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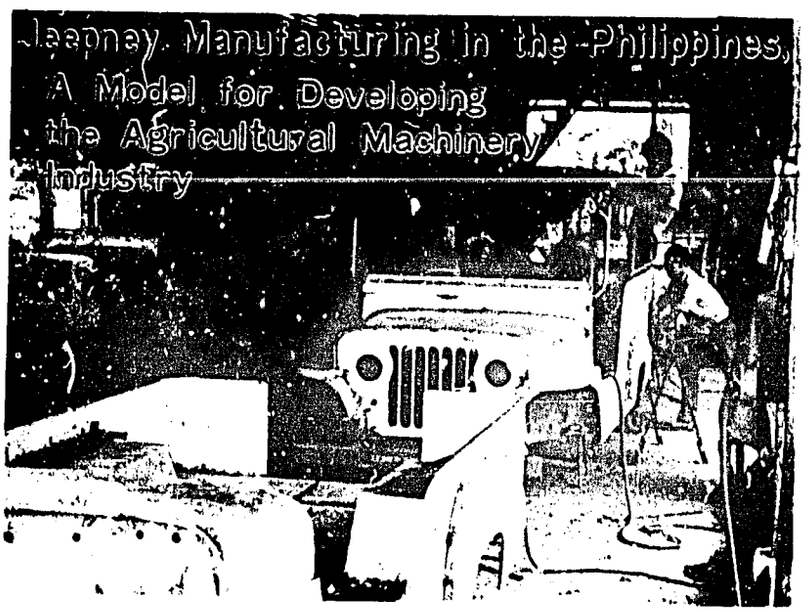
Jeepney Manufacturing in the Philippines, A Model for Developing the Agricultural Machinery Industry



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IT can be gleaned from many articles in the first book of Farm Machinery Industrial Research Corp., *Agricultural Mechanization in South East Asia* that mechanization cannot be attained solely through the importation of machinery. To these I would like to add a few observations to establish a framework on which the development of an agricultural machinery industry may be based.

The average hp/ha in Southeast Asia[1] excluding Japan, Republic of China and Nepal is 0.327. Japan which we may consider has a well-developed agricultural economy has the highest average of 3.00 hp/ha. The Philippines has only 0.198 hp/ha. For it to attain a level of mechanization of say 2 hp/ha in 15 years and considering for the sake of estimation that the Philippines were to import machinery in the form of 30 hp tractors, the Philippines would have to import 21% of the number of tractors existing evry year; so that by 1985, the Philippines would have spent 750 million US dollars. On a straight line basis this entails an annual expense of 53.6 million dollars[2]. This amount is already 9% of the Philippines budget for 1971. Obviously, even if the Philippines had the dollars, an allotment of this size cannot be implemented. It is therefore imperative that the bulk of the machinery be locally manufactured.

That a developing country like the Philippines is short of capital and rich in labor resources cannot be overemphasized. It is only logical to envisage a production technology that is more labor intensive than capital intensive. "Incorporate the farmers" would be the retort of any student of business. But in a developing country like the Philippines where government administration is invariably hamstrung by political and bureaucratic bottlenecks, constraints and even corruption,[3] economy of size that can be gained by such collective efforts for manufacture is at best a dream.

Capital intensive manufacturing is a high volume concern. With a farm size distribution of 95.4% in the 0-10 ha range (60.8% in the 0-3 ha range)[4], it is doubtful that large volume production can be continuously supported. Furthermore, agriculture involves vast areas of land which implies miles and miles of roads. Distribution of the machines, if produced by just a few large factories, would entail transportation considerations that significantly increase costs to the farmer without improvement of machine performance.[5]

In this particular framework, it seems that a low-volume, labor intensive production method is the more viable alternative in agricultural machinery production.

Khan[6] has asserted that this type of production is quite possible by citing as an example the very successful jeepney[7] industry in the Philippines.

The preponderance of cheap surplus material and the great need for public conveyance were the two main ingredients that started the jeepney industry after World War II. As soon as the concept was introduced, small shops producing crude versions cropped up almost overnight. Now it is a flourishing industry that involves annual sales of at least seventeen million dollars.

Two companies, Francisco Motors, Inc. and Sarao Motors, Inc. will be described for illustration. Although differing drastically in business philosophy, the choice is based on the following characteristics which are common to both:

1) They are the largest jeepney manufacturers, with dealers all over the Philippines; one indication of their financial stability is their good credit standing with banks;

2) Both started literally from scratch 20 years ago, using simple

tools; the founders were highly skilled artisans with no college level education.

