Production and Wage System in the Swedish Automotive Industry
— The Volvo Bus Plant —

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Preface[1]

The production system of the Swedish automotive industry has become well known through the experiments conducted at the Kalmar (1974-1994) and the Uddevalla (1987-1993) plants by Volvo in a bold move toward humanization of work. This was particularly true at the Uddevalla plant, which abolished the assembly line in favor of the highly parallelized product flow (Reflective Production System) for assembly of complete cars by teams. It was closed in 1993 but subsequently resumed production in the spring of 1997 as the jointly established AutoNova company venture formed between Volvo and Tom Walkinshaw Racing (TWR), and once again became the center of attention[2]. This production system featured by the Uddevalla plant is considered to be an alternative to the so-called lean production system. The explication of this system is still considered to be significant when studying future production systems for the Japanese automotive industry[3].

This paper does not directly study the Uddevalla production system, but intends to look at the present state of the production system conducted at the Borås plant for the past 20 years, which was, as it were, the predecessor of Uddevalla, together with its relevance to the wage system. The Borås plant production system is commented upon by Christian Berggren in *The Volvo Experience, Alternatives to Lean Production in the Swedish Auto Industry* regarding

conditions up to 1987. With respect to the wage system in effect, however, it gives a most insufficient picture. After a lapse of 10 years, I am interested in what changes have transpired in the production system.

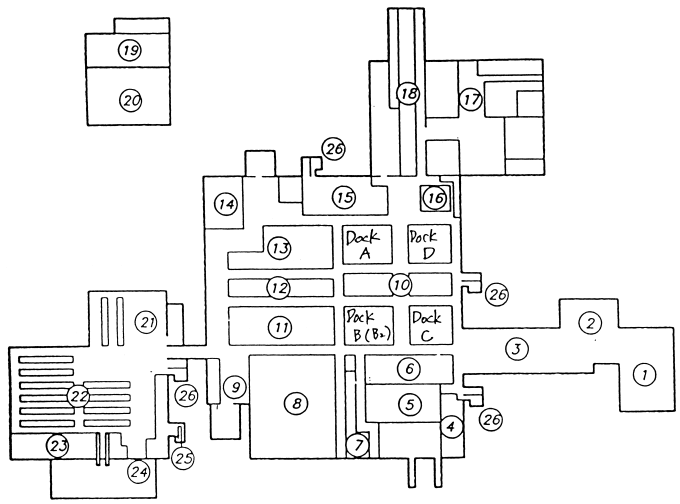
1. Outline and Features of the Borås Plant

Volvo Bus has 3,730 employees (as of December 31, 1996) with 14 major plants (2 domestic, 12 foreign) and manufactures 7,410 vehicles yearly (1996), consisting of large-scale buses (gross weight exceeding 12 tons each), as one of the world's leading bus manufacturers(4). The Borås plant commenced operations in 1977 with 363 employees (12% women workers, 64 white collar and 299 blue collar workers)(5), with the capacity to produce yearly 3,800 large size bus chassis and 1,100 completely knocked-down (CKD) kits as one of the major domestic Volvo Bus plants. Manufacturing is on a 5 day week, with working hours on a single shift of 07:00-16:00 hrs.

One major feature of this plant is that it concentrates upon the assembly of the bus chassis, while the manufacturing and painting of body and assembly of complete vehicles is conducted at another domestic plant (Säffle). The reason that the Borås plant does not integrate production from chassis to final assembly of the finished vehicle is believed to be due to the fact that there were restrictions on the plant space available for assembly of large size buses. Also in Japan, with large-scale buses, many companies are divided into chassis manufacturers and body manufacturers, but in the case of smaller-sized buses (micro buses) companies perform integrated production from body to assembly of the complete vehicle(6).

The plant's second feature is its distinctive production system. The layout of the plant (Diagram 1)

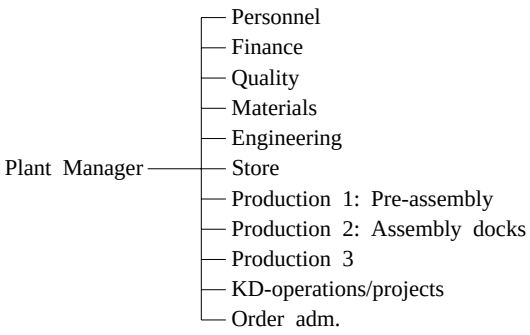
Diagram 1 Layout of the Borås Plant



1. Main administration, offices
2. Canteen
3. Changing-rooms, nurse, trade union offices
4. Pipe manufacturing (bending)
5. Frame pre-assembly
6. Buffer, pre-assembled frames
7. Cable harnesses and pre-assembly 5th wheel
8. Pre-assembly of smaller items
9. Material intake
10. Assembly docks
11. Front/rear axle pre-assembly
12. Hubs/brakes pre-assembly
13. Engine/gearbox pre-assembly
14. Welding workshop
15. Pre-assembly of smaller items
16. Buffer assembled chassis
17. Rectification workshop
18. Paintshop assembled chassis final assembly and inspection
19. Dynamometer, braketest and final inspection
20. Wheel fitting, stores and minor rectification
21. Material packing foreign production
22. Stores
23. Inspection of incoming material
24. Reception of incoming goods
25. Entrance to offices
26. Rest rooms

Source: Information provided by the company
N.B.) There are 6 assembly docks (from A to F). Only the major docks (A, B2, C, D) are diagrammed. As Dock B is large, it is divided into B1 and B2.

Diagram 2 Organization Chart of the Borås Plant (October 1997)



Source: Information provided by the company

shows in the upper right hand portion (⑩ in the Diagram) the assembly area (Assembly dock) for the bus chassis. Around this area, the assembly areas for the engine/gear box, the hubs/brakes and so on are located (Diagram ⑤～⑧, ⑪～⑬, ⑮). To the left edge of the plant (㉒ in the Diagram) is the parts inventory warehouse area("Stores"). This parts inventory warehouse was built in 1986. Previous to this, the warehouse at Göteborg was used. In chapter 2, as can be seen in detail, the assembly system at this plant was not a normal line production system. The assembly of the chassis was on a dock system made up of 4 different stages. In the pre-assembly, the assembly line had been completely abolished and a stage system for fixed assembly by small numbers of people has been adopted(7).

The third feature is the flat organization. The plant organization, as shown in Diagram 2, has a plant manager and 7 indirect departments (personnel, finance, quality, materials, engineering, store, and order administration) and also has 4 direct production departments (pre-assembly, chassis assembly, testing and final assembly, knockdown operations/projects). Of these, paying particular attention to the production department (Production 1 and Production 2), each of these departments has a person (production leader) in charge and 6 or 7 teams (the plant manager and production leaders are white collar). The respective teams have one DL (Driftledare = Working leader). But as can be seen later, they are all members of their respective teams, so that in fact the production department basically has only three levels: plant manager - production leader - production team, a decidedly flat organization. Compare this to one Japanese bus manufacturer. At the N bus factory of M automotive company (approximately 500 employees, direct and indirect ratio of about 3:2), the plant manager and vice-manager have a manufacturing department under their direction, where there is a production manager, vice-manager, section manager (administraion, chassis, assembly sections), chief, foreman, vice-foreman, and workers in the lineup organization. Compared to the Borås plant, there are a far larger number of employees and a high ratio of indirect departments, consisting of many different levels in a pyramid-shaped organizational structure.

