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Communicating Security: Technical Communication, Fire Security, and Fire Engine 'Experts' in the Early Modern Period

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Abstract: *»Kommunikation & Sicherheit: Technische Kommunikation zur Feuersicherheit und 'Experten' für Löschgeräte in der Frühen Neuzeit«*. This article deals with the question weather, and if so how, security could be produced by technical innovations and communication about these innovations in the Early Modern period. The linkage between fire security, by fire engines, technical knowledge and communication about this knowledge will be pointed out. With the discourse of the improvement of fire engines in journals of the Enlightenment a trigger for the change in the communication about fire engines can be found. Further it is discussed how inventions for fire-safety can be evaluated in the transforming scientific society in the Early Modern period.

Keywords: Security, Technical Communication, Expert, Fire Engine, Enlightenment, Technical Knowledge, Journals of the Enlightenment, Development of Technique, Scientific Revolution, Scientific Society, Public Experiments, Invention.

1. Introduction

The following article deals with the main question of whether, and if so how, security could be produced by technical innovations and communication about these innovations in the Early Modern period. To clarify this idea, one might envisage a triangle comprising technique and technical knowledge, technical communication and security. To trace such an information flow for a technical security topic, I will use the public discussion about 'fire engines' to enhance the fire security in cities, mainly in journals of the Enlightenment. Between 1700 and 1800 a shift took place concerning the technical standard of fire extinguishing equipment, particularly of fire engines. This can predominantly be seen in the lists of fire equipment in cities' fire regulations.[1]

To connect this shift with media of communication, a before/after distinction[2] will be presented concerning information exchange and dissemination

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[1] While in the beginning these fire regulations listed leather buckets and ladders, they later listed more and more different fire engines stored in their arsenal.

[2] Koselleck 1987, 270.

during the 18th century. But which factors were decisive for this development? Neither an exclusive 'top-down' model of expansion of knowledge and scientific research[3] nor the approach of the diffusion of scientific knowledge are sufficient to describe the diverse processes of knowledge transfer in the 18th century.[4] In the following, some of these processes will be analysed, considering the idea that communication, public discussions and demonstrations of inventions[5] of fire engines served as a trigger or motor for the transfer and diffusion of this technical knowledge. Furthermore, I will consider the general effect of this shift in the 18th century and its consequences for technical communication and knowledge.

In the sense of the triangle described above in the context of fire engines, the following questions arise:

- Who were the 'producers' of technical knowledge about fire engines and which different ways existed to communicate or spread technical information?
- How did they legitimate themselves as 'experts' or become legitimated and by whom?
- How can the inventions or innovations be evaluated?
- What is the interest in communication and public discussions and who are the addressees?
- Finally, consideration should be given to the consequences of the change in communication described as 'expert'.

2. 'Experts' and Knowledge

The changes of knowledge and communication undergone mainly in the 17th and 18th century seem to be a process which is difficult to comprehend. Since the early 20th century the sociology of knowledge has dealt with questions about relations between knowledge and society.[6] On the one hand the development of sciences by scholars, on the other hand the tacit knowledge of craftsmen which was made visible, and the institutionalization of knowledge, for example through the foundation of scientific societies, are all named as part of the so-called "scientific revolution".[7]

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[3] Hochadel 2008, 336.

[4] Remenyi 2008, 349.

[5] Although the term 'innovation' in the sense of the conversion of an idea into products or methods might be more suitable for the described processes, it cannot be found in the sources. The use of the term 'invention' follows the analysed sources. As today, in the Early Modern period this term described genuinely new ideas, mostly in a technical context. But as may be seen in the following, the use of this term was overstrained.

[6] Burke 2000, 13.

[7] The discussion about this term is continuous in historical science. Inter alia it can be found in Shapin 1996, 1-8.

But more than this, the change might be found in the combination of these different circles of knowledge, the reciprocal effect between scholarly knowledge and practical knowledge, and in the pluralization of knowledge.[8]

Within the group of technical experts, one can distinguish between the traditional knowledge of craftsmen and scholarly theories, although this is very simplified. While in the Late Middle Ages a strict separation between the technical domain of craftsmen and scholarship existed, both spheres moved towards each other from the second half of the 17th century. The 'new' professional group of engineers, besides their practical knowledge, increasingly used mathematics as a theoretical tool. Science started to benefit from technology and in a limited way vice versa, but the consolidation of technology into a science of its own still had a long way to go. However, both 'schools' found their commonalities in their effort to find useful solutions for the further development of society and for the 'Landeswohlfahrt' (state welfare).[9] The main 'innovation' of the Early Modern period was not the increase of genuinely new technical knowledge but the upgrading of useful and practical knowledge in the mid-18th century.[10] Useless knowledge was increasingly criticized and 'the new' was no longer rejected but in a way became a recommendation for 'experts'.[11] Under these circumstances it is not surprising that craftsmen in cities, which were a hub for technical communication and knowledge, or other practitioners took this chance to participate in the 'scientific society', a rising group which was no longer strictly accessible to the privileged classes only.[12] The authorities, as well as the public, were now interested in the specialist and useful knowledge of 'experts' who did not need to be legitimated solely by universities, or to be scholars. Every 'expert' was asked to communicate his knowledge. In the case of fire engines, producers of technical knowledge were bell founders or coppersmiths as well as mathematicians. Some ideas about the way of communicating and its change will be shown in the following chapters.

