Planetary Engineering: Entrepreneurship at the Interface of Cultures

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ABSTRACT

This contribution answers the question: what capacities are required for engineers to participate in entrepreneurship for development, specifically in developing countries? Related to this main question is a number of sub-questions: (a) what extra demands does a different cultural and institutional environment pose on entrepreneurship? (b) How does the management style of the enterprises involved find proper and effective solutions at the interface of different and often opposing (traditional and new) value sets and institutional arrangements? (c) How are these different value sets and institutional arrangements imbricated in each other and in (the use of) the technology – and technology in them? (d) How does this affect the education and curriculum building of engineering students? The author will move to and fro between experiences from practice and insights from theory so that theory and practice inform and explain each other. The author will finally propose one superior value or capacity in order to deal with the cultural and institutional differences indicated: the capacity for planetary movement, i.e. the capacity to alternate (consciously and deliberately) between different value sets and to compose a management style that combines different elements, timely and temporarily.

KEYWORDS: Engineering Education, Entrepreneurship for Development, Intercultural Management, Technology Transfer, Values and Technology

1 INTRODUCTION

Engineering differs from mere science in that it is focused on design. It doesn't only reduce phenomena to earlier causes, but it makes causal relationships subservient to future imperatives. Doing so it integrates dead matter into the process of life (Rosenstock-Huessy 2001). This implies that engineering takes place at the crucible. It should be both deep (understanding and manipulating natural phenomena) and broad (communicative and oriented to the future). By planetary engineering I mean the ability to alternate between these two capacities and to be good at both. That requires a high level of communicative competence and flexibility. For that reason I introduce the world "planetary". The planets are constantly on the move in unpredictable windings. I will come back to the meaning of that imagery. Engineering requires the ability to connect and go between different worlds. It even requires world creation. Engineers make decisions on how the future will or should look like, technically, socially. In this contribution I want to show what this world creation and this movement between worlds takes, on a theoretical level, but also in terms of engineering practice. I will draw my examples primarily from internships and master thesis projects in developing countries, which I happen to be supervising in great numbers.

2 KIBWEZI – A BUSINESS APPROACH TOWARDS WATER PUMPS

Let's first take a case study so that we start with the engineering practice. The example that I present is a typical example of the engineering way of approaching social problems as if they too were just another type of technical problems. So it is kind of a deficient case. But for that very reason it shows what is lacking to the 'business as usual' engineering education.

In the region of Kibwezi in Kenya Flying Doctors installed a great many (± 400) water pumps, of which after several years only 200 appeared to be still working and maintained by volunteers (Oltheten 2010). Organized in committees they were taking care of the remaining functioning water pumps, but being volunteers, it was increasingly difficult for them to keep up the quality and then of course there were the financial issues. As a solution students working on this case proposed a business approach and an improved logistical system. They developed this logistic model in extensive dialogue with the local volunteer committees. Ingredients: all of the committees in the neighborhood would have to adopt the same type of water pump, spare parts would be fetched from Nairobi once a month with a fully loaded truck, these spare parts would have to be stored and watched over carefully in a central storage facility, and a disciplined and transparent administrative system would have to be put in place in order to manage the continuous availability and cost recovery of the spare parts. In this approach the repair activities would become much more efficient and it would become possible to run the maintenance of water pumps as a business, generating an income for the practitioners involved.

However, it was underestimated what this takes in terms of a change in attitude at the interface of cultural value sets, the problem I mentioned above. Not only should the volunteers learn to deal with the new administrative system, but they would also lose their independence as water pump committees. They would need to adapt to more intense cooperation and generate more mutual trust and adopt a more intensely disciplined type of time management. In addition security at the storing facility would become an issue, including theft of the spare parts and/or corruption. In the end the system proposed by the students was not adopted. A follow-up internship, which was meant to work on the introduction of such a system was not accepted. The local volunteer groups liked the idea, but didn't like its implementation.