2. Assembly System and Work Organization

(1) Pre-assembly

As already mentioned, the major production departments of the Borås plant consist of the preassembly of the engine, etc., with the respective units that have been put together by pre-assembly being integrated onto the chassis frame at the chassis assembly (the 6 workshops from Dock A to Dock F). Let's first look at the assembly system employed at the pre-assembly department (Production 1). Pre-assembly under the production leader is performed by 6 teams which complete the cables, axles, engines, instruments, generators and ventilation units. In addition, there are persons managing quality control and transport, and also replacement personnel (refer to Diagram 3-1).

The various units in these 6 workshops are not produced on assmbly lines. Rather, the respective team members, who are small in number and in fixed locations (stages), complete the respective units. Of these, for engine unit assembly work (for the assembling engine and gearbox) the line production system has been completely abandoned since 1985 for a fixed assembly system (four parallel assembly areas). This is explained by Berggren[8]. It is notable that the fixed assembly system have been adopeted in all of the pre-assembly workshop other than the engine.

Here I would like to observe in more detail the pre-assembly work area for the engine unit, where I had the opportunity to interview the working leader and several workers. This working area consists of 6 stages (an increase over the 4 stages in 1987). At each stage, there are basically 2 workers who are engaged in assembly work. Depending upon the progress being

Diagram 3-1 Work Organization of the Pre-assembly Area (Production 1)

Production Leader
- Quality control: 1 person
- Replacement personnel: 4 persons
- Service trucking personnel: 1 person
- Personnel for dispatch to other areas: 7 persons
- Cable team: 3 persons (DL: 1 person, KL: 1 person)
- Axle team: 12 persons (DL: 1 person, KL: 1 person, MH: 1 person)
- Engine team: 12 persons (DL: 1 person, KL: 1 person, MH: 1 person, TO: 1 person, SK: 1 person; however, SK and MH are concurrent)
- Instrument team: 10 persons (DL: 1 person, KL: 1 person, FL: 1 person, HO: 1 person)
- Generator team: 5 persons (DL: 1 person, KL: 1 person)
- Ventilation team: 8 persons (DL: 1 person, KL: 1 person, FL: 1 person)

Source: Information provided by the company
N.B. 1) The number of persons is as of December 6, 1996
2) Numbers in parentheses are included.
3) The total of 64 persons minus persons dispatched to other working areas gives a net of 57.
4) DL=Driftledare (Working leader)
KL=Kvalitetsledare (Quality leader)
FL=Förbättringsgruppsledare (Improvement team leader)
MH=Materialhanterare (Person in charge of material handling)
TO=Teknikombud (Person in charge of assembly engineering)
HO=Huvudskyddsombud (Safety committee chairman)
SK=Skyddsombud (Safety committee member)

made, the number may vary from 1 to 3 persons, however. According to Berggren, the reasons that the engine assembly work area was changed from a production line to a parallel assembly area are the following. First, a production line cannot adjust to the demands of diversified products. The chassis assembly in the docks was often suspended because of this inability. Whereas, the parallel assembly system can flexibly adjust to the demands of diversified production. Second, in comparison to the production line, the working pace for the parallel assembly system allows the workers to work at their own pace. In the education and training field as well, it is highly effective [9].

The working leader I interviewed also indicated much the same thing. "(The reason for changing from a production line to a parallel assembly system) is because there are many variations in engines. These variations are also very large and this causes a production line to be delayed or stopped entirely. In a stage system (parallel assembly area), only 1 stage stops (when a problem arises). Furthermore, for the assembly worker the stage system is better. He can do many different tasks and the stress is not so high and quality improves" (The parenthesis show contents added by the writer as supplementary explanation, which is also true hereinafter). In other words, the advantages of a stage system lie first in the flexible accommodation of diversified products. Secondly, for the worker as well, work is not a boring or stressful. Thirdly, quality also improves.

Regarding the first advantage, as there are quite a few variations (models) in the engines, so that when each respective stage handles assembly work for each model engine unit (however, the number of these is not clear), the flexibility of production is assured. In other words, at the 1st and 3rd stages, the engine units for chassis assembly Docks A and B are assembled, and at the 4th and 6th stages the engine units for Docks C and D are assembled. At the 2nd and 4th stages, the production of the respective stages is adjusted, to handle delayed production of engines and stages where production of an engine model with a high production level will not be on time (in other words, at Stage 2 the engines for Docks A and B are assembled, while at the 4th stage the engines for Docks C and D are assembled).

Regarding the second advantage, in the case of such parallel assembly system, the overall frame of the working pace in the production plan determines a maximum time of 5 hours and a minimum time of 3 hours for the assembly time for an engine unit. At each respective stage, basically since 2 persons are working (the job cycle for one person is 2.5 to 1.5 hours), there is not effect on the working pace of one's own working stage according to the progress made in work at another stage when compared to production line work on the basis of a detailed division of labor. Thus, for the individual worker, freedom in working pace is ensured to some extent (technical autonomy)[10]. Furthermore, there is also a certain degree of freedom in methods of working. That is to say, although the work instructions for each model of an engine mention which parts are to be assembled in order of what specific place, the order does not

necessarily have to be observed. "When other parts will not fit when a part is assembled first one must follow them exactly as instructed, but otherwise the worker is free to choose his own order of work." (2nd stage worker) This sort of degree of freedom has the effect of relieving stress to a certain extent.

Furthermore in addition to a long job cycle of two or more hours, it appears that the job rotation and exchanges between the assembled models are frequently being made in order to change and expand the contents of work. This is primarily occurring by three different methods: (a)interchanges between work of a particular stage, (b)interchanges in engine models being assembled, and (c)changes that cross the demarcation of worshops. In (a), the work is interchanged between 2 people working in the same stage, as the models worked upon change. The division of work is not too specifically determined. In general, when each person is working on an engine, the other person is working on a gearbox. In(b), the assembled models at each stage are periodically interchanged. For instance the 1st and 3rd stages, which this week are working on the engine model for Dock A, will next week assemble the engine model for Dock B, so that every other week, there are alternate changes. This type of interchange is being quite definitely done on purpose. In actuality, of the 21 workers in engine pre-assembly, there are 18 who can do the tasks for all models. Of 67 persons in overall pre-assembly, 46 (68.7%) persons have work experience on all models (refer to Table 4 in the following pages). In (c), there is interchange between the pre-assembly and chassis assembly areas. These changes do not occur periodically. For instance, where there are not sufficient workers in the chassis assembly area, persons in the pre-assembly area who can do chassis assembly work are called upon. This is the equivalent of a temporary transfer (*oen*) in the Japanese workshop. Workers who can do work at both areas number 4-5 for each area. Interchanges in tasks and the models assembled which result in the change and expansion of the contents of work relieve the monotony of work and also contribute to effective improvements in workers skills.

