Minerva (2010) 48:413–427
DOI 10.1007/s11024-010-9156-9

Understanding Academic Drift: On the Institutional Dynamics of Higher Technical and Professional Education

Jonathan Harwood

Published online: 13 November 2010

Abstract 'Academic drift' is a term sometimes used to describe the process whereby knowledge which is intended to be useful gradually loses close ties to practice while becoming more tightly integrated with one or other body of scientific knowledge. Drift in this sense has been a common phenomenon in agriculture, engineering, medicine and management sciences in several countries in the 19th and 20th centuries. Understanding drift is obviously important, both to practitioners concerned that higher education should be relevant to practice, but also to historians who seek to make sense of long-term trends in knowledge-production. It is surprising, therefore, that although the existence of drift has been widely documented, remarkably little attention has been given so far to explaining it. In this paper I argue that drift is not an invariant universal tendency but a historically specific one which arises under particular circumstances. I outline a model of institutional dynamics which seeks to explain why drift has occurred at some institutions but not others. In the second section I explore the implications of the model for educationists and policy-makers concerned with the reform of higher education in these areas.

Keywords Academic drift · Academisation · Agricultural sciences · Engineering sciences · Higher education

'Academic drift' (or 'academisation') is a term sometimes used to describe the process whereby knowledge which is intended to be useful gradually loses close ties to practice while becoming more tightly integrated with one or other body of scientific knowledge. Drift in this sense has been a common phenomenon in a

J. Harwood (✉)
Centre for the History of Science, Technology and Medicine, University of Manchester, Manchester, UK
e-mail: jonathan.harwood@manchester.ac.uk

variety of fields - spanning agriculture, engineering, medicine and management sciences - in many countries in the 19th and 20th centuries (e.g. Danbom 1990; Servos 1996; Rothstein 1987; Locke 1984; Locke 1989). Understanding drift is obviously important, both to technologists and professionals concerned that higher education should be relevant to their practice, but also to historians of these fields who want to make sense of long-term trends in knowledge-production. It is surprising, therefore, that although the existence of this process has been widely documented, remarkably little attention has been given so far to explaining it (cf. Warner 1986).

Throughout the 19th century and well into the 20th, practitioners often took academic engineers and agricultural scientists to task for overly 'theoretical' research or curricula which were regarded as quite useless (Seely 1984; Seely 1993; Dienel 1995; Harwood 2005). Over the last generation, too, there has been no shortage of such criticism. In engineering, for example, French industrialists complained during the 1990s about the lack of practically-oriented engineers while in Britain the Finniston Report (and others since) have voiced similar discontent. In the United States engineering colleges have been concerned in recent years about the continuing gap between what academe supplies and industry demands (Grelon 1994; Committee of Inquiry 1980; Pollard 1989; Williams 2000; Seely 1999). Closing the gap, however, has not been easy, partly because some academic engineers continue to insist on calculus and higher mathematics in the curriculum while admitting that these may be of little relevance for job performance (Hacker 1983).

In medicine criticisms of an excessively science-oriented curriculum in the United States date from at least the 1930s. In the 1980s, both the Association of American Medical Colleges and the American Medical Association noted with concern that staff were not devoting much attention to the provision of general medical education. According to Rothstein, the main impetus for improving training in primary care over the last thirty years has come, not from the medical schools, but from state and federal governments. Nor, it would appear, have medical schools responded to such initiatives with much enthusiasm (Rothstein 1987). In Britain, similarly, there were sporadic attempts at curricular reform between the wars though with little impact. Only since the 1990s have major changes been implemented at some medical schools, usually at institutions where pre-clinical departments' lack of interest in educational matters – and power over the curriculum – could be overridden (Mahadevan 2002). In Germany, similar criticisms have led to a recent revision of state licensing requirements aimed at bringing medical education closer to clinical needs (Bartens 2004).

Since the 1960s higher agricultural education in both the United States and the Netherlands has been the subject of similar debate (Hightower 1973; Hadwiger 1982; Busch and Lacey 1983; Maat 2001). Critics have argued that in promoting 'scientific agriculture' in the interests of increased productivity, the agricultural faculties of the universities abandoned their historic mission to support the farming community as a whole in order to serve only the large farms and agricultural firms which are able to exploit such knowledge. And finally, since the 1970s management education has come in for related criticism from businessmen, in Britain but above all in the United States (Locke 1996). Higher education in these areas, according to the critics, has lost its way.

