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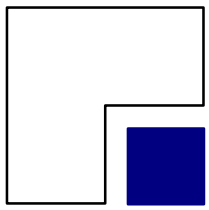
Path dependency in unplanned R&D

by Prof. Dr. Peter Augsdörfer



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Heft Nr. 4 aus der Reihe
"Arbeitsberichte - Working Papers"
ISSN 1612-6483

Ingolstadt, im Mai 2004

Path dependency in unplanned R&D

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Abstract

This paper confirms the importance of path dependency in the accumulation of firm-specific technological competencies. It shows that firms are guided by the selective logic of path dependency in their innovation process, even if it is not management taking the decision to invest in a new business idea. The research focused on the output of bootlegging, which is defined as research in which motivated corporate entrepreneurs pursue innovative activity, which they themselves define and secretly organise. Bootlegging emerges as an incremental continuous trail-and-error learning process in R&D. Total anarchic chaos and the violation of strategic direction settings as feared by some managers is not going to happen.

Keywords: bootlegging, path dependency, strategy, learning, uncertainty

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1. Introduction

The importance of learning and competence building in corporate R&D is widely recognised (e.g. Freeman, C., 1982, Pavitt, K. and Patel, P., 1991a, Miyazaki 1994). A particular productive form of learning is the process of 'learning-by-doing' (e.g. Arrow, K.J., 1962, Hippel, E. von, 1976, Rosenberg, 1982). Detailed studies on this learning process have identified the trial-and-error problem solving as an important source for incremental innovation (e.g. Allen, Th.J., 1966, Wheelwright, S.C. and Clark, K.B., 1992, Augsdorfer and Harding 1995). Since new competence building is to a large extent 'path dependent', the spectrum of corporate investment possibilities is reduced to the variety of competencies along the trajectory (Malerba and Orsenigo 1993). The set of (technical) relationship or 'value network' becomes a powerful barrier to embarking on a different knowledge trajectory (Rycroft, R. and Kash, D. 2002), (Christensen 1997). The implications for R&D and its strategy are important and rank quite high amongst management issues (Pavitt, K., 1991, Mintzberg, H., 1994, Scott, G., 2001). Strategy setting is the very function of management: to direct the organization toward more favourable environments. But strategy, defined as a set of principles, can only broadly guide decision-making about innovative activities. Firms have only a limited ability to change product and technologies as their possibilities are limited most of all by the objective characteristics of the knowledge base within they are working (Dosi 1982). In other words promising areas of research lie in the proximity of their competencies or in that of their suppliers.

In order to verify the 'path dependency' argument, this research looks at a very special form of innovation: the bootleg innovation, where researchers simply ignore management strategy. In covert action they (themselves!) decide to invest company resources and pursue innovation ideas. There is no management control to stop their creative freedom:

Consider this case: one day in autumn 1982, Dr. Cook a senior researcher at Beecham (today: Glaxo Smith Kline), entered his manager's office with what he considered to be a brilliant idea: 'I have just read in an engineering magazine that one of our equipment suppliers now markets a novel membrane filtration system which is being developed for use on dairy products and fruit juices. I think that we should take a closer look at this new technology and see whether we can apply it to the problem we have with the extraction from fermentation broth of compound X.' The blunt answer of his manager was 'No!' This new idea did not fit into his manager's vision of the further development of the process, although it could have been an improvement for 'Augmentin', one of the best selling drugs in Beecham's history.

However, researchers like Dr. Cook and his team did not give up so easily. They embarked on a period of twelve months' undercover work, involving also the membrane filter supplier. This covert activity would eventually lead to the investment of tens of millions of pounds in a new production facility incorporating this new technology. Today, the membrane filtration system has become a commonplace process for treatment of many fermentation broths and for the subsequent extraction of fermentation metabolites. It is both environmentally friendly and significantly reduces product cost.