The 3rd advantage is the improvement of quality. In the stage system, the quality of the assembled engine units from the respective stages are the responsibility of the workers involved. Therefore the awareness of quality is said to be stimulated. This works as follows in practice. First, before the assembled engine unit leaves the chassis assembly area (dock), the engine is checked by people at another stage for any errors or misses. Mistakes normally occur about twice a day. In which case, the workers immediately make the necessary corrections. Furthermore, when the engine unit is moved to the dock, it is checked again. If an error or mistake is discovered, it is entered into the computer and is reflected in the wages paid (on this point, refer to the individual assesment portion of wage composition given the details later). Among the errors or mistakes discovered at the dock, those which are simple are corrected by the dock workers (adjusters). Difficult ones are corrected by having the pre-assembly workers go to the dock to do the correction work. Reports are made so that when the same error or

mistake occurs frequently, causes and counter measures are necessary. Since the workers correct their own errors and mistakes, it serves to teach them not to make the same errors and mistakes repetitively.

(2) Chassis Assembly

1) Outline

Chassis assembly area (Production 2) is the core workshop of the Borås plant, where units that have been assembled during the pre-assembly are and various categories of parts are assembled into the chassis frame. The chassis of 11 out of the 15 models that are manufactured at Volvo Bus are assembled here at a rate of about 18 per day at six worksites called docks (A-F) (Refer to Table 1. To be precise, Docks A-D about 17 per day and Dock E about 1 is assembled and Dock F is producing a part of the chassis. Dock B1 and B2 comprises Dock B but is so large that it is divided into 2 parts).

This workshop has 7 chassis assembly teams (Dock A, B1, B2, C, D, E, F) working under a production leader. There are also quality control and transport personnel together with emergency personnel to deal with special problems which may arise. They are organized in a similar manner to the pre-assembly organization already reviewed, but the groups consist of a larger number of 97 workers excluding those who are dispatched to other areas (refer to Diagram 3-2).

As Breggren points out[11], the 6 chassis assembly docks A-F do not make up a production line based on a fragmental division of labor. Basically, there is single team at a single dock, undertaking production by completing a chassis (Dock system). However the production line has not been completely abandoned as a parallel assembly system. Within the Dock, the work is divided into 2-4 stages (steps) and in a 2-4 hour job cycle, the chassis moves between the respective stages to form a mini-line of its own.

In other words, excluding the 2 Docks (E and F)[12] which produce only a specific part of the

Table 1 Kinds of Chassis Models

Dock	Chassis Models produced (total of 11 models)
A	B10M, B12, B10L, B10LA
B (B1+B2)	B10M, B10B (when necessary), B10MA
C	B10M, B10B, B10BLE
D	B10M, B12, B12Bogie, B10MBogie, B7F, B7R
E	Production of special models, currently B10M
F	The trailer portion and engine package of B10MA

N.B. 1) According to an explanation by the production leader
2) There are 4 models other than these 11 models, with B58 produced in Brazil and Olympian, Olympian Bogie, B6/B6LE produced in the UK.

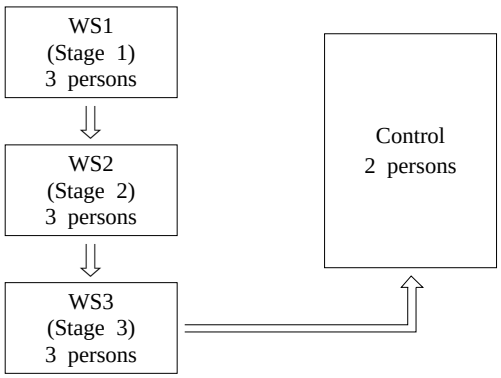
Diagram 3-2 Work Organization of the Chassis Assembly Area (Production 2)

Production Leader
- Quality control: 1 person
- Personnel to take care of special problems: 2 persons
- Personnel for moving items: 2 persons (MH : 2 persons)
- Personnel for dispatch to other areas: 11 persons
- Dock A: 21 persons (DL: 1 person, KL: 1 person, MH: 1 person, FA: 1 person)
- Dock B1: 10 persons (DL: 1 person, FL: 1 person)
- Dock B2: 11 persons (DL: 1 person, KL: 1 person, FL: 1 person, MH: 1 person, TS: 1 person)
- Dock C: 20 persons (DL: 1 person, KL: 1 person, FL: 3 persons, MH: 1 person)
- Dock D: 19 persons (DL: 1 person, KL: 1 person, FL: 2 persons, MH: 1 person, TS: 1 person, however, DL is concurrently both TS and FL)
- Dock E: 5 persons (DL: 1 person, KL: 1 person, FL: 1 person)
- Dock F: 5 persons (DL: 1 person, KL: 1 person, FL: 1 person, SK: 1 person, however, DL is concurrently also FL)

Source: Information provided by the company

N.B. 1) The numbers of persons is as of October 24, 1997.
2) Numbers in parentheses are included.
3) Total number of personnel is 108. However, excluding persons dispatched to other areas, the actual number is 97.
4) DL=Working leader
KL=Quality leader
FL=Improvement team leader
MH=Person in charge of material handling
TS=Person in charge of assembly engineering
SK=Safety committee member
FA=Shop steward

Diagram 4 Stage Layout of Dock A



N.B.) Interview record of plant visit (November 19, 1997)

chassis and only special models, the major 4 docks (A-D) are divided into 3 work stages (WS1-WS3) and 1 control stage (air and electrical testing and adjustment) (Refer to Diagram 4. However, in order to adjust the volume of production, only Dock B2 has 1 buffer stage). Also, each work stage respectively differs in work contents. At Stage 1, the engine and axle are assembled into the chassis, at Stage 2 the wire harness and driving seat are assembled, and in Stage 3 the electricals, muffler, fuel tank, ventilation, etc. are assembled into the chassis.

On the dock, a team of about 20 workers takes responsibility for the chassis assembly work. 2-3 workers are in charge of each work stage. When the respective work at each stage is completed (respective work is to be completed within about the same time), all the chassis

which are placed upon platforms with air cushions move simultaneously to their respective next stages for the assembly work to continue. At this time, the workers do not move with the chassis. Therefore, they do the same work as before on the next chassis.

The assembly time (excluding the time for testing and adjusting) for the chassis differs depending on the model. The longest (B10LA) is 37.5 hours, with the shortest (B7R) being 17.4 hours. This assembly time is affected by the following two conditions. With the diversification of models, the engineering becomes more complicated and the assembly times increase. On the other hand, the pre-assembly becomes larger and the assembly time is shortened. The chassis assembly normally is performed by 8-9 workers and the job cycle for each worker is determined by dividing the assembly time by the number of workers. In other words, for B10LA, 37.5 hours/9 persons 4.17 hours (about 4 hours and 10 minutes). For B7R, 17.4 hours/8 persons 2.175 hours (about 2 hours and 10 minutes). However, the length of assembly and the length of each job cycle do not necessarily coincide. With B7R, although the assembly time is the shortest, since there are 8 workers, the job cycle of one worker does not become the shortest. It is the shortest in the B10M which has a longer assembly time than the B7R and is assembled by 9 workers, that is 18.3 hours/9 workers 2.03 hours (about 2 hours and 2 minutes).