Because of its ubiquity some might be inclined to conclude that drift is inevitable. Perhaps the single most important fact about drift, however, is that it has *not* been an invariant universal process. Some colleges in particular times and places have not tended to drift closer to ‘science’. In higher German agricultural education, for example, the college in Berlin offers a paradigm case of academic drift over the period 1880–1930, but elsewhere - e.g. the colleges at Hohenheim or Weihenstephan - the process was negligible over long periods of time (Harwood 2005). In engineering education since 1945, despite recent criticisms of drift in Britain, France and the U.S., there are signs that curricula in Germany, Japan and the Netherlands have remained closer to industrial requirements (Ferguson 1992). In medical education in both the U.S. and Britain during the 20th century science-based medicine has not predominated to the same extent at every college (e.g. cp. Lawrence 1985 with Sturdy 1992). And among early 20th century centres of business education in Germany and Britain, similarly, the relative weight in the curriculum of commercial subjects versus ‘basic’ disciplines such as economics varied considerably (Franz 1998; Tribe 1994; Tribe 2003).

If, therefore, drift is not a universal tendency but a historically specific one, it becomes possible to identify the circumstances under which it has occurred. And armed with that understanding, it may be possible to design institutions in which drift is less likely. In this paper I outline a model of institutional dynamics which seeks to explain why teaching and research in colleges of agriculture, engineering and related fields have often tended to drift away from an initially practical orientation. In the second section I explore the implications of the model for educationists and policy-makers concerned with the reform of higher education in these areas.

The Institutional Dynamics of Higher Technical Education

The model I outline here emerged from an attempt to understand curricular variation among late 19th and early 20th century German agricultural colleges (Harwood 2005). If one compares these colleges in respect of their laboratory and demonstration facilities, the structure of their teaching programmes, and the kinds of journals in which staff published (among other things), many of them can be broadly characterised as either ‘science-oriented’ or ‘practice-oriented’. By *science-oriented* I mean that staff at such colleges took their research questions from the basic sciences and attempted to solve them through application to data or problems from the practical realm. Or they took their research problems from the practical realm but were convinced that solutions lay in the correct application of scientific theory. Or they were enamoured with the methodological apparatus of the sciences, making a point in their research or teaching to deploy the techniques, concepts, laws, data, and instruments from one or other basic science. At *practice-oriented* institutions, on the other hand, academics took their research questions from the practical domain and in attempting to solve them, drew in part upon theories and methods from the sciences, though without assuming that these alone would be sufficient for a solution. Instead, staff were attentive to what was both economically feasible and practically realistic under the particular circumstances in which their 'clients' in the practical domain were working. Once these contrasting approaches to problem-solving have been characterised, the process of academic drift can be defined as a shift of educational institutions toward a stronger 'science-orientation'.[1]

The study was based on a comparative analysis of seven colleges – some of them 'practical', the others 'science-oriented' - chosen because they varied in a number of respects which I originally thought might be important in explaining their contrasting orientations:

- the province or state in which they were located.
- whether they were situated in a city or the country.
- the kind of ministry which oversaw them.
- whether they were a separate college or part of a university.
- the geographical origins of their students.
- their position upon the academic status hierarchy.

When I compared 'scientific' institutions with 'practical' ones and looked for their distinguishing features, however, there were a number of surprises. For one thing, the ministry responsible seemed to make no difference; institutions funded by Ministries of Agriculture were no more practical than those funded by Education. Moreover there were no obvious differences between the educational policies of one province and another; Prussia and Bavaria, for example, maintained *both* scientific and practical institutions. Nor was it decisive whether an institution was a specialist agricultural college or a university department. (I had originally assumed that the ideology of purity which dominated the 19th century universities would mean that the orientation in university departments would generally be more 'scientific' than at the colleges, but this was not always the case.) As far as students' backgrounds are concerned, colleges which recruited predominantly from their region were no more practical than those with a cosmopolitan student body. On the other hand, a few of my hunches were borne out. There was a tendency for institutions in urban areas to be more scientifically inclined than those in rural ones. And an institution's location upon the status-hierarchy correlated quite strongly with its orientation: high-status places tended to be outposts of science while those at the bottom of the heap were more practical.

This approach helped in singling out which factors might be important in shaping educational institutions, but it conveyed little sense of the *process* of historical change, nor did it give much of a feel for the *relations* of these institutions to one another, i.e for the dynamics of the higher education system as a whole. In order to get round this problem, therefore, I studied two institutions in particular detail – at Munich and at Weihenstephan - and followed their development over a longer

[1] It is worth emphasising that when I describe an approach to problem-solving as 'scientific', I do not mean that the staff in question were necessarily uninterested in practical problems. On the contrary, many were, but the point is that they regarded science as by far the most important element in the solution to such problems. Conversely, when I describe an orientation as 'practical', I do not mean that such staff were either ignorant of, or made no use of theories, laws, concepts etc. from the basic sciences. Instead, they regarded these disciplines as just one resource among many for the solution of practical problems (much in the manner of the design engineer).

period. Since both were in Bavaria, comparative analysis was that much easier, and it also meant that their histories were closely intertwined. This allowed me to see more clearly how each institution developed within an evolving field of possibilities, a field defined partly by the presence of potential patrons who could be mobilised for support but also by the position of other competing academic institutions.

