Chapter 9
Academic Drift in European Professional Engineering Education: The End of Alternatives to the University?

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Abstract In this chapter, it is argued that insights from comparative studies of higher education are essential to develop an understanding of educational systems dynamics impacting on professional engineering education. Usually such structural dynamics tend to go unnoticed among engineering educators. This chapter is organised in the following way: After a theoretical framing of the argument, three examples of institutional transformations and cognitive shifts that have taken place in similar types of professional nonuniversity engineering education institutions in Great Britain, France and Germany from the massive expansion of higher education in the 1960s to the present are discussed. More precisely, academic drift processes in British polytechnics, French Instituts Universitaires de Technologie (IUTs) and German Fachhochschulen will be examined and compared. In reviewing the relevant literature, the following questions will be considered: (1) What do we know about the processes that have constituted the engineering curriculum? (2) Are such processes inevitable and irreversible? (3) What kind of tensions and dilemmas do they create? It is argued that a particularly powerful and coherent set of values and attitudes characteristic of universities may also be seen as lying at the heart of vocational nonuniversity higher education institutions, causing them to drift towards the university or imitate them as implied in the subtitle.

Keywords Vocational nonuniversity engineering education • Academic drift • Vocational drift • Mergers • Driving forces • Structural dynamics

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Introduction

The point of departure for this chapter is a personal reflection on institutional transformations seen for the past twenty five years at my own institution – Aarhus University, Institute of Business and Technology – from the point of view of the original vocational engineering school *Vestjysk Teknikum*. It has puzzled me that, in spite of the local and situated character of the institution's strategic decisions at different points in time since its establishment in 1987 the institution nevertheless seems either consciously or unconsciously to have followed a general pattern of transformations of nonuniversity higher education institutions in Europe since the 1960s.

This general pattern of transformations may be seen as related to my own institution in the following way:

(1) *Fragmented expansion.* Under the name Vestjysk Teknikum, the engineering education institution was established as a small subsidiary of the larger Horsens Teknikum in 1987 in an area characterised by a lack of postsecondary higher education traditions and institutions.
(2) *Horizontal integration.* As the first of its kind, the institution gained independence by merging with a business school in 1995, thus becoming *Institute of Business and Technology*.
(3) *Vertical integration*. In 2006, Institute of Business and Technology merged with Aarhus University under the name *Aarhus University – Institute of Business and Technology* and became part of the faculty of social science at Aarhus University.

By 2011, when this volume went into press, the name simply became *Aarhus University, Herning*. What happened in my own institution is a clear-cut example of academic drift caused by institutional and structural dynamics. Presently, these dynamics are also causing other engineering colleges in Denmark to merge either horizontally into large multi-profession institutional conglomerates or as the dominant trend with universities. In the following, examples of such processes taking place in Europe will be scrutinised from the perspective of comparative studies of higher education.

The notion of academic drift was originally coined by Tyrrell Burgess in 1972 to describe dynamics of change in higher education since the massive expansion of student enrolments in the 1960s (Burgess 1972; Pratt and Burgess 1974). However, the set of phenomena it was meant to capture is much older and has been a key characteristic of processes of professionalisation since the early beginnings of professional education. Elite status pretensions and continued striving for vertical distinctions have always acted to push educational requirements in a more genteel and theoretical direction and to make them less narrowly vocational (Collins 1979). Discussing academic drift in professional engineering education today is still important for two reasons. One reason is that it relates to historically rooted, though still ongoing, processes whereby the engineering curriculum gets constituted. The second

reason is that it relates to struggles over the appropriate place or locus for educating engineers for engineering practice. In many cases, these struggles have been affected by structural dynamics that have not yet attracted sufficient attention among engineering educators.

On the one hand, academic drift at a curricular level encompasses a *cognitive dimension*. From this perspective, academic drift refers to a tension between practice-oriented and science-oriented curricula. It thus refers to the process whereby knowledge derived from practical engineering work experience and intended to be useful for industrial practice gradually loses its close ties to practice. Instead engineering knowledge becomes increasingly theoretical and oriented towards engineering disciplines, including mathematics and natural science. Regarding the extensive use of mathematics in engineering problem solving, Brosan (1972) argues: "All too often parts of such courses are concerned with playing advanced mathematical tricks which are not concerned with what a man has to do in industry; little if any time is given to alternative formulations of the same basic problem!" (Brosan 1972, p. 45). Hence science-driven curricula reflect an approach to problem solving in which science is regarded as the single most important element in the solution of practical problems. Conversely, practice-driven curricula do not imply that no use is made of theories, laws, concepts, etc., from the basic sciences. Instead they are regarded as just one resource among many for the solution of practical problems (Harwood 2006). Historically, this transition marks a shift of orientation in engineering education from a perception of engineering as an "art" concerned with creative engineering design to a perception of engineering as a "science" concerned with scientific methodology and rigour (Heymann 2009).

On the other hand, academic drift also encompasses an *institutional dimension.* From this perspective, it refers to the question concerning the appropriate locus for educating professional engineering students for engineering practice. More precisely, academic drift here refers to a tension between what is considered "noble" and "less noble" institutions (Furth 1982; Teichler 2008) and accordingly to a tension between narrow vocational training and broad professional or research-oriented academic education (Burgess 1978). Academic drift in this dimension is thus meant to capture a long-term tendency of nonuniversity higher educational systems, institutions, study programmes, faculty and the student body to strive for an upward movement in the direction of an institutional setting or curriculum that resembles that of the university as the epitome of prestige (Jónasson and Jóhannsdottir 2010). In the historical perspective adopted here, it would seem that this process has been enhanced by a dialectic of forces in the sense that *academic drift* has been a driving force in nonuniversity higher education institutions, whereas *vocational drift* has been a driving force in universities. Both processes started in the 1970s and gained further momentum in the 1990s. As a result, the boundaries between the two types of institutions have become increasingly blurred (Kyvik 2009; Kehm and Teichler 1995; Teichler 1996).