Should managers be concerned about such disregard of their authority? Are these autonomous activities even profitable for the company? While some insights are beginning to emerge of how planned research can be organised, there is far less understanding about the organisation for bottom-up creativity and the fuzzy front end of innovation genesis for new business ideas. This paper explores the learning processes of bootlegging based on empirical research in 57 companies. The main focus of the paper is on the strategic fit of bootleg innovations. If the path dependency argument applies, the majority of bootleg innovations should be within the search trajectory of the firm, probably within the strategy and useful for the firm.

2. Definition of Bootlegging

Cases as the above mentioned, where individual and organisational entrepreneurial activity are not identical, were first described by Knight in 1967. He gave the phenomenon the name 'bootlegging' [Knight 1967]. In this research, it is more precisely defined as: research in which motivated individuals secretly organise the corporate innovation process. It usually is a bottom-up, non-programmed activity, without the official authorisation of the responsible management, but for the benefit of the company. It is not in the department's action plan nor are there any formal resources allocated towards it. [Augsdorfer 1996]

There are other names for it and some are firm specific: friday afternoon work, work behind the fume cupboard, free lance work, under the counter work, under the table work, pet-project, discretionary research, intrapreneurship[1], free wheeling, illicit research, scrounging , renegades work, work in the shadow- or underworld. Also very imaginative are the French, which call it 'research under the wick' or the Germans, which call it 'U-Boot', where a new product suddenly emerges on the 'commercial surface' like submarines suddenly breaking the sea surface. 'Skunk work'[2] is quite frequently, but falsely used as a synomym for 'bootlegging' (Peters 1988a), (Owen 1990), (Dickson et al. 1991) and (Trott 1997).

[1] Intrapreneurship originally had the meaning of corporate entrepreneurship and did not mean bootlegging. Over time, however, it was used as a synonym for bootlegging by a number of people.

[2] 'Skunk work' was originated by Johnson C.L. at Lockheed Corporation in 1943. The department LM Aero–Palmdale got its nickname, Skunk Works, from the "Skonk Works" of Al Capp's famed L'il Abner comic strip. Kelly Johnson was the founder and led Skunk Works for 32 years until retiring in 1975. It is a kind of elite department working officially, but secluded, on a given project alongside the formal organisation. Skunk Works created the XP-80, America's first jet fighter; the XF-104, the first Mach 2 fighter; the U-2 and SR-71 reconnaissance aircraft; and the F-117 Stealth Fighter. The difference to 'bootlegging' is that is has the approval of management.
(http://www.lockheedmartin.com/careers/campus_recruiting/pacific/skunk_works.html)

Forty one different sources in literature were found to discuss bootlegging. Why publications peaked around 1991 remains unclear. Table 1 indicates the authors basic attitude towards bootlegging. A significant number of authors has a positive attitude towards bootlegging. Only three think it is worthless research. If there was no clear statement for or against it, it was evaluated as a neutral attitude. Most authors quote a case or describe it in a few lines. Only five publications make it the main focus (marked with (x) behind their name). Amongst these, Hoffman's original research did not actually focus on bootlegging and Pearson based his assumptions mainly on a case from Nayak and Ketteringham's book (1986), which appeared to be not true.

Therefore, it doesn't come as a surprise, that its evaluation with regard to its contribution towards the corporate objectives offers a non consistent picture. For example, Cyert and March (1963) point out that only sometimes can one expect major innovations to result from bootlegging. Four years later Knight (1967) contradicts and speculates that the majority are radical innovations. Burgelman (1986) found that bootlegging mostly results from a technology push. But two years later Peters (1988b) identified ignored customer proposals as one of the main sources. Hoffman (1991) comes to the conclusion that bootlegging is more successful than normal research. Roussel et al. (1991) on the other hand disagree and say that bootlegging has occasional success, but countless failures. This confusion in literature demanded research designed to gather first hand information.