The model which grew out of this comparative work treats each institution as obliged to operate within two ‘fields’: a narrower *academic* field and a wider *politico-economic* field.[2] The academic field consisted of all the academic institutions involved in higher agricultural education. The politico-economic field can be seen as a cluster of economic clienteles or constituencies in the region inhabited by an institution which took an interest in its teaching and/or research, as well as the Ministry which funded the institution, approved its appointments, and generally oversaw its activities. The model assumes that each agricultural institution had to seek legitimacy, whether in the intangible form of ‘approval’ or in the material form of resources, from one or more of the agents in either of these fields. Thus the staff at every institution, faced with its particular constraints and resources as an organisation but also with its location within both of these fields, had to decide what strategy to pursue in order to obtain approval and funding. And whether an institution developed more in a scientific or practical direction depended on the strategy which its staff were able to pursue. Notice that the model is not sociologically determinist. It simply identifies the social, economic and political circumstances - the framework of possibilities, if you will - with which staff at agricultural colleges were confronted when they had to decide how best to develop their institution.

The key feature of the *academic field* was the fact that its constituent institutions competed with one another for status. At the top of this ladder in Germany were the universities since they were generally the oldest academic institutions, possessed strong research traditions, and provided for the education of the higher civil service and the professions. Further down the hierarchy came the engineering colleges (which had acquired the status of higher education institutions only from the 1870s), and at the bottom were the more specialised colleges of agriculture, forestry, or veterinary medicine which were the last to achieve this status. Thus agricultural institutions found themselves within a status hierarchy over which they had little control but which nonetheless had consequences for their recruitment of both staff and students as well as for the legitimation-strategies available to them. For example, institutions ranking high in the status hierarchy (e.g. the agricultural departments at various universities) enjoyed legitimacy in the eyes of the higher civil service, the academic community and sectors of the public. As a result, they rarely requested improved practical facilities or introduced more practical subjects into their curricula since (a) they had relatively little need for additional recognition from the economic realm, and (b) in any event such ‘improvements’ would only have compromised their academic status by reducing the differences between them

[2] As the term ‘field’ suggests, the model was loosely inspired by the work of Pierre Bourdieu (e.g. Bourdieu 1993).

and those institutions at the bottom of the ladder. The most avid status-seeking institutions were in the middle of the ladder (e.g. the Agricultural Faculty at the engineering college in Munich) where staff were particularly desperate not to be confused with institutions on the lower rungs and most anxious to be recognised by their ‘superiors’. For those at the bottom (e.g. the agricultural college at Weihenstephan), however, there was little prospect of enhancing academic status through mimicking the universities; this would have been at best a long-term strategy. The only realistic source of legitimacy available to them over the medium term was to try to come to terms with their position on the academic status-hierarchy and concentrate instead upon expanding their utility in order to secure recognition from the economic realm. While staff at all levels of the hierarchy were intensely concerned with academic status, therefore, the vigour with which they campaigned for it depended upon their position within the academic field.

Obtaining non-academic legitimacy required agricultural colleges to look beyond academe and to engage with the wider *politico-economic field*. Three aspects of this field were especially important. Unsurprisingly, the relevant ministry was important since it possessed the powers (though not always the inclination) to grant a college more generous practical facilities, approve the appointment of new staff, push for closer ties to the farming community, or upgrade colleges on the academic status-hierarchy. Equally important were powerful organisations within the regional agricultural economy. In some cases these took an active interest in a college’s work and provided financial and political support, but in other cases they could be indifferent or even critical. Obviously the farming community’s willingness to call for - or condemn - increased appropriations was crucial, and some colleges were able to attract more support from this constituency than others. To be sure, this ‘community’ did not speak with one voice, for the very different economic circumstances of small and large farmers made for different needs and thus quite different expectations of agricultural education. In general, large farmers were a good deal more tolerant of ‘science-oriented’ curricula – whose high-tech methods they could afford and whose longer-term payoffs they could afford to wait for – than were small farmers who sought inexpensive solutions quickly. But farmers were not the only interest group which kept a watchful eye on agricultural education. Plant-breeding firms, various branches of the food and drinks industry, and fertiliser companies were also important clienteles for particular colleges. Finally, the composition of the politico-economic field also depended in part upon the college’s geographic location since the agricultural economy varied from one region to another, and whether a college was located in a city or the countryside conferred both constraints and opportunities, whether in recruiting staff and students or in securing good demonstration facilities.