3. 'Classical' Media for Communication Before High Volume Printing

In the times before the spread of knowledge through periodicals such as the journals of the Enlightenment, a traditional medium of communication about

[8] Cf. Burke 2000, 22-27.
[9] Troitzsch 2004, 458.
[10] Burke 2000, 132; Feldner 2003, 9.
[11] Burke 2000, 136.
[12] But different actors of the 'science society' still tried to differentiate themselves from each other through the attempt at hierarchization of knowledge. This fact shows the heterogeneity of this emerging group. Cf. Hochadel 2003, 249-308.

inventions was correspondence.[13] An interesting example of correspondence about fire engines can be found in Dresden from the year 1686. It seems that after or because of the blaze in 'Altdresden' in 1685[14], the urban authority was still endeavouring to produce security by means of functional and useful fire engines. A letter written by Johann Wilde, "Bestalter der Artillerie und Schlangen- und Sprützenmeister" ("commander of the artillery and hose and fire engine master") in Hamburg, of March 27th 1686 to Christian Zencker in 'Altdresden' tells that the residence in Dresden had previously contacted Mr. Wilde and asked for a retrofitting of their fire engines with hoses and other technical innovations. He answered that he had received the drawings of the engines, on the basis of which he was to inspect them, and he evaluated the fire engines as defective. Furthermore, he described his own 'invention' of fire engines which were more useful than the predecessors.[15] Additionally he suggested for the Dresden fire engines that the copper and brass of the old engines could be reused to manufacture new ones for a price of 1000 to 1200 Mark. The letter also reported a recent fire and stated that only the new 'Schlangen Sprützen' (fire engines with hoses) had prevented the city from a major hazard.[16] To give a clearer idea of his new fire engines, the 'Spritzenmeister' from Hamburg sent five sketches of them to give the city council in Dresden a basis for their decision about the procurement.[17]

This correspondence shows how the formation of 'experts' for the construction of fire engines functioned over hundreds of years and that they enjoyed a good reputation across territorial borders. Such requests as the one described above could be used by these 'experts' to promote their own 'inventions'. The requesting authority had the possibility of being directly informed about the

[13] Cf. Döring 2008; Gierl 2004.

[14] Cf. Blaschke 1999, 157-172.

[15] "… Ich befinde, daß es grosse und schwäre Wercke, nicht allein zu bearbeiten, sondern auch fort zu bringen, und daneben invendig auch sehr mangelhafft seien. Dann die jezigen von mir inventierten wercke, so wol in als außwendig sind andere gestalt, auch nicht so schwär fort zu bringen und zu bearbeiten, wie Messieurs selben gesehen. … Messieurs hat selber gesehen, dass mir die Sprützen hiesiger Ohrter die so groß und schwär von holz gewesen alle verworffen, und neue darvon mit Schlangen und Röhren gemachet; und weil die nun von Küeffer und Eysen, so gar kein Holz als nur die Räder, sein sie nicht allein leicht fort zu bringen, sondern auch leicht zu bearbeiten …", Stadtarchiv Dresden, RA/2.1/F.XIV.13, 17r-19v.

[16] "… hetten wir keine Schlange Sprützen gehabt, wehre leider wieder eine grosse Einäscherung vieler Häuser zu besorgen gewest …", Stadtarchiv Dresden, RA/2.1/F.XIV.13, 17r-19v.

[17] "Hochgeehrter herr, Hierbey sende demselben fünff Abriesse, welche er E. E. Rathe zeigen kann, damit sie die Neuen Inventiones sehen können, so ich alhier gemacht, da sich als dan der Unterschied zeigen und finden wird, und mir solche nach belieben wieder zusenden …". One of these sketches is still conserved, and its simplicity clearly shows that the innovations were merely to be made visible, whereas the secret of this new invention was to be protected. Stadtarchiv Dresden, RA/2.1/F.XIV.13, 18r.

current state of fire engine technology by a capable craftsman and of improving their existing material or purchasing new inventions. Since the 16th century, the common way of procurement of craftsmen had been to decide on the basis of tendered sketches[18], and this practice can still be found at the end of the 17th century. The increment of craftsmen's drawings in the Early Modern period simultaneously shows the increasing differentiation of experts' technical knowledge.[19] Furthermore, the correspondence shows the knowledge transfer 'from the bottom up'. Due to its bipolar character, the communication about and the spread of technical knowledge via letters was heavily personalized. It was almost left to chance through which inofficial ways the contact with such an 'expert' craftsman was first generated. An active intention to establish such an information flow had to be present, but we cannot speak of a medium to form public technical communication, knowledge or understanding. Besides all the information about Dresden fire engines, the above-mentioned correspondence is significant because of the additional information given in it. Mr Wilde wrote that he had manufactured two fire engines for Amsterdam and that he intended to go there for a few weeks.[20] This little comment allows the construction of a communication network of fire engine experts.