2) Features of the Dock system

Since the opening of the Borås plant, this Dock system has been continued for over 20 years. It is considered to be quite unique for the assembly of large size buses. When compared to the traditional assembly line, its distinctive features are quite similar to the stage system in the pre-assembly area reviewed already, and can be considered according to the following points.

Firstly, it can flexibly respond to model diversification. As indicated in Table 1, at the Borås plant there are currently 11 models in production. There are 5 models which were developed in the 1990s, the B12(1991), B10B(1992), B10L(1994), B10LA(1995), B7R(1997). Compared to 1987, diversification has considerably progressed. This diversification in models has presumably further expanded the differences in assembly times, as mentioned before. If these were to be assembled on the traditional assembly line, considerable losses would be incurred in balancing. The advantage of the 6-dock assembly system, which reduces such balancing losses, is clearly apparent.

Secondly, there is the alleviation of stress on the workers that would otherwise arise from monotony of work and constraint on working pace. As has already been evident, with production from long job cycles of 2-4 hours and 6 parallel docks, the monotony of work and the constraint on working pace are considerably reduced, compared to the traditional assembly line[13]. However when compared to the stage system in the pre-assembly area, even though the job cycle has been lengthened, within the respective docks, there are a number of minilines consisting of 2-3 work stages (WS), and the respective works at stages must be completed at

about the same time (strength of mutual reliance) and in predetermined assembly times, which becomes a cause of some stress which cannot be entirely ignored. The strength of this time pressure is confirmed by the comments of an assembly worker in Dock A "(with respect to 1 job in 1 model) the work can be learned in about 2-3 days, but the most difficult element is speed. It is difficult to perform quickly. It takes about 3 weeks to master" (The comments of a young male worker having worked at WS1 for 9 months) [14].

Nevertheless, compared to the traditional assembly line, where stress comes from monotony of work and constraint on working pace, in addition to the already mentioned long job cycles in the 6 parallel dock systems, the following additional factors are further alleviating stress. This can be discerned in the change and expansion of the work contents. Similar to what has been seen in the engine pre-assembly workshop, this is made possible for three reasons: (a) the assembled chassis models differ within the same dock, (b) there is interchange between work within the same dock, and (c) there is interchange which extends beyond the assembly area.

With respect to (a), for instance, at Dock A 4 chassis models (B10M, B12, B10L, and B10LA) are produced. But since the assembled models differs in accordance with the production programs, the contents of the respective work change (work instructions are prepared for each separate model). To cite an example," the cooling system is normally installed at the work stage 3 (WS3) , but today for the B12 model, it is to be installed at the WS2. In this manner, the work contents change according to the model involved. Furthermore there are variations per model as well. There are never 2 buses that are exactly the same. For instance, this bus has an electric brake, in which case there is extra work involved in wire for the WS2 "(according to the working leader of Dock A).

Interchange of work under point (b) can occur in two ways. One consists of interchange between three jobs (one job is called the balance) within a WS. The other is job interchange between WSs. The actual interchange of jobs are not clear, but it is done quite purposely. This is evident from the fact that of the 99 workers in all of the Docks, there are 42 workers (42.4% of the total) who have experienced all of the jobs (balances) in the respective Docks involved (refer to Table 4 which follows). With respect to point (c), as already mentioned under pre-assembly, when there is a shortage of workers in pre-assembly and chassis assembly, there are temporary interchange between the assembly areas. In each assembly area, there are 4-5 persons who can do the jobs at both areas. In Dock A, at the time of surveying the plant, three workers were moved to pre-assembly. The changes in the work contents and their expansion in such a manner not only alleviates monotony in the work but also is effective in improving skills.

An important role in alleviating constraint on the pace of work is played by the flexibility of working hours (this is also identical to the pre-assembly area). The working hours at the Borås plant (Table 2) consist of a 5 day week, averaging 40 hours per week, from 07:00-16:00 hours each day in a single shift. But for each team, depending upon the pace at which work is

Table 2 Working Hours of the Production Department (in the case of Dock A)

Number of working hours per day (A)	7:00-16:00 (9 hours)
Break time	8:30- 8:42 (12 minutes)
Break time	13:30-13:42 (12 minutes)
Lunch time (B)	11:06-11:36 (30 minutes)
Working hours paid per day (C)	8 hours 30 minutes (A minus B)
Working hours paid per week	42 hours 30 minutes (C×5)

N.B. 1) Based on replies of the production leader to the writer's questions (May 1998)
2) The break and lunch time differ according to the Docks, due to the restrictions of available space in the restaurant, etc.
3) Break time is included in the number of working hours paid.
4) In order to total an average 40 hour week, every week 2.5 hours of overtime is accumulated in the hours-bank which are used on a free-day.

progressing, the working hours may be changed from day to day. Finishing work at 14:30 hours is a particular feature of Friday. Therefore depending upon the judgment of the team itself, "Work from Monday to Wednesday is done in excess to reduce the work load on Thursday and Friday. Then on Friday, work may end early after 14:30 hours" (according to the working leader of Dock A).

As in the pre-assembly area, although work instructions prepared for each chassis model are clearly specified which parts, in what order, shall be installed where, the order does not have to be strictly adhered to. "(The order) may be changed. If it can be considered better to change the order of installation, it is permitted, as long as the result is satisfactory" (according to a Dock A worker). Permitting a degree of freedom in the work also serves to alleviate work stress.

The third feature of the Dock system lies in the improvement of quality. In my interview, however, it was not possible to ascertain specific examples of improvement in quality. Therefore here we are only able to indicate the evaluation of Berggren that "quality level was very high and very stable."(15)

This concludes the features of the Dock sysytem at the present stage. The major difference compared to the parallel assembly system in the pre-assembly area is the fact that in the dock system, an assembly line remains partly. Therefore as far as further humanizing work is concerned, we may consider a further shift from the Dock system to the parallel assembly system. With respect to this shift, what sort of problems are faced?

3) The future of the Dock system

According to the production leader of the chassis assembly area, there are two major obstacles to a shift to the parallel assembly system. One is the problem of materials handling and the other is whether three workers could assemble one chassis. Regarding the first problem, the obstacles involved are that (1) at present, there are many parts and tools placed around the

Dock so that when the chassis is fixed in one place and assembled, the parts and tools must be brought from their respective places, so that compared to the assembly of one chassis at 3 WSs, efficiency would be reduced; and (2) assembly of a chassis at WS1 is commenced because considerable space is necessary to introduce the engine and axles, and for WS2, such space is not available.