At the surface it seemed that only a more sophisticated logistics system was at stake. At a deeper level, however, the refusal of this sophisticated system might be explained by difficulties at the interface of different cultural values involved (Jackson 2011). The volunteer committees were functioning as independent closed in-group entities. They probably didn't like the idea of introducing a hierarchical management system, especially not in the usual African version, in which power distance is very strong. So both lack of mutual trust and the fear of too much hierarchical control might be an issue. Also the disciplined time management, tracking system, and labor division might be the cause of the reluctance to accept this new logistical system. It affects the independence of the water committees. If only judged from an economic perspective, it might be good, somebody might even make a living from it. But to attain that economic gain, from the perspective of the volunteers too much of the traditional African value system might have to be sacrificed. So they preferred to continue as they did, even allowing for the risk that more of the existing water pumps would probably be lost in course of time.

The case shows the uneasy relationship between traditional and modern values at the interface of different cultures: Independence of the committees, distrust towards cooperation with other committees (closed in-group orientation), resistance to more hierarchical control, resistance to the disciplined and accurate tracking system. For those reasons capabilities that are in principle available (the business approach proposed seemed to be viable) could not be converted into reality. Finally the case shows the need for a viable 'economic culture' (Porter 2000). Giving in to the traditional African value system also means, in this case at least, but in many more cases, that the business is not effective and competitive. But what is the alternative? Should more extensive training be mandatory to learn such a committee how to deal with a modern entrepreneurial business approach? Or, the other way around, is a trade-off possible between the traditional African values and new values introduced by an entrepreneurial approach? Finally, the lack of an enabling environment (UNDP Report Capacity Development 1997) on the level of institutions also turns out to be an issue. With an enabling environment one might think of bad roads, but also failing

institutions, in this case the risk of theft from a central storage facility, or corruption if the workers at such a facility feel the need to help out friends or family. Anyway, a more complex management system, larger scale cooperation, the risk of theft of the spare parts, it all contributed to the lack of trust in the proposed solution.

3   ENGINEERING COMPETENCES AT THE CRUCIBLE

What insight does this case give us into the requirements for adequate engineering education? By means of internships in developing countries I think we are taking the engineering education to a next level. A more conscious deliberation about the integration of technology into an (existing) social and institutional environment is mandatory. Also required is the ability to respond to new and surprising challenges in creative ways. These two demands go beyond the usual understanding of the importance of communicative abilities of engineers.

Let me explain that. Stressing communication skills as necessary for engineering has become commonly accepted. The usual training in communication can be described as shown in figure 1 below.

Inside: communication

Outside: effective implementation

Fig.1. Two spaces – inside and outside

This model reflects the usual subject – object scheme in science. At the inside we have subjects with knowledge consisting in pieces of the puzzle, at the outside we have the forces of nature, or the forces of the market etc. It is generally accepted that communication is necessary to fine-tune the different contributions and to be effective in the application of technology. We can put *communication* at the inside over against *implementation* in the outer world. A group, or a society, needs to find common understanding, agreement on the important issues in order to be effective. For effective cooperation the different stakeholders, in the process, need to communicate. They need to create a common understanding or mental model of what they want to achieve. Usually training in communication abilities is required to evoke more commitment to each other, listen better, take the different contributions from each other into account, and coordinate affairs internally (Feely & Harzing 2003). All this is required in order to have a bigger impact on the realities of the outside world, in terms of good results and effective production. Many training courses contribute to that objective.

That is not sufficient anymore if we have to deal with cultural differences. Such cultural differences originate from different historical paths taken by different communities. For that reason they need to be understood from a larger time perspective derived from the history and tradition of a particular society (past). On top of that, in intercultural management it is necessary to sort out which cultural code should, at which point in time, receive priority and this needs to be figured out in view of new imperatives that need to be met (future). This can be illustrated in figure 2 below.