In Amsterdam, Jan van der Heyden (an artist, but also inventor and administrative practitioner) and his brother Nicolas (a hydraulic engineer) had been very committed to fire security needs since 1672. Inter alia they invented and sold "fire engines with water hoses". It is evident that the Hamburger 'Spritzenmeister' Wilde gained some of his knowledge about how to manufacture fire engines with hoses from his visits to Amsterdam and maybe from personal contact with the van der Heyden brothers.[21] He transferred it to his own work and used it for improving fire security in Hamburg. In addition, he offered his knowledge inter alia to Dresden. For Dresden, again, a direct con-

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[18] Popplow 2006, 109f.

[19] Popplow, 2006, 111.

[20] "… und weil ich vor die Stadt Amsterdam auch zwei Spritzen gemacht, dass ich nach Amsterdam wollte …", Stadtarchiv Dresden, RA/2.1/F.XIV.13, 17r-19v.

[21] One very important work about fire engines and the method of fire fighting, which is more than merely a machine book, should be kept in mind here: the "Description of the recently invented and patented Fire Engines with Water Hoses and the Method of Fighting Fires now used in Amsterdam" by the inventor Jan van der Heyden and Jan van der Heyden Junior, printed in 1690: *Beschryving der nieuwlyks uitgevonden en geotrojeerde slang-brandspuiten en haare wyze van brandblussen, teegenwording binnen Amsterdamin gebruik sinde*.
About Jan van der Heyden and his son: Both were very engaged in civic duties as Fire-Chief Generals of Amsterdam and certainly played a great role in the production and communication of specialist knowledge of fire engines. With their 'Brandspuitenfabrik', they successfully sold their fire engines all over Europe. Of course, the book and separated leaflets were written mainly for promotional reasons, and addressed to authorities who were willing and had the financial possibilities and consultants to understand and use this new fire engine technology in order to generate security. Heyden 1996, xxi.

tact to Amsterdam by means of the import of a "Holländische Feuer Sprütze" in the year 1685 can be proven.[22] This, in short, gives an idea of how communication and knowledge transfer based on personal contact and correspondence functioned to advance fire security with useful fire engine inventions. These ways of communication before the spread of knowledge by journals represent the high level of technical knowledge about fire engines existing in different circles and the generation of networks. But the level of this communication should be understood to have a single, pragmatic function. With the journals of the Enlightenment, we can ascertain a transformation of this communication to a higher level of display which was to some extent professionalized.

A link between both levels can be found in the 'machine books' of the late 16th and 17th century. They were a 'new' medium in the Early Modern period for the general popularization and pluralization of knowledge. A generalizing discourse about technical equipment began with the praise of new, useful and innovative machines in the printed theatra machinari[23] of the late 16th century. With the help of these books, contemporary engineers tried to increase their social status, especially by proving the intellectual fundament of their own profession.[24] However, the authors of the machine books focused on informing the reader about the results of their own efforts and had less interest in discussing technical skills. The models of the machines in the machine books served as an idealization of techniques through which their creators tried to distinguish themselves from the group of craftsmen.[25]

Thorsten Meyer states that the machine books were one of the most important media of spreading technical knowledge.[26] From the 16th century, the printed book served as a new structure to spread knowledge between experts and laymen who were able to read; this led to the popularization of technical know-how. This might also be described as a dialectic between specialized science and unspecialized public.[27] The machine books were first addressed to the nobility and the literate bourgeois.[28] Unfortunately, they showed little interest in fire extinguishing equipment and because of this, they contain only a little information about fire engines.[29] In the 18th century the machine books disappear as media of technical communication.[30] The machine books can be

[22] "… die … aus Hollandt … anhero gebrachte große Schlangen Brand Sprüze …", Stadtarchiv Dresden, RA/2.1/F.XIV.13, 2r-5v.
[23] Literature on machine books inter alia: Popplow 1998; Popplow 2006; Meyer 2004.
[24] Popplow 1998, 8.
[25] Troitzsch 2004, 451.
[26] Meyer 2004, 147.
[27] Daum 1995, 27.
[28] Meyer 2004.
[29] The theatrum machinarum of Heinrich Zeising, printed in 1610, introduced three fire engines with figures and explanations: Zeising 1610.
[30] Meyer 2004, 157.

seen as an interlude between correspondence and periodicals. They were an instance or element used to translate technical knowledge onto a higher level, but their authors had completely different fundamental ideas from the actors in journals of the Enlightenment. The medium '(machine) book' was very inflexible compared to a fast-moving and customizable periodical.