With respect to the second problem, tests are scheduled to be undertaken during 1998 on assembly work by three workers. If this becomes possible, it will be necessary to consider production under the parallel assembly system. These trials refer to maintaining the current stages within the Dock and having the workers move through WS1-WS3 with a single chassis and perform the assembly work (In this case, control work will be unnecessary, and only testing will remain, increasing efficiency to some extent). These trials, after training the workers, will be conducted at Dock A. The problem is the time required to train the workers. In other words, in order to acquire one job (one balance) for one model, a time totaling 3-4 weeks (9-12 weeks to acquire jobs for 3 WSs) is necessary. This means in order to produce several models at 1 Dock, for instance, making B10M for 2 days, and the next 2 days making a B10L, there will be an adverse effect of "having little time to repetitively learn the same job". Nevertheless in May 1998, of the 23 workers in Dock A, there are 11 workers who have experienced all the balances involved, so that we can assume that the educational conditions have already been satisfied (see Table 4 which follows).

In this manner, the technical obstacles in moving to the parallel assembly system are being overcome through trials of moving the workers together with the chassis. According to the Production Leader, another improvement is also being contemplated. That is to move pre-assembly stages nearer to Docks. For instance, the engine pre-assembly would not be conducted in a location far away from the Dock but be assembled near the Dock. If the pre-assembly and chassis assembly can be integrated into a single work flow, the workers would be able to handle even more diversification in their work and increase their flexibility in order to acquire an even more holistic viewpoint.

(3) Features of the Work Organization

We have looked at the features of the pre-assembly and chassis assembly production system in comparison to the assembly line system, which is based upon a fragmental division of labor. We shall now look at the features of team organization, which is the basic unit of the work organization, focused our attention on the roles of the team leader level. As we have already seen, under production leaders, 6 teams have been organized in pre-assembly and 7 teams in chassis assembly (Preceding Diagrams 3-1, 3-2). There are considerable differences between the numbers of workers on each team, which determines the jobs and numbers of the team leaders. However the basic structure of team organization is based upon one working leader

(DL), quality and improvement team leaders, and further workers in charge of assembly engineering and materials handling, under which there are respective workers.

1) Working Leader

First let's look at the jobs and the nature of the working leader (DL). The actual jobs of the DL differ according to the size of the team involved. Where there are many in the team (for instance an engine team of 12 workers), DL work is concentrated in an average 40 hour week as a full timer (however, when there is an insufficient number of people, assembly work is also done). With teams of fewer workers (for instance a generator team of 5 workers), 16 hours in a 40 hour week are devoted to DL work and 24 hours are used in assembly work (the division of respective hours is left to the respective judgment of the DL). The major jobs of the DL are as follows.

(1) Receipt of applications and providing permission for leave of absence for workers, (2) securing the needed number of workers and the allocation of the respective jobs for each worker, (3) preparation of education and training programs, (4) management of parts, (5) contact and negotiation with other plants (for instance in order to finish work early on Friday, wishing to do overtime on Thursday, negotiate directly with other plants for the early acquisition of the required parts), (6) adjustment of working hours due to changes in the working program (for instance determining overtime and the time to conclude work on Fridays, etc.), (7) reporting on the working hours of all workers (weekly reports which take 3-4 hours of preparation), (8) periodic meetings with the production leader (once a week 1-2 hours are necessary to consult on preparation of working programs and consulting each other every morning), and (9) holding of team meetings (once a week, 15 minutes - 1 hour during working hours, to convey company news or notices and to discuss problems arising on the assembly workshop and various other problems).

As can be readily seen, the major work of the working leader (DL) consists of management and adjustment of work. The DL is similar to the foreman (*shokucho*) in Japanese plants. Prior to the organization reform in 1993, such work was done by the foreman. Prior to the reform, there were a production chief (PC), foremen and teams. There is not a DL but a coordinator which is a contact person in a team. But in 1993 the foreman was eliminated in order to more directly exchange information between management and the workers. In practical terms, the present production leader (PL) instead of a PC and a DL instead of a coordinator were established. Management of the plant previously performed by the foreman became the work of the PL. Management and adjustment of workers was transferred to the DL. Thus the work of the DL has much wider authority than the work of the coordinator prior to reform[16].

The working leader (DL) is not elected by the team. the DL is appointed by the production leader from among the team members, conditioned by having leadership as the DL and him (or

Table 3 Wage Composition of Blue Collar Workers (Borås Plant)

Monetary unit: krona

I. Fixed wage (monthly)

① Basic wage		② Seniority allowance		③ Qualification allowance				⑤ Other allowances	
				A		B			
Work evaluation	Value	Period	Value	Qualific-ation	Value	Qualific-ation	Value	Category	Value
AV1	13,204	4 months-1 year	390	1	131	1	263	Education allowance	440
AV2	13,384	1-2 years	500	2	263	2	438	Painters allowance	368
AV3	13,564	2-3 years	550	3	438	3	753	Electrician qualification	788
AV4	13,744	3-4 years	600	4	753	4	1,129	Welders' qualification	525
AV5	13,924	4-5 years	650					DL allowance	525
AV6	14,104	5-6 years	700					DL allowance (90%)	473
	*14,429	6-7 years	750					KL allowance	300
AV7	14,551	7-8 years	800					KL allowance (90%)	270
AV8	14,781	8-9 years	850	④Individual assessment portion				DL or KL: 100% +DL or KL: 90%	701
*signifies applicable to Dock workers		9-10 years	900					(DL+KL): 90%	619
		10-11 years	950					Laundry time (per day)	24.18
		11-12 years	1,000	Value: 0 - 270					
		Over 12 years	1,200						

II. Fluctuating wage (monthly)
Value : 0-540

III. Bonus (monthly)
Value: about 850 (notwithstanding twice yearly paid in summer and winter)

Source: Information provided by labor union
N.B. 1) This wage is effective from March 1, 1997.
2) 1 krona \17 (as of November 1997)

her) intention of taking its jobs. But when determining this, the opinions of the team members are given due consideration. The DL is replaced by other team members every 6 months to a year. The DL is given a DL allowance of 525 kronor per month. When persons who have been DLs cooperate with the current DL and prepare to do the DL work again in the future, they may maintain 90% of the DL allowance (473 kronor/month) (refer to Table 3 following). In other words, the DL is a member of the team. In appointment, the opinions of the team are given due consideration. The position is not confined permanently to a single person, as is the case in Japan. Therefore, since the DL has the above authority, this means that the same authority is held by the team itself. In which case, when compared to work teams in Japan, there is a much higher autonomy. Furthermore the autonomy of such an organization is also supported and ensured in part (for instance in the adjustment of working hours) by the technical autonomy derived from the parallel assembly and Dock system.

2) Other leaders and persons in charge

The delegation of various kinds of authority to the team is extremely important to the accepting of responsibility to a great extent by the worker group in the production involved.

