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Co-evolution of Technology and Institutions: Government Regulation and Technological Creativity in the Swedish Moped History 1952–70

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Abstract: The first of July 1952, the moped was legislatively excluded from existing restrictions for heavier two-wheeled motorized vehicles. A driver/owner of a "bicycle with auxiliary engine" – this was the original denomination of the vehicle – thus needed no registration, driver's license or insurance, nor pay any vehicle tax. The legislators did, however, postulate some technical requirements. Besides regulation of the engine, the vehicle should be "bicycle-like" and have pedals. It should thus be driven primarily by means of human, not mechanical, power (i.e., it was *not* supposed to be a lighter version of a motorcycle). In terms of social and economic goals, the state assumed workers to be the primary users, and a utilitarian use rather than one connected to pleasure and spare time.

Very quickly, however, the moped lost all resemblance with the ordinary bicycle (except for the pedals). In a new legislation in 1961, the state yielded to the technical development. The moped no longer needed to resemble a bicycle or have pedals. Meanwhile, the moped also became more of a toy for boys – a vehicle for freedom – rather than the useful tool the state had wished for. In fact, we argue that the demands from user groups not foreseen played a crucial role in changing the legal technical requirements of the moped.

This paper deals with the co-evolution, technically and institutionally, of the moped during the period 1952–75. Using a method inspired by evolutionary theory, the moped models released in Sweden in these years are grouped in "families" with distinctive technical features and accompanying presumed uses. We analyze this development using concepts from the theoretical fields of innovation studies and the history of technology (STS/SCOT):

Key words: bicycle, co-evolution of technology and institutions, demand specification, dominant design, evolutionary theory, history of technology, industrial dynamics, moped, motorcycle, road traffic legislation, technology studies, transport history

JEL Codes: B25, B52, L51, L61, N74, O31, O33, Z18

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Introduction

This Working Paper is a summary and a development of our report (in Swedish): Pär Blomkvist & Martin Emanuel, *Från nyttofordon till frihetsmaskin: Teknisk och institutionell samevolution kring mopeden i Sverige 1952–75 [From Utility to Freedom: The Co-evolution of Technology and Institutions in the History of the Swedish Moped 1952–75]*, Division of Industrial Dynamics, Royal Institute of Technology, Stockholm (Stockholm 2009). The paper is reworked from an earlier version presented at the INDEK WP-seminar 2013-09-13 (under the title "A Wild Goose Chase: Government Regulation and Technological Creativity in Swedish Moped History 1952–70).

The text is intentionally heavy in empirical information, rich in possible pathways and not very focused on a specific objective. We have not yet finalized the conclusions. In this Working Paper we outline possible topics for further research in three areas connected to the theoretical fields of innovation studies and the history of technology (STS/SCOT):

1. Co-evolution of institutions and technology
2. User driven innovation
3. Evolutionary methods in innovation studies

Our story is about government efforts to regulate the "unruly" moped technology in Sweden from the first moped law in 1952 to around 1970. We call the technology unruly because it was not easy to control and contain. Users and producers innovated constantly and with great creativity, challenging both the letter and the intent of the law.[3]

The Swedish moped case is interesting from both a history of technology and an innovation studies perspective. By focusing on the co-evolution of technology and institutions, we want to contribute in bridging the gap between these two academic fields.[4] But the moped history also has contemporary

[3] This article is based on (in Swedish) Pär Blomkvist & Martin Emanuel, *Från nyttofordon till frihetsmaskin: Teknisk och institutionell samevolution kring mopeden i Sverige 1952–75 [From Utility to Freedom: The Co-evolution of Technology and Institutions in the History of the Swedish Moped 1952–75]*, Division of Industrial Dynamics, Royal Institute of Technology, Stockholm (Stockholm 2009). There we discuss gender, class and youth culture in relation to the moped history more extensively. Here we will focus on government regulation and technical creativity. All references can be found in the foot-notes. Some of the references and some text in tables are in Swedish.

[4] We refer to Frank Geels precise summary of the research on co-evolution – Co-evolution between technology and users (Coombs et al., 2001; Lundvall, 1988; Leonard-Barton, 1988; Lie and Sørensen, 1996; Oudshoorn and Pinch, 2003); Co-evolution between technology, industry structure and policy institutions (Nelson, 1994, 1995; Van de Ven and Garud, 1994; Rosenkopf and Tushman, 1994; Lynn et al., 1996; Leydesdorff and Etzkowitz, 1998); Co-evolution of science, technology and the market; (Callon, 1991; Stankiewicz, 1992); Co-evolution of science and technology (Kline and Rosenberg, 1986; Layton, 1971, 1979); Co-evolution of technology and culture (Du Gay et al., 1997; Van Dijck, 1998): Co-evolution of technology and society (Rip and Kemp, 1998;

implications. Global warming and industrial globalization creates a heavy transformation pressure on governments and international agencies to contain and regulate technology.[5] Examples from a Swedish context are efforts to regulate automobile engines to create a green car fleet and government attempts to prevent the "electric bicycle" from becoming a moped-like vehicle – a striking parallel to the moped history. We return to these issues in the last part of the article.

Our history starts 1 July 1952 when the moped—short for mo(tor)ped(als)—was legislatively exempted from existing restrictions for two-wheeled motorized vehicles. A driver of a "bicycle with auxiliary engine", the original denomination of the vehicle, thus needed no registration, driver's license or insurance, nor pay any vehicle tax. Moreover, and this was controversial, the legal age was set to 15 instead of 16 years, which was the regular age for a light-weight motorcycle. The legislators did, however, postulate some technical requirements. Besides regulation of the engine and the design speed (0,8 hp, 50 cc, 30 km/h), the vehicle should be "bicycle-like" and have pedals. It should be driven primarily by means of human, not mechanical, power. It was *not* supposed to be a lighter version of a motorcycle. In terms of social and economic goals, the state assumed manual workers to be the primary users, and expected a utilitarian and work-related usage of the moped, rather than one connected to pleasure and spare time.

As the number of mopeds increased rapidly, within a few years the moped lost all resemblance with the ordinary bicycle (except for the compulsory pedals). Meanwhile, the moped became a "toy for boys"—a vehicle for freedom—rather than the useful tool the state had wished for. In 1961, the state yielded to technical development. According to the new legislation the moped, while it was still exempted from most regulations on motorized two-wheelers, no longer needed to resemble a bicycle or have pedals.

In this article, we argue that the demands from user groups not foreseen played a crucial role in altering the moped as well as its legal technical requirements. That users contribute to the design processes of technologies is widely accepted and is commonly captured by terms such as appropriation, domestication or co-construction.[6] We welcome such attempts to efface the solid

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Freeman and Soete, 1997). Frank W. Geels "From sectoral systems of innovation to socio-technical systems. Insights about dynamics and change from sociology and institutional theory" in *Research Policy* 33 (2004) 897–920

[5] E.g. Laestadius, Staffan, *Klimatet och välfärden: Mot en ny svensk modell*, Umeå: Boréa Bokförlag, 2013.

[6] On co-construction, see in particular the contributions in Oudshoorn, Nelly & Trevor Pinch (eds.), *How Users Matter: The Co-Construction of Users and Technologies* (Cambridge, MA, 2003). Other examples include Ronald Kline & Trevor Pinch, "Users as Agents of Technological Change: The Social Construction of the Automobile in the Rural United States", *Technology & Culture* 37:4 (1996), 763–95; Silverstone, Roger & Eric Hirsch (eds.), *Consuming Technologies: Media and information in domestic spaces* (London/New York: Routledge, 1992); Ruth Schwarz Cowan, "The Consumption Junction: A Proposal for Research Strategies in the Sociology of

demarcations between production and consumption. On the other hand, STS literature can be criticized for often overestimating the capacities of users and consumers, or restated, underestimating the wider frameworks within which design and innovation processes are embedded—institutions such as legislation being one of them.

The general purpose of this article is to make sense of the interplay between institutional regulations of technology and the user/market-driven development in the moped field in Sweden. The user-producer-nexus of moped innovation or, to use a term of Ruth Schwarz Cowan, the "consumption junction" of the moped, is situated in the context of state legislation and our general research questions is: Why and how did the bicycle with an auxiliary engine, meant for utilitarian purposes, so rapidly transform into a pleasure/recreational vehicle with very little resemblance with a bicycle, when the law clearly stated that this was not supposed to happen?[7]

To answer this question we have investigated what we call "windows of innovation". The regulations in the moped law of 1952 had a clear aim. Expressed in SCOT-parlance, authorities tried to reduce the interpretative flexibility of light-weight two-wheeled motorized vehicles and establish stability and even closure in moped technology. At the same time legislators had to take many different and sometimes contradictory factors—both social and technical—into account. Closure was thus not complete. Unclear aspects of the legislation, and those not attended to at all, allowed for different actors to challenge the closure and increase the flexible interpretation of moped technology and design.[8] For some user groups and some producers and retailers these gaps and ambiguities became windows of innovation. They aimed at creating a less bicycle-like and a less utilitarian vehicle (more MC-like, more of a recreational vehicle) by increasing the engine power and vehicle speed or by changing the structural design and appearance of the vehicle. In the following we will analyze this development by focusing on innovations in three areas:

1. *Core technology innovations*: Innovations and alterations on the engine (increasing effect and power) and innovations and alterations in the construction of the drive line between the engine/pedals and the wheel and also on the gearing and gear wheels of the power

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Technology." In *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, eds. Wiebe E. Bijker, Thomas P. Hughes & Trevor Pinch, Cambridge, MA: MIT Press, 1989, 261–80.