4. The Discourse about the Improvement of Fire Engines in Journals of the Enlightenment

Besides books, one other medium increasingly replaced correspondence as a messenger: periodicals.[31] In particular, the 18th century was shaped by the Enlightenment and closely linked with this was the effort to popularize knowledge. The formation of the 'modern' sciences from the early 17th century led to the foundation of scientific Academies, followed by the publication of scientific periodicals and journals. These technical periodicals were predominantly the most effective medium of spreading knowledge[32] and caused a major change to communication in the mid-18th century. By degrees, social communication processes were generated which brought about and intended the access to technical knowledge of different interested social groups.[33] Popular journalism served not only as information, enlightenment and amusement but was also used for social control over the interpretive power of knowledge. Within popular scientific rhetoric, natural science and new disciplines but also the delimitation between 'experts' and 'laymen' could be legitimated, which was appreciated by the scientists.[34]

While the social situation limits information to family or insider knowledge, as is usual in the technical crafts, the journal transforms knowledge into science.[35] Following this statement, it becomes evident that technical know-how spread through publication in journals brought about the depersonalization of knowledge and its sustainable use. The border between crafts and sciences was softened. Through journals which were printed periodically in large volumes, specialist knowledge was accumulated, formalized and made publicly available, in complete accordance with the sense of Enlightenment.[36]

Some examples of the depersonalization of technical knowledge in the case of fire engines and its spread through scientific journals will be presented in the following. The examples will be evaluated with the focus on actors, legitima-

[31] Döring 2008, 101.
[32] Burke 200, 132; Feldner 2003, 209.
[33] Tschopp 2004, 471.
[34] Remenyi 2008, 348.
[35] Gierl 2004, 430.
[36] Troitzsch 1966, 105.

tion, specialist rhetoric of inventiveness[37] and the demand for invention and inventive content.

The basic idea behind the discussion about the improvement of extinguishing equipment, especially fire engines, is based on the hazard of a blaze in cities. Everyone who tried to find ways to diminish or prevent such a hazard for the good of society was authorized to consider the question of fire-fighting.[38] Thus there was a demand for everyone for useful tools to increase fire security and diminish or prevent disasters. This wide demand for specialist knowledge complied with the idea of the scientific academies of a linkage between "theoria cum praxi";[39] this is what is meant by a linkage or conflation of scientific knowledge, technical-empirical know-how and economic knowledge.

4.1 Transformation of Lost Tacit Knowledge Through Theoretical Reconstruction

In 1759 in an issue of the journal "Hannoverische Beyträge zum Nutzen und Vergnügen" ("Hanoverian articles for utility and enjoyment"), an article entitled "a proposal for fire fighting" can be found.[40] The author states that twenty years ago, a leaflet reached his hands in which an unknown person announced that he had invented a kind of water catapult that would be more sustainable to extinguish an ember than a fire engine. The author of this leaflet was deceased and his sketches of the invention could not be found.[41] In addition, the author of the article tried to reconstruct theoretically the specialist knowledge which was lost due to the death of the craftsman. His solutions were wooden vats, filled with water and thrown into the fire by "Feuerwerker" (fire workers).[42] However, in the same breath he stated that until now his theoretical thoughts had not been practically proven. With regard to such a practical use, the author stated that this proof should be made by somebody else.[43] He was satisfied and saw his work as done because of his proposal of such an invention, which he

[37] The terms 'scientific rhetoric' or 'rhetoric of inventiveness' are used in the sense of the formation of specialist elements and a way of describing 'inventions' which was establishing itself, including the translation of practical elements in journals.

[38] Claproth 1762, 1106.

[39] Troitzsch 1999, 275.

[40] S., A. C. 1759.

[41] "… Vor etwa 20 Jahren [machte] … ein Unbekannter … mit vieler Gründlichkeit, obgleich schlechter Schreibart bekannt: es seyn die bisherigen Löschmaschinen dem großen Feuer nicht proportional … Seine Erfindung … ein Wurfwerk … sey mit seinem Geräthschaften nicht so kostbar, als eine Feuersprytze … und sey ganz zuverlässig … Der Mann war bald nachher … verstorben [und] mir entgiengen alle Mittel aus dieser Erfindung eine Entdeckung zu machen …" S., A.C. 1759.

[42] "… so haben wir, was der gute Erfinder mit sich ins Grab genommen." S., A.C. 1759.

[43] "… Nun versuche, ändere, verbessere und führe aus, wer will. Den übrigen wird ein Spott, verachten und auslachen auch gerne vergönnet. Mich genüget, zu einer Erfindung Vorschläge gethan zu haben …". S., A.C. 1759.

declares to be "A thousand million times better ... than what Schwarz, Coehorn, Gernhard von Gahlen and other butcher-birds have hatched, to the misfortune of the world".[44]

Because of the way that the writer describes the deceased inventor, the above-mentioned separation between theory and practice and his alienation from empirical experiments, it can be assumed that he considered himself to be part of the group of scholars within the group of 'technical intelligence'. The justification of the usefulness and importance of his reconstructed invention is twofold. On the one hand he states that these vats could be more suitable than fire engines in some cases. On the other hand he alludes to the securitizing factor of his invention in contrast to, for example, Coehorn's weapon of war.