Besides the working leader (DL), the team consists of a quality leader (KL), improvement leader (FL), person in charge of assembly engineering (TO, TS), and person in charge of materials handling (MH). Furthermore, there are shop stewards (FA), safety committee chairman (HO), safety committee member (SK), as persons in charge of labour union work. Not all of the teams have 4 leaders and persons in charge, but nearly all of the teams have a KL, and the importance placed on quality is apparent. Here let us take a look at the content of work done by the KL, FL, and TO/TS.

KL (Kvalitetsledare = Quality leader) has the job of making sure that the quality of the product is assured. For instance, when a new engine is being assembled, after a minimum 10 units have been assembled, the method of assembly is checked to make sure it has been done correctly. Responsibility for the tools is also held, and lubrication and correct torque are also checked once a week. When a question arises concerning quality, the fact is entered into the computer for each team. The KL extracts the respective lists every day to check on problems, investigates actual problems, and when necessary, problems are discussed at team meetings. Similar to the DL, experienced persons in KL and KL respectively receive allowances of 270 and 300 kronor monthly (refer to Table 3 following).

The FL (Förbättringsgruppsledare = Improvement group leader) is in charge of improving the ways in which work is done within the team and the development of individual abilities, etc. The TO (Teknikombud)/TS (Teknikstöd = Technical representative) collects the necessary information when new parts are to be employed or when assembly is changed, and takes over the responsibility of conveying and teaching this to the team members and providing the engineering support. Previously, this type of work was considered the role of the engineers.

The determining of such leaders and persons in charge is not clear. But it is probably the same as in the case of the DL. Moreover, similar to the DL, their roles within the teams change every year, with the intent of improving the skills of the team members. In this way, a portion of the work related to quality and engineering is transferred from the staff members (white collar workers) to the working teams (blue collar workers). This trend will probably be intensified. According to the DL of the engine pre-assembly workshop, "The work in the plant is becoming increasingly interesting. Not just turning the screws but being given gradually more responsibility." "In 5 or 10 years, white collar work will disappear." An aged worker in the same workshop say that, "Assembly and sales will be done by us." Such remarks may be a little extreme, but in the offices and plants of Volvo, it is clearly evident that in the future there will be a fusion of work between white and blue collar workers, as it is a basic policy to endeavor to eliminate the demarcation between work roles [17].

3. Wage System

The wage system in Sweden is based upon job evaluation and on the principle of equality, whereby differences in pay are extremely limited. This is determined by central negotiations between representatives of corporations and labor which commenced in the late 1950s between the SAF (Swedish Federation of Management) and the LO (the Swedish Trade Union Confederation). Since the late 1980s, wage negotiations have been shifting from comprehensive central negotiations to industrially or corporate segregated negotiations, which has brought about new wage systems in which wages are based upon the performances and abilities of the individual[18]. However wage systems for separate corporations are not quite clarified[19]. On the basis of the information obtained, the writer wishes to discuss the evaluation system and the wage composition of blue collar workers in the Borås plant. The following comments are based on the explanations of the chairman of the local metal workers union (Local LO-branch) and the production leaders of the pre-assembly and chassis assembly.

(1) Wage Composition

As indicated in Table 3, the wages of the blue collar workers are divided into the three parts: fixed wage, fluctuating wage and bonuses. At one time they used hourly wages. Since 1994, this has been changed to monthly wages identical to the white collar system. Firstly, fixed wage was classified into five stages: (1) Basic wage - (5) other allowances. (1) Basic wage is the main part of wages. On the basis of the work evaluation method established by the Swedish metal industry employers and employees, it is divided into 8 classes of wage (AV1 - AV8). The differences between classifications range from 13,204 - 14,781 kronor monthly (a difference of about 12%), so that the extent is limited. For instance, Assembly workers at the Docks are all classified as * of AV6 (14,429 kronor), with the pre-assembly workers at various different levels. Workers in charge of material handling at the stores are at a lower level as opposed to the higher levels of AV7 and AV8, which are applicable to workers in charge of adjustment.

(2) Seniority allowance provides 390 kronor for persons employed for longer than 4 months. For every additional year, there is a raise of 50 kronor, and for over 12 years a maximum of 1,200 kronor. This is similar to the periodic pay raise in Japan, but the extent of each change is much smaller. (3) Qualification allowance is divided into two classes (A and B), which are then further divided into four classifications each. The lowest is 131 kronor and the maximum is 1,129 kronor. This allowance is the wage portion that reflects job enlargement (refer to Table 4 for details). (4) Individual assessment portion is the part determined once a year on the basis of the evaluation of the production leader for each worker based on the worker's work performance and ability. It ranges between 0-270 kronor. This evaluation of the individual was introduced about 5 years ago. (5) Other allowances cover payments made to the working leader

(DL) and the quality leader (KL), and also to wokers who have special skills. There are a minimum of 270 kronor and a maximum of 788 kronor.

The second kind of fluctuating wage has a range of 0-540 kronor. It based upon the monthly production volume (achieving of production target) and quality, and is a group incentive wage paid to each plant employee in identical monthly amounts. In other words, there are no differences between individuals and teams. According to the production leader, this fluctuating wage was introduced in 1994. Before that, a norm system was in effect. Currently there is no difference in wages between teams, but henceforth differences may be considered.

Thirdly, bonuses were introduced as a system in 1982, based on 4 standards of weekly productivity, quality, percentage of zero-defect vehicles and delivery[20]. The value per hour is calculated, multiplying by the weekly hours worked, and the cumulative total value to that week is shown. For instance, for the 42nd week of 1997, 224.83 kronor were calculated. From the 23rd week to the 42nd week of 1997, the cumulative total was 3,073.57 kronor. This, converted to a monthly average, came to about 850 kronor. A bonus of that amount is given to all the workers excluding the plant manager, and is paid to the workers twice, in the summer and winter.

That is a review of the overall wage composition. An example of what one worker is actually paid and the structural percentages will now be considered. In the following example, the amounts given are what the workers union has indicated. They can be presumed to be a general example.

Table 4 Number of Workers by Team and Grade of Qualification Allowance (KVT)

May 1998

Pre-assembly						Chassis assembly					
Team	Number	KVT=A 1	2	3	4	Team (Dock)	Number	KVT=B 1	2	3	4
Cable	2				2	A	23		3	9	11
Axle	17	2	4	4	7	B (B1+B2)	22	4	3	10	5
Instrument	12			4	8	C	22	1	2	7	12
Generator	6			2	4	D	23	2	2	12	7
Ventilation	9			2	7	E	6			2	4
		KVT=B				F	3				3
		1	2	3	4	Total	99	7	10	40	42
Engine	21		2	1	18						
Total	67	2	6	13	46						

N.B. 1) Replies of production leaders to writer's questionnaire (May, June 1998)
2) A of KVT is applicable to assembly work of less than 2 hour job cycle.
B is applicable to assembly work of over 2 hours.
3) A1 = assembly of 1 model possible
A2 = assembly of 2 models possible
A3 = assembly of 3 models possible
A4 = assembly of all models possible
4) B1 = in the dock, 1 balance (task) of 1 WS possible
B2 = in the dock, 1 balance (task) respectively of 2 WS possible
B3 = in the dock, 1 balance (task) respectively of 3 WS possible
B4 = all balances in the dock possible

Example) Monthly wage (17,517) = basic wage (14,104) + seniority allowance (1,000)
+ qualification allowance (753)
+ individual assessment portion (110)
+ other allowances (180) + fluctuating wage (540)
+ bonus monthly average (830).