In these intertwined processes of cognitive shifts and institutional transformations, status and funding have played a prominent role (Harwood 2006). The status question has been a prominent factor in the history of engineering education in

Europe since the eighteenth century. As to funding, Seely (1993, 1999) offers an illuminating example. He has shown that the vast increase in US federal funding of engineering research related to what came to be called the military-industrial complex in the wake of World War II and the Cold War period was the decisive factor for a major paradigm shift in engineering education in the United States. This paradigm shift tilted the balance in engineering curricula towards academisation and engineering disciplines. This paradigm shift also had a pervasive impact on both professional and academic engineering curricula in Europe. In 1991, Herbert Simon noted that in the United States, there was also a "contagious effect" of such development in business schools and medical schools:

> My initial views were that engineering education needed less vocationalism and more science. As I began to understand the trends in the stronger engineering schools, I saw the same things that were happening to them were happening to the new model business education: science was replacing professional skills in the curriculum. I looked a little further, and saw the same thing going in medicine. More and more, business schools were becoming schools of operations research, engineering schools were becoming schools of applied physics and math, and medical schools were becoming schools of biochemistry and molecular biology. Professional skills were disappearing from the curricula, and professionals possessing those skills were disappearing from the faculties.
>
> (The quotation is from Skoie 2000, p. 415)

In the extension of the contagious effect of academisation noted by Herbert Simon, academic drift also refers to a *structural dimension*. In this dimension, academic drift operates across the entire nonuniversity higher education sector to transform educational systems. In many European countries, there has been a sequence of structural transformations since the 1960s starting from university-dominated systems, over dual systems and binary systems to unified systems of higher education, with stratified systems like the French as an exception. Here academic drift spans a variety of fields such as engineering, agriculture, nursing and other healthcare programmes, social work, business administration and information technology. Therefore, at this level, the term implies that there is a macrostructure of higher education and that individual institutions are not self-sustaining entities. Institutions are embedded in common frameworks of societal expectations, regulatory frameworks and cooperative or competitive linkages (Teichler 2004, 2008; Jónasson 2006; Kyvik 2009). Understanding the driving forces behind academic drift at all three levels is therefore important for professionals concerned that higher education should be relevant to their practice.

Some critics have complained that academic drift has made engineering education increasingly irrelevant to actual needs. For some of them, the issue is how to bring engineering education closer to industrial needs. For others, the decline in graduates' design skills has been a key concern. However, such concerns inevitably imply a number of more complex and intricate questions. These are the following: What processes work to transform the engineering curriculum over time? How are research priorities set? Who has a say in the kind of staff that are appointed? Which factors tend to encourage academic drift and which factors work against it (Harwood 2006, p. 70)?

Theoretical Framework

According to Kyvik (2009), European nonuniversity institutions of higher education seem to a great extent to have gone through three different though overlapping phases of transformations since the 1960s. Formulated in an ideal typical fashion, these are the following:

1. *Fragmented expansion* aiming at differentiation and diversification by means of geographical and institutional decentralisation. As a result, dual systems of tertiary education became established with a clear division between universities and the college sector. In this model, the college sector is fragmented into many small and specialised professional schools that offer short-cycle 2- or 3-year vocational courses. Each of the schools has distinct vocational cultures and is subject to different public regulations.
2. *Horizontal integration* aiming at field contraction, authority unification, institutional de-differentiation, programme coordination and regionalisation. The outcome of this process may be characterised as a gradual transition to a binary model where the college sector came to be organised in comprehensive vocational multi-profession colleges, sometimes termed polytechnics, beside the university sector. The college sector now becomes subject to a common system of regulations.
3. *Vertical integration* aiming at academisation, field coupling, student mobility, structural convergence, network building and organisational integration. The outcome of this phase is characterised by a gradual transition to a unified system of tertiary education. In unified systems, both traditional academic studies as well as vocational programmes are offered within universities. Unified systems have been created in three different ways: by upgrading polytechnics, by merging traditional universities and other higher education institutions and by incorporating professional schools into universities (Kyvik 2009).

In order to discuss academic drift processes in a European context, I have selected three institutions offering professional engineering education for further examination: British *Polytechnics*, French *Instituts Universitaires de Technologie* (IUTs), and German *Fachhochschulen*. I have the following questions in mind: (1) What do we know about the processes whereby the engineering curriculum has been constituted? (2) Are such processes inevitable and irreversible? (3) What kind of tensions and dilemmas do they create? The choice of institutions has been dictated by four considerations. First, all three institutions are examples of institutions that emerged in Europe in the 1960s and early 1970s and were expected to prepare engineering students for professional practice in a more direct manner than universities. Second, they all challenged the autonomy of universities and their conception of knowledge for its own sake. Third, they have been selected as the three institutions each in their own way have served as ideal typical cases of drift processes in comparative studies of higher education (see Kehm and Teichler 1995). Finally, the United Kingdom, France and Germany have been selected to represent three historical reference

models of higher education – the Oxbridge, the Napoleonic and the Humboldtian. These reference models constitute the historical initial conditions for the shaping of engineering education and the different status and roles attributed to engineers in the three countries.

In the following, the focus is on the tensions that were latent in the three institutions since their establishment in the 1960s and early 1970s. In this period, a transition from elite to mass higher education took place. The new types of institutions were created to deal with increasing numbers, a more diversified student body and a rapidly growing need for manpower in advanced industrial societies (Slantcheva-Durst 2010).

For lack of space, I refrain from a lengthy theoretical discussion of the various interpretations of the notion of academic drift. However, to be able to compare the three institutions, four dimensions of academic drift will be needed: policy drift, institutional drift, staff drift and cognitive drift in curricular emphasis (see Neave 1978, 1979; for further elaboration, see Jónasson 2006 and Kyvik 2009). I first give a brief presentation of each of the three institutions focusing on the phases of transformations they went through, if any, and the tensions that were latent in the institutions from their establishment. Next, I discuss in which dimensions, if any, of academic drift took place in the three institutions and what kind of new tensions and dilemmas followed from these drift processes.