The 'invention' that vats filled with water could extinguish a fire seems to be in itself neither new nor even inventive. But the way in which the author of this article sets this alleged lost knowledge in context with the case of the ineffectiveness of fire engines and 'negative inventions' such as weapons of war can be seen as a developing 'rhetoric of inventiveness'. It seems that it was mainly not genuinely new inventions that were communicated and recognised by these journal articles, but that the way they were described and set in context was becoming increasingly important. In the developing knowledge society and with public communication through journals, authors knew how they could represent themselves as 'inventors' and 'experts' in this way.

4.2 Prize Questions for the Collection of Knowledge

In 1771, the Danish Society of Sciences in Copenhagen posed a prize question concerning the most advantageous configuration of fire engines.[45] Johann Gustaf Karsten Wenceslaus, mathematics professor, received the prize for his "Treatise on the most advantageous arrangement of fire engines".[46] In the preface of his book, he relates that since 1770 he had had orders from the ducal government of Mecklenburg to coordinate the procurement of useful fire-extinguishing machines for small rural towns and to control their capability and price-quality ratio. These experiences were the basis for his treatise.[47]

However, these competitions were not genuinely addressed to scholars and their theories. In 1772 the "Royal Prussian general chief finance, war and domains directorate" tendered a prize concerning the best manufacture of a fire engine for the use of the flat country. This prize was halved and awarded to two people. The first was the professor of mathematics and teacher Georg Simon

[44] "… Millionen tausendmal besser … als was Schwarz, Coehorn, Gernhard von Gahlen und andere Neuntödter der Welt zum Unglücke ausgebrütet haben." S., A.C. 1759.
[45] Meister "Review" 1775a.
[46] Wenceslaus 1773.
[47] Wenceslaus 1773, 3.

Kügel, who had authored the treatise,[48] and the second the "hand fire engine maker" Insel from Berlin who had proven himself as the most legitimate to manufacture a fire engine following the theoretical guidelines made by Kügel. This fire engine was compared to other useful fire engines and performed excellently.[49] Regarding the awarding of prizes, scholars as well as craftsmen participated in competitions and were thus recognised in the literate discourse about fire engines. However, in cases of prize questions one can see that the main intent was not the generation of new knowledge or new inventions. The first aim was rather to collect and combine different tacit knowledge. The legitimation for participants in these prize questions was given by the tendering institutions themselves and some participants could show their suitability by official posts or particular skills concerning their daily business. It could be stated that competitions aimed firstly at the inventory of different technical knowledge in different circles; they were intended to support useful knowledge and bring different circles of knowledge together. The prize questions by academies and authorial institutions were a practice to generate stocks of knowledge.[50] Of course, the institutions also intended to find special knowledge for their own efforts and by awarding prizes to technical specialists, these persons became 'experts'.

4.3 Economic Competition in the Manufacture of Fire Engines

A teaser by J. C. Riepenhausen was published in the 'Hannoverisches Magazin' in 1772 with the title "Invention of a new kind of fire engines or so-called water mills".[51] At first he remarked that fire engines available on the market cost between 500 and 700 Reichstaler and procurement was too expensive.[52] As he emphasized, he offered an equivalent alternative for about 100 Reichstaler. As a reason for this cheap manufacture, he stated that his design got along without a bellows and screws, but nevertheless ensured a continuous water jet from the pipe. Furthermore, he claimed that this sort of engine would have more advantages concerning its handling, compared to the familiar fire engines. At the end of his article, he even advertised other, optical, mathematical and physical instruments that he had produced.

The author of this article was a 'Practicus', which is not surprising, since only by manufacturing fire engines would it be possible to see which components can be omitted while still retaining the function of the machine. It is not possible to verify whether this so-called "new invention" really functioned as

[48] Kügel 1774.
[49] Meister, "Review" 1775b.
[50] Keller 2008, 37.
[51] Riepenhausen, "Erfindung" 1772.
[52] "… trotz aller Nützlichkeit [wird] oft vom Kauf abgesehen …, da man ein solches Kapital nicht investieren möchte …", in: Riepenhausen, "Erfindung" 1772.

well as described. The article gives no information about any test or any other kind of legitimation of the 'inventor's' ability. The only legitimation one could imagine is the cheap price, but it is not possible to determine whether this was assessed in general. Taking as a starting point Riepenhausen's assumption that his fire engine worked, the importance of the economic aspect concerning a cheaper production seems to have increased and been further promoted through more active competition, which developed owing to public discussions. Its positive effect was that functional fire engines and thereby better fire security became generally affordable. This development was based on the step-by-step efforts to equip rural and small towns with fire engines too. The addressees of those teasers were no longer only 'major cities' which had the financial power to procure the highly developed and very expensive fire engines. With the small cities, a new market focused on the economic aspect was opened up. To fill this market niche, enter the market and successfully place the offered products, a fire engine manufacturer had to spread information about the (mainly economic) advantages of his 'inventions' through a 'mass medium' such as a journal. This example shows that the spread of information about fire engines not only supported the idea of development of techniques but also of economic aspects. Fire security was not only triggered by the spread of genuinely new and better fire engines but also by the promotion and rising availability of existing technical standards and a change of the audience from a few cities to the multitude of smaller towns.