In view of the structure of these fields, then, how can we account for the emergence of ‘scientific’ and ‘practical’ institutions? The argument is a simple one: that a college’s development was shaped by the interaction of countervailing forces. On the one hand, in most cases staff sought to enhance their institution’s academic status. The consequence of doing so was to push the institution in a ‘scientific’ direction (thus constituting academic drift) since many of the organisational changes which upgrading entailed either reduced the institution’s accountability to the

Ministry - and thus to agricultural interest-groups – or distanced its activities from practical agriculture in other ways. Whether an institution *actually succeeded* in moving in this direction, however, also depended upon the composition of its politico-economic field. For drift could be facilitated where the state and the major interest groups in the region were sympathetic to 'science' but stymied where they were suspicious. If the model is correct, therefore, drift was anything but an automatic process 'inherent' in the development of the agricultural sciences. It has arisen instead through a historically specific set of circumstances in which state and economy were prepared to accommodate academic staff's status ambitions.

At first sight, it may seem as though this model is saying little more than 'if you want to understand a college's trajectory, consider its social circumstances'. If it were proposing nothing more than this, it would scarcely deserve to be called a 'model'. In fact, however, the model's predictions are rather more specific. As I noted above, for example, by focussing our attention upon two key variables (state/economy/geography and academic status hierarchy), the model rules out a number of causal factors which originally looked plausible but turned out to be negligible. Furthermore, the model prompts us to look more closely at the key variables and to ask further questions about them, for example:

- Was the concern among agricultural scientists with academic status a 'universal', or have there been significant national variations in this regard?
- Has academic drift been more pronounced in those societies where the status of educational institutions is state-sanctioned (as in France or Germany) than in societies like the U.S. where such hierarchy is informal and unofficial? And why have states sometimes fostered academic drift while blocking it at other times?
- Does the science/practice orientation of a college bear any consistent relation to the structure of the regional economy? (For example, did large farmers everywhere favour science-oriented colleges over practical ones? Which forms of agricultural education were preferred by the food industry or agricultural firms?)

As it stands, the model is helpful in understanding German agricultural education, but evidence suggests that it may be much more widely applicable (Harwood 2005, 224ff). Agricultural education in Britain, for example, was also taught both in university departments and in independent colleges of agriculture, with the curricula in the former tending to be more science-oriented. And the higher status attached to science there, as in the Netherlands, gave rise to academic drift in both countries (Brassley 2008; Maat 2001). The role of the state, foundations and industrial interest-groups in facilitating this process is particularly clear in the United States (Harwood 2005, 229–233). Turning to the literature on the history of engineering education in France, Germany, Britain and the United States, the picture is quite similar (Harwood 2006). Colleges varied greatly in the structure of their curricula as well as the research interests of their staff in ways that allow them to be classified as 'scientific' or 'practical' in orientation. Academic hierarchies were especially pronounced in European settings - with status attached to curricula of a heavily mathematical or science-based kind - and staff at many colleges sought to raise their institution's scientific profile in a bid for greater autonomy, increased resources, and higher academic status. In many cases they succeeded, thanks to abundant funding from non-industrial sources, a cooperative attitude in the education ministry, and indifference among firms. As far as the history of medicine is concerned, an extensive literature has addressed the ‘rise of laboratory medicine’ since the late 19th century and the criticism it has encountered, especially since the 1980s (Rothstein 1987). But as Steve Sturdy demonstrates in a new review of this literature,[3] the ‘lab’ did not actually *replace* the ‘clinic’ at all medical schools. Clinical practitioners and medical scientists have historically displayed a variety of relationships to one another - sometimes agonistic, at other times collaborative - and it is the task of the historian to account for this diversity. Finally, management education in the 20th century has also been caught in the crossfire between the worlds of science and practice. In Germany before the First World War, for example, the pressures upon the early commercial colleges to conform to prevailing academic norms were considerable. Staff were concerned that the young discipline of ‘business economics’ would never be accepted if they took anything so coarse as profit to be the measure of a firm’s success (so they opted for ‘efficiency’ instead). By the 1920s, the new field was better regarded, but status-anxiety persisted. On the one hand, staff were uneasy about new developments in the field which would have made it more useful to businessmen; on the other, they had no such qualms in pressing for the colleges’ right to award the doctorate (Franz 1998).

In summary, the histories of higher education in agriculture, engineering, medicine and management in a range of countries suggest that the model of institutional dynamics outlined above may be quite widely applicable. Only further inquiry, of course, can establish whether that will prove to be a productive exercise. In the meantime, however, it may be useful to consider what the model’s implications for policy might be.

Implications for Higher Education Policy

As noted, the fact that not all colleges have gone down the same science-oriented path indicates that academic drift is certainly not inevitable. Thus we might ask what kinds of organisational changes might be necessary in order to keep technical and professional education more closely tied to practice. The model suggests three general points which might be borne in mind when establishing new educational institutions or reorganising old ones.

