

Deployment of Industrial Engineering and the Ford System in Germany after World War II

Toshio Yamazaki*

Abstract

This paper discusses the deployment of American-style management and production systems in Germany after World War II. The major issues are industrial engineering (IE) and the Ford system. We first consider the deployment of IE, and then examine the deployment of the Ford system. We analyze these issues in relation to German environmental factors such as labor relations, management values and traditions, and the market structure in Germany and Europe. The primary issue was the implementation of the work factor method and Methods Time Measurement (MTM) for the deployment of IE. We further examine the deployment of the Ford system, the rollout of the mass production system, and German manufacturing on the basis of German and European market characteristics.

Keywords: Americanization, Industrial Engineering (IE), work factor method, Methods Time Measurement (MTM), Ford system, German manufacturing, Management values, "Re-framing"

- I Research Problems
- II Deployment of American Management Methods and "Re-framing"
 - Analytical Framework —
- III Deployment of Industrial Engineering in Germany
 - 1 Development and Impact of Industrial Engineering
 - 2 Deployment of Work Factor Method
 - 3 Deployment of MTM
 - 4 Deployment of the Work Factor Method and MTM in Major Industrial Sectors
 - 5 Characteristics of Industrial Engineering Deployment in Germany
- IV German Rollout of the Ford System and German Manufacturing
 - 1 General Conditions in the Postwar Deployment of the Ford System
 - 2 Deployment of the Ford System and Rollout of Mass Production

*Professor/Ritsumeikan University, Faculty of Business Administration, 1-1-1 Noji-higashi, Kusatsu, Shiga, 525-8577 Japan
 Office: Tel +81-77-561-4865, Fax +81-77-561-3955
 e-mail tyt01363@ba.ritsume.ac.jp

Systems in the Automotive Industry

- (1) Volkswagen Case Study
 - (2) Opel Case Study
 - (3) Daimler-Benz Case Study
- 3 The Rollout of Mass Production Systems and German Manufacturing

I Research Problems

As other European countries and Japan did after World War II, Germany developed enterprises, industries, and its economy by deploying and adapting technology and management methods from the United States. American management methods were introduced and implemented under the US-led Productivity Movement. The major American management methods implemented in these countries were (1) management and production systems (Industrial Engineering, Statistical Quality Control, Human Relations, and Ford System), (2) management education, (3) methods for adjusting to a mass market (Marketing, Public Relations, and Operations Research) and (4) divisional structure.

Introduction of the American management system post WWII constituted a fundamental condition for the development of full-scale mass production. Eventually in the 1950s and 1960s, the mass production system was established in Germany. Among American management and production systems, IE is an advanced form of scientific management that originated in America and gained broad acceptance after World War II. The Ford system was implemented in Germany even before the war and became commonplace afterward. This not only enabled mass production within the processing and assembly industries, but also became the basis for the post-war mass production system.

However, these changes included the adaptations of systems to local conditions based on an overall structure of and relationship with German capitalism in business management. How business management in Germany changed with the deployment of US technology and management methods? Along with commonalities with the US, what types of unique developments emerged? How were US management methods reformed to accommodate German conditions? And how were the German management style and characteristics created? What was the significance of these developments? In this paper, we will describe how American-style management systems were implemented in Germany and the resulting changes in corporate management. In regard to the deployment of the Ford system, we will examine the rollout of the mass production system, and German manufacturing on the basis of German and European market characteristics.

Many studies approach this theme from the perspective of economic and business histories.¹⁾ However, these studies do not always identify which elements of American and German management methods were combined, how they were hybridized, and which factors determined the hybridization. It is very important to elucidate how German-style business management and its particular characteristics, conforming to European conditions while still

bearing on the German management style, surfaced during the deployment of the American management method from the perspective of structural analysis. We will consider the problems from the author's original framework.

In Section II, we will first attempt to elucidate an analytical framework. Next, in Section III, we consider the deployment of American IE methods and then study the deployment of the Ford system and the resulting production system reforms, along with its relationship to German-style manufacturing in Section IV.

II Deployment of American Management Methods and "Re-framing" — Analytical Framework —

We will first attempt to explain an analytical framework. The author establishes the idea of "re-framing," using which we analyze the various problems in deploying American management methods that created conditions that facilitated business management changes in the postwar era.

Re-framing, that is, the framework for analyzing various problems with the deployment of US management methods is explained below. Re-framing in this text refers to business management methods and systems that are defined by structural characteristics of a country's capitalism and how these are adapted, modified, and made compatible with the structural characteristics of capitalism in a country to which it is transferred. Among these, structural characteristics of this capitalism are related to the state of existence of the following items: a structure of productive forces, industrial structures, and market structures — these three characteristics of Germany are deeply connected to re-framing. In addition, management values, business management traditions, and cultural factors and definability from an institutional perspective are also closely related to re-framing.

Among the structure of productive forces, industrial structures, and market structures, regarding the structure of commodity markets, a country's domestic market and export market characteristics, along with its regional and product compositions, are matters of market structure. These issues are closely related to price and quality competition and other competitive structures in a market. Thus, management methods must be developed according to differences in market structure. Labor markets are related to a country's regulatory mechanisms, the state of labor relations, and the system of worker participation in management. Financial markets are connected with market involvement in the credit business and securities market, their composition, and the system of financial institutions. In industrial structures, characteristics of industrial development and international competition are important issues, as are the structure of productive forces, adapted to market and industrial structures, and the characteristics of the structure of productive forces, reflected in the development process. Characteristics of the structure of productive forces are, to a certain extent, connected to systems of specialized skills and vocational education, and exert a tremendous influence on the deployment of foreign elements of productive forces and the state of labor utilization.