4.4 Public Experiments and their Description in Journals as Legitimation

In 1770 the "Berlinische Sammlungen"[53] reported about a bell founder's assistant from Saxony, who had created a fire engine which evoked great admiration during a public test. The water was lifted through the pipe for 193 "Salzburg shoes" or 102 "Leipzig cubits".[54] With the fire engines created and built by him, Mr. Thilläyn ("fire engine maker with royal privileges at Rouen") made an attempt in which he lifted the water without the help of leather hoses and in a constant beam up to 100 "foot".[55] Expectedly, he promised to create such fire engines for everyone at a low price but could not publish the secret of his in-

[53] Anonymous, "Neue Wassersprützen" 1770.

[54] "[Diese Feuerspritze hat] bei der öffentlichen Probe eine allgemeine Bewunderung erreget. … das Wasser ist vermittelst derselben [Röhre], noch 70 Schuhe höher, als das Dach der Salzburgischen Domkirche und also 193 Salzburger Schuhe oder 102 Leipziger Ellen hoch getrieben worden." Anonymous, "Neue Wassersprützen" 1770.

[55] "Herr Thilläyn … hat mit einigen neuen Brandsprützen, von seiner eigenen Erfindung, einen Versuch gemacht, unter welchen sich eine befindet, die … [das Wasser] ohne Hülfe von lederner Schlangen, mit einem beständigen Strahl 100 Fuß hoch treibet." Anonymous, "Neue Wassersprützen" 1770.

vention for any price.[56] This article was written anonymously, so the author's motivation is not known, but it might be suspected that the author was an eyewitness of the public test, because of the nearly emotional way he describes what happened. It might be suspected that he was not very well educated in technical knowledge, because he does not give any information about the technical details of the fire engines tested. For him the yardstick for the functionality and usefulness of the fire engines was how high they could bring the water and if the beam was constant. Certainly these two factors were inter alia important to evaluate the suitability of fire engines, but not solely. In this case, much more important is what he tells the reader about the manufacturers of the engines. They are both craftsmen, but in different social positions. The journeyman is from Saxony, while Mr. Thilläyn comes all the way from Rouen.

In his study of electricity in the German Enlightenment, Oliver Hochadel analyses the role of electricity showmen with the example of the 'electrifier' Martin Berschitz and explains the kind of space such showmen took up in the culture of science of the Enlightenment, how far they produced knowledge, what this knowledge was about and how it was transferred.[57] A comparable practice seems to be evident for fire engine manufacture. The above-mentioned manufacturers of fire engines travelled to cities to promote their engines. In this way they informed about fire engines by demonstrating their useful function, of course without revealing their technical 'inventions'. But in contrast to the 'electrifiers' and their demonstrations, the manufacturers of fire engines had to prove the applicability of their inventions for fire-fighting. Hence a reciprocal result of these demonstrations was that a successful public test was equivalent to a proof of usefulness. In this way different kinds of fire engines gained public acceptance and recognition in the micro-historical city circle of knowledge. Through public opinion, they were perceived as an 'invention' or technical progress for fire security nearly without reflection on whether in a wider context of knowledge this could really be considered 'new' or not.

In the "Journal von und für Deutschland", the 'fountain master' Karl Kirn from Trier published a description of a new fire engine in 1785. Inter alia he advertised his machine, which could be offered at a reasonable price in the sense of an economic improvement. He emphasised the convincing functionality of this fire engine in its public demonstration at the cathedral's square. Therefore the spectators and laymen were considered as witnesses.[58]

This article shows two things: On the one hand the above-mentioned economic aspect; on the other hand the fact that the public proof for fire engines

[56] "Er wird für jeden, der es verlangt, dergleichen Sprützen um einen billigen Preis verfertigen, kann aber vor der Hand, sein Geheimnis, dessen Erfindung ihm viel Zeit und Mühe gekostet, noch nicht entdecken." Anonymous, "Neue Wassersprützen"1770.
[57] Hochadel 2008, 331.
[58] Kirn 1784, 92.

was not only used as a legitimation medium by travelling showmen but also by craftsmen in situ to present their skills in manufacturing useful fire engines to the public.

In the category "Dresden curiosities", the "Magazin der sächsischen Geschichte" (magazine of Saxon history)[59] reported a general fire engine test ('Hauptspritzenprobe') at the old market square on October 6th 1787, which was attended by the chancellor and the governing mayor among other spectators. The "ingenious Inspector Köhler" was sent to Weimar by the elector to get a personal impression of the excellent fire engine facility there. According to his plans, he supervised the construction of an engine which could also be used as a water-feeder. The 'copper-molder' La Mare had also manufactured a new big fire engine and a water-feeder. Both machines were tested with different hoses and different distances of the feeder. As a result it was stated that it would be "desirable for the encouragement of diligence as well as for the good of the city that the public should acquire this engine as their property."[60] Again, the author is anonymous. His descriptions prove the continuous efforts of the authorities to collect and exchange knowledge through the inducement and financing of these journeys. Although personal contact is still essential, a change of tactic can be recognised. To create public acceptance it was no longer correspondence, which had been the most important way for many years, but public proof that was used as a medium. The official Dresden general fire engine tests demonstrated the special interest of authorities in the assessment and advancement of new technologies. The public discussion, although not always about genuinely new 'inventions' and improvements, led to a rising perception and acceptance of technological progress for the welfare of the whole society.