By using perspectives and theoretical frameworks from comparative studies of higher education, we might be able to better understand some of the forces and obstacles that engineering educators are confronted with at a structural level in their effort to swing the educational pendulum back towards engineering practice (Sheppard et al. 2009). Moreover using a comparative perspective would also make it possible to be able to better estimate the likelihood of success in attempting to reverse the process of academic drift.

Three Institutions of Professional Engineering Education in the United Kingdom, France and Germany

British Polytechnics

The so-called British polytechnic experiment may be seen as an ideal type of institutional and cognitive transformations in engineering education related to all three phases in Kyvik's phase model. By means of horizontal integration, British polytechnics were created in 1965 as a separate sector different from, but supposed to be equal in status to, the traditional university. The creation of this institutional novelty marked a transition from a dual system to a binary system of higher education. In 1992, British polytechnics were upgraded to university status. With the upgrading, a transition from the binary system to a unified system of higher education took place, and the British binary experiment can be said to have come to an end (Pratt 1997).

What makes the British binary policy so fascinating is that one of its purposes was to prevent academic drift. In 1965, Secretary of State Anthony Crosland, who was the architect behind the binary policy, warned against academic drift saying: "For more than a century, colleges founded in the technical college tradition have gradually exchanged it for that of universities. They have aspired to an increasing level of work, to a narrowing of student intake, to a rationalization of course structure, and to a more academic course content" (Pratt 1997, p. 12). With the objectives of the new type of institution, it was intended to put an end to the academic drift tradition. The objectives were set out by Crosland and justified in his speeches at Woolwich and Lancaster Polytechnics in 1965 and 1967. Here he said that the binary policy was aimed at fulfilling four main objectives (Neave 1979, p. 147):

(a) That the purpose of the polytechnics was to meet the increasing demand for vocational, professional and industrially based courses which the universities could not supply
(b) That a separate sector outside the universities but in the higher education system be created
(c) That greater public control should be brought to bear upon the new establishments to ensure their ensued responsiveness to the social and economic demands of the locality
(d) That vocational and professional education needed greater standing if the international competitiveness of England and Wales was to improve

As pointed out by Neave (1979, pp. 156–157), implementing the binary policy was not as easy as Crosland originally had imagined. The objectives appeared to be ambiguous and gave rise to a number of unresolved questions which eventually led to "policy drift" by the British government and, as a result, to the upgrading of polytechnics to university status in 1992. Some of these unresolved questions related to a–d were as follows: (a) Demands by whom? By the government? By students? By the economy? (b) Should there be some degree of mobility between the sectors with students passing from the nonuniversity sector to the university sector? How large should the proportion of university staff be in polytechnics? (c) How precisely to handle the problem that close supervision by local and central authorities had not previously prevented drift in curricular emphasis, and did not automatically ensure sensitivity to social demands or the needs of the locality? (d) Increased standing in relation to what? To university education? To general secondary education?

However, taken at surface value and interpreted in terms of curricular thrust, the above-mentioned objectives are nevertheless characterised by a strong work orientation and orientation towards the needs of the local community and industry for a skilled workforce to boost growth and competitiveness in the regional economy.

Already in 1980, the Finniston report commented on deficiencies in engineering education in British polytechnics. These deficiencies were related to an observed cognitive drift of curricular emphasis. According to Pratt (1997), among criticisms of engineering education was the harsh observation "that it was unduly scientific and theoretical; that newly-graduated engineers lacked awareness of 'real life' constraints;

that they were oriented too much towards research and development work and were not interested in working in production or marketing functions" (Pratt 1997, p. 114).

From its inception, the British binary policy created a number of tensions. First among them was the tension between institutions belonging to the "autonomous" tradition as opposed to those belonging to the "service" tradition. Burgess (1978) formulated the tension in the following way. Institutions in the service tradition

> seek to place the knowledge they have at the service of society. Indeed they believe that human knowledge advances as much through the solution of practical problems as through pure thought… In seeking to serve it takes on very serious difficulties. In the first place there is the question of service to whom? Is it the student who is to be served, society as a whole, the government?… Can the institution serve more than one? The autonomous tradition settles this by asserting the priority of the discipline.
>
> (Burgess 1978, p. 46)

Already in 1974, Pratt and Burgess noted that many of the polytechnics were seeking to escape from public control by striving to become autonomous institutions like universities (Pratt and Burgess 1974, p. 173). Moreover, in 1979, Neave illuminated the inherent problems in the service tradition mentioned in the quote. Neave (1979) noted that polytechnics generally failed in distinguishing between student demands and the demands of industry and the economy (Neave 1979, p. 147).

A second tension was of a social nature. In the original Oxbridge model, elite schooling was for the upper classes focused on the development of leadership. What counted was the development of character, not the mastery of "skills" or of vast bodies of knowledge. The curriculum was therefore dominated by classical history, literature and philosophy. There was a disdain for "technical subjects like science and certainly the economic and managerial subjects that might prepare captains of Industry" (Grubb 2004, p. 6). Contrary to this tradition, the aim of polytechnics was to educate personnel for technical middle-level positions. Crosland described the kind of students that polytechnics would be catering for in the following way:

> Perhaps they left school early, perhaps they were late developers, perhaps they were first generation aspirants to higher education who were too modest at the right moment to apply to a university, perhaps they had started on a career and thought that a technical college course would more directly improve their qualifications for doing it.
>
> (Pratt and Burgess 1974, pp. 5–6)

Crosland's description clearly indicates that what he had in mind was "working-class students" and that an important purpose of British polytechnics would be to offer these students a second chance of higher education. However, somewhat paradoxically, the social tension in the emerging binary system of higher education was transformed into a tension in polytechnics between categories of students. Here a tension arose between part-time students, evening students and sub-degree level students on the one hand and degree students and post-degree students on the other. The overall consequence was that there was a rapid expansion of the academic potential of polytechnics causing the original vocational orientation and student clienteles from industry to suffer. The final upgrading of polytechnics in 1992 and the transition from a binary to a unified system of engineering education

coincided with the transition from industrialism to post-industrialism. This has led Kyvik (2009) to conclude the following:

> In many ways, the binary model should be seen as a metaphor for the old class society, where the class a person was born into was decisive for his or her social status, cultural taste, and income. In the same way, the binary divide between universities and colleges would preserve a socially constructed and socially institutionalized division between noble and less noble higher education institutions.
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> (Kyvik 2009, p. 204)

It appears to be the irony of history that the institutional bottom-up strategy leading to institutional drift of polytechnics and to their final upgrading in 1992 to university status has had the adverse effect that polytechnics have now become the second division of the university sector. Pratt (2002) characterised the new situation in the following way:

> They can point to the maintenance of vocationally oriented degree courses, to their many part-time courses, and to greater access than old universities to student from lower socio-economic groups, 34 per cent against 20 per cent. Some have a growing research reputation. Yet they appear at the bottom of most league tables, gain only a few per cent of the research assessment exercise funding, and are struggling to attract applicants. In many respects, they are the second division of the university sector.
>
> (Pratt 2002, p. 1)

After this somewhat sketchy presentation of British polytechnics, I now turn to the French IUTs where the tensions were of a different kind.

French Instituts Universitaires de Technologie (IUTs)

French IUTs were established in 1966 to provide short-cycle 2-year course programmes equivalent with the French university first cycle (2 + 1 + 1 + 1) (Lamoure and Rontopoulou 1992). Their aim was to train skilled, middle-level graduates to assume "technical functions in productions in applied research and the services" as formulated in the founding decree of January 1966 (van de Graaff 1976, p. 195). More precisely, the aim was that graduates should be more narrowly specialised than an engineer but with a broader education than a technician.

The creation of IUTs was an attempt by the French Ministry of Education to create a new kind of institution better suited than the traditional university to cater for the new cohorts of postsecondary students (van de Graaff 1976). The Ministry of Education therefore wanted to introduce more flexible but still highly selective admission procedures, new objectives and pedagogies and open up the university to the world surrounding it. As argued by Reichert and Smith (2009), in France, "the celebrated ideal of free access and provision for all coexists with a cherished culture of selectivity that seems to be held in equally high public esteem and is not as neutral to socio-economic origins as true meritocracy would imply". This ambivalence dates back to the Napoleonic reform of higher education in France in the wake of the French Revolution in 1789 (Reichert and Smith 2009, p. 45).

The creation of IUTs as selective institutions was therefore no exception. Selectivity came in as a *numerus clausus.* IUTs were only allowed to admit students up to a prescribed capacity. Besides the traditional *baccalauréat* (or *bac*), there were three other possibilities for admission aiming at attracting high-calibre students: (1) acquisition of equivalent training in industry, (2) completion of a diploma that would grant access to university studies, and (3) obtaining validation of professional experience or previous learning (Mikhail 2008, p. 76).

The creation of IUTs may be interpreted as an attempt by the French government at horizontal integration of technical and administrative fields and fields of service provisions related to the primary, secondary and tertiary sectors of the French economy (Bernard 1973). However, in the end, the advent of IUTs added further to a fragmented and stratified system of engineering education in France. Engineering education came progressively to rest on four pillars consisting of two binary structures in which each pillar corresponded to a distinctive set of administrative arrangements. One binary structure was established for long study programmes including universities and the *grandes écoles*. Another binary structure was established for short study programmes including IUTs associated with universities and STS (*sections de techniciens supérieurs*) which were run by the *lycées*. The *lycées* were in charge of two of the four pillars, namely, the STS as already noted and the *classes préparatoires* for admission into the highest ranking institutions in the French educational system, namely, the highly selective but less research-intensive elite institutions, the *grandes écoles* (Jallade 1992; Giret 2011).

A key concern of the responsible Ministry of Education regarding the separation of universities and *grandes écoles* was a concern related to the overall rationality of the French educational system. A major problem was that it led to a waste of intellectual potential to the detriment of France's international economic competitiveness and research reputation. First and most importantly, the most gifted students were drawn into the less research-intensive but highly prestigious *grandes écoles* depriving the research system of these talents. Second, the universities were not selective, and they therefore had to cope with massification on their own (Witte et al. 2008, p. 224). This problem was related to a legal aspect of the *bac.* In France as opposed to other European countries, the *bac* confers a legal right to students who have obtained it to be enrolled in the university without restrictions (Jallade 1992, p. 134).

Turning to the IUTs, the autonomy and accountability of IUTs fell under the remit of the Ministry of Education. Since 1968, a high degree of pedagogical, scientific, administrative and financial autonomy had been assigned to IUTs. To this day, however, this autonomy has remained a subject of conflict with the university (Mikhail 2008, p. 75). Besides the Ministry of Education and the university, there was a substantial involvement on the part of the private industry and the trade union. This tripartite involvement created an uneasy position regarding function and status. The trade union in particular stressed the need for better "research opportunities for the staff and the creation of sufficient additional teaching posts so that most of the temporary staff can be regularly employed" (van de Graaff 1976, p. 201).

The vocational type of qualification offered by IUTs was conceived to be terminal leading to the diplôme universitaire de technologie (the DUT). Intensive school-like teaching and learning methods were therefore introduced in IUTs as a pedagogical innovation (see Jallade 1992). Courses were made mandatory as a general rule, attendance at courses was to be monitored, and students could be dismissed for absenteeism. Evaluation of students was not a terminal one but was taking place currently and finally added up to the DUT. IUT students were therefore expected to attend at least 32 contact hours per week, over an academic 2-year training averaging 30 weeks per year, to which a further 6–10 weeks of apprenticeship experience was to be added,[1] as opposed to the university norm of 12 h per week in 26 weeks (Jallade 1992).

As observed by Quermonne (1973) with regard to IUTs, "the staffing ratio and the special educational methods in IUTs have been so designed that students entering employment on leaving them have received an education combining the necessary technical skills with an adequate general training" (Quermonne 1973, p. 226). Regarding the general education mentioned at the end of the quotation, such general training would be of a more nonutilitarian nature and would therefore be expected to be more academically inclined. It might therefore be argued that the IUTs already from start had been charged with a dual responsibility which would later in 1999 be reemphasised for short-cycle programmes during the so-called Bologna Process, namely, to train graduates for employment as well as prepare them for further studies (Slantcheva-Durst 2010).