These various elements that comprise the structural characteristics of a country's capitalism are closely related to management values and business management traditions, culture, and systems. Business management traditions and culture interrelated with business management standards and values. Even regarding capitalism, wherein the pursuit of profit is the greatest goal, a country's corporate standards and values do not necessarily match those of other countries. For example, the US has traditionally emphasized standards and values based on pragmatism, and both the US and UK have placed significant importance on obtaining financial profit through interest-bearing capital; in contrast, the countries of continental Europe and Japan do not necessarily consider these their top priorities. Decisions on where to place value, that is, production, technology, quality, or marketing policies, which are more directly tied to profit, specifically short-term profit, greatly affect corporate behavior. However, management values and business management culture are not simply matters of general culture, but have deep connections with the structural characteristics of target markets identified by corporations. For example, if the commodity market in a certain country or region prioritizes product quality or functionality, corporations will focus on values and differentiation in technology or production because management values conform to market characteristics. Thus, market characteristics are closely related to management standards and values regarded important by corporations.

Institutional factors include legal systems comprising all types of regulations; labor relations; educational systems; and system for specialized skills. Labor relations define business management characteristics, such as investment in labor education based on labor conditions and employment security systems, corporate product and market strategies based on these investments, and production and management systems adapted to these strategies. A country's educational system is closely related with the cultivation of executives and managers and that of skilled workers. In addition, production systems also influence management standards and values. In discussions regarding varieties of capitalism, a country's production regime is deeply connected to institutional factors, the complementarity of education and training systems, labor market regulations and corporate governance, financial systems, and inter-firm relationships from the perspective of market competition and technology transfer. As a result, when a country's production systems and management methods that supported these systems are deployed in other countries, these institutional factors often influence the re-framing of management methods.

This concept of re-framing emphasizes the conditionality of structural characteristics tied to reproduction mechanisms of capitalism, particularly in the country where management methods and systems are created and that to which they are transferred and deployed. The management methods and systems of the originating country are adapted and modified to the capitalist structure of the country to which they are transferred. In addition, as these methods and systems begin to function, their circumstances define the structure and characteristics of capitalism and the aspects of reproduction structure in that country. Re-framing, in this text, focuses on problems that occur when the social system in an organization, specifically a corporation, is transferred to another country. Thus, the receiving na-

tion's capitalistic characteristics are amended or modified to an adaptable form when the originating country's management methods, created for its own capitalistic structural characteristics, are introduced and spread throughout a foreign country using that country's methods. Accordingly, re-framing is the process of structural adaptation in response to different environmental conditions and a method of structural analysis, whereby the overall structure of business management is foundational.

III Deployment of Industrial Engineering in Germany

I Development and Impact of Industrial Engineering

As we next look at IE, we see that work studies consider it the next level of development, and that the US had a decisively leading role in the IE field. A Siemens US study trip report in 1963, the end of the productivity movement, noted that the predetermined time method then being implemented in the world of capitalism was without exception developed and tested in the US prior to being made public. For example, WF (work factor) was developed in the US in the mid-1930s, implemented after 1938, and then used internationally from 1952. In the International Management Conference held in September 1963, there was a discussion on issues of WF time standards and WF use. MTM (methods time measurement) was developed by H. B. Maynard, G. J. Stegemerten, and J. L. Schwab in the 1940s at Westinghouse, and spread after the war.

Even in Germany, according to a 1948 source, manufacturers began to place great significance on work study. For example, electrical manufacturer AEG noted that from the 1950s to the 1960s, the rationalization of work and time studies played an important role in productivity improvement. However, by the mid-1950s, the German organization REFA's activities and wage payment methods were becoming prominent. For example, in a March 1956 survey of 2,655 corporations conducted by Ifo, REFA systems accounted for as much as 80% of the work study methods used by manufacturers, with REFA systems having taken a dominant position.

However, the situation changed by the latter half of the 1950s. The increasing importance of work and time studies, along with the further development of REFA's methods, is particularly apparent in the US predetermined time method. Even in West Germany, use of such methods expanded greatly by the end of the 1950s, and REFA was instrumental in its deployment. In the early 1960s, REFA was at the IE expansion stage, and had translated a US handbook into German. Upon publication of this translated *IE Handbook*, the first education course in this field was conducted using improved teaching methods. However, by around 1960, the original industrial engineering training had been around for quite some time in Anglo-Saxon countries, and in West Germany the opportunity to receive training in the IE field was largely nonexistent apart from the efforts of several organizations like REFA.

IE training began to significantly increase in the 1960s. The structure of training events

fundamentally changed in 1969, with IE courses comprising 24.7% of all education courses.¹⁵⁾ In addition, the number of work study personnel trained in WF and MTM had risen to 2,491 by 1966.¹⁶⁾ There were a total of 52 IE seminars by the mid-1973, and about half of the candidates who completed the course were in IE positions, with the remainder being managers responsible for production control or business management, heads of labor science departments, or their assistants.¹⁷⁾ Regarding IE materials and books, 1967 saw the publication of a companion volume to the *IE Handbook*, thereby completing the REFA standard works for engineer training. Further, as REFA's third original report, a magazine was published for work studies and IE managers,¹⁸⁾ and from 1971 onward, *Industrial Engineering Magazine* was published on a bi-monthly basis.¹⁹⁾

Responding to wages and cost pressures was an issue in the spread of IE in the mid-1950s when Germany was at full employment. Because of this issue, the predetermined time method was implemented primarily for labor efficiency (in job design). However, the overall spread of the predetermined time method was generally first considered successful during the downturn of 1966/67 and its subsequent easing of the tight labor market.²⁰⁾ We will now examine the deployment of WF and MTM in detail.