Many descriptions of such tests of fire engines can be found in journals of the Enlightenment over the years. As indicated, they can be interpreted on two levels. Firstly, the public experiment itself: The idea of an empirical, rational and experimental renewal of sciences began with Francis Bacon in the 16th/17th century.[61] With public tests this experimental science seems to have been transferred to the daily business of fire engine manufacturers. In accordance with this, the tacit knowledge of craftsmen rose as a public legitimation for fire engine 'experts' at the end of the 18th century. Clearly committed demonstrations with nearly identical machines were put on repeatedly, although in the meantime everybody knew about the function of fire engines. These repetitions made the public test of fire engines become more and more of a ritual.

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[59] Anonymous, "Dresdner Merkwürdigkeiten" 1787.

[60] "Es wäre sowohl zu Aufmunterung des Fleisses als zum Besten der Stadt zu wünschen, dass das Publicum diese Spritze zu seinem Eigenthum erhielte.", in Anonymous, "Dresdner Merkwürdigkeiten" 1787.

[61] Krohn 1990, 211.

Secondly, their description in journals of the Enlightenment: For the most part these descriptions were not written by the manufacturers themselves. But because of their publication in journals, they were recognised in scholarly circles and adopted. The practice of experimental legitimation was spread through 'technical intelligence', which led to a decline of philosophical constructs and the integration of tangible elements into theorems.[62] This shift towards experience and experiment in journals of the Enlightenment made the public test into an inventiveness-rhetoric element. From being an auxiliary method of legitimation, the experiment was transferred from practice into theoretical thinking.

4.5 Utopian Theorems or 'Inventions'?

The journals of the Enlightenment did not only report about obviously successful 'inventions' of fire engine technique. The case of the 'invention' by the mining master ('Bergmeister') Löscher can prove that not everything named 'invention' was accepted. First, a review written by Löscher about his own publication "invention of a fire engine without pipework, pistons and valves"[63] can be found.[64] Most likely because of this review, a second article on Löscher's invention by an anonymous author followed. Assessing the 'invention' in the context of fire engine standards at the end of the 18th century, it seems probable that the 'funnel fire engine'('Löschers Trichterspritze') would not have found any consideration in the *Gelehrtenrepublik* (scholars' republic). It does not provide any technical refinements and is based on merely the simplest physical laws of pressure. Accordingly, the "Neue Allgemeine Bibliothek" stated that this funnel fire engine was cost-effective and could be a useful machine for the peasantry, at least.[65] But all in all this funnel fire engine had no genuinely new usefulness owing to the lack of hose connections and air vessel. Therefore it was not even able to produce a constant water jet. Perhaps this fact is the reason why Löscher did not try to keep the secret of his 'invention'. On the contrary: Löscher described the engine and its functionality so precisely that "every artist could manufacture this machine".[66]

Another example that seems to belong to the less successful improvement concepts is the 'invention' by Mr. Fürst, described in the "Monatsschrift für Mecklenburg". The results of the tests using the equipment (probably a hose attached to a frame to produce higher water lifting) were damaging for the

[62] Fischer 2004, 158.
[63] Löscher 1792.
[64] Löscher 1793.
[65] "… wenigstens für das Landvolk eine nützliche Maschine." Anonymous, "Review" 1793.
[66] Anonymous, "Review" 1793.

competence of its inventor:[67] The hose broke and for fire fighting it was not useful in any way.[68] It is inconceivable that, following such a public report about the unsuitability of a certain invention, any actor of security production would consider a purchase. Thus the publication and public declaration of unusable inventions contributed to the production of fire security in cities by preventing the production of insecurity.

One example of a nearly utopian theoretical idea, which was insufficiently tested under laboratory conditions and could not be practically realized, is the description of an allegedly fireproofed suit. This suit, made of raw material and soaked with ash water, was intended to enable a human to stand in the fire. This might have been retrospectively perceived as a quack theory, since in order to do this it would constantly have to be poured with ash or salt water by bystanders, and the person would also have to be guided because his eyes would have to be protected by the suit. The 'theoreticus' Justus Calproth himself barely thought about the practical possibilities of realizing this idea. He wanted to leave this to others. But in order to avoid the rejection of his theory by the population, he indicated that this work, which only *seemed* to be dangerous, must be made savoury and plausible to the common man by public tests.[69] Claproth was a lawyer and taught in Göttingen. Maybe he and his thoughts were ahead of his time, as today we have refractory suits, and his invention for recycling paper also required centuries to assert itself.[70] Nevertheless this invention can be seen as an insecurity and danger-producing theoretical consideration for fire-fighting. Probably the practical impossibility appeared here as a healthy regulation to the formation of theories. However, in this example the tactic of inventive rhetoric can be seen too. For the scholars, the laboratory tests were not enough to strengthen the persuasiveness of the invention, so the genuine legitimation tool of the practitioner, the public test, was used. The practice of using practical legitimation rituals to break down a scholarly theory becomes evident.