Inside: communication

History, tradition, values
(past)

Imperatives, priorities
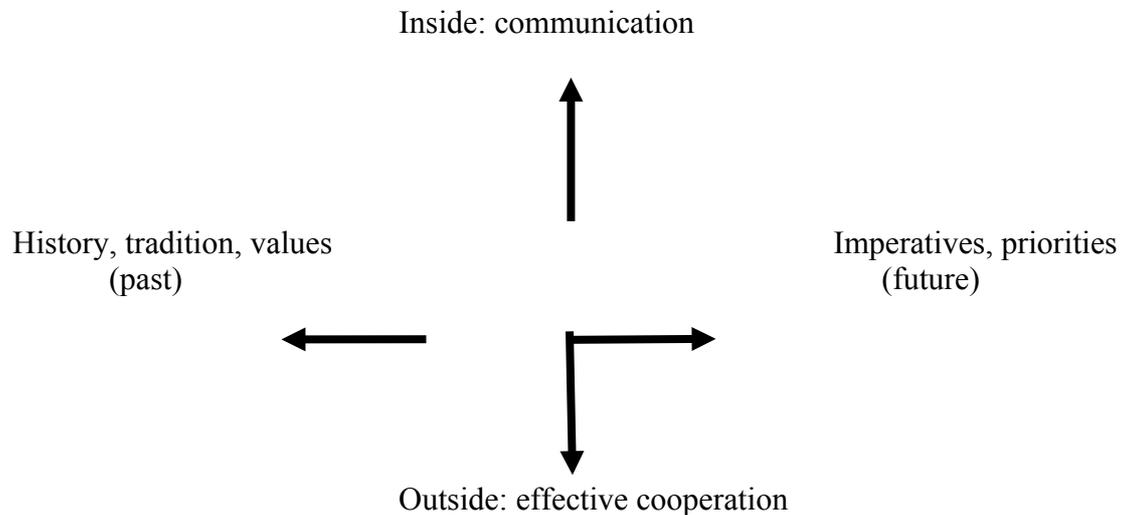(future)

Outside: effective cooperation

Fig. 2. Two spaces, two times

In other words, effective cooperation across cultural differences, does not only anymore involve the space axis between inside and outside, but also the time axis of past and future. In order to cooperate effectively (outside), communication is necessary (inside) but this communication needs to take into account different historically constituted values shaping human behavior (past) and it also needs to take into account the right imperative to be followed at a given moment in time (future). The important thing is, that orientation on past and future becomes an unavoidable necessity. This is extremely important, because it appears now that orientation on past and future is becoming indispensable in order to get the work done. Our industrial society has a long tradition of blinding off this broader perspective of human orientation and destination. During the last 40 or 50 years the communicative dimension, claiming respect and valuing each other's contributions, has slowly become indispensable for effective cooperation. The intercultural debate now forces us to make the historical dimension (values, common ways of life) and the future dimension (new imperatives and priorities) also an indispensable part of such communication (Kroesen 2014).

Already the setup of these internships gives a perspective on this development. Most of the students participate in an internship as part of a minor of half-a-year, during their bachelors study. In this half-year minor, they are prepared during a period of three months for these internships by following courses on entrepreneurship, the history of development policies, intercultural communication and project management, including business and finance. Role games and the interpretation of practical cases are an integral part of this course. The intercultural debate in, but also outside the Netherlands, has been framed to a large extent by two sociologists of Dutch origin, Hofstede and Trompenaars (Hofstede 1997, Trompenaars & Hampden-Turner 1999), who did a lot of quantitative research on cultural differences. Similar to the long list of values that can be mentioned in virtue ethics this as well leads to a list of values, among others power distance versus egalitarianism, community spirit versus individual judgment, traditionalism versus initiative, status by position or by achievement and labor etc, with percentages exactly indicating the differences per national culture. Always when such differences between cultures are listed, the question emerges

which one is better or worse, or by what criteria some priority can be established. I would suggest that there is no such criterion, except one: timeliness (Kroesen 2014). Timeliness means: a concrete historical constellation requires a specific priority, which is good for that constellation. Often such timely priorities are path dependent, which means, dependent on the trajectory a specific society or group has gone through. They should also be responsive to the constraints of this trajectory, and to the options that are open for future action from this perspective (Deneulin 2003). For example: sometimes one just should be obedient, and follow the group, but at other times one should be critical and independent. Inasmuch as we have to deal with always new situations we need to remain open and cannot make decisions in advance, at least not for novel situations and problems. We cannot do otherwise but listen to the imperative of each new historical situation.