3. The Function of R&D Strategy

In a very broad sense, Arrow (1969) defines the output-function of R&D as to advance technology by reducing technological uncertainty. However, the mere focus on technological progress and technological uncertainty alone seems to be insufficient. Von Hippel (1976) correctly points out, that it is very unlikely to identify new business opportunities without knowledge of the market. Consequently

efficient R&D work ideally deals with both the reduction of technological uncertainties through the accumulation of technological knowledge and the reduction of market uncertainties through advanced market knowledge. Simplified , providing technology based business opportunities for the company includes two main capabilities. First, it is one of monitoring and identify technologies with prospective significance to the company. And subsequently, once management has decided for a new business idea, it is one of innovation development (Cohen and Levinthal 1990). The main difference is that, whereas the first is diverging the focus of the laboratory, offering a choice of investments in new business areas, the second has a clear focus, converging towards the release of a new or improved product or process. Moreover, as the speed of knowledge assimilation becomes increasingly important [Pfeiffer 1985], it seems highly desirable for companies to optimise the R&D learning process. In the case of convergent R&D, product or process innovation development results in refined methods of project management. On the other hand, in divergent R&D, a way to establish organisational routines for efficient search is strategic planning. Thompson (1969) defined it very nicely: "*If an organisation is to act as an entity, it must have a 'body of doctrine' that explains 'what it is doing and what it ought to do*'". The increasing number of useful and useless tools developed to serve management in its strategic R&D planning is reflecting this trend.

The red herring is that the (technological) future is unknown and strategies trying to determine precisely experimental learning often fail to recognise valuable business ideas. Peters and Waterman (1982) refer to the fact that nearly every major breakthrough had difficulties in being acknowledged as such. Well known examples for wrong predictions are numerous in business history. A famous and often quoted example is IBMs late acknowledgement of the PC market, because its management thought to sell only five computers in the USA (Freeman 1982). Interestingly, even some of the early 'high priests' of strategic planning, Ansoff and Stewart (1967), warn about strategic planning close to the 'state of art' and say it can only be guesswork. Without any doubts, there seems to be a dilemma between

strategic planning on the one hand and experimental learning on the other (Kanter 1983).

Bootleg researchers liberate themselves from the dilemma because they work in the underground. There is no management filter to stop their ideas. In table 1, a majority of scholars estimate that bootlegging occurs because the idea is difficult to justify, quite risky and more radical in nature. If this is the case, bootleg innovations would be in stark contradiction to the strategy outlined by the firm. In turn, more incremental innovations would underlie the rule of path dependency and relate more to the firms current knowledge base, as such follow/project the technological trajectory of a firm. This represents the central hypothesis of this research.

4. Methodology and Empirical Evidence

The sample contained 57 companies in the three European countries England, France, and Germany. The choice of the companies was arbitrary, except that it had to have a corporate R&D department. Companies were selected with research activities in the following fields: software, telecommunication, computer science, electronics, chemical, mechanical engineering, new materials science, and health care. The multidisciplinary, and multi-nationality of the sample assured to capture as many aspects of the problematic area were strategy might conflict with creativity. The methodology of the study focused on qualitative instead of quantitative aspects. A total of one-hundred and twenty three semi-structured interviews were carried out. In general, it was tried to question both the head of R&D and a bootleg researcher. Of course, the common caveats of a quality based research methodology apply and diminish the value of this research. The tables used in this paper shall provide a rough picture of significance and have no true statistical value.

A fundamental difficulty was as how to measure the benefits of bootleg research. Measuring innovation is generally very difficult if not impossible (Jewkes et al.

1969). Both from a theoretical and a practical point of view it appeared therefore desirable to carry out a comprehensive study about bootlegging interpreting 'corporate valuability' as broad as possible. Thus, the value of bootleg research for a company can have both tangible and intangible forms. Tangible results of bootleg research have clear economic benefits in terms of profit increase for the company. Intangible benefits increase the technological knowledge base through competence building. The first one seems relatively easy to measure. It can be defined through success or failure of the innovation resulting from bootleg research. Intangible benefits cannot really be measured. At best they can be expressed indirectly. Are they an accelerator on the technological trajectory of the company (technology advancement) or is the knowledge not at all useful for the company?