[7] Ruth Swartz Cowan first brought attention to the importance of the consumer in determining the success or failure of technologies. She defined the "consumption junction" as "the place and time at which the consumer makes choices between competing technologies". Schwarz Cowan 1989,

[8] The concepts of interpretative flexibility, stability and closure were first launched in Pinch, Trevor & Wiebe Bijker, "The social construction of facts and artifacts: Or how the sociology of science and the sociology of technology might benefit each other." In *The social construction of technological systems: New directions in the sociology and history of technology*, eds. Wiebe Bijker et al., Cambridge, MA: MIT Press, 1987, 17–50.

transmission. Following the wording of Henderson and Clark, core technology innovations can be "modular" (in the engine) or "architectural" (in the composition of the power train).[9]

2. *Structural design innovations*: Innovations and alterations in the "rigging" and composition of the vehicle, such as different positioning of the gasoline tank, saddle, size and shape of the frame and different wheel size, etc.

3. *Aesthetic design innovations*: Innovations and alterations with the purpose to change the appearance of the vehicle signaling a certain identity of the user and/or giving references to other vehicles and artifacts associating the moped with modernity, "coolness", speed, etc.

These are of course no clear-cut categories. Certain changes to the core technology may also have structural and aesthetic dimensions and consequences, and many structural innovations surely have aesthetic signaling effects.

Mapping the interplay between legislation, production and consumption, the views and actions of legislators and producers are comparatively easy to capture by means of traditional source material. To capture actual usage and the influence of users in innovation processes is, however, not always an easy task. Ethnologists and historians working on relatively contemporary issues may conduct interviews with users regarding their present and historical usage. Alternatively, users may have left written traces of their usage, e.g. in the form of diaries or other accounts. More commonly, however, historians need to make use of others' representations of users and their usage, e.g. representations made by "mediators" such as engineers, lobby groups or consumer organizations.[10]

A surprisingly underutilized source material is the objects being used. Determined to move away from "internal" histories of technology and instead relate the sub-discipline to the "great" historical concerns – in an attempt to be more "relevant" to generalist historians – historians of technology have too quickly abandoned materiality.[11] While social constructivism once radically twisted our conceptions about technology, it is today broadly accepted and hardly in need of more qualification. We argue that it is time for historians of technology to return to the "thingness of things" as a productive way to come to terms with users and usage, while not disposing of the insights from

[9] Henderson, Rebeccca M. & Kim B. Clark, "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms", *Administrative Science Quarterly* 35:1 (1990), 9–30.
[10] See e.g. the editors' introductory chapter in Albert de la Bruhèze, Adri A. & Oldenziel, Ruth (eds.), *Manufacturing technology, manufacturing consumers: The making of Dutch consumer society*, Amsterdam: Aksant, 2009.
[11] See e.g. Corn, Joseph J., "Object Lessons/Object Myths?" In *Learning from things: method and theory of material culture studies*, ed. W. David Kingery, Washington, D.C.: Smithsonian Institution Press, 1996, 36f.

constructivism or forgetting to consider technology in relation to greater social dynamics. In short, and to paraphrase political scientist Theda Skocpol, we want to "bring technology back in".[12]

We argue that the demands of user groups as collectives may be captured by a close study of the technology and the artefacts themselves. We draw conclusions on different kinds of users and usage by analysing the technical, structural and aesthetic design built into mopeds by producers and users.[13] This means that our quest is not primarily to read "symbolic meaning" from artefacts, as scholars of material culture would. We discuss cultures, subcultures, age, class, gender, etc. in our analyses, but our focus is not to problematize these issues in any depth.[14]

Applying a method inspired by evolutionary theory, the moped models released in Sweden in the period 1952–75 are grouped in "families" with distinctive technical features and accompanying presumed users and usages.[15] When combined with other primary sources (marketing material, interviews, records of Parliament and the archive of the Swedish Moped Investigation operating in 1955–1960) this approach allow for an analysis of the interplay between producers, consumers and the legislation framing technology usage. In the next section our methodological approach is further elaborated, before returning to the contradictory decision by the state to "liberate" the moped in Sweden by actually *regulating* it.

Moped (R)evolution

The re-regulation of bicycles with auxiliary engine resulted in a moped revolution. Only eight days after the new legislation entered into force, 18 different engines had been approved for trade by the authorities. Four months later, the number of approved engines had risen to 40, in 1954 to 80, and very soon custom-made mopeds with built-in engines were also available.[16] The industry knew of the plans to provide some relief for bicycles with auxiliary engines, why some brands were available already before 1 July 1952.[17]

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[12] Skocpol, Theda, *Bringing the State Back In* (with Peter B. Evans and Dietrich Rueschemeyer), Cambridge, MA: Cambridge U.P., 1985.

[13] For a similar approach see Mom, Gijs, "Translating Properties into Functions (and Vice Versa): Design, User Culture and the Creation of an American and a European Car (1930–70)", *Journal of Design History*, 21:2 (2007), 171–81.

[14] For a celebrated cultural analysis of the Italian scooter, see Hebdige, Dick, "Object as Image: The Italian Scooter Cycle", in *Hiding in the light: On images and things*, ed. Dick Hebdige, London: Routledge, 1988, 77–115.

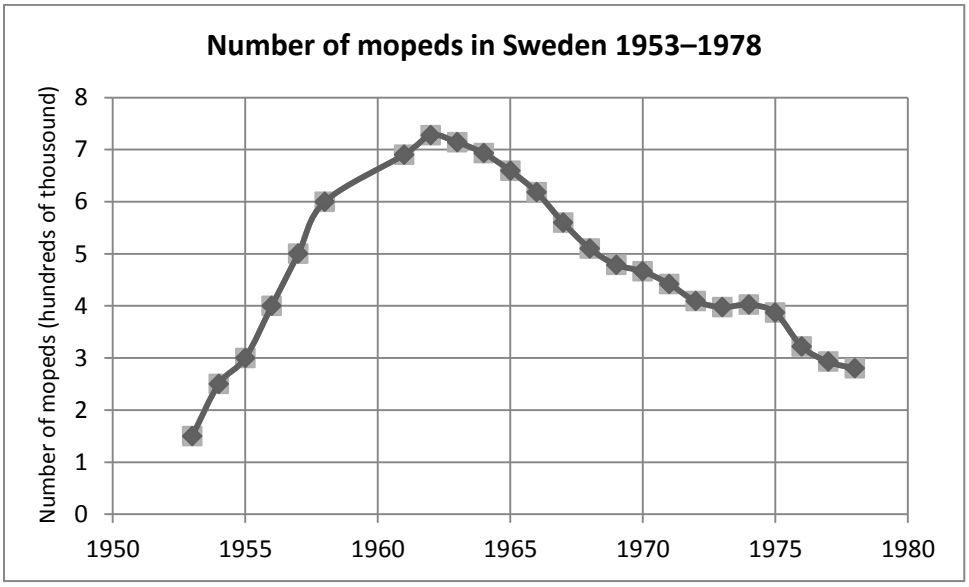
[15] A standard work is Basalla, George, *The Evolution of Technology*, Cambridge, MA: Cambridge U.P., 1988. More sources of inspiration in this regard are brought up in the following section.

[16] Johansson, Claes, *Tretti knyck! Mopeden i Sverige*, Stockholm: Byggförlaget, 2001, 12

[17] For examples of early experiments and production of auxiliary engines by the Swedish producers Monark and Nymans, see Wiking-Faria, Pablo & Lars-Åke Wiman, "Motorcyklar och mopeder i museets samlingar." I *På två*

Both the number of mopeds and moped traffic increased explosively. The number of mopeds in use rose from 150 000 to 600 000 between 1953 and 1958, according to a state investigation to a large degree at the expense of the number of bicycles – which fell dramatically, from 285 000 sold bicycle in 1952 to 140 000 bicycles in 1958.[18]

The growth in number of mopeds had its counterpart all over in Europe, but its speed varied, depending on the degree of regulation of the vehicle. Among the Nordic countries, for example, the expansion in Sweden and Denmark by far exceeded that in Norway and Finland, where reliefs for the moped were introduced later. France and Germany were forerunner in moped technology (that is, smaller engines) and therefore had a head start both in number of vehicles and moped traffic. The Netherlands was also, consideration taken to the size of the population, a leading moped nation. Relative to the number of inhabitants in the respective countries, Sweden came second among all West European countries in 1955 and 1956, after France and closely followed by the Netherlands and Denmark.[19]



Number of mopeds in Sweden 1952–78. Source: For the years 1953–58 based on estimations made by the Swedish Moped Investigation. For the years 1961–78 based on the number of third party insured mopeds according to Ds K 1979:3, *Säkrare mopedtrafik*, 29. Though insurance of mopeds was made mandatory in 1961 it is likely that not all mopeds were insured (and therefore included in the statistics).