This dual responsibility gave rise to a tension. Although the courses were designed as terminal courses, van de Graaff (1976) noted that already in 1976 more than one third of IUT graduates went on to higher education. Since then, the proportion has been steadily increasing, indicating an institutional identity problem, a clear mission drift of IUTs and a policy drift by the French Ministry of Education (Ratouly 1975; Reichert and Smith 2009, p. 47).

Regarding the composition of the teaching staff of the IUTs, this was from start the remit of the Ministry of Education. According to van de Graaff (1976), national policy was aiming at a symmetrical, tripartite composition of the teaching staff. One third should be drawn from higher education, one third from the *lycées,* and finally one third from industry representing the relevant professions.[2] Here national policy failed. Instead this requirement gave rise to a number of tensions. First, it led to a sharp division between secondary personnel mainly from technical secondary education and higher education personnel from universities. As secondary

[1] These figures are based on personal communication with Bernard Delahousse, former teacher and head of the International Office at IUT "A" – Lille 1; actually they vary from one IUT department to the other, especially industrial departments versus business ones.

[2] To be more precise, this symmetrical dimension did not apply to the personnel composition properly speaking but to the quota of teaching hours delivered by each category, i.e. a third of the total contact hours over the 2 years was to be taught by university personnel, a second third by teachers from the lycées, and the last third by engineers or executives from the professions.

personnel did not possess the proper credentials for university employment, they could in a formal sense only be temporarily assigned to IUTs. A second tension was that if and when university personnel wanted to become involved in the IUTs, they deliberately had to sacrifice all possibility of university promotion as promotion would depend on their research productivity for which there was neither sufficient time due to a high teaching workload nor facilities in the IUTs (van de Graaff 1976, p. 201).

When the Bologna Process was launched in 1999 by the European Commission to create transparency in European higher education by gradually implementing a common scheme of curricular cycles (3+2+3) throughout EU member states, it came as a shock for higher education in France as the French degree structure was not attuned to the new system (see Malan 2004; Witte et al. 2008; Mikhail 2008). Even though the diploma (the DUT) offered by the IUTs was equivalent with the first French university 2-year cycle, it could not be considered equivalent with the proposed new first 3-year cycle leading to a bachelor's degree. Therefore, as argued by Witte et al. (2008, p. 218), the change of degree structure was an opportunity for policymakers and other stakeholders to reconsider institutional identities and the distribution of roles and status between the institutional types in the system. As a consequence, a process of curricular drift in IUTs towards *la licence professionnelle* started.

The *licence professionnelle* (bac+DUT+1) is equivalent with the new French vocational bachelor degree which was introduced in 2000–2001. The *licence professionnelle* is conferred by universities along with IUTs (Malan 2004, p. 294). The development of IUTs and the connections to more advanced levels of engineering education might be interpreted as a process that in many ways resembles what Neave (1979) has called "curriculum inversion". This concept is understood to mean that practical vocational education comes first in all engineering courses and degree programmes no matter what kind of institution offers them to ensure the employability of candidates to be followed later by more advanced theoretical studies.

German Fachhochschulen

When German Fachhochschulen started operation in 1971, the historical point of departure was the inertia and resistance to change in the German university system which was still to a high degree committed to the core values of the Humboldtian university. To be sure, its core values "autonomy", "unity of teaching and research", "unity of all knowledge", and "scholarly life in solitude and liberty" were still kept alive after the reconstruction of the German university in the wake of World War II (Rau 1993). These values were seen as the sound core of the German university after the damaging effects of the Nazi period. However, as argued by Rau, the Humboldtian values only appealed and apparently still do to a tiny fraction of students, those, namely, "who are interested in a research career or those who are in a position simply to enjoy a liberal education". According to Rau, the majority of students cannot be

adequately served this way. They need and want "a vocational orientation, often look for social, political or ecological meaning in their studies, and are often rather bored by the kind of teaching which is delivered at the university" (Rau 1993, p. 40).

To accommodate the vast increase in student numbers in the 1960s, it was assumed that expenses for higher education in Germany, as well as in France and the UK, could not increase to the same extent as the growth in student numbers. Therefore, structural changes were needed in order to serve the new types of students and the needs of the labour market in a more cost-efficient way (Teichler 1996).

In Germany, the advent of Fachhochschulen in 1971 should therefore be seen as a policy response to the need for structural change. The change marked a transition from a dual system of higher education to a binary system. The binary system was created by means of horizontal integration of former engineering schools (Ingenieurhochschulen) and higher vocational schools (höhere Fachschulen). The latter were predominantly representing economic and applied social science areas. The binary divide applied to engineering education is much the same way as the binary divide in the UK. Universities and Fachhochschulen should complement each other regarding their education of engineers and the professional qualification of their graduates. The underlying concept was that Fachhochschulen were different in nature but were supposed to be equal in status to the universities. According to Taurit (1993, p. 23), the role of the universities was:

- To preserve the unity of science, the variety of disciplines and the autonomy of faculty members and institutions.
- To ensure the unity and equivalence of research and teaching, to educate future generations of researchers and to build strong communities of professors and students.
- To be the only institutions with the exclusive right to award doctoral degrees. However, in engineering degree programmes, universities had a right to award both Dipl. Ing. and Dr. Ing..

The research of universities was therefore characterised by a strong focus on fundamentals related to engineering disciplines but could also be engaged in applied research. In contrast, the profile of Fachhochschulen was characterised by the following seven features:

- Practical orientation
- Short terminal courses for direct employment leading to the engineering diploma and title Dipl. Ing.
- School-like teaching methods including periods of internships in companies
- Emphasis on teaching
- Courses attuned to the demands of the labour market
- Partnerships with predominantly small and middle-sized companies in the region
- Applied development and research

Student admission was mainly based on two different routes. Taurit (1993) estimated that in 1993, half of the students were admitted via the *Abitur* from the

gymnasium plus half a year of practical training. The remainder of students were admitted via extensive practical experience acquired through 3 years of apprenticeship in a craft. The vocational orientation of Fachhochschulen was further reflected in requirements for staff employment. Professors were required to have 3–5 years of practical experience in industry after their doctoral degree. According to Teichler (1996) in 1991, on average 84% of regular academic staff were professors.