4   DESIGN AND WORLD MAKING

Actually technology and design is in this way becoming part of the human endeavour as such. The everlasting question from where we come and where we go is becoming part of technological design or, the other way around, the design of technology is becoming part of this continuous historical dialogue. Different technical designs promote different values. In turn different values materialize or are incorporated in different design options. In designing an information system, for instance, hierarchical values or more egalitarian values will predominate according to the accessibility of the information to different positions within the hierarchy (Friedman e.a. 2006). This is a matter of choice and these choices are informed by value priorities about which we judge, but in this way our judgments and decisions as of this moment create the world in which the next generation will live. By designing technologies we are also creating institutions and by creating institutions we are creating future societies and opening up and closing of historical paths.

These considerations are the more important if we take into account that by its nature, technology implies large scale. Only thanks to large scale use technology becomes accessible, affordable and profitable. The large-scale of technology always entails the cooperation of a great many different stakeholders and actors and for that reason also a great many different interests and value laden perspectives. And these need to find common ground and orientation in order to be implemented. A technology often can only be effective if these different interests and values are coordinated, if they open up and listen to each other. We move through time as a society, just like we move in language, by means of grammar. The moods of grammar reflect our cooperation and discussion, conjugation and inclination, and our being singled out.

The crossroads imagery we used before can explain that more accurately. In science we may have to deal with subjects and objects, thinking and space, mind and matter. But as people living their lives in concrete historical and political developments we are not that much in control. Often we are thrown beyond ourselves into situations we do not understand. We feel lost, because it seems that nothing works in this new situation as it worked before. A new *imperative* makes itself felt and needs articulation at the front of the future. It's really new. It wasn't there before. It is not just new to you or me individually, but new to all of us. We don't even have the words for it. We use some familiar names maybe, but we have to adapt them to the new situation in order to express the new element. Environmentalism is such a word. The word "environment" already existed for a long time. But now the word environmentalism entered our vocabulary. It expresses the urgency to take the vulnerability of our natural environment into account. In former times it was not necessary, because nature was overwhelmingly powerful. Now it has become vulnerable. It is the experience of an imperative, not the result of an analysis in the first place. As soon as we start analysing we start to diverge, even if we recognize the new imperative. Probably we disagree as much about the problem as about the solution. That is where in grammar the *subjunctive* use of language sets in. In figure 2 above we called this subjunctive the inside reality of intersubjectivity, where people are inclined to adapt to each other. As different individuals and subjects we try to join each other with

proposals and propositions to make. We propose to each other. We invite each other to take over our point of view. In course of time we may find some common ground and shared understanding. Thanks to a shared history some agreement develops about shared codes. There phase 3 sets in, the phase of having a common history and tradition, a shared approach of reality, common ground. This is the phase of the *participative* mood, in which a shared history and common experience is expressed. Finally the new imperative can be institutionalized in the outside world. For instance the imperative of environmentalism may in part be realized by the introduction of the an electric car. We might find more such solutions. Then phase 4 sets in, the *indicative* phase, the phase in which we can point to concrete results: here it is! That which first was a problem has found a solution and that solution has now become a fact of life. This hermeneutic circle going from *imperative* to *subjunctive*, to the *participative* mood and finally to the *indicative*, reflects the circle of life (Rosenstock-Huessy 1963). It is continuous, and as well repetitive as creative. By understanding this fourfold circle we may therefore have a better understanding of the sentence I started with, namely that engineering and technology reintegrate dead matter into the process of life. It is the most beautiful definition of technology I ever heard. This hermeneutic circle is at the same time a process of world making. Our solutions are the basis for future developments, future flourishing, future problems.

Everything said so far about the plurality of values, communication etc. is more emphatically true in intercultural management, because there is a wider range of values between different streams of culture. The gap between traditional values and the new values derived from Western modernity is larger. It is more difficult to achieve cooperation and even more difficult to get transparent governance, technology policy and regulation in place in developing societies, due to the different and conflicting value priorities. These societies happen to be at the crucible, at the interface of different values and cultures (Tshikuku 2001, Jackson 2011, Ayittey 2006). They have to find new solutions, to create a new world for the next generation. In many developing countries a transition is taking place between traditional and new and this leads to sort of a twilight zone. Old values are not functioning anymore as they once did. But a new set of values is not commonly accepted yet. In such a crisis situation often a society receives the worst from both, past and future (Rosenstock-Huessy 1993).