The first should be fairly obvious, though it is ignored surprisingly often: that geography matters. It is already recognised, for example, that medical schools are best situated in larger urban areas so that students can become acquainted with (and staff can investigate) the widest range of health problems. Engineering colleges, similarly, need to be located near industrial areas so that linkages such as consulting and sponsorship are easier to arrange. From this point of view, smaller cathedral

[3] Sturdy, ‘Looking for trouble: medical science and clinical practice in the historiography of modern medicine’, *Social History of Medicine*, forthcoming.

towns – the site of so many new British universities ca. 1970 – while offering a pleasant environment for work and study, are scarcely appropriate sites for technical education. As far as higher agricultural education is concerned, it is unlikely that new colleges will be established in the near future. But for those existing ones which are beginning to reorient their research and teaching toward a larger public, a college's geographical location is likely to affect whether it can more easily serve a rural community or urban consumers.

Second, as is clear from the history of higher agricultural education, the development of institutions has been shaped by pressures from both government and user-groups in the wider economy. After the First World War, for example, the Prussian and Württemberg Ministries of Education tried to increase agricultural bodies' influence by establishing advisory boards at the agricultural colleges. Although these were understandably not popular with academic staff, it is hard to avoid the conclusion that something similar is necessary today in order to keep such institutions responsive to their constituencies. Defining the membership of such boards, of course, is a political issue and would need to ensure accountability to relevant publics at the local, regional and national levels. The representatives of 'the public interest' on an engineering college's board, for example, should not be restricted to industrialists, and it would be important to have local general practitioners and laypeople on a medical college's board rather than merely consultants or non-medical academics. This issue of accountability arises, too, in recent recommendations for the reform of British veterinary education (Royal College of Veterinary Surgeons, 1997). The Report complains of the overly practical curriculum and the lack of research opportunities at most veterinary colleges (the same is said to apply to dental education). Before introducing any reforms – which would in effect induce academic drift among the colleges – however, any government must ascertain whether the RCVS recommendations in fact meet the needs of most of those groups with an interest in veterinary education.

Where higher education is in the hands of the state, boards might advise the relevant ministries, but ultimate authority resides with the ministers themselves. And it is clear from the history of German agricultural education that ministerial indifference was capable of inadvertently furthering drift, just as action was able to block it. One way in which the state affects drift, of course, is through the particular ways in which it channels funding. Thus if drift is to be discouraged, the rules governing such funding must be appropriate. As Bruce Seely has shown, for example, an important cause of the academisation of engineering education in the United States after 1945 was the enormous expansion of federal funding for engineering research. Because funding bodies favoured work regarded as 'fundamental', the emphasis within both research and teaching at most engineering colleges began to shift toward 'engineering science' (Seely 1993). Or consider the way in which the research conducted in British universities has been evaluated since the mid-1980s (the 'Research Assessment Exercise'). For the first ten years or so universities were rewarded primarily for publishing in conventional academic journals. While this may have been reasonable for many areas of the arts and sciences, in the case of technical and professional disciplines it sent entirely the wrong message. If academic drift is to be discouraged, other forms of research, professional engagement or ‘outreach’ activity - e.g. consulting, patenting, publishing in trade journals, collaboration with user-groups - must also receive recognition.

Third, one ought to consider how the structure of the higher education system itself might be altered.[4] At the heart of academic drift, according to the model I have presented, is the perceived higher status of the basic sciences. As pernicious as this value is, however, it seems quite unrealistic to hope that it can be changed in our lifetime. For in the western tradition the subordination of hand to head and of ‘practice’ to ‘theory’ seems too deep-rooted to be shifted easily. The British engineering professor, W.J.M. Rankine, railed against it in the mid-19th century (Calvert 1967). In the 18th century, Diderot ‘seldom [lost] an opportunity to strike a contrast between the pathetic and appealing humility of technique and the haughty arrogance of mathematical abstraction’(Gillispie 1959, p. 270). In classical antiquity those branches of knowledge which aimed at utility rather than knowledge for its own sake, were generally deemed inferior, and a similar hierarchy of knowledges was common to ancient Indian and, for the most part, Chinese traditions (Stokes 1997; Bray 1997; Sivin 1984). If these values are so long-standing and widespread, educational reform will require institutional changes which can counteract them.

One way to proceed would be to reduce the opportunities for such prejudice to be expressed. For example, at the Universities of Halle and Breslau around 1900, agricultural staff (who were in a small minority) ran up against a good deal of condescension and scepticism from their colleagues in the natural sciences and humanities. Were one to try to reduce this damaging social interaction by simply removing the agricultural sciences from such large multi-faculty institutions, however, the consequences could be serious. So how is an institution to maintain the possibility of fruitful connections between the technical sciences and basic sciences while keeping the destructive snobbery of head-and-hand at bay? An obvious solution would be to place each of the technical sciences in specialised colleges which contained posts or departments dedicated to the relevant basic subjects. This is in fact just how the former German engineering colleges were organised. Engineers were numerically and culturally dominant in such colleges while physicists and mathematicians constituted a minority ‘tail’ which was in no position to wag the dog. Moreover, a condition of basic scientists’ appointment in such colleges was that they were prepared to explore possible links between their own disciplines and related technical ones. The cognitive payoff from this form of organisation may have been very considerable. One reason why the contributions of early 20th century German academic engineers to aeronautics were rather more substantial than those of their counterparts at Cambridge, David Bloor argues, is that unlike the latter, German engineers worked in institutions where they were not