Converted to yearly income, 17,517×12 months=210,204 kronor.

In this case, if the various component percentages are calculated, the basic wage is 80.5%, the seniority allowance 5.7%, qualification allowance 4.3%, individual assessment portion 0.6%, other allowances 1.0%, fluctuating wage 3.1%, and bonuses 4.7%. This shows that percentage of basic wage is particularly high. Despite the fact that "individualization in wages" based upon differences in individual performance and abilities progresses, in Sweden the persistent tradition of equality in wages appears to be being maintained.

Moreover, with relation to assembly system as seen already, qualification allowance should be mentioned. The parallel assembly system and the Dock system have been adopted as major elements in the ability to flexibly adjust to the diversification of products. In order to efficiently assemble a wide variety of products, the workers are required to be able to adjust to the assembly of a wide range of products. Henceforth, the expansion of ability is also of importance in the dock system and in the preparation to move towards the parallel assembly system. Qualification allowance is worthy of attention as an incentive for that purpose. However, the maximum limit of qualification allowance in a majority of the pre-assembly workers is 753 kronor. It is 1,129 kronor in the case of engine pre-assembly workers and dock assembly workers. Its percentage of the monthly wage is about 4-6%. We could not in this instance ascertain to what extent this was effective as an incentive.

Furthermore in order to achieve flexibility in production, the moving of workers was frequently undertaken. The temporary transfer of workers between pre-assembly and chassis assembly has often occurred. If the basic wage is predetermined by job, changing of basic wage may become a problem when moving the workshop. The production leader explains on this particular point as follows. The temporary transfer in workshop does not basically affect any change in basic wage, but for a permanent transfer, if the evaluation of work changes, the basic wage is affected for the change. This wage system is not an obstacle to the temporary transfer in workshop.

(2) Evaluation System

The individual assessment portion (0-270 kronor) was a mere 1% of the monthly wage and this percentage does not change since about 5 years ago. If the difference is only this much, it will not work as an incentive to encourage competition between workers. Nevertheless from now on, this portion may be expanded. Thereby it cannot be denied that competition may arise

Table 5 Evaluation Chart

Name:

Department: Team: Employee Number:

Main Station: Work Task:

Level	1	2	3	4	5	Result
A. Work Performance						
-Efficiency	30	60	90	120	150	……
-Use of time	10		30		50	……
-Quality of work	30		90		150	……
B. Education						
-Basic education	10/10	20/25	30/50	40/75	60/100	……
-Profession/ Field of specialization	10/10	20/25	30/50	40/75	60/100	……
C. Personal Characteristics						
-Instruction/leadership	10		30		50	……
-Ability to solve problems	25		75		120	……
-Judgment/responsibility	20		60		80	……
-Teamwork	20		60		80	……
					880	(Points)

Evaluation term Date Evaluator name Signature Total number of points Value (Öre)

Notes

Source: Information provided by company

N.B. 1) Evaluation is in stages of 3-5 levels and the basis is as follows. For instance, in the "efficiency" item of "A work performance," it is evaluated how much of the work required was accomplished (ofen, good, better, more than sufficient, very much in excess). For "B education," it is evaluated whether professional training other than basic education was taken or not, the number of years, time, and also whether such education is related to the work at Borås plant or not. "C personal characteristics" under "instruction/leadership" evaluates whether a worker's able to teach others his duties, or teach the whole team work (effect leadership), and whether he can substitute as a production leader. The average level is "3". Further, it was not clarified whether relative evaluation or absolute evaluation is used, but from the B standards, it is probably an absolute evaluation.

2) Basis for conversion of total number of points to pecuniary value (individual assessment portion) is as follows: 0-400 points:×0.1 kronor, 401-650 points:×0.2 kronor, 651-880 points:×0.3 kronor

3) The "Signature" column signed by the department manager (in the manufacturing department, probably the production leader)

between workers. Therefore the evaluation system should be commented upon here.

Evaluation is once a year, undertaken by the production leader (PL) for each worker based on work performance and ability, to be reflected in the wage paid. Table 5 (Evaluation Chart) indicates this evaluation. The evaluation elements include three elements: A Work Performance, B Education, and C Personal Characteristics. These are each broken down into a number of further items. For each of the individual workers, the PL evaluate these in 3-5 levels and the total number of points is converted to a monetary value per point, to determine the respective wage levels of each worker (refer to the N.B. of Table 5).

Among the ABC evaluation elements, B is based on education level and length of time, so that an objective result is obtained. However A and C are affected by the subjective opinions of the evaluator. In comparison to the generally practiced personnel evaluations in Japan, A is a "performance evaluation" and C is equivalent of a "capability evaluation" and a "personal evaluation," but the number of items evaluated is very limited.

Since the A and C evaluation elements depend on the subjective opinions of the evaluator, the evaluation results may give rise to objections and dissatisfaction on the workers' side. In the preceding evaluation chart, there is no column to indicate the "agreement" of the worker to the evaluation, and the system does not provide for revealing the evaluation results to the subject [21]. Of course, the overall result becomes known to the worker after considering the results reflected in his wage. But a problem remains with respect to the individual evaluation elements. Revealing of results has not been systematized, so when an individual wishes to know the results, he (or she) is able to see them. We have not ascertained how satisfied or dissatisfied the workers are with the evaluations and how they are being handled. According to the PL, there are cases when the results are questioned by the worker as a misunderstanding. However besides the discussions held by the PL with the individual workers (2 hours, once a year) for the development of education and ability of each individual, the PL is in daily contact with each worker, therefore no major problems arise.

Conclusion

Let us review the major points covered by the current study. First, the parallel assembly system that began in engine pre-assembly in 1985, has subsequently expanded, so that the same assembly system has commenced in other pre-assembly workshops. In the engine pre-assembly workshop, the division of labor and interchange of workers have also been ascertained to a certain extent.

Second, with respect to the Dock system in chassis assembly, no basic changes have been seen during the past 10 years. However, the diversity of products has increased and the number of docks has increased. It has been ascertained that the same chassis and different chassis in each dock are being produced. As the desired form of dock system for the future, we understand that preparation is in progress for 3 workers to assemble one chassis. The pre-assembly stage will be moved nearer to the docks, to make pre-assembly and chassis assembly a single flow. In the future, shift to the parallel assembly system is being studied as a possibility. In other words, the Dock system is currently in under expansion.