2 Deployment of Work Factor Method

WF deployment was accomplished with the cooperation of US corporations and through licensing methods. REFA assisted in the deployment and spread of predetermined time methods such as WF.²¹⁾ On February 1, 1958, REFA and the Work-Factor Company signed an agreement on implementing WF training courses in West Berlin and West Germany.²²⁾ The Work-Factor Company was a technical consulting organization that provided global IE services to economic and industrial institutions.²³⁾ After extensive research into number systems (MTM, WF, BMT, DMT, etc.), the REFA Institute for Labor Science became a licensee of the Work-Factor Company.²⁴⁾ REFA also acquired the rights to translate the Work Factor Handbook and the rights to use the German translation which was based on the Dutch company, Philips. The second WF training course held in September 1958 was conducted by two people from Philips under contract with the Work-Factor Company, and Philips was heavily involved.²⁵⁾ However, the situation changed greatly in the 1960s; by 1964, REFA instructors were using the original German training materials.²⁶⁾ Other corporations, such as AEG, Bosch, Siemens, and Olympia, acquired their own WF licenses, and deployed the American system.²⁷⁾

At the beginning of the 1960s, as the productivity movement was drawing to a close, job design was becoming more important than standard time settings because of the rapid onset of mechanization.²⁸⁾ REFA regarded WF as an appropriate tool for job design, and the focus of its activities shifted increasingly away from predetermined time methods toward job design in the latter half of the 1950s. In this manner, the significance of motion study increased,²⁹⁾ and WF deployment also became more significant.³⁰⁾

3 Deployment of MTM

Study trips under the auspices of the US Technical Assistance Plan played an important role in the study and deployment of MTM methods, to which REFA also greatly contributed.³¹⁾ Many of REFA's regional branches saw the possibility of providing information on US time study systems.³²⁾

According to a source in 1963, MTM saw its greatest usage in the US but was also spreading in Germany,³³⁾ primarily being taught and spread by foreign consulting engineers. In comparison with WF, MTM had a more long-term, subdued role; however, in 1963, companies that had executed it formed the German MTM Association.³⁴⁾ The greatest impediment to European worker productivity, other than the delay in mass production and large-scale lot production, was supposedly job design and work flow, which was far weaker than in the US. The German MTM Association accepted the US predetermined time method in 1964/65, adapted it to German circumstances, and disseminated it throughout Germany.³⁵⁾

The German MTM Association's membership grew 2.6 times, from 115 corporations in 1966 to approximately 300 in 1973. The employees of these member companies more than quadrupled, from roughly 500,000 to 2,000,000. More than half of these member companies were in the precision equipment (30% in 1974) and metal processing (23% in 1974) industries, and other industries included clothing (14%), steel (4%), chemical (4%), service and banking (5%) industries.³⁶⁾ In many cases, activities sponsored by organizations such as the German MTM Association were made possible with the cooperation of corporations and similar organizations in the US. The new US motion and time study methods were often implemented in Germany through private US companies.³⁷⁾

4 Deployment of the Work Factor Method and MTM in Major Industrial Sectors

Looking next at major industrial sectors, IE methodologies were first deployed in various areas within mass production management, but the primary focus was the electrical and automotive industries. At Bosch, a transition to WF methods began in the mid-1950s, but in 1960 the decision was made to use MTM, and work councils and company management signed a shop agreement. MTM deployment had special priority in the production department, and was afterward expanded for the first time, though on a smaller scale, to the maintenance and control departments.³⁸⁾ Daimler-Benz also used MTM from the 1960s onward. Although in retrospect, there were but a few cases of MTM being used at Daimler-Benz, in the German automotive industry in general or even in various departments within the electrical industry, MTM proved to be the best tool for job design and time economics.³⁹⁾

A 1965 IG Metall report states that WF, MTM, and other predetermined time methods were gaining popularity in the metals industry. For example, corporations in the steel industry were systematically moving toward the streamlining of maintenance and repair departments using predetermined time methods based on the deployment of wage incentive systems.⁴⁰⁾ The shipbuilding industry also increased its usage of predetermined time methods. Deployment of predetermined time methods in maintenance tasks could also be seen in the chemical and mining industries.⁴¹⁾ A 1969 report noted that usage of IE methods were not

limited to the machinery or transportation equipment industries, but was spreading to steel and metals, clothing, construction, chemicals, and even service industries.⁴²⁾ For example, MTM was being used in the sewing industry by the 1950s,⁴³⁾ and all sorts of MTM-based data systems could be used to locate time data within the clothing and machinery industries.⁴⁴⁾ To German industries, IE was an important element in creating satisfactory management results and competitive advantage.⁴⁵⁾