5. Findings

5.1. Specification of Bootlegging

Bootlegging could be found in all industrial sectors investigated. On average, five to ten per cent of the researchers in an R&D laboratory emerged as bootleg entrepreneurs. Bootleg time accounted for approximately five to ten per cent of working hours. Moreover, bootlegging varies over time, the definition of what exactly is working time, paid or unpaid overtime is blurring, and the fact that 'bootlegging' can be interpreted broadly or narrowly adds additional uncertainty to this value. However, during the research, it became obvious that overstatements generally outweighed understatements. In other words, people liked to 'show off' by exaggerating. This fact would point towards an even smaller number of bootleg entrepreneurs in corporate laboratories.

In the early stage of innovative activity, very little difference exists between bootleg projects and 'normal' projects. Nearly all bottom up innovations begin their development without explicit, but often with tacit consent of management. The first steps of research usually consist of crude data collection, either in the form of small

experiments or literature reviews. The longer this learning phase and the more progressive steps are made is under cover, the clearer it becomes what is traditionally (commonly) understood as bootleg project. But also, the less is management inclined to support it explaining the different attitudes towards it.

Another central finding is that bootlegging is mostly incremental in nature. In particular, bootleg research focuses on the feasibility of new ideas and concerns both product and process improvements. The case brought forward by Peters and Waterman (1982) or Knight (1967) suggesting that bootleg projects are more radical in nature proved not to be the case.

Moreover, the focus of bootlegging in literature is predominantly on new product innovation (e.g. Hoffman 1991). This reflects a distorted picture of bootlegging because the development of completely new products represents only a very small part of bootleg activity. A more important purpose of bootlegging is for example pre-research for objective setting or product improvements. In total, the purposes fell into five main activities: (i) pre-research, (ii) product of process improvement, (iii) troubleshooting, (iv) new product and process development, and (v) purely scientific research.

(i) Nearly all bootleg researchers carried out pre-research. The notion 'pre-research' shall define research which advances the search for objectives for the annual planning system. In other words, the feasibility of objectives to be proposed is verified with the help of small experiments. The verification concerns both new objectives and continued objectives of the preceding year's research. The purpose of pre-research is therefore to avoid possible failure to meet those objectives.

(ii) Frequently, bootlegging was undertaken to improve existing products or processes. Improvements can either introduce a new or different technology or simplify the product or process. The overall design of the product does generally not change and therefore it can be defined as incremental improvements. Mostly, it concerns technological solutions to key parts of already existing products or

processes. The improvements are not always completely developed. Pre-stages, in the form of ‘prototypes’ or ‘feasibility studies’, are quite common. That way, researchers put a handle on technology. The pre-stages rank from preliminary data collection, to the feasibility stage showing the basic principle of an idea, to the prototype stage which is a first version of the final product.

(iii) Troubleshooting as a purpose for bootlegging was only carried out in certain laboratories. However, when it occurred, it accounted for quite a significant amount of bootleg time. ‘Troubleshooting’ describes a favour for a colleague or another department within the company. Usually, the help is urgently required because damages, delays, or losses are likely to occur. The cause of the problem is often due to human error. Troubleshooting covers up the errors for fear of cautions. Most of the time, it is a mutual favour in the sense ‘if you scratch my back I’ll scratch yours’.

(iv) Although most case studies provided by companies concern new product development, the impression is deceptive. The interviews showed that the development of completely new products or processes in bootlegging does not occur very often. More frequent, but still rare, are the development of early or advanced stages (prototypes) of new products or processes.

(v) Bootlegging, specified as purely scientific research was found in very few cases and had no direct benefits for the company. Indirectly of course, a company always has an advantage if the knowledge is diverse (Henderson 1994). Occasionally, an academic paper comes out of such research which then could contribute for the branding of the company.

The distribution of these five specifications varies among companies and over time. It also seems to be associated with the industrial sector. For example, troubleshooting was not found in the research laboratories focusing on new materials. As far as the data showed, troubleshooting was primarily found in the engineering and software industries. Likewise was the case of pre-research. In

some corporate organisations the pressure was at times so enormous that it could not be carried out. Finally, purely scientific research was more often found in ‘basic research’ laboratories. The example of an engineering company in table 2 is chosen to give an understanding about the approximate distribution.