5   VALUE SENSITIVE ENTREPRENEURSHIP

This theoretical exposition may sound rather abstract. So let me give some more examples. First a personal memory. I have cooperated with a consultant in civil engineering who worked for a long time in Bangladesh for a government agency on water issues. Like so many people he was depressed by the sight of the many rickshaws which occupy the streets of Dhaka, looking for customers and working hard for little money. If a farmer does not have any means of subsistence or lost his land due to debts, he will go to the city and become a rickshaw puller. My friend the engineer asked himself – he told me the story himself – whether these rickshaws and the life of the pullers could be improved by means of a gear. During three months in the evening he worked on the design and in the end he had figured it out. By the implementation of his invention the rickshaws would only increase in price by one or two dollars (it was in the 90s by then). But then he discovered that his invention would not work anyway... Why not? It turned out that the rickshaw pullers do not own the rickshaws themselves. And those who owned the rickshaws did not care about his new invention. They rented the rickshaws and they could find customers in abundance and they didn't care about their hard labour. It's Bangladesh, you know. So, he stopped there.

Reflecting on the case it is easy to see that the technical innovation bounced back on the institutional arrangements in Bangladesh. In terms of figure 2 a new imperative (phase 1) bounced back on existing institutions (phase 4). And these institutional arrangements in turn are a reflection of the cultural values predominant in Bangladesh, such as high power distance, low esteem of labour, and an indifferent attitude of people of high status towards those at the bottom of society. It

is impossible to innovate the technology of the rickshaws without a cultural and institutional change. My friend gave up. But in a sense the story continues. I was surprised to find out a few years ago that a Dutch NGO, One World Foundation (www.1we.com), is now involved in entrepreneurship in rickshaw services. Normally a rickshaw puller earns three dollars a day and he has to pay two dollars for the rent of the rickshaw. What's left is one dollar, just enough for a meal of rice for the family. But this NGO installed a rotating fund for leasing rickshaws. If the rickshaw puller hires a rickshaw from this NGO he actually participates in a microcredit system and after a while he has paid enough to become the owner of the rickshaw, thus bypassing the usual rickshaw renters and starting a business of his own. It seems to work, since a growing number of rickshaw pullers participated in and even left the system already. But again we have to reflect on the institutional and cultural change which is promoted in this way. This rickshaw puller is now turned into an individual entrepreneur, and the Dutch NGO is promoting a more egalitarian social system within the hierarchical Bangladeshi society. The Dutch NGO as well as the rickshaw pullers following this line of action do intervene in the value system of Bangladesh and change its institutions. They introduce new values, different institutions and all that is what I call "world creation" (Cristaudo 2013).

It requires very specific engineering competences to invent and implement a business plan like this NGO is doing. The case is therefore instructive. The civil engineer I mentioned earlier was so much focused on the technology that he couldn't continue from the moment he discovered that the problem was not only with the technology, but with the institutional and cultural environment of Bangladesh. He was very competent but in a limited sense. The Dutch NGO installed a rotating fund for buying and selling rickshaws, and on top of that it put in place entrepreneurial training schemes for the rickshaw pullers and for their counterparts in Bangladesh and it took off.