In the electrical industry, WF attracted attention at the end of the 1950s at Siemens as an aid to job design planners and production equipment designers, and both WF and MTM were the most well-known work study methods.⁴⁶⁾ Siemens implemented approximately 15 WF information education courses by 1962, and in addition to sponsoring many seminars for supervisors and specialists had roughly 100 WF-trained workers in their factories. The largest portion of these trained personnel worked in production preparation and work planning departments for large-lot and mass production. The Siemens Work Factor Group comprising nine members from three Siemens companies was formed, and the results of their work were tested and then conveyed to the REFA Institute, after which they could be adopted by any company that had WF-trained personnel.⁴⁷⁾ An "IE Theory and Practice in the US"-themed study group participated in a US IE Institute international conference and a WF international conference, and visited Westinghouse, Bell and Howell, Teletype, and the Work-Factor Company. Siemens' WF instructors were instrumental in providing guidance in the preparation of Germany's public WF manual. By April 1964, a total of 615 people had participated in 35 WF training courses held in West Germany. Twelve of these courses were taught internally for Siemens' organizations, and Siemens had approximately 150 trained WF personnel. In two particular teacher training courses, there were 31 REFA instructors qualified to teach, of which eight were Siemens employees. At the time, 27 major corporations, such as Siemens, AEG, Olympia, and Zeiss, were formally using WF, and it was becoming clear that it would be necessary to adapt WF to the overall situation in Germany as well as to the special environment within Siemens. To that end, Siemens formed a team of specialists experienced in WF. This study group was conscious of the need to modify WF for a number of reasons, and they applied Siemens' scientific human engineering research not only to psychological effects but also to specific operations. This same group published a companion volume to the internal Siemens manual so that WF could be uniformly used across Siemens organizations,⁴⁸⁾ and a document explaining WF was created in 1970.⁴⁹⁾

Within the chemical industry, Glanzstoff decided to deploy WF in the REFA Institute training courses, and both four-week basic and one-week information training courses were held.⁵⁰⁾ WF specialists from US consulting firms conducted practical work and research studies as part of the WF deployment. As a result of a detailed examination of both WF and MTM methods, Glanzstoff pressed ahead in using the WF method.⁵¹⁾ A 1962 document by Glanzstoff's rationalization department showed that predetermined time methods such as WF and MTM were excellent ways to make systematic improvements.⁵²⁾ Time units of less than 1/1000 (.06 seconds) became the elements of work analysis through film and prede-

terminated time methods (WF and MTM). This was one reason BASF chose to compare results from various time measurement devices using test film and high-speed camera photography, and to compare predetermined lengths of time as well. Deployment, however, varied by company, and Henkel, for example, used methods like IE to a very limited extent, even in the latter half of the 1960s.⁵³⁾

With new methods such as IE, predetermined time methods were not negotiated between workers and those making time measurements as done in the REFA methods; instead, the usage and modifications of performance measurements were negotiated between management and work councils that represented workers, or between management and labor unions.⁵⁴⁾ There was a great deal of opposition to certain aspects of the predetermined time method, but the fact that labor unions did not oppose them in principle made it much easier for corporations to implement.⁵⁵⁾

5 Characteristics of Industrial Engineering Deployment in Germany

Next, let us look at characteristics of the German IE deployment. Within IE, American methods like WF and MTM were promoted based on REFA's strong involvement, along with the cooperation of the Work-Factor Company, the German MTM Association, consultants, and others. Between the late 1950s and the first half of the 1960s, US superiority in IE had greatly diminished compared with similar standard methods used in other progressive industrial nations.⁵⁶⁾

However, REFA had traditionally played an important role in Germany since the rationalization movement of the 1920s. K. Schlaich notes that, from an operational perspective, it is only natural that the spread of IE is mainly attributed to REFA.⁵⁷⁾ A 1960 Hämmerling report noted that there were certainly efforts to reduce production times through a partial adoption of new methods such as MTM and WF based on US practice, but these methods would not have succeeded without their incorporation into REFA's methods.⁵⁸⁾ A 1975 Schwartzman report noted that the German industry had built work studies based on REFA thinking over the last several decades.⁵⁹⁾ Thus, we see that the dissemination of IE was related to REFA activities, and was also greatly affected by US-based IE.⁶⁰⁾

REFA had researched and examined various predetermined time methods including MTM and WF for a long time, and as a result decided to support WF, obtaining a license to use and disseminate the method.⁶¹⁾ However, REFA did not, for the most part, deprioritize its own systems in promoting WF. As a result, these US methods were not widely adopted in German industry, unlike countries such as Sweden, where the creator of MTM, H.B. Maynard and his consulting firm, were highly successful in selling the method to corporations.⁶²⁾

Procuring training and deployment routes for IE methodologies, like the agreement with Work-Factor Company or the use of consulting firms, provided characteristically greater opportunities for the deployment of American-style methods, unlike other management methods. An additional important characteristic was that German organizations played a major part, as can be seen in the efforts and roles of REFA and the German MTM Asso-

ciation. However, the deployment and dissemination of American-style methods continued with the help of REFA's leadership in work studies and their activities in the 1920s, along with the attempts to apply these methods to German circumstances under REFA's strong influence.

IV German Rollout of the Ford System and German Manufacturing

Next, let us look at the issues of production system innovation via deployment of the Ford system and German-style manufacturing. The US form of mass production was new to Europe in the 1950s.⁶³⁾ In the automotive industry, which was the most pivotal, until the 1940s, the types of production organizations were definitively regulated by the markets it supplied. It has been noted that as long as that was the case, Americanism would only spread on a selective basis.⁶⁴⁾ In contrast, postwar market changes brought mass motorization, which enabled full-scale deployment of the Ford system.