5.2. Product Technology

A large majority of companies characterise the average bootleg innovation as a ‘technological improvement’, either by adding functionality or replacing ‘technological imperfections’. However, it has to be added that the cases provided some evidence that the improvements are based on ‘ingenious’ solutions. In table 3, thirty-two firms made forty-eight statements about the distribution of the technological nature of bootleg research. The focus is less on the search for new products or new markets using existing technology, but more the love for a technology challenge. Sometimes improvements are immediately integrated into existing projects. This ‘up-dating’ of products is not directly recognised by management as it often misses out an official decision making process.

In a few cases beside new research topics, research from previous projects had been continued. Often researchers are still ‘emotionally’ connected to the technology of ‘old projects’. Sometimes they intentionally try to keep their knowledge from old projects up to date with bootleg research. It might become useful again for a further, similar project. Another characteristic of bootlegging includes fun and interest for fashionable topics such as ‘artificial intelligence’ or ‘small computer gimmicks’. As the examples already indicate, those topics seem to be particularly common in software technology. However, often software gimmicks have been evaluated as ‘useless’. In spite of this, in one case a major new business stemmed from such a fashionable topic, and in another case a gimmick had a beneficial effect on the company’s sales and public relations. It reinforced its corporate reputation as a high-tech company.

Products and technology become more and more complex. As a result, time and knowledge constraints make it impossible to develop whole products or complete

new technologies ‘single handed’. This provides one explanation for the high number of improvements among bootleg projects. Improvements seem to lie more than any other bootleg project within the range of what is possible for a researcher in terms of money, time and expertise. For example, the development of a modern paint spray-gun requires expertise in electronics, mechanics, fluid mechanics, and pneumatics that can only be achieved with combined skills of a research team. Sometimes however, there were whole research teams working on a bootleg project to gather all the expertise together.

5.3. Business Needs

Most bootleg products are considered to be commercially valuable for the firm. From an earlier paragraph it is known that most bootlegging concerns incremental improvements of the existing product range. Those products are already officially approved by management. By deduction, improvements of approved products should be equally meeting the business needs. In table 4, thirty-nine companies made fifty-one statements, clearly in favour for bootlegging meeting business needs. Only five called the value into question. Doubts existed mainly about software development and scientific research.

The analysis of the case studies shows an unexpectedly high acceptance of bootleg products. However, when interpreting the results it should be borne in mind that firms relate to pre-selected cases. They have idiosyncratic reasons to provide successful bootleg case studies and they also build on the heroism and fascination of bootlegging. An overview can be seen in table 5 and the result seems significant.

Twenty-six projects have been further developed, or are expected to be further developed within the formal framework of the companies. Twice only parts or modified versions of the bootleg innovation were considered to be useful for the company. One company could not make any statements as to whether the bootleg products would be accepted or not, because the bootleg activity was still ‘under

cover'. Another company is still seeking an application for its bootleg innovation. Three bootleg products were not pursued further. In the case, the investment to launch the product on the market was too high. However, the idea was promising and the company patented the idea to get income from patent rents. In three cases, bootlegging had only scientific value. One of the researchers voluntarily admitted that the company is probably not interested in his innovation, because it had purely scientific value. Finally, there was the case of company where management simply would not take a decision after being confronted with the proposal. The researcher continued to bootleg.

5.4. Uncertainty

Another element which is important for evaluating bootlegging is its uncertainty, more specifically the technological uncertainty or its technological success rate. There is irrefutable evidence from the statements that bootleg activity is generally considered to be connected with a low degree of uncertainty. The research showed that generally bootleg researchers use their resources carefully, simply because they are scarce. Bootleg research causes no or only minor additional costs in terms of the number of bootleg entrepreneurs, time consumption, as well as tools, material and equipment. The calculation of uncertainty is easy to demonstrate: the number of bootleg entrepreneurs has to be multiplied by numbers of hours spent for bootlegging. This value has to be set in comparison to total manpower in R&D. According to the results of this research: five to ten per cent of bootleg entrepreneurs multiplied by ten per cent of their working time equals less than one per cent of the total working force. As one R&D manager confessed, 'bootlegging is peanuts in comparison to the enormous money spent in R&D'. Material, equipment, and tools are mostly already to hand in the laboratory. The expenses for materials are usually small as bootleg researchers showed to be masters in improvisation. Thus, by far, the biggest danger for all companies interviewed was that official projects could be jeopardised through bootleg activity. A more detailed classification of the distribution of statements on technological uncertainty can be found in table 6. Moreover, the majority of companies subscribe to a lower