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hjul: Om cyklar, mopeder och motorcyklar, ed. Eva Berntsson Melin, Varberg: Varbergs Museum Årsbok, 1994, 92; Darphin, Jean-Paul, *Nymans verkstäder: cykelgiganten i lärdomsstaden Uppsala*, Uppsala: Industrihus, 1995), 135f.

[18] Mopedutredningen 1959, 59.

[19] Mopedutredningen 1959, 74. In Sweden the number of mopeds per 1 000 inhabitants was 48 in 1955 and 62 in 1956. The corresponding figures for France was 53 and 69; for the Netherlands 47 and 60; and for Denmark 47 and 57.

Making sense of the several hundreds of moped models released on the Swedish market in Encyclopedic-like books for moped enthusiasts was initially a daunting task. Using a method inspired by evolutionary theory, however, helped us see, group and categorize patterns in the moped development that would otherwise be difficult to grasp due to the sheer number of different moped brands and models.

The most comprehensive collection of pictures and technical data of mopeds in Sweden ought to be Lars Golbe's *Mopedboken* (2002), including the vast majority of the more than 400 models launched in Sweden by 80 different firms between 1952 and 1975.[20] Golbe sorted these mopeds by mark and firm. By rearranging the mopeds chronologically and independent of brand we could map a striking development that was grouped into different types, or "families", of mopeds. Examining the pictures and the technical data we constructed a table with the most important technical, constructive and design characteristics (see attachment in the original report).

The result was essentially what biologists and paleontologists call a "phylogenic tree", used when investigating family relations between different species.[21]

In a similar fashion we identify ten distinctive "moped families" and construct a family tree (see attachment 1). By a "moped family" we mean a certain distinctive type of technical design that is stable and successful in the market for a number of years. In defining the families we focus on what kind of usage the moped is meant for and what sort of user that can be connected to the different families. We use the following characteristics to sort the mopeds into their respective family: general features, frame, handlebars, saddle, carrier for luggage, wheels/tires, mudguard/fender, pedals/foot pins, brakes, springs, gasoline tank (placement and volume), engine (placement, effect and cylinder volume), transmission function, gearbox and vehicle weight.

The families are further grouped into categories corresponding to three phases which capture the major traits in moped evolution and usage: a utility phase 1952–55 (family 1–3), a transitional phase

[20] Golbe, Lars, *Mopedboken: En sammanställning*, Motala: Veteranförlaget, 2002.

[21] This method of sorting species of artifacts into family groups has been used by W. Bernard Carlson when analyzing Edison's sketches on the telephone. Carlson, W. Bernard, "Invention and evolution: The case of Edison's sketches of the telephone." In *Technological Innovation as an Evolutionary Process*, ed. John Ziman, Cambridge, MA: Cambridge U.P., 2000, 150. Regarding co-evolution of technology and institutions, see also Van de Ven, Andrew H. & Ragu Garud, "The Coevolution of Technical and Institutional events in the Development of an Innovation." In *Evolutionary Dynamics of Organizations*, eds. Joel A.C. Baum & Jitendra V. Sing, Oxford: Oxford U.P., 1994; Langlouis, Richard N., "The Coevolution of Technology and Organization in the Transition of the Factory System." In *Authority and control in modern industry: Theoretical and empirical perspectives*, ed. Paul L. Robertson, London: Routledge, 1999; Rosenkopf, Lori & Michael L. Tuchman, "The Coevolution of Technology and Organization", in Baum & Sing 1994.

1955–61 (family 4–7) and a recreational phase 1961–75 (family 8–10). In this article we will focus on the first two phases: 1952–61.

The evolutionary method helps us to conceptualize the development of the moped by identifying and separating the important traits within each moped family. It is important to note, however, that the evolutionary approach is a simplification of the dynamics in the moped market. The "selection process", to speak in evolutionary terms, is not a result of consumer choice only, but is influenced by marketing initiatives by producers and retailers. Moreover, "variation", or rather the lack of it, may result not only from stable user preferences, but also from producers being tied up by certain production techniques or overall product programs.

The moped law 1952: State strategy and motives

The aim of the 1952 legislation was twofold. Firstly, it was a pronounced desire of the Swedish Government (the Social Democratic Party and the Center Party) to "democratize" the use of motor vehicles. The moped was seen as an opportunity for people of lesser means to gain access to motorized transport and therefore a first step towards full participation in a motorized society.[22] Secondly, the Swedish Government wanted to standardize the road traffic system and improve road safety by regulating a component in the system.[23]

The trade-offs between perceived social benefits of motorization and traffic safety concerns had a long history. Regulations on two-wheeled motorized vehicles varied greatly during the first half of the twentieth century. The archaic motorcycle from the beginning of the twentieth century was basically an ordinary pedal bicycle with a combustion engine. In Sweden the closure around MC design, as we know it today, can be dated to around 1916 when Husqvarna launched its first model without pedals. The rules differed over time, but were typically based on a divide into two classes of motorcycles: heavy and light MC. The parameters were speed, engine effect and vehicle weight, and both classes required the driver to have a driver´s license, insurance and to be of a certain age (18 and 16 years respectively).

The archaic motorcycle (the pedal bicycle with an engine) prevailed, however, and most of the time remained outside the realm of the law. Sweden thus had a plethora of unregistered two-wheelers that were neither bicycles nor motorcycles, according to the letter of the law. They were often home-

[22] Blomkvist, Pär, *Den goda vägens vänner: väg- och billobbyn och framväxten av det svenska bilsamhället 1914–1959*, Eslöv: Symposion, 2001; Lundin, Per, *Bilsamhället: ideologi, expertis och regelskapande i efterkrigstidens Sverige*, Stockholm: Stockholmia Förlag, 2008.
[23] See e.g. Kullström, Gunnar, "Mopedens plats i trafiksystemet", *Trafiksäkert stadsbyggande: Fortbildningskurs i stadsbyggnad vid KTH 29–30 september 1966*, Stockholm: Kungliga tekniska högskolan, 1966, 107–9.

built, constructed by the user and displayed a great amount of creativity which was however not always matched by mechanical skills or a sense for traffic safety. The engine was often too heavy for the slim bicycle frame. In the 1930s, when motorized road traffic of all types surged, these vehicles became an annoyance to the authorities. After some twists and turns, from 1939, the law included all sorts of motorized bicycles in a third, even lighter, MC category, regulating speed, vehicle weight, tax, age (16 years) and introducing a simpler form a driver´s license.[24]

A decade later, however, technological developments had brought forth lighter (typically 4–7 kg) and less powerful auxiliary engines that were better suited for the construction of un-altered bicycles and allowing for speeds around 30 km/h only.[25] The 1949 International Road Traffic Convention had, moreover, opened up for excluding ordinary bicycles with engines of less than 50 cc from the vehicle category of motor vehicles.[26] Swedish Minister of Communications found it reasonable that ordinary bicycles equipped with such tailor-made auxiliary engines were exempted from regulation without risking traffic safety.[27]

The 1952 legislation clearly focused on regulating the engine – that is, using our terminology, the law was targeted "core technology innovations". Leaving the weight of the engine and the vehicle open, which had been a corner stone in earlier MC-regulations, the legislators elaborated with three kinds of limits: the maximum cylinder *volume* (50 cc) and *effect* (0,8 hp) , and a *design speed* limit of 30 km/h. The law finally included all three limits.[28]

For the "structural design", the composition of the vehicle, the law simply stated that it should have the "main characteristics of a bicycle". From the texts preceding the 1952 legislation it is clear that, besides the bicycle-likeness in terms of appearance, its traffic properties should not differ from an ordinary bicycle in any other ways than being propelled by "mechanical instead of human power". The auxiliary engine should thus be "suited for a bicycle of normal construction" in terms of weight and mode of action, and its capacity should not exceed the power with which a cyclist could propel the bicycle using the pedals.[29]

The Minister of Communications agreed on these terms, and he urged for a control mechanism which would "guarantee … that the technical development [did] not – as has previously been the

[24] Prop. 182/1952, 4ff; Mopedutredningen 1959, 14–26.
[25] Prop. 182/1952, 7f.
[26] Prop. 182/1952, 8.
[27] Prop. 182/1952, 15.
[28] Prop. 182/1952, 19ff.
[29] Prop. 182/1952, 1f, 8f, 11, 19.

case – lead towards heavier and faster and thus more dangerous kinds."[30] By means of the new moped law, the state wanted to create a "dominant design" of light-weight two-wheeled vehicle technology; the legislation can be considered an attempt of "path creation".[31]

As we will see below, however, not specifying the weight and composition (the structural design) of the vehicle more carefully left the floor open for exactly that, users and producers finding windows of innovation and thus challenging the intention of the law. Focusing only on the engine may seem odd in retrospect, but was a rational choice given the strong conception of the moped as a bicycle with auxiliary engine—propulsion would primarily be human and the engine indeed an add-on.