Nevertheless, it is not easy to be successful even with such an entrepreneurial attitude. Two cases from interns in Surinam can illustrate this. The first one is about a bakery in Moengo (Hof & Spoelder 2012). Moengo is a small town of nearby 10,000 inhabitants at two hours distance from Paramaribo, the capital of Surinam. In former times it had more than one bakery of its own, but during the jungle war between two competing factions of the Surinam Army in 1986 during the military dictatorship all of this was destroyed. But after that for the people that returned, the bread would only come from Paramaribo, transported by car each day, produced in a factory. An old lady was daring enough to invest in a small bakery in which bread was baked in the old way. The oven is heated by burning wood in it. When the wood is burned and the oven is still very hot bread can be baked in it and the result is very tasteful. Two female students from industrial design took up this assignment. The assignment was to build the oven with local materials available and design a business and marketing plan by which the enterprise could start. The first meeting with this old lady was not very promising. The two students wanted to talk about the oven immediately and discuss the design options and the place of it and the money involved etc. But they had the impression this lady seemed to keep them at a distance and on their inquiry it seemed that she did not have the money either. Within a week I got a phone call from the two students to please put them on a different assignment. This one would not work. After a talk with the old lady it appeared that she did have the money and was willing to build this oven, but she felt overruled by the students and was hesitating to trust him. I gave the advice to the students to visit the old lady once more and chat about a lot of things and only return to the issue of the oven after they all felt comfortable with each other, say after there had been some laughter. The advice worked. They went to work in building the oven with the help of a former baker who had worked with this type of ovens in the past, an old man also. The two students were very much on the job and the old man enjoyed their energy, although they had many quarrels with him about the materials and about the design and the way to make progress. I think, if this old man wouldn't have liked the positive energy of these two girls, he would have left the project. He must have felt insulted many times, because they didn't want to

listen to him and didn't respect his old age, and they were very direct. They were focused on doing and finishing the job. Nevertheless, it worked, and the oven was finished. Time was over for the students and they had to leave. They were so much focused on the oven itself that they didn't have the time anymore for the business plan. But this issue was solved by the old baker. He had worked as a baker in the past. He baked his bread and bicycled through the neighbourhood each day and he sold it each day, because people just loved it.

Other problems, however, lurked around the corner. The baker wasn't paid sufficiently. The old lady borrowed some money and had to pay back, but on top of that: the land on which the oven had been built was owned by a relative of hers. The land was just laying idle and he agreed to lend it to her without compensation. But now he heard that this bakery was so successful, he came and asked for his share. Although we wouldn't think of that as a very elegant thing to do, it is a very common practice not only in Surinam but also in many African countries. Family is all. Family solidarity requires that you do not make a point of the use of your land for the benefit of another family member, especially if you do not use it yourself. But if the other family member starts making money with the help of your property the same value of family solidarity legitimates to withdraw the original agreement and require your family members to share the benefit. Family is all, isn't it? In this way not enough was left for the baker. After half a year the baker, not having been paid for a long time, quit his job and the oven stood idle from then onwards.

In Surinam as well as many African countries it is habitual to maintain a sort of an internal bookkeeping system of charitable deeds between family members, neighbours, clan members etc. If somebody is successful in a business, his private property or a part of it is often morally claimed by family members in need. Outside the family there is less solidarity and distrust easily creeps in. This moral attitude also became an issue in another entrepreneurial initiative in Surinam, this time a craft shop (Starre e.a. 2013). Now I want to explain how this – call it – jealousy was cleared away by an effective strategy of the students. A schoolteacher (female) in Moengo put in place a small craft shop where handicraft (garments, bags, shawls etc.) was sold to tourists passing by. The craft shop was in need of innovation and the students did some fundraising in the Netherlands and the schoolteacher in Surinam borrowed money from the bank. The assignment of the students was to innovate the shop and look for ways to enlarge the production and bring the crafters together in a cooperative effort. The innovation of the craft shop was not the big problem. It was not easy, because the Dutch students had to deal with Surinam businesses and that already takes an effort in intercultural communication, as well as alertness in order to prevent being cheated etc. Nevertheless, the enlargement of the production and cooperation between the crafters was the bigger problem. The students solved this problem by means of a two-pronged strategy. First they introduced an excel sheet to keep track of all the garment and other things produced in a transparent way. They calculated the innovation costs, the running costs of the shop and the overhead costs that needed to be put on each piece and on the basis of that they set prices for sale. Secondly, they had many meetings with the crafters and the shopkeeper to discuss the procedures and prices, explain the overhead cost structure, but also: have fun with each other and build relationships of trust. This two-pronged strategy of transparent bookkeeping and price calculation, and building up confidence by a long series of meetings laid the foundation for a cooperation between the crafters and the shop which still holds until now.

