowest satisfaction was noted by graduates of Civil Engineering and Industrial Management, and highest satisfaction was noted by Electrical and Electronics Engineering, Chemical Engineering, and Biotechnology, and Mechanical Engineering.

Project fulfilled students' expectations: Least fulfilled expectations in the Civil Engineering Department, and most fulfilled expectations in the Electrical and Electronics Engineering Department.

Project helped gain employment: Least helped find employment in Civil Engineering, and most helped find employment in Chemical Engineering, and Biotechnology.

Project grade: Project grades were higher in the Department of Industrial Management than in the Department of Mechanical Engineering.

Project and degree grades

Graduates' average project grade was 88.60 (SD = 7.37). Grades ranged from 60 to 100. Average degree grade was 81.27 (SD = 5.85). A positive correlation was found between students' project grade and their final degree grade (r=0.53, p<.001): The higher the project grade, the higher the final degree grade. Nonetheless, students' final project grades were significantly higher (M=88.61, SD=7.39) than their final degree grades (M=81.28, SD=5.86). Table 3 presents Pearson correlation coefficients of the measures and project and degree grades.

Table 3
Pearson correlation coefficients of the measures and project and degree grades

	Project grade		Degree grade	
	Correlation	N	Correlation	N
Satisfaction with the advisor	* 0.14	255	0.04	255
Satisfaction with the guidance process	** 0.19	253	0.11	253
Congruence between theoretical knowledge and project	* -0.14	254	0.06-	254
Association between project and practical work	0.05	254	0.09-	254
Exposure to new skills	0.10	254	0.10	254
Technological equipment	0.02-	246	0.02-	246
Expectations	*** 0.26	254	0.07	254
Project assisted in gaining employment	0.03-	227	0.07-	227

* p<.05 ** p<.01 *** p<.001

Table 3 indicates a positive correlation between project grades and satisfaction with the advisor, satisfaction with the guidance process, and expectations. A negative correlation was found between congruence between theoretical knowledge of project execution and project grade. No significant correlations were found between final degree grade and any of the measure.

Conclusions

This study, which sought to examine final projects in engineering programs, offers several clear conclusions. The high proportion of graduates who believe that the project was an essential part of their engineering training was striking. The proportion of graduates who managed to combine theoretical studies and their practical project was also impressive. The vast majority of graduates were very satisfied with their project.

Feedback during students' studies is commonly collected. The novelty and significance of this study is the fact that it is based on information from graduates, with a more mature perspective. We continue to collect questionnaires from our graduates and hope to extend the study when we obtain a sufficiently large sample which will allow us to examine the variance in responses based on the different projects in which graduates were involved, differences between the various engineering disciplines, and the impact of different departments' approaches to project structure on graduates' satisfaction.

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