There was anxiety about what this new kind of vehicle would imply with regards to traffic safety.[32] But the social dimensions and the moped's "freedom" was considered so important that road safety – when pitted against each other – had to stand back. The social benefits depended to a great deal on whom the legislators envisioned would use the new kind of vehicle. In the texts preceding the 1952 legislation, five main user groups can be discerned: labor workers, rural residents, those with small economical means, youths, and physically impaired.[33]

That youths would be frequent users was evident from the beginning. In the 1952 Government Bill, the minimum age for driving a bicycle with auxiliary engine was proposed to be 16 years. The Second Legal Affairs Committee [andra lagutskottet], however, suggested that the age limit was lowered to 15 years—which was approved by the Parliament.[34] In 1952, Sweden still had an 8-levelled elementary school (which was substituted for a 9-levelled comprehensive primary school during the course of the 1950s and 1960s). There were thus many youths and potential moped users leaving school for work at the age of 15.[35]

To summarize, a number of specifications of the bicycle with an auxiliary engine entered the 1952 legislation. The vehicle should be bicycle-like; a pretty vague definition, which, since neither weight nor the "structural design" of the bicycle was specified, essentially came to mean that it should be equipped with pedals.

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[30] Prop. 182/1952, 18 and 22.
[31] "Dominant design" is a concept developed within evolutionary economics and used by Abernathy, W.J. & J.M. Utterback, "Patterns of Innovation in Technology", *Technology Review* 80:7 (1978), 4–47. Regarding "path creation" as something desirable, in contrast to the often undesired effects of "path dependence", see e.g. the editors' introductory chapter in Garud, Raghu & Peter Kvarnøe (eds.), *Path Dependence and Creation,* Mahwah, N.J.: LEA Publishers, 2001.
[32] Prop. 182/1952, 10f, 16f.
[33] Se e.g. Prop. 182/1952, 8f, 11–17 and AL utlåt. 43/1952, 11f.
[34] AL utlåt. 43/1952, 11.
[35] Prop. 68/1960, 37.

Utility was the *leit motif* for the Government as well as for many bodies considering the proposed legislation. The bicycle with auxiliary engine was to facilitate a more flexible choice of workplace comparatively far away from place of living, which was helpful considering the transformation of society and the huge relocation of the workforce. The moped was seen as an ingredient in the machinery that would take Sweden into the modern industrial age.[36] In a rational industrial policy the worker needed to be mobile. In the Government Bill in 1952, the Minister of transportation stated: "The bicycle with auxiliary engine thus seems to fill a utilitarian transportation need. For pure entertainment and sport the vehicle in question, by contrast, seems to be of secondary importance."[37] History was going to prove him wrong.

The utility phase 1952–55

The first few years after the 1952 legislation most moped models sold in Sweden complied with the framework postulated by government. During the period 1952–55 three distinctive and sequential moped families can be discerned: the *bicycle with a separate auxiliary engine*, the *bicycle with an integrated auxiliary engine* and the *utility moped* (family 1–3 in attachment 2). All of them fulfilled the requirements of being bicycle-like and having pedals (but in a gradual move away from bicycle-likeness), and, moreover, they were all clearly targeted towards utility.

One of the most popular engines was the "Flink" auxiliary engine mounted on the front fender with the power transmitted by a reel [rulle] on the front wheel (friction drive). Using a lever the engine could be lifted off and decoupled. The "Flink" was a 0.7 hp, two-stroke engine, with a cylinder capacity of 43 cc, weight of 6.9 kg and the fuel tank held two liters. Similar engines, such as "Totaco", "Pilot" and "Power Pak", had friction drive (reel) on the rear wheel. The engines were mounted on a special steel plate at the luggage carrier of the bike. A third way to motorize the bicycle, not too common, was by replacing the front or the rear wheel with a "auxiliary-engine-wheel". The engine was thus built into the wheel, it was relatively small, 32 cc, and ranging from 0,37 ("Velmo") to 0,6 hp ("Cyclemaster").[38]

[36] Prop. 182/1952, 13f.
[37] Prop. 182/1952, 16. Swedish original: "Cykeln med hjälpmotor förefaller sålunda kunna fylla ett behov i nyttotrafikens tjänst. För den rena nöjes- och sportåkningen synes fordonet i fråga däremot bli av underordnad betydelse."
[38] Golbe, 44, 166.

From left: “Flink”, “Velmo”, and “Victoria”.

None of the three kinds of auxiliary engines described above required any major alterations of the ordinary pedal bicycle. The power transmission from the engine was clearly separated from the manual power transmission through the pedals and the chain, and they were quite easily attached to the bicycle. The “Victoria FM 38” represents a fourth variant which is somewhat different and signals the path towards the next stage in moped development.[39] It was a 0,69 hp, two stroke engine with a cylinder volume of 38 cc, weight of 11,5 kg and a 3 liter gas tank. The Victoria thus was heavier than the other kinds of engines and suited for longer engine-powered trips. Even so, it was not a very big machine, and kept well below the stipulations in the moped law (0,8 hp/50 cc). The gasoline tank was placed under the luggage carrier and the bike thus had to be rebuilt slightly more than in the previous examples. More importantly, power transmission from the engine was accomplished by a separate chain working on an extra gearwheel (pinion) attached to the back wheel. The Victoria had two gears and the engine could be decoupled to allow for the use of the ordinary pedals working on their separate gearwheel.

To summarize, the size and power of the separately sold engines were often well below the letter of the law, but given the comparatively low weights of the complete equipage (engine and ordinary bicycle) they were still able to give rise to speeds of around 30 km/h.

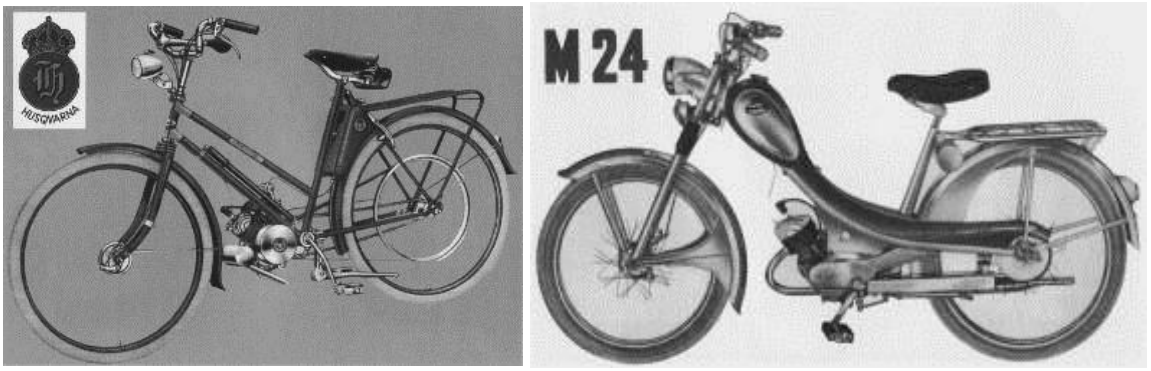
The ordinary bicycle with a separately sold auxiliary engine was a short-lived phenomenon. Auxiliary engines became impossible to sell after a few years only, and several of the international producers of such engines (e.g. Lohmann, Berini, Cyclemaster) ceased production in 1954.[40] Different factors may have contributed to the quick decline. Firstly, the effort and skill needed to mount the engine on one’s own bicycle probably made the technically less skilled opt for a ready-mounted equipage. Secondly, the frame of the ordinary bicycle did not always lend the stability required for hinging an

[39] Golbe, 268.
[40] Interview with Lars Golbe 19/2 2009; Johansson 2001, 10; *Classic Motor Album* 11, 40–42.

auxiliary engine to it. This was brought up in a later state investigation, and, moreover, several pictures reveal reinforcements that are usually not needed on a bike. Amateur moped historian highlight a third reason for the short success of the separate auxiliary engine. At least among young urbanites, having ordinary bikes with auxiliary engines was soon considered ridiculous and something for old men and women (sic!) only.[41]

The bicycle with a separate auxiliary engine mounted on an ordinary bicycle was soon replaced by vehicles built with an integrated auxiliary engine and sold complete to the costumer. During the years 1952–54 a vast number of variants were produced and sold. "Husqvarna Novolette 3311" is an ideal-typical example – a sales success and the most popular variant in this family in Sweden.[42] The frame had the shape of an ordinary (female model) bicycle but of thicker steel pipes and more robust. The engine was mounted close to the pedals, which would later become the standard position. The biggest difference from most of the earlier add-on engines was that the Novolette had an exclusive system for power transmission from the engine. A separate wheel inside the back wheel was propelled by a leather belt and the bike thus had two back wheel gearwheels – one for the engine and one for the pedals. The vehicle was started by pedaling the bike up to speed and plug in the engine. The cylinder volume varied between 32–49 cc and the effect was often around 0,6–0,7 hp.

Other characteristics of the bicycle with an integrated auxiliary engine were the saddle and the luggage carrier. The saddle was a regular bicycle type and well suited in size for the use of the pedals as a power source. The wheels were large (26-28") and thin compared to later mopeds and the fenders/mud-shields compared to those on ordinary bikes. The vehicle had no springs and the total weight was approximately 30 kg. The gasoline tank contained 2–3 liters (not for long motor-driven trips) and was discretely placed under the saddle and integrated in the frame.



From left: "Husqvarna Novolette 3311" and "Monark Monarped M 24".

[41] Interview with Lars Golbe 19/2 2009; Mopedutredningen 1959
[42] Interview with Lars Golbe 19/2 2009; Johansson 2001, 38.