5. Conclusion

These examples are proof of a shift in the self-imaging of the technical intelligence and in its public image, and a change in communication and information about technical topics. To summarize:

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[67] "… was bei dem Versuche geleistet worden, wird jedermann von dem Werthe dieser Erfindung Licht geben …" Anonymous, "Beschreibung des Versuchs" 1790.

[68] "… von einer Maschine, die mit langen Stängen gerichtet werden muß, nicht wohl Gebrauch zu machen", Ibid.

[69] "bloß dem Anschein nach gefährliche Arbeit dem gemeinen Mann durch Versuche schmackhaft und plausibel gemacht werden [soll]", Claproth 1762.

[70] Claproth 1774.

- New institutions and their efforts at the collection of useful knowledge led to new media for technical communication.
- These institutions and their media served as a legitimation for 'experts'.
- These 'experts' were no longer only scholars since, according to the idea of usefulness, the demand for tacit knowledge and craftsmen's skills arose.
- Due to the concentration and conflation of these different processes of information and communication in the journals of the Enlightenment, the former hierarchy of knowledge had softened. Thereby the reciprocal character should be pointed out.
- Because the practice of craftsmen was now becoming visible, the method of empirical experiment was distributed and accepted as producing knowledge.[71]
- Hence it was not the actors of the production of technical knowledge for fire engines that were changing but the attention to and the emphasis on them. Access to wider and new markets was opened. The radius for the diffusion of knowledge increased.

Regarding the inventiveness of the fire engineers described in the presented articles, it must be granted that the communication of genuinely new inventions was less significant compared to the tacit knowledge of them becoming public. Owing to the legitimation and general validity that they achieved in different ways, they received public acceptance, and these 'inventions' were transferred from 'specialized or even secret knowledge' to 'general knowledge'.

This transfer of special knowledge and, as a consequence thereof, legitimation as an 'expert' also comprised a lucrative incentive to participate, not only in the fire engine discussion. Hence it is not surprising that scholars as well as practitioners promoted their 'inventions' in journals. Based on this, communication in the 18th century seems to have taken place on a secondary level of the 'knowledge revolution': The rhetoric of inventiveness had become daily business and a process of self-fashioning inventors was set in motion. The participants knew which instruments and arguments they could use for stylization and legitimation of themselves as an 'inventor' or 'expert'. There was a recognised need to describe or demonstrate the function of inventions. For this reason the difference between the demand for invention and the innovative contents can be ascertained.

To conclude, a few considerations should be mentioned concerning shifting communication, invention, fire security and security in general.

The general Enlightenment idea of the usefulness of technical knowledge, of pluralizing knowledge and of general education seemed to cause more security. There was a general fear of the population and a need for security which could

[71] Shapin 1996, 96-100.

only be produced if there was a common perception and reception and a general understanding of the operating mode.

Although a quantitative analysis is still lacking, the qualitative analysis allows us to state that the articles concerning fire engines in the journals of Enlightenment support the effect of security, because topics concerning fire security were mentioned more often than, for example, they were in machine books. The examples presented show how fire hazards in a technical sense were prevented and handled. They demonstrate processes to enhance security in case of the disasters pointed out.

After the mid-18th century, a general change in technical communication and in the diffusion of different knowledge systems can be seen. The ideal type of a scholarly inventor who created new inventions for security did not function without practical elements. Theorems led to the borders of the thinkable and to utopian ideas. The transference of practical and tacit knowledge to a theoretical level by the inclusion of it in the scriptualization process and the increasing rhetoric of inventiveness can be found. And vice versa, theorems were broken down to practical usefulness. The combination of emerging sciences and the diffusion of empirical knowledge produced security in general. In Early Modern cities the main actor of security production were the authorities, and the market of security products was mainly focused on them. The predominant aim was the 'promotion of the state's welfare' ('Beförderung des Landeswohls').

One of the major influential factors might not be seen in genuinely 'new inventions' but in the developing communication and the involvement of the public, resulting in depersonalization and the formation of a pool of knowledge which was used to develop this 'Landeswohlfahrt'. Not only a few outstanding inventors but the collectivity of them affected the flow of information and the knowledge about fire engines. But although the popular Enlightenment and within it the technical Enlightenment is tangible in the second half of the 18th century, distinguishing this time from 'before', there was no discernable overall progress of inventive knowledge but rather a progress of the spread of inventive communication.

Nevertheless, the discourse about fire engines and other fire-securing methods led to so-called shifting baselines and changed the fundamental sense of security of following generations.

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