technological success rate of bootleg projects in comparison with normal innovation projects. A possible explanation is that bootleg ideas, although incremental, are more technologically challenging and thus more likely to fail. Also, it has to be taken into account that most bootlegging takes place in a fairly early stage of the innovation process, where the uncertainty of failure is consequently higher. When innovations become official, most uncertainty is probably already reduced.

6. Conclusion

This study was motivated by the question how unplanned activity should be evaluated in the corporate context. What is the value of learning defined by researchers themselves and most interesting: is it contributing to corporate profitability? The results presented show clearly that bootleg research is likely to be beneficial for firms because it is a trail-and-error learning process along the firm's knowledge trajectory. This was manifest in several of the findings:

Firstly, bootlegging concerns very often product or process improvements which are incremental in nature. As such it has already passed the strategic filtration process and represent no contradiction to the strategic path the firm has embarked on. This finding is in sharp contrast to assumptions made in literature such as Knight (1967), Burgelman (1986), Roberts (1991) and Hoffman (1991). They assumed that in general, bootlegging would challenge the strategy and lead to new business. Authors like Peters and Waterman (1982) as well as academic scholars like Thompson (1969) even observed a large number of radical breakthroughs developed in bootlegging. Why this different view? The most plausible explanation is that their focus of research has been selective on radical innovations rather than including the complete research output. Sharing their perspective it seems natural that breakthroughs and radical innovations are more likely to be outside the strategy.

Secondly, bootlegging makes a positive contribution to the company's goals, as the majority of companies confirmed that bootleg output meets their business needs. A number of scholars have tried to achieve this result in a more or less inductive and intuitive way (Peters and Waterman 1982). Their arguments focused by and large on radical innovations (Burgelman 1986). However, some authors remained sceptical about benefits for the company. They correctly referred to the occasional success which becomes public against the countless failures which are never made public (Roussel et al. 1991). Failures, however, are significant for all kinds of research and are not symptomatic for bootlegging. As one researcher expressed it: 'to be a connoisseur, you have to drink a lot of bad port to find the good one'. The 'rejection' or 'acceptance' of new ideas always came after a deliberate decision by management. And moreover, the decision was mostly dependent on the availability of investment resources and competencies rather than strategic fit. The results highlight some important implication for both innovation genesis and strategy crafting. (i) One relates directly to the path dependency argument. Ideas don't develop by accident or in isolation. New ideas are somehow 'related to what researchers do'. In this sense, even new business proposals are rarely completely 'a priori' against the strategy. (ii) Secondly, it shows the limits of strategic direction setting. Most strategies were designed so broadly that they would include the large majority of the ideas created by bootleg researchers.

Thirdly, like most initial research efforts, bootlegging is usually not very expensive. The majority of bootlegging is pre-research for new ideas and resources consists mostly of slack resources (5-10%), which a minority (5-10%) of researchers use. Often they are prepared to invest additional spare time. From this, it follows that bootlegging has a low degree of uncertainty unless mainstream projects get delayed.

R&D managers afraid of loosing control can be assured that there is nothing to fear. A kind of self-organising mechanism is in place which concerns the technological projection of un-controlled innovative advances. The 'blind variation' (Cambell 1987 in Metcalf 1994, p.160) of bootleg innovation, which a priori is

considered independent of a managerial selective advantage, is not that blind. In other words, the innovations aren't of all sorts of things. The findings confirm by and large the selective logic of technological path dependency.