Like the policy behind British polytechnics, German higher education planners were concerned to create a stable system able to resist the pressures of academic drift from the "less noble" sector. The merit of a stable system would be its ability to counterbalance "the trend that too many want to become 'chiefs' and too few want to remain 'Indians'" (Teichler 1996, p. 128). In 1996, Teichler noticed confidently that the Fachhochschulen seemed to have achieved this goal. However, with the benefit of hindsight, it has fascinated me that Teichler, a keen educational observer of structural changes, has been proven wrong. Academic drift had not been prevented once and for all.

Already from start, there were a number of tensions in German Fachhochschulen. First among them was the degree structure. The German Dipl. Ing. is below the master degree but above the bachelor degree. To begin with, the study for the engineering diploma was planned to take 3 years, but from the 1980s, the duration of the courses increased to between four and a half and five and a half years (Grose 2000). This meant that the degree structure came out of tune when compared with the bachelor, master, and doctoral degree system. A second tension was that Fachhochschule graduates were not entitled to become master and doctoral candidates due to the terminal nature of their courses. If they wanted to study for a master or a doctoral degree, they would have to complete a university degree *in toto* (Teichler 1996, p. 126). A third tension was related to the teaching workload of faculty members and professors (18 h per week) and the possibility of doing research. In this tension was also included the question of salaries. Salaries were on average 20% lower than the salaries of university professors. Finally, even though on average 84% of faculty members in Fachhochschulen were professors, they were not allowed to train their future faculty members and professors. These tensions would appear to be unsustainable in the long run. Furthermore, since the reunion of Germany after the fall of the Berlin Wall in 1989 and the Iron Curtain, it was also an enormous challenge to integrate the educational systems of East and West Germany.

As a result of the Bologna Process starting in 1999, the unification of degree structures (3 + 2 + 3) took place both in Germany and France. However, the prime concern of the reforms was to harmonise the two first cycles. In the UK, the new bachelor, master, and doctoral degree structure was not new but already existing. In Germany, this process went further than in any other European country. As a result, the final outcome in Germany was that the gap between the two types of institutions in the binary system eroded from 1999 to 2004. From 2004 onwards, both universities and Fachhochschulen were able to offer both academic research-oriented programmes and professionally or practice-oriented programmes. This development may be interpreted as a de-institutionalisation of degree types in the sense that both types of bachelor and master degrees could be offered in both types of institutions. With the erosion of the binary divide between universities and

Fachhochschulen, Germany came very close to a transition to a unified system of engineering education (Witte et al. 2008, p. 222, Vogel 2009). Contrary to Teichler's expectations in 1996, academic drift can be said to have destabilised and eventually almost abolished an apparently stable binary system.

Dimensions of Academic Drift in the Three Institutions

To be able to briefly summarise and compare academic drift in British polytechnics, French IUTs and German Fachhochschulen, an operational definition of academic drift will be needed. Here, I draw on my introduction, and in addition, I draw on Neave (1979, p. 155). The main difference between my conceptualisation and Neave's is that what I have termed staff drift serves as the exclusive definition of academic drift in Neave's conceptualisation. Neave in turn draws heavily on Pratt and Burgess (1974). Given this relationship, it should therefore come as no surprise that British polytechnics as an ideal typical case of academic drift live up to the operational definition. In the following, I shall therefore concentrate mainly on French IUTs and German Fachhochschulen with an eye to recent mergers of Danish engineering colleges and universities (Table 9.1).

A common characteristic of the three institutions was that their objectives were similar, namely:

- Meeting the demands for vocational, professional and industrially based courses of a terminal nature
- To train middle-level technical personnel for employment in small and middle-sized companies
- The creation of a separate sector of higher education outside the universities
- Greater public control to ensure continued responsiveness to social and economic demands of the locality
- Increased standing of vocational and professional education

However, their attempts to seek parity with the university and to adopt academic values, practices, and research were of different kinds. In any event, these attempts, partly or wholly successful as they were, came to constitute a departure in terms of curricular emphasis from the above-mentioned objectives.

All three institutions were created from scratch. British polytechnics were upgraded to university status in 1992. In Germany, the gap between universities and Fachhochschulen narrowed down or simply eroded from 2001 to 2004 as the outcome of the Bologna Process. In contrast, French IUTs were nested into universities already from start. Yet a different attempt to seek parity with the university would be merging engineering colleges with universities. This attempt has been the dominant trend in Denmark since the mid-1990s. In Denmark, professional engineering colleges – former so-called Teknika – were created in the early twentieth century and were from start nested into technical schools for the crafts. In 1962, Danish Teknika gained independence from the supervision by the technical school leadership and became part of a binary system of engineering education (Frandsen

Table 9.1 Operational definition of academic drift

Dimensions of academic drift	Administrative locus	Definition	The three institutions
1. Policy drift	Central administration Regional administration	Inadequately defined objectives, failure to enforce policy, reluctance to monitor implementation of policy and to intervene at an institutional level	British polytechnics French IUTs German Fachhochschulen
2. Institutional drift	Individual institutions or institutional type	Reorganisation of course structure along academic lines, attempt to seek parity with the university sector, redefinition of institutional objectives by institutions themselves	British polytechnics German Fachhochschulen
3. Staff drift	Faculty members and departments in the individual institution or type of institution	Emphasis on advanced work, less significance attached to part-time students, or to recurrent education, increasing emphasis on academic values, practices, and research, and failure or lack of will to recruit experienced "practitioner" personnel	British polytechnics French IUTs
4. Cognitive drift in curricular emphasis	Curricular content, the teaching context or situation	Increasing emphasis on abstract theoretical knowledge, gradual reduction in emphasis attached to experience based practical knowledge, move away from a utilitarian approach to an approach focused on engineering disciplines	British polytechnics French IUTs German Fachhochschulen

and Harnow 2011). The following figure illustrates the development of Danish professional engineering education institutions from the early 1970s to the present (see Christensen and Ernø-kjølhede 2011, p. 290).