1 General Conditions in the Postwar Deployment of the Ford System

First, let us examine the overall circumstances at the time of the Ford system deployment. Deployment occurred in processing and assembly industries such as the automotive and electrical industries (but particularly in final assembly of primary product lines such as radios, televisions, vacuum cleaners, washing machines, dishwashers, and electric ranges).⁶⁵⁾ In 1953, there were very few production fields that could economically use production lines based on American-style methods because of changes to product and component design and structure as well as fluctuations in production volume.⁶⁶⁾ A 1956 report mentioned that flow production was still in its initial stages,⁶⁷⁾ but this situation changed in a major way in the latter half of the 1950s. For example, a 1958 report noted that the principles of flow production had become much more widespread and had completely eliminated the principle of organization by machine type.⁶⁸⁾ K. Springer also stated in 1963 that the need for rationalization increasingly led to production via work flow in manufacturing industries.⁶⁹⁾

The automotive industry was the most typical sector in which American-style methods were deployed, and the end of the 1950s⁷⁰⁾ saw a continuous transition away from smaller cars toward mid-sized vehicles in Germany. The deployment of the Ford system was a response to this trend,⁷¹⁾ and the industry-wide switch to Fordism accelerated during the last third of the 1950s. One focus of the automotive industry effort to rationalize in the 1950s and 1960s was a large-scale production revolution using conveyor belt technology in the body production, unit assembly, and final assembly departments.⁷²⁾ For example, according to a 1963 report, in many cases manual work dominated assembly, despite the high standards already being achieved by machines and automation in cutting and machining of processed parts.⁷³⁾ Thus, the rollout of the flow production system and its synchronization of overall assembly processes were particularly meaningful.

2 Deployment of the Ford System and Rollout of Mass Production Systems in the Automotive Industry

Here, we will review case studies of corporations in the automotive industry. These corporations are prime examples in which Ford system deployment was most dominant.

(1) Volkswagen Case Study

Let us first look at Volkswagen. Volkswagen was the trendsetter in accepting Ford production methods and in the formation of corresponding labor relations.⁷⁴⁾ In 1946, immediately after the war ended, a number of assembly and final assembly conveyors were already in operation for transmissions, axles, and engines, producing approximately 1,000-1,200 automobiles per month.⁷⁵⁾ After 1954, Volkswagen worked on technical reshuffling, one objective being the creation of an external force for the work rhythm using Takt time (Effective working time in a period \div Demand in a period) of machines and conveyors. The time required for each process was calculated and set as a standard time for workers. This technical reshuffling in the Wolfsburg plant forced the labor organization to adapt from the outset and fall in line with the US model.⁷⁶⁾ The conveyor assembly line that began operating in 1946 produced only one model, the Beetle, and by the beginning of the 1960s, a perfect flow had been built for coordinated mass production.⁷⁷⁾ In the summer of 1961, two new assembly conveyors were completed that allowed Volkswagen to produce 250,000 VW1500 vehicles per year.⁷⁸⁾

In the new delivery van factory operating in Hanover in 1956, final assembly used a conveyor belt as well. Production was organized by deploying many new mechanized or partially automated routings to individual lines that fed the final assembly. Assembly using fully mechanized conveyor belts was typical, and the widespread use of conveyor belts was characteristic of the production technology of this plant. Body production conveyors were synchronized with body panel production, and these production methods reduced work time by 25% compared with stationary assembly.⁷⁹⁾

For the deployment of special-purpose machinery and automation technology, which was important in the expansion of Ford system type mass production methods, H. Nordhoff sought a "perfect new direction" by the spring of 1954. Automation of body frame production as well as painting and plating areas was already well underway. In contrast, press plants and machining departments were striving to gradually eliminate or drastically reduce manual work.⁸⁰⁾ In 1955, automation efforts expanded, and the company made large investments in special-purpose machine tools and general automation as they replaced old multipurpose tools. The company's continuous flow production was developed by connecting the stages of individual routings through the transfer machines of many work spaces. In all cases where planning of the production volume without frequent design and structure coordination was possible, multipurpose machinery was replaced by flexible special-purpose machinery. This type of automation was deployed early on in the production of the Beetle economy car.⁸¹⁾

Technical aspects of Volkswagen's automation concentrated on two aspects: combining

individual processing stages using production lines and more powerful use of special-purpose machinery.⁸²⁾ However, by the end of the 1950s, despite Volkswagen possessing the most modern equipment among West German corporations,⁸³⁾ manufacturing processes were automated very cautiously until the company was sure that markets could absorb the production increases that the additional automation enabled. This kind of corporate behavior resulted from operating in product markets and factor supply conditions that were clearly different from those of the US.⁸⁴⁾ However, the 1960s saw a more intense expansion in the automotive market, and a full-scale deployment of American-style automation technology was attempted. For example, the 1963 annual report of the "Purchasing and Materials Management Department" for the board of directors mentioned the approval of many orders for presses, equipment, and transfer machines in the Kasel and Hanover plants.⁸⁵⁾ In 1964 at the Wolfsburg plant, new transfer machines for automated assembly of the 1200 and 1300 Beetles were in operation.⁸⁶⁾