By the end of the second year with the moped legislation, most vehicles were still aligned with both the social and technical/functional intentions of the authorities. The vehicle clearly resembled an ordinary bicycle and it was supposed to be used in a work-related, utilitarian way. The next moped family identified, the “utility moped”, was the most popular kind of moped from the mid-1950s to the mid-1960s. As its label suggests, it lived up to the expectation of the legislators in terms of usage. In terms of structural innovations and aesthetic appearance, however, a transformation had begun.

After the launching of some intermediate variants with big wheels, thin tires, no springs and ordinary bicycle saddles, the utility moped found its form around 1954. Exemplified here by “Monark M 24”, the utility moped had a lower and sturdier frame, although still inspired by the female-framed bicycle. The frame was built by curved and welded steel pipes, while the frame was covered by steel plates for visual design. The weight of the vehicle was 35–40 kg and the engine stabilized around 50 cc and 0,8 hp. Another significant change was the smaller wheels (24”) and thicker rubber tires, the wider mud fender and standard springs on both front and rear wheel. The gasoline tank was not integrated in the frame, but similar to the motor cycle, placed in front of the driver and measuring 5–6 liters. The utility moped moreover had a bigger and more comfortable saddle, which was not suitable for pedaling. It had, of course, the prescribed pedals, but this vehicle was clearly not primarily intended to be human-powered.

Single driveline: A key core technology innovation

In functional terms the utility moped conferred with the expectations of the legislators. Its robust construction and sturdy luggage rack clearly signals that this moped belonged to the productive/reproductive sphere rather than in entertainment and recreation. In terms of bicycle-likeness, however, the utility moped diverged from the letter of the law. It was subject to a host of structural, and to a lesser extent aesthetic, innovations during the first few years following the 1952 legislation. The utility moped had lower wheels, bigger saddle, the fuel tank up-front, and so on. More crucial to the further development of the moped (how the bicycle with an auxiliary engine could turn into a MC-like vehicle), however, was a core technology innovation.

The most important distinguishing trait concerning the core technology, separating the utility moped from its predecessors, was the single drive line for power transmission. In the first moped family the power from the auxiliary engine and from the pedals was transmitted by two separate systems; a friction roll transferred the power from the engine, while the pedaling power was conveyed by a chain as on an ordinary bicycle. Later the friction roll was replaced by a driving belt working on a separate inner wheel mounted in the back wheel of the bike. The pedals still worked on the ordinary

gear wheel by means of a chain. The important innovation was the establishment of a single driving line – one single chain – for power transmission from both the engine and the pedals. This innovation made it extremely tiring to pedal the moped, and in practice most people used the pedals for starting up the engine only.[43]

Mopeds with different drivelines for pedals and engines did continue to exist long after 1954, but they were exceptions. The single driveline quickly became a "dominant design".[44] In the words of Rebecca Henderson and Kim Clark, the incremental development towards a single driving line was an "architectural innovation" (how the core technology components are assembled) as opposed to a "modular innovation" (innovation *within* core technology components).[45] The 1952 legislation included clear stipulations for the engine, but none regarding the power transmission. It was thus not allowed to manipulate (innovate in) the engine. Incremental innovations in the driveline, on the other hand, were below the radar of the authorities. The transformation to one single driveline paved the way for other, structural innovations, such as even smaller wheels and lower position of the seat – which made the pedals even less practical. When pedals were made the secondary power source it opened up for creativity and experimentation.

To summarize, the moped law of 1952 expressed a clear vision of certain type of vehicle: a pedal bicycle with an auxiliary engine used for utilitarian purposes. But the law had some "windows of innovations" for both producers and users. Firstly, and most importantly, the producers gradually, but very fast, decided on a single driveline for power transmission. This core technology innovation paved the way for other innovations such as wheel size etc., making the moped look less and less of a bicycle. The utilitarian usage intended in the law was, however, basically unaltered. This may be an important reason why authorities avoided taking action towards moped development. The real threat to the intended utilitarian usage of the moped law came in the following years.

[43] Interview with Lars Golbe 19/2 2009.
[44] Our source material does not reveal the explicit motives behind this core technology innovation. Interviews with motor journalists and moped enthusiasts of today give a strong impression that the development towards a single driveline had two main reasons: It was easier to produce and needed less maintenance and, perhaps more importantly, "everyone" wanted a motorized vehicle, not a pedal bicycle. Interview with Claes Johansson, maj 2013.
[45] Henderson & Clark 1990, 12.

Three drivelines, from left: reel [rule], rim [rem] and chain. Sourse: Flodén, Gunnar, *Fylla moppe: Så minns vi mopedens guldålder: 50 cc som förändrade Sverige* (Uppsala 2008), p. 26.

The transitional phase 1955–61

During the period 1955–61 four new moped families emerged: the *youth-styled utility* moped, the *luxury-styled utility moped*, the *scooter moped*, and *the sports moped with pedals* (family 4–7 in attachment 2).

During this period there are no radical innovations in the core technology from the producer side. But some incremental technical developments are important to notice. Gradually the 50 cc cylinder volume became the "dominant design". Furthermore, which is important for the discussion below, foreign engines became standard: either imported engines mounted on Swedish makes, or as part of complete foreign mopeds. These European engines were stronger (3–5 hp) and mechanically adjusted to the Swedish stipulation of 0,8 hp. They allowed for a more effective gearing box (3–4 gears) and, probably most important for the users, they were quite easy to re-adjust back to the original engine effect.

Apart from the incremental developments in core technology the moped families during this period signaled a radically new way of moped usage. The common denominators were that they all, in various ways, tried to mimic motorcycle design, signaling youth, modernity and, most of all, recreational driving. In this phase structural and aesthetic innovations challenged the regulations of 1952. But, as will be discussed later, a couple of core technology innovations also had a large influence: "tuning" – user and producer innovations (manipulations) of the engine and power transmission drive line to achieve higher speed.

The first sign of this new structural and aesthetic design trend came in motorcycle-inspired, "youth-styled", variants of the utility moped, as exemplified in "Puch MS 50" and "Crescent Sport". These mopeds were fitted with handlebars and had saddles similar to contemporary cruising-type of motorcycles, such as Honda Benley 1956. Though it had the mandatory pedals, they were thus even more difficult to use. Aesthetic innovations had a clear direction towards modernity and youth

culture. The Puch MS 50 had references to the motorcycle and to youth and the Crescent Sport was explicitly designed with reference to space rockets and American automobiles.

From left: “Puch MS 50” (1955), “Crescent Sport” (1959).

The luxury-styled utility moped was never very common in Sweden, but shared the heritage from the utility moped and borrowed from American car design. Its design was modeled on the German Kreidler, which interestingly enough in 1958 was one of the prime inspirations for the famous Japanese moped/scooter Honda Cub (one of the most selling motor vehicles in history).[46]

Another motorcycle trend influencing the moped during the transitional phase was the Italian scooter with its small wheels. The scooter moped was the only kind with a clear feminine gender-coding. The Vespa-styled moped was often portrayed as a big trend, but in reality was never that important. The weak engine had difficulties to support the heavy steel frames of the scooter moped. On the scooter moped the required pedals were really an absurdity; it was obviously not possible to pedal these low and heavy vehicles.

[46] Conekin, Becky E., “Fashioning Mod Twiggy and the moped in ‘swinging’ London”*, History and Technology: An International Journa*l, 28:2 (2012), 209–15.

From left: ”Piccolo Scooter” (1954), “Crescent 1145 Scooter” (1955)

The most important new family during this phase was the “sports moped”. Unlike all the others, its frame had the diamond-shape of a male bicycle. In the first variants the steel pipes was in open view, but they were soon covered with pressed steel plates. This moped family was clearly targeted for young boys. Three early examples, all Swedish makes, were Husqvarna’s “Novolette Sport” and “Rex Crossline” from 1955 and “Monark M 31” from 1957. The early sport mopeds were not that heavy (35 kg) compared to the later development after 1961, when a sport moped could weigh around 70 kg. Other distinctive traits were the oblong gasoline tank mounted horizontally behind the handlebars (approx. 5–10 liters) and the characteristic “loaf” saddle. The sports mopeds had no luggage carrier, 24” wheels, and the straight and low handlebar rendered the rider a racer-like position – features signaling recreational purposes.

From left: “Husqvarna Novolette Sport” (1955), “Monark M 31” (1957), “Rex Rexoped Crossline” (1955).

Users and producers inventing in core technology

Swedish authorities closely followed the development of the moped. A committee was appointed in 1955 to have a closer look at the moped market and to suggest actions. The “Moped Investigation” was active until 1959 and its work led to a new moped law in 1961. Besides certain insurance-related

issues the committee was, in our terminology, concerned with core technology and structural innovations.