In the table, a lack of year indicates that only an informal and loosely defined association with a university has taken place presently. However, it also indicates that a future merger is likely to take place with the respective university. The end of structural reforms in professional engineering education is destined by an act of the Danish Parliament to be completed no later than by 2015 (Table 9.2).

Table 9.2 Merging Danish professional engineering education institutions from the mid-1970s to the present

University colleges		Engineering colleges		Universities		Engineering academies
VIA	←	Horsens (2008) Helsingør (1995) Haslev (1997)	→	Technical University of Denmark	←	The Danish Academy of Engineering in Copenhagen (1995)
		Aalborg (1974) Esbjerg (1995) Copenhagen	→	Aalborg University	←	The Danish Academy of Engineering in Aalborg (1974)
		Sønderborg (1997) Odense (2006)	→	University of Southern Denmark		
		Herning (2006) Aarhus	→	Aarhus University		

Based on Frandsen et al. (2011, pp. 149–152)

In the table, it is noteworthy that the only institution that merged horizontally into a polytechnic type of institution presently seems to have regretted its decision and now wants to merge vertically with a university instead.

In French IUTs, academic drift took place in dimensions 1, 3 and 4. What triggered the drift process was the emergence of a changing pattern of education among entrant students, causing a mission drift by IUTs as the majority of students went on to higher education. Mission drift therefore took the form of a drift away from the original vocational and terminal nature of the course. A contributing factor here was the selective admission of only high-calibre students. The acceptance of the mission drift of IUTs by the French Ministry of Education may be seen as a clear example of policy drift. In dimension 3, academic drift took place as the originally planned tripartite recruitment of faculty members could not be fulfilled. Neave quotes Jean Capelle (senior civil servant under De Gaulle) for saying: "Disillusion with the IUTs set in when they slipped from the hands of men who practiced commercial and industrial affairs as part of their daily life… Instead they have turned into talking shops (*institutions bavardes*) – sub-universities run by a surplus of students from doctoral seminars or under the aegis of university chair holders" (Neave 1979, p. 151). The quotation, which of course in itself is no valid evidence, indicates that increasing emphasis was put on academic values, practices and research. Finally, drift in dimension 4 set in during the Bologna Process where the degree structure became gradually attuned to the bachelor level (*bac* + DUT + 1), therefore causing the 2-year courses to drift towards the 3-year *licence professionnelle*.

As I have shown, the German binary policy attaching different roles and status to universities and Fachhochschulen was relatively stable from the early 1970s until 1999 when the Bologna Process started. In itself, there was nothing in the Bologna Process that indicated that the binary system could not be sustained after the harmonisation of degree structures. However, in addition to the Bologna Process,

the current German reform agenda is concerned with the introduction of market-oriented, competition-based academic self-governance by hierarchical structures and powerful management positions like in many other European countries (Vogel 2009, p. 1). Moreover, as argued by Witte et al. (2008), the policy formulated by German state actors and advisory bodies started to drift "as the state actors and advisory bodies' perception that Fachhochschulen were doing a better job than universities in providing relevant higher education at moderate cost to large numbers of student, certainly contributed to their willingness to narrow the status gap between universities and Fachhochschulen" (Witte et al. 2008, p. 225). As a result, there is clear evidence of academic drift in dimension 1. The de-institutionalisation of degree types is evidence of institutional drift and a blurring of institutional boundaries in dimension 2. In dimension 3, it would be difficult to speak of academic drift related to recruitment of staff and the professoriate in Fachhochschulen as Fachhochschule professors are tenured academics with years of experience outside academia. However, there is a difference between university professors and Fachhochschule professors. University professors "insist that defining their own standards, applying their own scientific judgement, and making decision about their own affairs on the basis of criteria that reflect the inner logic of the academic world". These values form an integral part of their professional identity and are deeply rooted in the Humboldtian principle of "solitude and freedom" (Vogel 2009, p. 1). Contrary to that Fachhochschule professors regard managerial and market-oriented reforms as aligned with their professional identity.

Regarding cognitive drift in curricular emphasis – dimension 4 – there is clear evidence of cognitive drift in curricular emphasis. The original terminal nature of the curriculum has been changed and adapted to a new degree structure and the need by students for higher educational credentials to be able to compete in the job market. However Fachhochschulen may still be devoted to their professional mission, the difference is that they implement this mission in a more academic mode than before (Jónasson 2006). Moreover, Fachhochschule professors, according to Vogel (2009), perceive their substantial teaching obligation as a prime threat to their professional identity. This is an indication that research and in particular applied research would better fulfil their normative professional ideal and therefore might be expected to have spillovers to the teaching function in the sense of gradually shifting away from being work-based to being text-based instead. Jónasson (2006) has argued that in general "the new combined institution assumes to all intents and purposes the character of the higher-prestige institution" (Jónasson 2006, p. 9). However, Fachhochschule professors do not have an individual obligation to be research-active. The research obligation rests only with Fachhochschulen as an institution. The current ambition of Fachhochschulen is to improve their research conditions and to obtain the right to award doctoral degrees (Vogel 2009, p. 5). To the extent that Fachhochschulen succeed in fulfilling this ambition, a number of tensions and dilemmas are likely to occur.