In the deployment of these kinds of production technology innovations within Volkswagen, C. Kleinschmidt maintains that with the exception of companies such as Ford and Opel, Volkswagen is the only German automotive manufacturer capable of putting the American model to use over the course of decades. Volkswagen became strongly aligned with the American model, particularly Ford's River Rouge plant, and in the 1950s, the US played a decisive role in Volkswagen's success.⁸⁷⁾

In reality however, one secret of Volkswagen's success was their selective approach to the American model. While Volkswagen followed the US expansion, they used specialized know-how such as highly mechanized proprietary transfer machines⁸⁸⁾ for body assembly, and could thus relax their very strict alignment with US development. One way Volkswagen pursued a German approach to production technology innovation was to replace the US style of automation called "Detroit automation," which impeded flexible production methods, with one adapted to German circumstances. As a follower, Volkswagen was able to learn from others' mistakes and avoid the difficulties first-movers had experienced in the automation process. In this manner, a new type of typical German Fordism was born, enabling Volkswagen to survive the decline of the 1970s through this application of American methods to German circumstances. The essence of this method could be seen in the diverse, high quality production that dominated the country in concert with German-style labor relations that were critical to codetermination. This system of harmonious labor relations based on labor resource cooperation in distributing shop floor power between labor and management is said to reflect the essential elements of a classic paradigm of highly skilled labor that values technical precision.⁸⁹⁾

(2) Opel Case Study

We will next consider Opel's case. K40, Opel's new, large scale body and assembly plants were in full operation by August 1956, and the company was working on production system innovations. Two basic chassis types, for 1.5-liter and 2.5-liter engine vehicles, were separately assembled on two conveyors within body assembly, and these merged onto one

conveyor to produce white bodies. After undercoating, painting, and interior installation, completed bodies were sent via conveyor to final assembly, where engines and chassis also moved on conveyors. Two thirds of the main assembly conveyors comprised overhead chain conveyors whose height could be adjusted based on the work being performed.⁹⁰⁾ A 1957 report mentions that only one 6,500 meter long main conveyor remained in the new Rüsselsheim plant for body manufacturing, where all six types of vehicles were produced. Production using large belt conveyors can be performed in two ways: continuous production using larger volumes of the same model or a mixed production environment for all models based on the assembly plan. Opel chose the latter method because of long work times that varied by model, and also because they could effectively use tools set up along the conveyor belt.⁹¹⁾ The combined length of the plant's conveyor belts and assembly conveyors amounted to 28,000 meters. To manage the assembly of all models other than trucks on the same conveyor, a teletype system was created, making the plant one of the world's most modern automotive plants.⁹²⁾

The Bochum plant began production in 1962. The Number 2 plant produced engines and chassis parts, with engine assembly being done using conveyors as well. The Number 1 plant produced bodies and performed final assembly using overheard chain conveyors, assembly conveyors, and other transportation equipment that totaled 31 kilometers in length over 227 pieces of equipment. The length of conveyor belts and assembly conveyors in the Number 2 plant was 11 kilometers. Bodies, pre-assembled chassis units, and engines converged on final assembly conveyors.⁹³⁾

Opel primarily manufactured small cars and economy vehicles, and they put great effort into deploying the Ford system. In 1962, Opel noted that conveyor belts were being used for mass production, with one automobile rolling off the line every 50 seconds.⁹⁴⁾

In reviewing the deployment of special-purpose machinery and automation technology, we see that transfer machines and other automation equipment were implemented for crankshaft production in machining departments in the mid-1950s.⁹⁵⁾ According to one source in 1956, a characteristic of this period's production was the addition to the work flow of numerous pieces of equipment that could also monitor and control the work, rather than simply automating it.⁹⁶⁾ At the end of 1958, a new, large investment project was begun, and the pace of investment accelerated.⁹⁷⁾ Around this time, Opel began using cylinder piston lines along with many general transfer machines, a phenomenon unique to this plant.⁹⁸⁾

The Rüsselsheim plant began production using new equipment for engines and transmissions in August 1961. At the time, the plant had 55 transfer machines,⁹⁹⁾ 70 multi-axis lathes, and 1,175 individual pieces of machine tools. In 1962, the Bochum plant began production of engines, transmissions, axles, cardan shafts, and other components using 1,147 individual machine tools. The standard of technology was high, with much of the equipment being the 47 transfer machines used to process cylinder blocks, crankshafts, connecting rods, gearboxes, and the like.¹⁰⁰⁾ Opel also stated in their 1962 corporate history that they had begun using transfer machines to automatically transport all work-in-process inventory.¹⁰¹⁾

When transferring production systems to a subsidiary of an American company, as was

the case with Opel and Ford, it was sometimes necessary to know and understand subsidiary production system dynamics not present in the parent company. Even in cases where the subsidiary was most receptive, this transfer required innovation and flexibility.¹⁰²⁾ This issue also relates to the adaptation of methodologies to the conditions in postwar Germany. There was sometimes a huge gap between the potential power of GM and Ford's methods and the ability to effectively apply them. In Germany, Volkswagen serves as the best example of the selective and skillful application of the American experience in the European context.¹⁰³⁾

(3) Daimler-Benz Case Study

Our next subject is Daimler-Benz. In 1950, Daimler-Benz had begun work on production lines for the 220 and 300 model automobiles. The 220 model was produced using conveyor belts beginning in the fall of 1951, and the 300 model moved to mass production, although slowly at first, beginning in November 1951.¹⁰⁴⁾ After the war, the Sindelfingen plant began final assembly work in addition to body production.¹⁰⁵⁾ In the fiscal year 1957, the company invested in production methods that would lower costs and worked on improving production methods for mass production along with complete process modernization.¹⁰⁶⁾