[4] It is interesting in this regard to note Hightower’s recommendations for the reform of American agricultural research (Hightower 1973, chp. 9). Many of them are pitched at the level of national policy-making (e.g. public inquiries, congressional committees) while relatively few concern the structure of agricultural institutions or the higher education system more generally. Nothing is said, for example, about changing the reward systems or research-funding arrangements for agricultural scientists, nor about restructuring the extension service so as to give it more influence upon research agendas.

regarded by scientists and mathematicians as second-class citizens.[5] Reorganising colleges of engineering, medicine, management or agriculture in a similar way could potentially reap the cognitive benefits of the sciences' proximity while not suffering the attendant status humiliation.

The adverse consequences of situating medical education in multi-faculty universities are also clear from studies of academic drift in the medical curriculum. One major reason for drift there has been that staff in the pre-clinical sciences are responsible for teaching, not only medical students, but also general biological sciences (Rothstein 1987; Mahadevan 2002). Moreover, their research is funded largely by bodies responsible, not for medical research, but for basic biology. Under the circumstances, who can be surprised that these staff have been more interested in their own research and graduate students than in teaching medical students?

Creating specialised technical or medical colleges, however, is unlikely to be sufficient on its own to forestall academic drift. For in Germany, staff at some of the agricultural colleges, like those at engineering colleges in the late 19th century, still fought hard to raise the formal academic status of their institutions and in so doing were prepared to further the process by shifting their activities closer to 'science' (a notable example of which was the Agricultural College at Berlin). This suggests that education ministries will also be obliged to introduce measures which undermine the formation of academic status hierarchies by assuring genuine formal equality among the different sectors of higher education. This is precisely what German education ministries ca. 1900 largely failed to do. Even after they had granted German engineering colleges the much-coveted right to award the doctorate at the turn of the century, a variety of less obvious organisational differences and privileges persisted between the colleges and the universities which continued to annoy academic engineers into the 1920s (Manegold 1970, p. 305), and the situation was little different in the agricultural colleges.

Even today there are signs that education ministries have real difficulty in conceiving of higher education systems in non-hierarchical ways. In Germany, for example, while most of the old engineering colleges were upgraded over the last few decades to 'technical universities', there is still a lower rung on the academic status-hierarchy occupied by 'technical colleges' (*Fachhochschulen*). These colleges have been much praised by both industry and the national advisory body on higher education (*Wissenschaftsrat*) because their graduates are more practically-oriented than university graduates, and there have been frequent calls for more of them to be established. Unfortunately, however, students have not been enrolling at these colleges in increasing numbers as had been hoped, in part because graduates of the colleges – unlike university graduates – are not permitted to apply for jobs in the higher civil service. Moreover, there have been difficulties in filling academic positions at these colleges with highly qualified staff, presumably because staff there are not as well paid as those at universities, have much heavier teaching loads, and have relatively limited research facilities (*Wissenschaftsrat* 2002; Spiewak 2002; anon. 2010a).

---

5 Bloor, *The Enigma of the Aerofoil, 1909-1930: Rival Theories in Aerodynamics. A Sociological and Historical Study of a Scientific Dispute* (forthcoming); cf. Sanderson (1972).

On the basis of the model I have outlined here, one would expect that staff in these colleges would react by pressing for the kinds of institutional changes which they believe will qualify them for university-status – drift revisited – but will, in the process, jettison the very qualities which currently make them so attractive to industry.[6] This appears to be just what is happening. Having failed to secure the universities' cooperation in setting up joint doctoral programmes, the colleges now want the right to award their own doctorates (Burchard 2010). Predictably, industrial groups are critical of such convergence since they wish to be able to continue to recruit the more practically-oriented graduates which the colleges have so far produced (anon. 2010b). The state has thus been sending a clear message: that the technical colleges, despite their admirable qualities, are second-class institutions. If, therefore, governments want to preserve the kind of institutional diversity which industry is calling for, they must dismantle the stratification of higher education so that institutions can be different but still equal. Allowing formal differences of status to persist is asking for trouble.

Some readers may feel that this paper condemns academic drift too harshly. One has even suggested that I have too hastily taken for granted the criticisms of drift which are, after all, coming from self-interested parties. It is important to be clear on this point. First, the criticisms of drift are, of course, rooted in sectional interests within the industrial, medical and agricultural communities; nevertheless I find much of that criticism entirely justified. It seems to me legitimate to ask that engineering colleges convey skills which suit its graduates for work in industry (and elsewhere). I share the concern within sections of the medical community that medical students have been graduating with a thorough training in biochemistry and anatomy while lacking elementary diagnostic skills. And I sympathise with small farmers and consumers who complain that higher agricultural education has generated ever more science-oriented knowledge which largely serves the interests of a relatively small number of commercial farms. The point of higher technical education is not to generate knowledge for its own sake nor to cater to the needs of a narrow clientele but to serve the general public.