Clearly the students didn't need only the competence of designing a business plan, they also needed communicative abilities, like showing interest in each of the participants, bonding and creating trust and confidence. In the process they also changed the culture and institutional environment of Surinam. A schoolteacher would normally not be very transparent in dealing with uneducated women like these crafters. Power distance and difference in status would stand in the way of such egalitarian relationships. The excel form is maintained until this day, but the schoolteacher had to be reminded several times to maintain this transparency in order not to lose the confidence of the

crafters. In this way the power distance gap is closed a bit. On top of that group cohesion between the crafters and team spirit is promoted and thereby relationships of trust beyond family loyalties. The entrepreneurial opportunity couldn't have been realized without this change of the cultural and institutional environment. Engineers that want to be entrepreneurs as well, especially in developing countries, need these capacities. They contribute to the social transition taking place in those societies. And they need to be trained to be capable to do so in a responsible way.

6 TRAINING AND EDUCATION FOR ENTREPRENEURSHIP

Normally institutions of higher learning tend to emphasize that they offer unbiased, value free knowledge and skills. Since Weber science is supposed to be value free and it is only the political will of the scientists (or engineers) that introduces priorities and values into the debate (Weber 1973). However, sociologists of knowledge already taught us that even in the choice of our objects of study we already adhere to specific values and social priorities. Moreover, practical training and internships entered institutions of higher learning, first with the intention to prepare the students for their jobs in a merely practical sense, later and increasingly also to educate them and turn them into responsible citizens. The discourse of "competences" was introduced. With the introduction of entrepreneurship even a specific human type, endowed with a particular set of value characteristics enters the scene of institutions of higher learning (Isaacs e.a. 2007) as a matter of study and promotion. In intercultural management this trend towards value laden teaching is even intensified more, in that students have to learn to deal with different cultural value sets. Training is required to do so. Training in intercultural management is required in a twofold sense. 1. *Flexibility* is required to adapt to different cultural codes. When in Rome, act like the Romans, the saying goes. Students should be able to interpret concrete behavioural phenomena within a broader framework of cultural differences and be able to respect those differences in their behaviour. But there is yet another layer in intercultural management: 2. *Participation* in the institutionalization of a particular business culture at the interface of different values. We can also call this: world making. We may take the craft shop in Surinam as an example once more. The students succeeded in creating a more egalitarian business culture with a transparent tracking system by means of an excel sheet, and by means of many meetings, in order to build trust. This already involves the two values of egalitarianism and trust between members of different families in a situation where in principle family is all. This made the business more effective and contributed to the success. This is the job of creating a business culture and institutionalizing particular values. It interferes in the culture and institutions of Surinam.

It cannot be predicted in advance behind a desk how such a business culture should look like. It can only be developed by trial and error, by bad luck or a lucky strike, by listening and talking. Depending on time and situation, depending on the constraints and opportunities of the particular path the institution under consideration is following, a particular institutional innovation may be possible and even imperative. Imperative, because without it the business might not survive. This is what Porter pointed out in his concept of "economic culture" (Porter 2000). Not every set of values is equally conducive to economic success. Without due planning, labour discipline, initiative etc. a business might not be competitive and not survive in the market. Not every set of values is equally conducive to economic success in all circumstances.

Another example: in many sub-Saharan countries the cooperation of different ethnic groups (and languages!) in one enterprise often appears to be problematic (Kroesen & Rozendaal 2010). How to solve that issue in a particular concrete business plan? It means that either companies have chosen to confine their membership to one tribe or ethnic group, or otherwise they have to put in place a conscious strategy of training and education to make the cooperation work and to build trust. For instance, a company might decide to have the workers trained to work at different workstations in order to mix the different tribes. The decision might be taken not to allow ethnic languages in the