Third, to ensure flexibility in production, the interchange of jobs is being quite aggressively practiced and the skills of the workers are gradually expanding in scope. Fourth, the wage

systems of the blue collar workers have been quite clearly ascertained. As far as the Borås plant is concerned, the frequently-mentioned "individualization in wages" cannot be said to have made that much progress. On the contrary, there is very little difference between workers and equality in wages is still basically in effect. Nevertheless, the possibility of future introduction of wage differentials between teams and between individuals cannot be denied in the individual assessment and bonus portions or the fluctuating wage areas. It will be necessary to watch this possibility. Furthermore, with relation to production system, we cannot overlook the fact that incentives are being prepared in order to widen the differentials in skills and promote leadership in teams. The extent of these incentives and their effect are still not practically known. This is a subject to be pursued in future investigation.

Fifth, the organization has been further flattened along with plant organization reformed in the 1990s. In comparison to before, the working leader has been given much more power. The role is not confined to specific members and when woking leader is appointed, the opinions of teams is considered. In other words, the teams are autonomous to a greater degree than before. This is in part supported by the adoption of the parallel assembly system and the Dock system (in other words, technical autonomy) which alleviate stresses on the jobs, compared to a long assembly line, and by the more flexible working hours system.

Notes

(1) This paper is a portion of the study results undertaken during a writer's stay in Sweden (October-November 1997) under the Ministry of Education system (Fiscal 1997) for dispatch of researchers for investigation of overseas studies and development trends. In conducting the study, the writer is greatly obliged to the assistance extended by Kajsa Ellegård of Göteborg University. Extensive assistance was also given by the many persons at the Borås plant. In pre-assembly and chassis assembly, production leaders Gunnar Lönn and Lars Wahlqvist provided interviews when the writer visited the plant on October 24 and November 19, 1997 and also provided detailed written replies in response to queries by the writer in May 1998. I wish to mention my gratitude here.

(2) The reflective production system practiced at the Uddevalla plant has been written on extensively in the basic reference *Reforming Industrial Work - Principles and Realities in the Planning of Volvo's Car Assembly Plant in Uddevalla* by Kajsa Ellegård and Tomas Engström & Lennart Nilsson, Swedish Work Environment Fund, Stockholm 1991.

(3) As an alternative to lean production, a comparison between the Volvo experiment and Toyota has been widely discussed in *The Volvo Experience, Alternatives to Lean Production in the Swedish Auto Industry,* by Christian Berggren, Macmillan 1993.

(4) Volvo Buses 1997 Facts.

(5) There are about 15 women in the pre-assembly workplace. In the chassis assembly, due to the heavy handling work, there are few women. There are only 1 each in the 5 Docks (total of 5 female workers). In the N bus factory of M automotive company in Japan, with about 500 employees, with the capacity to

yearly produce 6,000 small size buses (2 shifts) and 1,800 large size buses (1 shift) there are only 4 women in the sub-assembly line as direct women workers according to an investigation conducted in January 27, 1998 by Masaki Saruta, Uichi Asao, and Ayako Ikeda. The following description of the N bus plant of M automotive company is based on this investigation report.

(6) The only exception is the N bus plant of the M automotive company. There, not only the assembly of chassis, but also welding of bodies, painting and assembly into completed buses are performed in the case of small and large scale buses.

(7) In Japanese bus manufacturers, line production system are accepted as the general practice. For instance the N bus plant of the M automotive company produces both small and large buses on assembly lines.

(8) Christian Berggren, op.cit., p.113.

(9) ibid., p.113.

(10) The freedom of the work pace is greatly affected by pressure from external time limits, and the freedom of work pace in the parallel assembly area is difficult to actually ascertain. When I asked to a worker with 10 years of service in the 2nd stage, "What is the most difficult in engine assembly?", he said, "Tightening screws is not that difficult but it is difficult to complete the work within 3-5 hours. And as there are many variants, it is difficult to remember". One can see that the workers recognize the pressure of a time limit.

(11) Berggren, op.cit., p.109. As of 1987, the presence of the 4 docks (A-D) and respective 3 stages (steps) has been pointed out. After 10 years, as of 1997, there are some changes.

(12) In Dock E, there are only 2 work stages, where 5 workers with high working abilities assemble the chassis. Whether or not there is a control stage is unknown, and the number of stages in Dock F is also unknown.

(13) Before the construction of the Borås plant, the assembly of Volvo Bus chassis was conducted at the production line of the Göteborg truck assembly plant, and the job cycle was 53 minutes. (Berggren, op.cit., p.109). The N bus plant of M automotive company in Japan at the time of the study, produced 75 units of large size buses monthly in 1 shift (yearly production equivalent of about 900 units). At that time the job cycle (tact time) was about a little more than 1.5 hours (1 hour and 30 minutes). Suppose the number of units produced declines further, in order to meet delivery, the tact time maximum is considered 1 hour and 40 minutes at best.

(14) According to Berggren, the strength of performance demands and time pressures increased the physical burden on the dock assembly workers and the mutual reliance upon one another within the docks generated stress. It is pointed out that in 1987, assembly work in the docks was the most unattractive in the plant (Berggren, op. cit., p.111 and 211).

(15) Berggren, op. cit., p.112.

(16) In the employment of new employees, the production leader now interviews the applicants and makes the selection. According to the dock production leader's comments, in the future, probably the production leader will select about 3 candidates in the initial interview and from those 3, the Dock (team) members will make the selection. If this is realized, the strength of the team authority will be further enforced. In this manner, the engagement of team in the selection of new members is already in practice at the Uddevalla plant (AutoNova). On November 14, 1997 the writer found this out at an interview with the branch officer of the metal workers union organized at the Uddevalla plant.

(17) An organization in which such demarcation has been eliminated is called a GFO (Gränslös Flödes Organisation; borderless organization) at the head office of the Volvo Group (The writer learned this in an interview with Glenn Carlsson, head office manager, on 21 October 1997).

(18) On changes in recent wage negotiations in Sweden, refer to Norio Okazawa and Taro Miyamoto, *Sweden Handbook* (Japanese), Waseda University Press, Chapter 13, 1997 and Takeshi Shinoda "Changes of Industrial Relations in Sweden (Japanese)," *Journal of Japanese Scientists*, Vol.33, April 1998.

(19) Toshiko Kamata and Tetsuhiro Kamata, "An Experiment in New 'Humanization of Work' in Sweden (Japanese)," *The annual of the Japanese Association of Labor Sociology*, No.3, 1992, cites a wage scale by category and age for a machine assembly corporation. The wage system of the Köping plant, which manufactures automotive parts for Volvo, is also introduced.

(20) Productivity is the number of chassis produced per worker. The zero-defect vehicle is that can be immediately delivered after test driving (Berggren, op. cit., p.112). The percentage of zero-defect vehicles never reaches 100% and 85% should be acceptable.

(21) At the Volkswagen company in Germany, there is a column for the worker's signature on the evaluation sheet regarding the results of evaluation, as to whether the agreement of the evaluated employees is obtained or not (Uichi Asao, "Agreement on merit rating at the VW [Japanese]", *Journal of Toho Gakuen Junior College*, No.22, December 1993, p.90).