The complex interplay between producers, consumers and the state is perhaps nowhere as manifest as in the regulation (and manipulation) of the engine and the power transmission – innovations in the core technology of the moped. As mentioned, the 1952 legislation brought up several conditions for the engine. The condition that the engine's design speed was limited to 30 km/h was complemented with the instruction that it "not without difficulty" could be changed for higher speeds.[47] But it turned out not to pose any major difficulties tuning mopeds. There are three basic ways to up-tune a moped for higher speeds: manipulating the engine (by widening its [inloppskanal] or removing the simple bushing used for reducing the effect, or manipulating the gearing of the power transmission.[48] To the detriment to legislators and "honest" industry actors, tuners were helped out by retailers with special tuning kits for sale. Mopedägarnas Inköpscentral i Malmö, for example, provided aspiring tuners with special "racer"-performance parts, special tools for tuning and step-by-step instructions on how to tune a two-stroke engine.[49] In 1959, the moped investigators noted that tuning was "so easy and at the same time so tempting" that it was hardly thinkable to keep especially younger moped owners from doing it.[50]

Adding to the complexity, the Swedish moped market was small in a European context. No Swedish manufacturer but Husqvarna had their own moped engine, and foreign producers rarely produced tailor-made engines exclusively for the Swedish market. (Neither did Swedish authorities and producers have much possibility to influence international foreign choices of structural design.) Most imported engines – that is, almost all moped engines used in Sweden – thus had to be artificially hampered to lower the effect to 0,8 hp. Moped users were aware of this and they also knew that the engine quite easily could be re-adjusted to its original effect, although it was, of course, illegal.

The Moped Investigation noted the existence of mopeds that, already at the time of sale, were constructed for speeds exceeding 30 km/h. More than half of the engines inspected over a two-year period exceeded this limit, several having maximum speeds as high as 35–45 km/h.[51] From their contacts with Swedish moped industry, the moped investigators drew the conclusion that mopeds

[47] Prop. 182/1952, 2.
[48] Mopedutredningen 1959, 45f; Prop. 68/1960, 13, 17. Se också Claes Johanssons redogörelser för olika sätt att trimma i Johansson 1993 och Johansson 1994.
[49] *Produktkatalog över racer- och trimdelar samt annat tillbehör*, Mopedköparnas Inköpscentral AB, 43, 96ff, 103f.
[50] Mopedutredningen 1959, 47.
[51] Mopedutredningen 1959, 79f.

with excessive design speeds were more popular in the market, why it was a competitive disadvantage to keep to the letter of the law.[52]

A closer look reveals the unequal possibilities among different actors in the market to meet prominent user demands. In fact, Swedish moped producers had brought the investigators' attention to the issue of excessive design speeds. Profiling themselves as responsible manufacturing firms, they were eager to point out the violations of what they considered to be less scrupulous importers of foreign makes.[53]

For the major importers of foreign makes it was thus all the more important to position themselves as "loyal" actors in the Swedish market for mopeds. When a Puch MS 50L was caught in inspection in 1956, the director of the Swedish Puch-importer Motorlund AB stressed that he had taken full and immediate action, pausing all import from the Austrian factory until things had been cleared up and corrected.[54] The director assured that he had not known that their mopeds were too speedy. According to him, Puch mopeds were subject to comparatively much manipulation since it "through its racer-appearance has a special clientele, which to a large extent tries to manipulate the mopeds."[55]

The Austrian-made Puch, however, had a reputation of being easily manipulated. From popular media and advertisements from firms selling up-tuning equipment it is clear that one of the most important reasons behind Puch's success in Sweden was its powerful engine, so easily tuned to reach its full potential. By contrast, engineers at Husqvarna were frustrated that their company always had to be so moral and wholesome. Knowing that the [slidmatning] of their engines made tuning practically impossible, and that youths wanted "easily up-tuned engines", they tried (in vain) to avert it from being used on the models aimed at youths.[56]

Retailers, importers and producers took part in the process of manipulating the core technology of mopeds in accordance to user demands. There were different ways to adjust the effect downwards on strong foreign engines, but none were immune to user re-adjustments. The stipulation thus constituted a major window of opportunity, begging to be opened by users, who in turn were helped

[52] Mopedutredningen 1959, 80.
[53] MU, Volym 2, Handlingar: Tekniska frågan: Thure Öberg, Husqvarna Vapenfabriks Aktiebolag, till Hovrättsrådet Gunnar von Sydow, 7 juli 1955; MU, Volym 1, Inkomna skrivelser: Dnr A 9/1956, AB Cykelfabriken Monark (Tage Warborn) till Hovrättsrådet Gunnar von Sydow, 5.6.1956 and 8.6.1956.
[54] MU, Volym 1, Inkomna skrivelser: Dnr A 13/1956, Motorlund AB (Clas Clemenson) till Kungl. Väg- och Vattenbyggnadsstyrelsen, Vägtrafikavdelningen, 31/7 1956; Dnr A 17/1956, avskrift av Statens Provningsanstalt Intyg nr 13828.
[55] MU, Volym 1, Inkomna skrivelser: Dnr A 6/1957, "Protokoll över ett sammanträde ang. mopedmotorers konstruktion", Stockholm, 4 juli 1957, undertecknat Pehrson från Statens Provningsanstalt.
[56] Johansson 2001, 42.

out in different degrees to do so by producers and importers. The loyalty among Swedish producers towards the Swedish authorities in this case was a competitive disadvantage. Foreign firms and the importers of their makes did not have to maintain the same trustful relationship to the Swedish authorities.

Re-interpreting structural design innovations

It was not only tuning and the moped industry's manipulation of core technology that caught the attention of the moped investigation. Swedish authorities watched the development of the moped in terms of structural design innovations with great anxiety. When the secretary of the Moped Investigation noted in 1957 that the mopeds had "taken the shape of a motorcycle" he referred to its structural design rather than its capacity in terms of engine power. In its final report issued in 1959, the investigation noted: "The moped has gradually become a small motorcycle. Riding position, suspension, equipment, starting of the engine, gear ratios in the transmission for [igångsättning och backtagning] etc., is essentially the same as that of a motorcycle." Thus moped had lost all resemblance with an ordinary bicycle, which had been stressed so forcefully in the 1952 legislation.[57]

In the end, the investigators, influenced by the producers, turned a problem into an advantage. Already in 1952, the industry had argued that certain deviations from the ordinary bicycle was only beneficial from a driving and safety point of view, and it continued doing so.[58] Back in 1952, the relatively low weight of a bicycle with an auxiliary engine had been considered an asset in terms of traffic safety; the bicycle-likeness guaranteed that the vehicle was not more prone to serious accidents than the bicycle. By the late 1950s the heaviness of the moped had been, using SCOT terminology, "re-interpreted"; it now signaled stability, sturdiness and was in fact considered to improve traffic safety. [59] The moped investigators advised against a weight limitation, since it would counter the production of "sturdy and safe mopeds".[60] A host of other actors, including producers and the moped users' organization, shared this assessment of the increased weight of the moped.[61]

Praising the heaviness of the moped and its MC-resemblance did not make the investigators blind to the possible consequences of the development. Both they and the moped industry realized that the structural design innovations could lead to the conclusion that the moped no longer could remain a

[57] Mopedutredningen 1959, 39.
[58] Prop. 182/1952, 21; MU, Volym 1, Protokoll: "Referat från sammanträde i Kommunikationsdepartementet den 27/6 1957 klockan 10.30 med representanter för tillverkarna av mopeder i Sverige".
[59] Ekman, Tomas, *Spår i vägen: Teknikval, politik och spårvägstrafik i Stockholm 1920–2002*, Stockholm: Kungliga Tekniska Högskolan, 2003.
[60] Mopedutredningen 1959, 54.
[61] See e.g. MU, Volym 1, Inkomna skrivelser: Dnr A 2a/1958, Cykel- och mopedfrämjandet (Olle Thörnqvist) till Kanslisekreterare Yngve Westerberg, 15/5 1958.

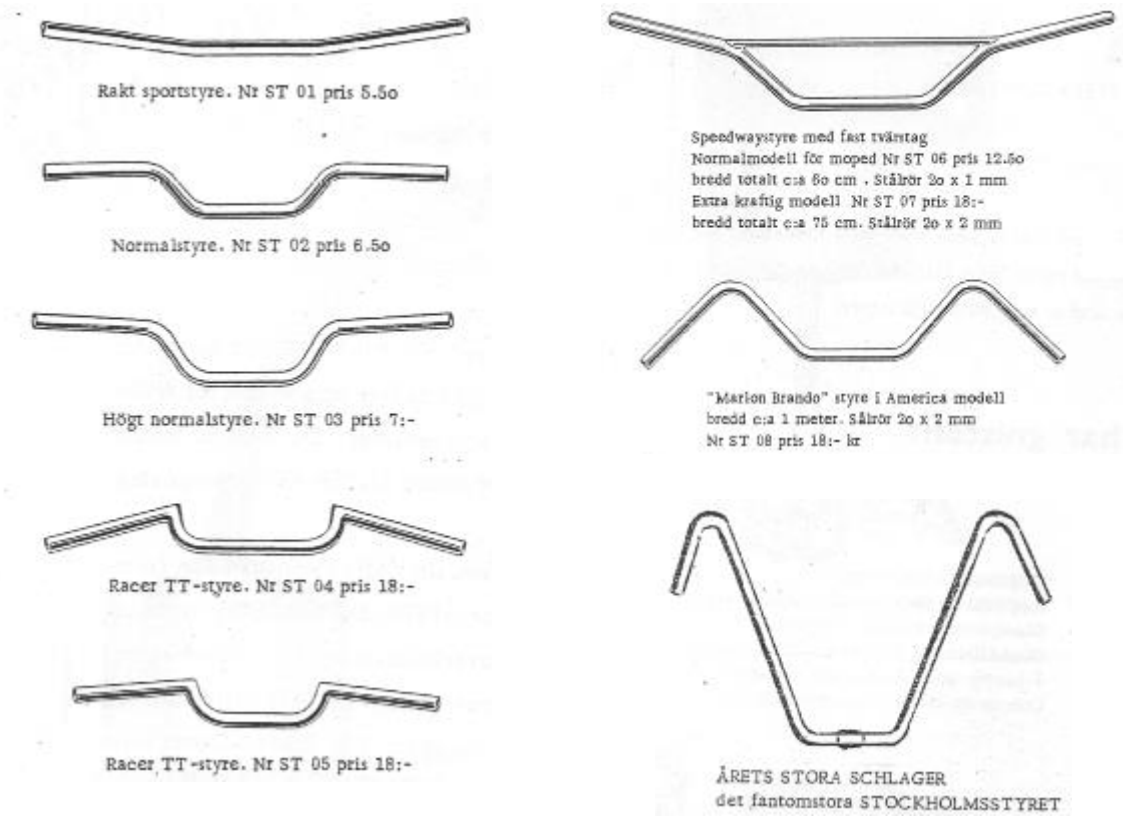
"liberated" two-wheeler. If it was in fact a small motorcycle, why not treat it as such and make it subject to the same regulation as other motorcycles?[62]