company and to wear the same uniforms or overalls and to install a strategy of intentional bonding between the different groups by means of identification with the company (Kroesen & Rozendaal 2010). Often also sectoral cooperation between different companies is problematic because of lack of trust. Often there is competition , but no cooperation between different companies, like there is in the Western market. This is due to the existence of closed in-groups in many African societies which results in the compartmentalization of civil society not allowing for changing coalitions and shifting memberships (Kroesen & Ndegwah 2013, Tack 2010, Kefale 2009). This has consequences for development, for instance in that chain management for vegetables may not only require cooling, but also large-scale cooperation, also over large distances and between different companies and ethnic groups. On top of that chain management requires accurate planning and disciplined and precise labour. These are not only technical innovations, but also institutional and cultural innovations, introducing different values. It is necessary to overcome the compartmentalization and lack of trust between competing institutions. In the West it is more usual that such companies do compete, but also cooperate. Although the Western world in its neoliberal fashion talks a lot about competition, turning it almost into a gospel, often people don't even realize how much cooperation in markets and between companies and companies and government institutions etc. is the actual basis and condition for such competition. It is just taken for granted that institutions and people cooperate even despite competition. In Africa or India this is more difficult. The experience of participating during an internship in such low trust societies for a while and learning to deal with institutional compartmentalization like in Africa and also India, often helps a lot to get a deeper understanding of one's own hidden values. In confrontation with the other I learn who I am.

In short, the students have to learn how technologies, values, society and development dovetail into each other in a business plan or a feasibility study. In a sense capacity is built at both sides, the students doing the internship and their target group. Building capacity for entrepreneurship in developing countries also requires the capacity to deal with these value related institutional matters, from the side of the students. I called this earlier: participation in the institutionalization of a particular business culture at the interface of different value sets. This is also an important issue on the level the design of a concrete prototype. Even this is, as stated before, not value free. That may mean, that if the students design a prototype for low educated practitioners, they should for instance be able to take this low level of education as a design demand for easy and simple maintenance and operation of the prototype. They have to show that they can give a comprehensive account of all these aspects in their business design or product design and in the end also in their report. In that report they are also required to reflect on their own behaviour in such projects: did they operate tactically and effectively in the context they worked in? What did they learn from obstacles they met, sometimes even from crisis situations?

7   CONCLUSION

The comprehensive project approach presented here is illustrated by many examples, in which technologies, values and institutions interact. In these examples the insight I started with is becoming more concrete, i.e. that engineering doesn't only reduce phenomena to earlier causes, but it makes causal relationships subservient to future imperatives. Doing so it integrates dead matter into the process of life. Engineering is only partly a matter of natural science. In its other half it is part of the social sciences and its mission is that matter should not matter in reaching socially desirable objectives. In engineering *causation* (by the past, by natural causes) and *destination* (by the future, by social necessities and imperatives) meet. By the examples mentioned it also becomes clear what this comprehensive approach means in terms of capacities. Future engineers need the capacity (learning goal) of what I propose to call "planetary movement". They have to move between different value sets. They have to create bridges between cultures, bridges also between past and future. In the competition between a plurality of different values there is no good and bad, higher and lower, backwards and modern. All values have value. But these many values are in need

of some higher value or meta-value that decides about their timely and temporary operation. I would consider that one value as the higher value that we all need to endorse. One categorical meta-value makes all values possible. It is the value to stop timely, and to move from one value to the other, before maintaining the prevailing line of action causes too much damage. It is the power to change timely and the power to push through only temporary. It is the value and capacity for timely change. The perception of new imperatives and needs makes us change. We have to alter our course and open new avenues into the future. And yet these new values need to be connected to and coordinated with older layers of culture like respect for the elders, valuation of the moment (instead of too much planning) and attention for personal relationships. The all-important question is: when and how long? Therefore we all need the capacity for planetary movement, (i.e. moving, derived from the Greek "plano"). In the earlier days the earth and the stars were considered to be fixed, while the planets were moving in unpredictable windings. Nowadays human beings themselves should behave like the old planets, constantly on the move and alternating between different cultural repertoires in an unstable universe. It is in such processes of continuous revolutionary change that the future is engineered. It is engineered by the capacity to communicate in a "planetary" way, moving between different value sets, creating a bridge between them and creating temporary worlds that humans can inhabit.

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