To take this position, however, does *not* mean that one must reject drift categorically. Indeed, to do so would be a mistake. For an important point which emerges from the history of the technical disciplines is that the consequences of drift have not invariably been detrimental; on the contrary, sometimes drift has increased a field's utility in the practical realm. Thomas Hughes, for example, has shown that although the mathematics which 19th century German electrical engineers had to learn was of little use in inventing direct-current devices – Edison, for example, had little mathematical knowledge – it was very important in the construction and improvement of alternating-current equipment (Hughes 1983). Similarly, Edwin Layton has argued that the development of engineering theories which were sophisticated enough to help designers predict scale effects required the use of differential equations. Consequently, most of the theorists of this

[6] There is some evidence that this has already occurred (Locke 1989, pp.174–175), and in Britain something similar seems to have happened at comparable institutions (the polytechnic colleges) between their creation in the 1960s and their upgrading to universities in 1992.

'dimensionless revolution' were European engineers who were well-versed in the calculus (as their more practically-oriented American counterparts were not; Layton 1988). Instances of this kind can also be found in the agricultural sciences. There is no doubt, for example, that early 20th century advocates of Mendelian theory who claimed that it would revolutionise the practice of plant-breeding were enormously exaggerating the theory's impact. But that does not mean that genetic theory was of no significance whatever. In the German-speaking world, for example, academic plant-breeders like Erich von Tschermak, Erwin Baur or Theodor Roemer were successful in developing new plant-varieties partly because they drew upon theory as a guide to practice (Harwood 2005, chp. 4). The general point is that there is no one right road to success in the technical sciences; preserving institutional diversity is therefore crucial. And this means that reformers keen to make technical education more 'relevant' must be very careful not to throw the baby out with the bathwater.

It is a truism that history never repeats itself; the future never simply reproduces the past. It would be naïve, therefore, to expect history to provide a blueprint for action. What it can do, however, is to provide tools for thinking, a way of looking at the problem which may suggest possible solutions. That is what I have tried to do here.

Acknowledgments I thank David Bloor for helpful criticism of this paper in draft form.

References

Anon. 2010a. Professoren verdienen 73,000 Euro In *Der Tagespiegel*, 15 June, 28 (Berlin).
Anon. 2010b. FHs sollten Unis nicht nacheifern In *Der Tagespiegel*, 30 March, 24 (Berlin).
Bartens, Werner. 2004. Neue Aerzte braucht das Land In *Die Zeit*, 15 April, 35–36.
Bourdieu, Pierre. 1993. The field of cultural production. In *The field of cultural production*, ed. Pierre Bourdieu, 29–73. Cambridge: Polity Press.
Brassley, Paul. 2008. Agricultural education, training and advice in the UK, 1850–2000. In *The state and rural societies: Policy and education in Europe, 1750–2000*, ed. Nadine Vivier, 259–278. Turnhout, Belgium: Brepols.
Bray, Francesca. 1997. *Technology and gender: Fabrics of power in late imperial China*. Berkeley/London: University of California Press.
Burchard, Amory. 2010. FHs sollen weiter an Unis herumdoktern In *Der Tagespiegel*, 6 July (Berlin).
Busch, Lawrence, and William Lacey. 1983. *Science, Agriculture, and the Politics of Research*. Boulder/London: Westview Press.
Calvert, Monte. 1967. *The Mechanical Engineer in America, 1830–1910*. Baltimore: Johns Hopkins University Press.
Danbom, David. 1990. *Our purpose is to serve: The first century of the North Dakota agricultural experiment station*. Fargo, ND: North Dakota Institute for Regional Studies.
Dienel, Hans.-Liudger. 1995. *Ingenieure zwischen Hochschule und Industrie: Kaltetechnik in Deutschland und Amerika, 1870–1930*. Gottingen: Vandenhoeck und Ruprecht.
Ferguson, Eugene. 1992. *Engineering and the Mind's Eye*. Cambridge, MA: MIT Press.
Franz, Heike. 1998. *Zwischen Markt und Profession: Betriebswirte in Deutschland im Spannungsfeld von Bildungs- und Wirtschaftsburgertum (1900–1945)*. Gottingen: Vandenhoeck and Ruprecht.
Gillispie, C.C. 1959. The Encyclopedie and the Jacobin philosophy of science: A study in ideas and consequences. In *Critical Problems in the History of Science*, ed. Marshall Clagett, 255–289. Madison: Wisconsin University Press.
Grelon, Andre. 1994. Die deutschen Ingenieure aus franzosischer Sicht, 1770–1990. In *Ingenieure in Deutschland, 1770–1990*, eds. Peter Lundgreen and Andre Grelon, 369–386. Frankfurt/New York: Campus.