Ignoring aesthetic design innovations

It is important also to note mention the emerging aftermarket where creativity was blossoming in the fields of constructive and, most notably, aesthetic design innovations. Contributing to the change from a utilitarian usage to the recreational moped was the fact that youngsters bought used utility mopeds and, to use a modern term, "pimped" them. New high handlebars, saddles and stickers were used to transform the appearance signaling speed, coolness and modernity. From our interviews, advertisements from firms specializing in moped accessory and paraphernalia, and from photographs we have understood that this development is important when trying to understand the transitional phase. The user-driven innovations in the aftermarket blurred the boundaries between utility and recreation, as the utilitarian vehicle sold to the first user was altered by the second user to fit for recreational usage.

These aesthetic design innovations were largely ignored by the authorities, probably since they were considered unimportant in any *actual* transformation of the moped into something more dangerous than a bicycle with an auxiliary engine. This may have been an overly materialistic understanding of moped technology. In the Marxist parlance of cultural historian Raymond Williams, culture, understood as our processes of meaning-making, should not be considered a mere superstructure to but rather as constitutive of the material-economic base. From this perspective, aesthetic design innovations may be crucial to our very definition of a (e.g. moped) technology.[63]

[62] Mopedutredningen 1959, 50.
[63] Williams, Raymond, *Marxism and literature*, Oxford U.P., Oxford, 1977



Styren till salu i katalog från Mopedköparnas Inköpscentral. T.v. ovanifrån: Rakt sportstyre, Normalstyre, Högt normalstyre, samt två sorters Racer TT-styre. T.h. ovanifrån: Speedwaystyre, Marlon Brando-styre och Stockholmsstyret. *Produktkatalog över racer- och trimdelar samt annat tillbehör*, Mopedköparnas Inköpscentral AB, 16, 19.

Kataloger från Mopedägarnas Inköpscentral i Malmö (t.v.) respektive Motoraktiebolaget Ivan Höök (t.h.).

The new moped law 1961: Yielding to technological and social development

A new moped law was approved by Swedish parliament on 1 July 1961. The moped was from now on a separate vehicle category, subject to mandatory insurance, and the complete vehicle – not only the engine as in the law of 1952 – was to be inspected and approved. Regarding the core technology the government kept the stipulations of maximum cylinder volume (50 cc) and design speed (30 km/h). The stipulation of engine effect to 0,8 hp was rejected, however – it was not considered well aligned with the 50 cc-limit – in favor of a procedure where inspectors would assess the "effect curve" of complete vehicles, in order to reduce the speed gains from manipulating the gearing. The Minister of Communication stressed the importance of a strict assessment of the possibilities for tuning, the leading principle being that such changes should not be possible without "considerable professional skill and access to good workshop equipment."[64]

While the government thus took action in trying to close the window of core technology innovation, making tuning more difficult, the structural innovations of the preceding decade were more or less accepted and incorporated in the new law. All previous formulations about bicycle-likeness were scrapped in the 1961 text. In the Government Bill, the Minister rejected that the engine should be suited for an ordinary bicycle and that the vehicle should have pedals. According to him these stipulations no longer filled any function.[65]

The moped was clearly no longer a bicycle with an engine in the eyes of the legislators. The moped investigators had made the general assessment that the moped was "almost equivalent to a small motorcycle".[66] Should the moped, then, not be subject to the same regulations as motorcycles? Some actors certainly thought so. Voices had been raised on increasing the age limit for mopeds to 16 years and on enforcing a driver´s license. The Minister, however, saw no reason to regulate the use of mopeds; if they were there was no point in carving out a separate category for them in the first place: "The mopeds fill a practical need, and the rules should be designed as not to inhibit the use of mopeds as a means of transportation."[67] The Minister seems to have missed out on the radical transformation in moped user groups and usage since 1952. Except for making insurance mandatory, the "freedom" of the moped was thus kept intact in the 1961 legislation.

To summarize, in the new moped law the government let go of the two principles that had justified the law of 1952: the bicycle-likeness and the utilitarian usage. Core technology and structural

[64] Prop. 68/1960, 23f.
[65] Prop. 68/1960, 23ff.
[66] Prop. 68/1960, 13.
[67] Prop. 68/1960, 17.

innovations had made the pedals obsolete – starting already in 1954 and accelerating during the transitional phase 1955–61. Meanwhile, structural and aesthetic innovations grounded in modern design trends and youth culture had completely turned moped usage away from utility and towards pleasure. The vehicle no longer had any connection to the productive sphere of society. It had become a leisure tool used in the increasingly important "spare time".

These developments all propagated into the 1960s. The school reform of the early 1960s (which successively replaced the 8-levelled elementary school with a 9-levelled comprehensive primary school) meant that, by definition, that there were no longer any 15-year-old boys or girls needing a motorized vehicle for work travels. Swedes also had progressively more money to spend in the decades after World War II and spare time and young people became an increasingly important commercial market. A private car came within reach for ever more Swedes; declining car prices and increasing wages meant, for example, that the amount of time a labor worker had to work to purchase a car in 1965 was one fourth of the time spent in 1946. Already in 1953, Sweden became the car-densest country in Europe – a position that was lost first in the 1970s.[68] In an increasingly (car)-motorized society, the moped (and the motorcycle) lost its importance as a "step-in-vehicle". Meanwhile, the surge in incomes probably provided more parents the economical space to purchase a recreational and pleasure vehicle for their youngsters.

The youth and recreational phase 1961–70

In conventional wisdom and in popular historical accounts moped history is most often described like this:[69]

- The law of 1952 created a new vehicle type – the moped
- The technical development after 1952 was hampered because the law stated that bicycle pedals were mandatory
- The law of 1961 created the sports moped – no pedals and motor cycle design

Our investigation reveals an alternative and more complex story:

- The law of 1952 created a new vehicle type – a bicycle with auxiliary engine

[68] Lundin, Bosse, "Från borgerlig automobil till folklig bil. En ekonomisk och social studie av svensk privatbilismen 1930–65", opublicerad MK-uppsats ht 1999, Ekonomisk-historiska institutionen, Stockholms universitet: "Figur 3. Biltätheten i olika länder 1930–64, antal bilar per 1000 invånare", p. 19; "Figur 5. Reala bilpriser 1946–65. Index", p. 23; and "Figur 6. Bilpriser 1946–65 uttryckta i en industriarbetares bruttolön. Index", p. 24.

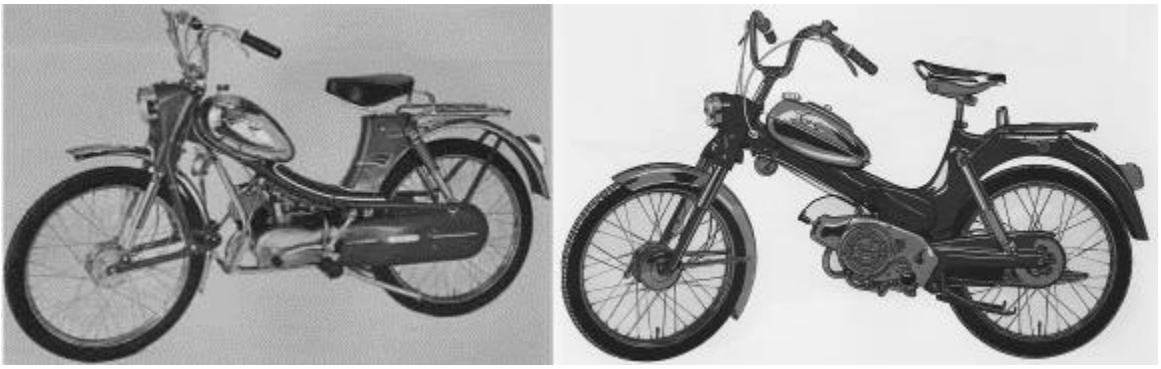
[69] For example in the history of Nymanbolagen (producer of Crescent mopeds): http://www.raketsport.com/jetlinjen.htm

- The technical development after 1952 was intense – the “moped” was developed in 1954 challenging the stipulated core technology and structural design specifications in the law. A great variety of mopeds were released into the market creating a pressure against the stipulated definition of a moped
- The law of 1961 was a response to this pressure

After the moped law of 1961 the market was dominated by two families: the *cruise moped* and the *sports moped without pedals*, which both originated from the transitional phase 1955–61. When pedals were no longer mandatory the inspiration from the motorcycle could reach its full potential. It must be noted, though, that the moped evolution after 1961 is taking place on a rapidly declining market. In the second half of the 1960s these motorcycle-inspired mopeds were sided by a complete newcomer: the *city moped*.