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Table 1 Bootleg Literature

Year	Author	Basic attitude (positve, negative, neutral)
1963	Cyert / March	Neutral
1967	Knight	Neutral
1967	Shepard	Neutral
1967	Gleicher	Neutral
1969	Thompson	Neutral
1974	Freeman	Neutral
1980	Thom	Neutral
1982	Peters / Waterman	Positive
1983	Kanter[3]	Positive
1985	Drucker	Positive
1985	Pinchot	Positive
1986	Hirota	Neutral
1986	Burgelman	Positive
1988a	Peters	Positive
1988b	Peters	Positive
1988	Burgelman	Positive
1988	Pinchot	Positive
1989	Bürgel	Negative
1989	Weiss	Neutral
1990	Alter	Neutral
1990	Brockhoff	Neutral
1990	Owen	Positive
1990	Mintzberg	Positive
1990	Pearson	Neutral
1991	Brown	Neutral
1991	Dickson et al.	Neutral
1991	Burgelman	Neutral
1991	Dougherty / Heller[4]	Neutral
1991	Roussel et al.	Negative
1991	Hoffman (x)	Positive
1991	Roberts	Positive
1992	Lengnick-Hall	Neutral
1993	Berke et al.	Positive
1993	Brockhoff	Negative
1993	Augsdorfer (x)	Positive
1993	Mezias / Glynn	Neutral
1994	Miyazaki	Neutral
1994	Augsdorfer (x)	Positive
1994	Pearson (x)	Positive
1996	Augsdorfer (x)	Positive
1997	Pearson (x)	Positive
1997	Trott	Neutral

(x) research object was bootlegging

[3] Kanter refers to Farbstein (1980), who's paper was not available.

[4] This reference was found in Dougherty (1992). The original paper could not be obtained.

Table 2 Example Of Engineering Company

Main activity	Percentage
Pre-research	40 %
Product / Process Improvement	34 %
Troubleshooting	20 %
New products of processes	5 %
Purely scientific research	1%

Table 3 Nature Of Technology

48 statements (32 companies supplied data)	Frequency of answers
Mostly technological improvements	21
Application of new technology	13
Technological spin-offs, experiments	4
Application of any technology	3
Continuation of previous research topics	2
More radical technological innovations	2
Fun and fashion topics	2
Search for novel application of existing technology	1

Table 4 Business Needs

51 Statements (39 companies supplied data)	Frequency of answers
Most bootlegging meets business needs	28
Most bootlegging does not meet business needs	5
Many innovation start as bootlegging	6
Some of the best ideas started in bootlegging	4
Bootleg products are commercially more successful	3
Bootleg products face a higher degree of market uncertainty	1
Market uncertainty is equal for bootleg and normal products	1
Bootleg products have mostly scientific character	1
Bootlegging has synergy effects to current research topics	1
Without bootlegging the firm faces the risk of eliminating potentially good ideas	1

Table 5 Acceptance After Disclosure

31 Statements (31 companies supplied data)	Frequency of answers
Product accepted	26
Not further pursued	3
Only scientific value, company probably not interested	3
Partly accepted	2
Search for application	1
Indecisive attitude	1

Table 6 Uncertainty of Bootleg Innovations

46 Statements (31 companies supplied data)	Frequency of answers
Low degree of uncertainty: no additional costs	12
Low degree of uncertainty: only few bootleggers	6
Low degree of uncertainty: marginal additional cost for tools, material, equipment	3
Low degree of uncertainty: time limited by fear of discovery	1
Low degree of uncertainty: control by colleagues	1
Same degree of uncertainty as normal research	1
Lower tech. success rate	7
Higher tech. success rate	2
Same tech. success rate	1
Formal objectives aren't jeopardised	3
Formal objectives might get jeopardised	2
No waste of resources	5
Risk of wasting time	1
Same risk of wasting resources	1

Impressum

Herausgeber
Der Präsident der
Fachhochschule Ingolstadt

Esplanade 10
85049 Ingolstadt
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Fax: 08 41 / 93 48 - 200
E-Mail: info@fh-ingolstadt.de

Druck
Hausdruck

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"Arbeitsberichte/ Working Papers"
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ISSN 1612-6483