Hacker, Sally. 1983. Mathematisation of engineering: Limits on women and the field. In *Machina ex dea: Feminist perspectives on technology*, ed. Joan Rothschild, 38–58. New York/Oxford: Pergamon Press.
Hadwiger, Don. 1982. *The politics of agricultural research*. Lincoln and London: University of Nebraska Press.
Harwood, Jonathan. 2005. *Technology's dilemma: Agricultural colleges between science and practice in Germany, 1860–1934*. Frankfurt/Bern/New York: Peter Lang.
Harwood, Jonathan. 2006. Engineering education between science and practice: Rethinking the historiography. *History and Technology* 22: 53–79.
Hightower, Jim. 1973. *Hard tomatoes, hard times*. Cambridge, Mass.: Schenkman.
Hughes, Thomas. 1983. *Networks of Power: Electrification in Western Society, 1880–1930*. Baltimore/London: Johns Hopkins University Press.
Lawrence, Christopher. 1985. Incommunicable knowledge: Science, technology and the clinical art in Britain, 1830–1914. *Journal of Contemporary History* 20: 503–520.
Layton, Edwin. 1988. The dimensional revolution: the new relations between theory and experiment in engineering in the age of Michelson. In *The Michelson Era in American Science, 1870–1930*, ed. S. Goldberg, and R. Stuewer, 23–41. New York: American Institute of Physics.
Locke, Robert. 1984. *The end of practical man: Entrepreneurship and higher education in Germany, France and Great Britain, 1880–1940*. Greenwich, Conn.: JAI Press.
Locke, Robert. 1989. *Management and higher education since 1940: The influence of America and Japan on West Germany, Great Britain and France*. Cambridge: Cambridge University Press.
Locke, Robert. 1996. *The collapse of the American management mystique*. Oxford: Oxford University Press.
Maat, Harro. 2001. *Science cultivating practice: A history of agricultural science in the Netherlands and its colonies, 1863–1986*. Wageningen: Ponsen and Looijen.
Mahadevan, Dushyanthan. 2002. Creating Tomorrow's Doctors: The Development of Problem-Based Learning in British Medical Schools. Undergraduate dissertation, University of Manchester.
Manegold, Karl-Heinz. 1970. *Universität. Technische Hochschule und Industrie*. Berlin: Duncker und Humblot.
Pollard, A.F. 1989. *The education and training of chartered engineers for the 21st century*. London: Fellowship of Engineering.
Rothstein, William. 1987. *American medical schools and the practice of medicine: A History*. New York/Oxford: Oxford University Press.
Royal College of Veterinary Surgeons. 1997. *Report of the committee of inquiry into veterinary research*. London: Wellcome Trust.
Sanderson, Michael. 1972. *The Universities and British Industry, 1850–1970*. London: Routledge and Kegan Paul.
Seely, Bruce. 1984. The scientific mystique in engineering: Highway research at the Bureau of Public Roads, 1918–1940. *Technology and Culture* 25: 798–831.
Seely, Bruce. 1993. Research, engineering, science in American engineering colleges, 1900–1960. *Technology and Culture* 34: 344–386.
Seely, Bruce. 1999. The imbalance of theory and practice in American engineering education: reforms and changes, 1920–1980. *Icon* 5: 40–63.
Servos, John. 1996. Engineers, businessmen and the academy: The beginnings of sponsored research at the University of Michigan. *Technology and Culture* 37: 721–762.
Sivin, Nathan. 1984. *Why the Scientific Revolution did not take place in China—or didn't it? In Transformation and Tradition in the Sciences*, edited by Everett Mendelsohn, 531–554. Cambridge: Cambridge University Press.
Spiewak, Martin. 2002. Klassenkampf: die Fachhochschulen werden weiterhin diskriminiert. *Die Zeit*, 23 May.
Stokes, Donald. 1997. *Pasteur's quadrant: Basic science and technological innovation*. Washington, DC: Brookings Institution Press.
Sturdy, Steve. 1992. The political economy of scientific medicine: Science, education and the transformation of medical practice in Sheffield, 1890–1922. *Medical History* 36: 125–159.
Tribe, Keith. 1994. *Strategies of economic order*. Cambridge: Cambridge University Press.
Tribe, Keith. 2003. The faculty of commerce and Manchester economics, 1903–1944. *The Manchester School 71* 6: 680–710.

Warner, John.Harley. 1986. *The therapeutic perspective: Medical practice, knowledge, and identity in America, 1820–1885*. Cambridge, MA/London: Harvard University Press.

Williams, Rosalind. 2000. All that is solid melts into air: Historians of technology in the information revolution. *Technology and Culture* 41: 641–668.

Wissenschaftsrat. 2002. *Empfehlungen zur Entwicklung der Fachhochschulen*. Berlin: Wissenschaftsrat