Kyvik and Skodvin (2003) have argued that a new type of tensions and dilemmas related to status and funding is likely to emerge when nonuniversity institutions are trying to emulate university values, practices and research. In so doing, it has been evidenced in the same type of institutions in Norway that they gradually became

entangled in the following eight tensions and dilemmas related to allocation of resources and recruitment of staff (Kyvik and Skodvin 2003, p. 205):

- Allocation of resources – R&D versus teaching
- Distribution of R&D resources – quality criteria versus need for developing research skills
- Distribution of R&D resources – institutional versus individual rights and obligations
- Research-based teaching versus dissemination of advanced knowledge[3]
- Recruitment of staff – research abilities versus professional experience
- Distribution of R&D resources – specialisation versus breadth
- Vocational- and regional-oriented research versus discipline-oriented research
- Institutional control of R&D versus the staff's own preference

Conclusion

In 2006, Jónasson (2006) argued that a combination of academic drift and the effect of credentialism might be used to predict the convergence of institutions and systems of higher education under conditions of further expansion of higher education. A summary of his argument would also serve as a summary of the overall argument that I have been trying to advance in this chapter. In the three institutions examined here, two main drivers of structural change may be observed. On the one hand, there has been a general trend since the 1960s towards quantitative expansion and massification of higher education. On the other hand, massification has been countered by structural transformations and diversification of national educational systems. The prime objectives of structural transformations have been (1) to ensure that higher education contributes to the economy, (2) to accommodate increasing numbers of an increasingly diversified student body in more cost-efficient ways, and (3) to take enrolment pressures away from the university. Furthermore, structural dynamics have become increasingly complex as they have moved beyond the nation state to a transnational level. Even though the increase of engineering student enrolments might appear to have been relatively smaller than elsewhere in the educational system, professional engineering education has nevertheless been affected by the above-mentioned structural dynamics, but in various ways as it has been shown.

[3] Building research capacity in former nonuniversity institutions implies that both faculty members and students should be acquainted with the scientific culture, scientific methods and developments within their field. Moreover, building research capacity also relates to the question of research-based education. In 1998, the Danish Ministry of Science, Technology and Innovation listed 5 interpretations of research-based education indicating the scope of the concept: (1) instruction in research methodology given by active researchers, (2) instruction given by active researchers within their research area, (3) instruction given by researchers, (4) instruction given in institutions governed by researchers and in which the course material has been developed by researchers, and (5) instruction given in institutions which are under supervision of research institutions and in which the course material is developed by researchers (Skoie 2000, p. 412).

At a descriptive level, Kyvik's phase model captures a general pattern of institutional transformations in the nonuniversity sector. As it has been argued in this chapter, British polytechnics and German Fachhochschulen have developed in accordance with the model, whereas French IUTs differ from it. Whether institutions fit the bill or not may be due to historical initial conditions which have been described in the three historical reference models of higher education. However, what is lacking in Kyvik's phase model is a causal mechanism which would be able theoretically to provide a causal explanation of the above-mentioned structural transformations and the functioning of academic drift. Such framework for causal theorising has been elaborated by Jónasson (2006). Jónasson has termed his approach the credentialing perspective. The credential account implies

> that public policy initiatives and the demand for a skilled workforce should be seen as external modulating or facilitating factors rather than as primary causal mechanisms. The students (according to this account the primary consumers of education), along with their aspirations for educational credentials, are interpreted as a substantial driving force behind educational expansion. The academic faculty, on the other hand, having a similar aspiration for status, affect the internal structures of institutions and of the system, partly as a response to institutional growth and partly as a method to gain status, which leads to the academic drift that we witness.
>
> (Jónasson 2006, p. 4)

According to this account, structural transformations of institutions and educational systems take place in three steps. First, students in search of credentials to be able to better compete in job markets drive educational expansion. Second, academically inclined faculty members on the one hand and institutional leadership on the other with similar aspirations for individual and institutional status are looking for an opportunity to revamp internal institutional structures along academic lines, thus creating a push for structural change of the educational system. For institutions, this means that they would be more competitive in the market for higher education as the credentials they award are more attractive to larger numbers of students than those offered by institutions with less prestige. It also means that they would be better able to attract high-calibre students, thus allowing themselves to be more selective. Third, the constant push created in the first two dimensions is modulated by policy initiatives and manpower planning considerations. According to this perspective, the Bologna Process should not be seen as a causal mechanism but rather as an opportunity for policymakers and other constituencies to reconsider institutional identities and the distribution of roles and status between the institutional types in the system.

I shall now return to the three questions that were posed in the abstract, namely, (1) What do we know about the processes whereby the engineering curriculum has been constituted? (2) Are such processes inevitable and irreversible? (3) What kind of tensions and dilemmas do they create? To answer the questions in the inverse order, the third question has already been dealt with at the end of the previous section. The eight tensions and dilemmas presented here may be seen as of a general nature. They almost inevitably will arise when former nonuniversity institutions try to emulate academic values, practices and research. Regarding the second question I tend to share the view put forward by Jónasson (2006). According to him, academic

drift is a primary characteristic of long-term educational development of nonuniversity institutions and higher education systems. It should therefore be seen as an irreversible process and a natural part of the trajectories of educational institutions and systems. Generally, transformations take place in moments of opportunity provided by external state, public, private or transnational agencies. However, the void after the transformation of institutions may need filling by a new type of short-cycle institution, and the process can go on once again. Regarding the first question, it has been shown how the three institutions came into being with a clearly defined mission and a clear vocational emphasis in the curriculum that eventually was exposed to cognitive drift. However, here we should be more cautious to generalise as pendulum movements between theory and practice historically have been seen many times in engineering education as demonstrated by Harwood (2006) and Heymann (2009).

In 1979, Neave (1979, p. 157) pointed to a particularly powerful and coherent set of academic values and attitudes that worked against the objectives set for the three institutions. It is not unlikely that these values and attitudes will continue to exert their influence in professional engineering education as pressures for higher credentials are steadily increasing. The elements of this value system are the following:

1. That higher education is based upon a concept of personal autonomy
2. That higher education is distinguished by its grounding in research
3. That dissemination of knowledge requires the academic to work at the cutting edge of his/her chosen field – at the boundary of discovery
4. That staff should be of the highest quality, such quality being judged in terms of scholarly performance
5. That institutes of higher education cannot develop effectively if, at the same time, they have to attend to the demands of nondegree students
6. That students, if they are to derive the fullest benefit from higher education, must be full-time

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