However, even in the first half of the 1960s, there was a serious gap in productivity between Daimler-Benz and US corporations. In the US, Ford produced a maximum of 2,500 cars per day, while Daimler-Benz required 17 manufacturing hours to assemble even the smallest passenger car. The high production capacity of US factories' was due to the complete mechanization of transportation using conveyors and conveyor belts. One important way to create economies of scale was the response by standardization based on "unit system" principles that enabled both model variety and economically profitable volumes. Daimler-Benz implemented standardized mass production by using the unit system and cutting back on certain models in both the passenger and commercial vehicle departments.¹⁰⁷⁾

The applicability of standardized production factors based on unit system principles and the integration work that increases their applicability were very important. In Daimler's case, when considering production methods from a work organization perspective, it appeared to be nothing more than an organized flow of work as would be found in the US. However, the skills within the key production elements between design and production were significant. Thus, emphasis was placed on the development of high quality production that encompassed labor process flexibility based on Daimler-Benz's reliance on skilled labor.

In examining the deployment of special-purpose machinery and automation, an August 1958 survey noted that production volumes were low at the Untertürkheim plant, and that its equipment were far from meeting the highest standards of modernization.¹⁰⁸⁾ An annual report on that plant in 1959 reported that there were limits to further automation for larger-scale production because of the diverse models being produced.¹⁰⁹⁾ This factor alone demonstrates that standardization critical in deploying the latest technology, and in the 1960s it became an even more important issue. Deployment of automation technology began in earnest in the 1960s at Daimler-Benz. For example, investment for transfer machines in the

Untertürkheim plant numbered 4 in 1961, 13 in 1962, 1 in 1963, 7 in 1965, 1 in 1966, 10 in 1967, and 5 in 1970. The deployment scope was not limited to engine production, but expanded to axles, transmissions, oil pans, bracing tubes, and other systems.¹¹⁰⁾ An annual report on the Untertürkheim plant listed machines and their years of use, but reports after 1959 provided a simple average of machines by year of purchase and did not accurately reflect the aging of equipment because of the deployment of special-purpose machinery and the increase of high-performance transfer machines for many machining processes.¹¹¹⁾

Corporations such as Daimler-Benz that were pursuing a product strategy emphasizing upper-class market segments sought a German production model while deploying American-style mass production technologies and systems. Specifically, to ensure high quality and to differentiate themselves in the marketplace, Daimler-Benz relied on high quality, skilled labor that complemented the standards created by technical equipment, and integration of production factors within the unit system as they rolled out a system for diverse, high-quality production. In this context, it could be said that they chose to Germanize the model in a different way than did Volkswagen.

3 The Rollout of Mass Production Systems and German Manufacturing

As these examples demonstrate, postwar Germany's deployment of mass production systems such as the Ford system centered on typical volume production industries like the automotive and electrical industries. Overall, changes in production during the 1950s were not simply a "rebuilding" of the prewar state, as they also became more flexible and dynamic. It has been stated before that rationalization along the lines of Taylor-Ford using an American-style mass production model was integrated with the management climate of the 1950s and modified based on collective experience.¹¹²⁾ On this point, A. Ambrosius identifies two important factors in the failure of the Taylor-Ford model of rationalization in quickly spreading in 1950s West Germany: consumer goods production at the time was merely of supplementary significance and German managers had a traditionally skeptical attitude toward American-style Fordism. This not only has to do with the issue of the wide-scale management units necessary to roll out this type of rationalization model, but is also related to the "Made in Germany" brand, combined with flexible labor- and knowledge-intensive production methods instead of globally standardized mass production.¹¹³⁾

Mass production did progress in Germany during the 1950s and 1960s, but even there it was limited to two types of companies. First are companies like Volkswagen with a corporate policy of producing affordable cars for their broad customer base that pursue economies of scale through American-style mass production.¹¹⁴⁾ In contrast, companies that had developed management and product strategies, which prioritized high-end market segments with outstanding quality and technology and considered the relatively low price-elasticity of upper segments in the market, occupied an important position but applied a different strategy.¹¹⁵⁾ Companies like Daimler-Benz and BMW in particular implemented strategies to design products targeting market segments with high quality, value-added products based on a relatively long-term model policy. From the manufacturer's perspective, their product de-

sign concepts were based on their users' functional needs of quality and durability, which were different from the needs of US consumers.

For example, in the 1950s, Daimler-Benz had a corporate philosophy anchored in two production concepts: manufacturing vehicles with a utility value created in response to the demands for uniqueness and luxury, and a broad and comprehensive supply for commercial vehicles. This philosophy proved highly successful.¹¹⁶⁾ Such product and production concepts are related to the production model. According to W. Streeck, there were two types of auto manufacturers in postwar West Germany: mass production manufacturers in the north (Volkswagen, Ford, and Opel) and luxury car manufacturers, a remnant of craft production, in the south (BMW, Daimler-Benz, and their competitors). These regional differences developed in response to differences in manufacturing principles and philosophies.¹¹⁷⁾ Southern manufacturers had technical creativity and were engineering perfectionists. For these manufacturers, specializing in these particular market segments with a value-add strategy of high quality and high performance meant that there was little necessity for cost superiority through economies of scale.¹¹⁸⁾ Strategies for product design concepts and market positioning greatly influenced the important characteristics of quality and flexible production concept, an inherently German characteristic.