A common denominator for all three families was that the engine, the driveline and the gearbox was the same for almost every moped type. The European high-effect engine, adjusted to Swedish norms, had become the standard after the transitional phase. Swedish production of moped engines was no more. Along with the pedals came the kick-start, foot operated gears and heavier “drum-brakes” such as on motorcycles. Thus, innovations in this period, was focused on structural and aesthetic design.

Early examples of the new cruise moped built heavily on the “youth-styled utility moped” from the transitional phase. Except from addressing youth culture and symbols of modernity such as space vehicles and American automobiles, the cruise moped conveyed the message of the daring young and male rebel from movies like *Easy Rider.* It was clearly not the moped of the working man.[70]



“Rex Sport” (1964–70), “Puch Florida” (1962–)

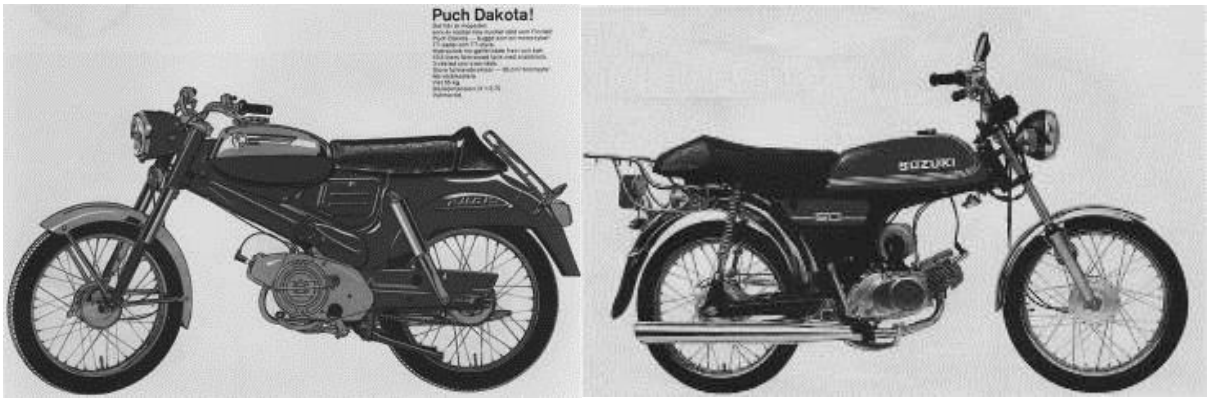
The sports moped, now without pedals, became the total dominant on the (declining) moped market from the mid-1960s. This was not a utility vehicle and it had a clear recreational purpose. It alluded

[70] Bengt Sahlström i *Classic Motor Album*, nr 11, s 5.

to youth culture in a way that resonated with rock 'n' roll, motor bikes and freedom from authority. The only common denominator between the utility and the sports moped was the social class of the driver. The sports moped was clearly targeted at boys from the lower middle class or the working class.

"Puch Dakota" became an icon in the moped community. Puch in Sweden targeted young boys and to some extent girls. They did not have a widespread network of retailers, like the Swedish producers Husqvarna and Crescent. Instead they aimed directly at the youngsters using ads and printing their own magazine – the *Puch Journal* – distributed to every 14-year old boy in the country. Puch clearly gave the impression of speed and action. It was well known that the engine was quite easy to tune for higher speeds, and the robust sport design of the Dakota promised freedom in the joy to drive. [71]

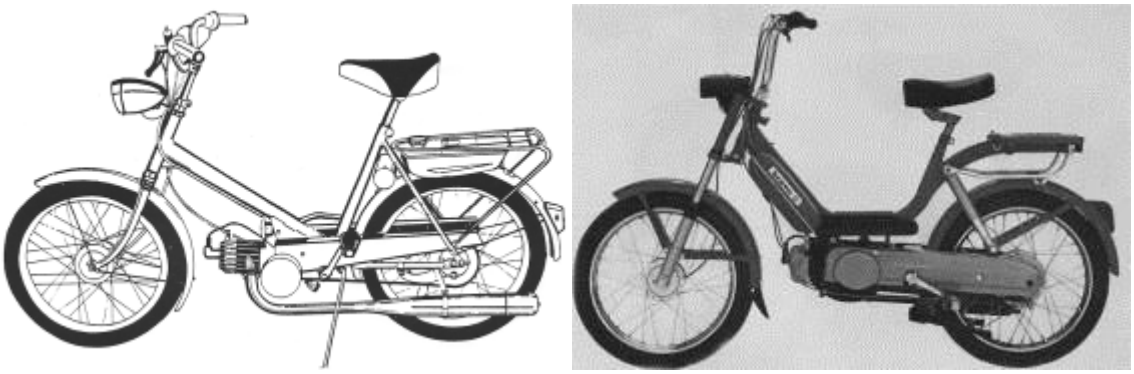
Swedish producers like Husqvarna and Crescent/Monark lost the sports moped market. It was to be dominated by marks as Puch (Austria), Zündapp (Germany), DBS (Denmark) and towards the end of the 1960s by Suzuki and Yamaha (Japan).



"Puch Dakota" (1966–70), "Suzuki K 50 N" (1967–)

The last family, the city moped from the middle/end of the 1960:s did not become a big seller in Sweden. But it is interesting because of its architectural and aesthetic innovations, clearly echoing both European modern "slim" trends such as the Piaggioand, in many ways a return to the simplistic and utilitarian design of the first mopeds of 1952. But, and this is important, a utilitarian design for aesthetic purposes, not for utilitarian usage in the original meaning of the term.

[71] Johansson 1993, 24.



"Crescent mod. 1238" (1968–71), "Piaggio Bravo" (1970–)

Technical development as well followed the trajectories established in the transitional phase. Using the words of James Utterback the moped had reached maturity and the industry entered the "specific phase". The market was dominated by two families: the *cruise moped* and the *sports moped without pedals*. In the second half of the 1960s these motorcycle-inspired mopeds were paralleled by a complete newcomer: the *city moped* (see attachment 2).

A common denominator for all three families was that the engine, the driveline and the gearbox were the same for almost every kind of moped. Swedish production of moped engines, which had always been marginal, seized, and the European high-effect engine, adjusted to Swedish norms, became standard. When pedals were no longer mandatory and thus largely gone, kick-start, foot operated gears and heavier MC-like drum-brakes were introduced.

Innovation after the 1961 legislation was, however, largely focused on structural and aesthetic design. With no mandatory pedals the inspiration from the motorcycle could reach its full potential. The sports moped, now without pedals and clearly for recreational rather than utility purposes, became the total dominant on the (rapidly declining) moped market from the mid-1960s. It alluded to youth culture in a way that resonated with rock 'n' roll, motor bikes and freedom from authority. The only common denominator between the utility moped and the sports moped was the social position of the driver. The sports moped was clearly targeted at boys from the lower middle class or the working class.

The city moped from the mid/late-1960s never became a big seller in Sweden. But it is interesting because of its architectural and aesthetic innovations, clearly echoing both European modern "slim" trends such as the Piaggio, and in many ways represents a return to the simplistic and utilitarian

design of the first mopeds of 1952. But, and this is important, it was a utilitarian design for aesthetic purposes, not for utilitarian usage in the original sense.

Future research to investigate unruly technologies

As mentioned in the introduction we have used this Working Paper to outline topics for further research in three areas connected to the theoretical fields of innovation studies and the history of technology (STS/SCOT):

1. Co-evolution of institutions and technology

Our story clearly demonstrates co-evolution between institutions put up by legislators and technological development. We have shown the difficulties in regulating consumer technologies such as the moped. Technical stipulations alone cannot fully govern user behavior. Harsh regulations are a theoretical possibility but hardly an option in a democratic society. If the wish is to regulate user behavior legislators must understand the interdependence between institutions and the technological creativity of users and producers.

2. User driven innovation

The Swedish moped history does indeed support the assertion that users do matter in innovation processes. But user influence is not a straightforward process. It needs to be positioned in the greater context of institutions such as the legal framework set up by the state. The concept “window of innovation” offers an interesting possibility to examine various, and historically contingent, factors to understand how users actually do matter.

3. Evolutionary methods in innovation studies

We have provided a method – evolutionary mapping – by which we are able to “read” users and usage from artifacts. This way of “bringing technology back in” is vital for the fields of technology and innovation analysis. Cultural historians would primarily look “outwards” and read meaning from moped technology, design, clothes etc. By looking “inwards”, into the details of moped technology, we are able to discern innovations on three different levels: core technology design, structural design and aesthetic design. All three levels are important analytical tools to enriching our understanding of the overall development of technology.

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(references to prime sources/archival material are given in the footnotes)

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Appendix 1, Moped family tree