This focus on "quality and a flexible production concept" could be seen in prewar Germany as one method of production responding to market limits.¹¹⁹⁾ The basic principles of this same production concept could also be seen in postwar Germany. That is, one can identify German characteristics in production methods and systems based on product design concepts, such as avoiding price competition, positioning, and specific niche strategies in postwar international market expansion. Even though work organization itself was a flow production system that may have been founded on a US model and although these corporations pursued economies of scale in mass production, the elements of high quality, knowledge-intensive production relying on skilled labor, and German-specific systems of vocational education and specialist qualifications, such as the meister system, were quite significant. Germany had a production system based on technical qualifications and vocational education, and production management work in corporations was dominated by skilled engineers. Thus, the skill level of production managers was very high. This was an important factor in the superiority of the design, development, production, and quality of German products.¹²⁰⁾ In Germany's case, quality in the form of product functionality, durability, dependability, and safety was heavily emphasized, as was reliance on expert, skilled labor in certain jobs. This model differs from Japan's, where integration emphasizing operational capability was a major source of competitive advantage.¹²¹⁾ The distinct characteristics of German-style manufacturing can be seen in production, which reflected product design concepts emphasizing quality, function, and branding against the background of the European market's competitiveness and factors of competitive advantage.

In this context, despite the common perception of "Americanization," important aspects of German characteristics in German production and manufacturing can be observed in the midst of the postwar American influence. However, these characteristics are deeply rooted

in market structures and differed with those of the US, which had a highly standardized market. Because this phenomenon was born of the uniquely German and European market emphasis on quality and function, it is important to understand that the German production and manufacturing model was a rational adaptation to the nature of these markets.

The following table (see next page) visualizes the conditions surrounding the introduction of American IE methods and the Ford system as well as “re-framing” and the factors defining it, based on the discussion so far in this paper.

Table Americanization and Re-framing: German Characteristics of Management and Production systems

Management Methods Deployment and Factors Affecting Them		Management & Production Systems	
		Industrial Engineering	The Ford System
Overall Conditions in the Deployment of American Management Methods		<ul style="list-style-type: none"> • Deployments focused on the Work-Factor Method and MTM • Deployments focused on processing and assembly, steel and metal, chemical, ship-building, and clothing industries • The delay in the spread of IE relative to other countries • Inter-industry and inter-corporate differences in the selection of the Work-Factor Method and MTM 	<ul style="list-style-type: none"> • Deployment of flow production system mechanisms and production organization principles
Deployment Characteristics of American Management Methods		<ul style="list-style-type: none"> • Strong involvement and leadership of the REFA (e.g., IE introduction, launch of education courses, etc.) • REFA's prioritization of their own system • Deployments based on REFA's license agreement with the Work-Factor Company • The establishment of the German MTM Association and its efforts 	<ul style="list-style-type: none"> • Differences in production systems among companies • The development of diversified quality production based on skilled or specialized labor • Case of deployments of mixed-model assembly line
Modifications in American Management Methods		<ul style="list-style-type: none"> • Creation and development of work study based on REFA thinking despite the influence of IE • Case of the application of human engineering research (Siemens) 	<ul style="list-style-type: none"> • The pursuit of economies of scale by using unit systems
Amalgamation of American and German Elements		<ul style="list-style-type: none"> • Integration of IE methods into the REFA system 	<ul style="list-style-type: none"> • Linking unique prewar production system elements in Germany • Use of knowledge-intensive skills relying on skilled workers • Linking standardization systems through the unit system
Factors of "Re-framing" in Americanization	Influence of Traditions and Cultural Factors and Management Values on Business Management	<ul style="list-style-type: none"> • Traditional German adaptations through modifications of the Taylor system to REFA in the 1920s 	<ul style="list-style-type: none"> • Technology-, quality-, and functionality-oriented management values • Management values and manufacturing views based on understanding customer needs, rather than production perspectives • The tradition of prioritizing skilled engineers in the production management function
	Influence of Institutional Factors	<ul style="list-style-type: none"> • Systematic foundation of REFA efforts in time and work studies • Promotion of implementation and execution based on acceptable views by unions • Case of implementation and execution through work agreements with work councils 	<ul style="list-style-type: none"> • Production systems with the foundation of the vocational education system and professional qualification system (the Meister system)
	Influencing factors of the Structure of Productive Forces	<ul style="list-style-type: none"> • The development of management through the REFA system since the prewar era 	<ul style="list-style-type: none"> • Pursuit of economies of scale based on lower production volumes since the prewar era and the development of production systems that ensured production flexibility • Prewar tradition of flexible quality production

Factors of "Re-framing" in Americanization	Influence of Industrial Structure Factors	<ul style="list-style-type: none"> • Development of the metals industry and the processing and assembly industries since the prewar era • Postwar development and expansion in the processing and assembly industries 	<ul style="list-style-type: none"> • Expansion of processing and assembly industries since the prewar period • Further development and expansion of the processing and assembly industries after World War II • Foundation of international industrial competitiveness based on a second industrial revolution
	Influence of Market Structure Factors	—	<ul style="list-style-type: none"> • Market characteristics of the German and European emphasis on quality and functionality • Postwar expansion of the mass consumer market • Patterns of foreign trade based on complementary relationships among European industrial and product fields

Source: Author

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