3) Low-volume production-each produces 5 to 6 jeepneys a day;

4) Labor intensive-employing more than 300 men in the factory alone;

5) Both firms have never had a strike, and have never laid off men.

Francisco Motors seems to be the more dynamic one since its concern is one of continuous development. It has been gradually "modernizing" its production methods by adopting the moving assembly line technique. Many manual operations are also being replaced by "transition" machines. The replacement by machines however is being made only to redistribute the men to other lines, of which they now have three: jeepney assembly, special make and micro-bus lines. Another assembly line for a Japanese car is not continuously operated. The micro-bus line is more of a diversification. These characteristics may classify this firm as a modern small industry specially in its outlook-in which "there is a continual search for improved ways and has ready adaptability."[8]

Sarao Motors on the other hand upon attaining the present production level has stabilized activities. Aside from a few improvements, it has remained traditional. Its skilled workers today are still doing what they used to do when they were making only a few jeepneys a month. Production was increased mainly by adding more men and buying a few simple tools. Except for welding, absolutely no production machine is used, not even for cutting sheet metal. Without moving the assembly from its location, three men with hammer and die and welding equipment work on it until the body is completed. This is indeed very primitive; but some of the experts in the very modern car industry are now realizing that assembly for the sake of efficiency with people as a subordinate consideration may in the long run not be so beneficial. In the former type of assembly (traditional) the men gain a sense of accomplishment in their work while in the high capacity modern car assembly line, where specialization has been reduced to the tightening of bolts, men ask to be compensated for being bored (it would be tragic to discover in the end that mechanization has only transferred human drudgery from the farm to the factory!) The main reason for Sarao Motors remaining traditional is the belief that the jeepney will be the chief public conveyance of the Philippines. It is also the belief that although handmade, it's quality is comparable to that produced by machines. In the words of Leonardo Sarao, president and general manager:

> "I am not concerned about the future of my company. Selling jeepneys has never been my problem. The jeepney is here to stay. It will always be used for short-distance runs even if mass transit systems are developed in Manila. And it cannot be replaced in the provinces."

And upon one of his brothers being asked if the company was making money, "To tell you frankly, among us four brothers, we own the best and the latest cars in the Philippines." Pointing to a young man working in the shop, "That is my son, I am training him to work in the factory and know the men. He sometimes goes to school in his Torino, although he regularly uses a Sarao jeep." (At Francisco Motors, the key men stay in the office, and have taken management courses to keep pace with the company's development.)

It might be of interest to note that engineers were employed only after these companies had reached maturity-after most of the problems of machine design had been solved.

Although these two companies, together with four slightly smaller ones produce the bulk of the jeepneys in the Philippines, there are more than 100 jeep and jeepney body builders in the country. These are small shops with floor areas ranging from 200 to 500 square meters, employing about ten men. In these shops one will find about eight jeeps and jeepneys spaced one to two meters apart in various in stages of assembly. The majority of vehicles assembled in these shops are jeeps (not for public conveyance). Some of the grill, fender, tailgate and windshield frames are produced by other local manufacturers who have presses. The rest are formed in the shop with special forming frames and clamps. The cost of the material is about 50% of selling price.

The success of the jeep and jeepney can be attributed mainly to the following:

1) low cost-most of the engine and undercarriage are war surplus material. It is odd, though fortunate, that the Philippines government permits the importation of worse than second hand material while the import of second hand cars, which could also be imported at lower costs, is restricted. Engine reconditioning has given rise to other types of shops with precision machines (reboring, crankshaft grinding etc.) and has enhanced the development of highly skilled mechanics;

2) availability of spare parts -fast moving jeepney parts can be bought in almost all towns in the Philippines.

3) the jeep was designed by the US Army for strength and traction and as such is just the natural vehicle for country roads and rugged terrain.

Comprising 45.2% of the total car population,[9] there are 119,953 jeeps and jeepneys registered in the Philippines in 1970. Jeepneys alone number 43,283 units and these are managed by at least

15,000 operators. At the rate of peso 6.50 to the dollar, selling prices are as follows:

Jeepney (12 passengers)

Body only with upholstery and paint, chassis included···US$660.00
Complete jeepney with reconditioned surplus engine ·····1,920.00
Complete jeepney with brand new diesel engine ·····2,615.00
Ditto, deluxe model ·····2,880.00
Jeep (for private use) body only ····· US $ 310.00
Complete jeep (reconditioned engine) ·····1,600.00

A total of 9,585 units of chassis were produced by the three local chassis manufacturers in the period 1969-1970 and previous figures indicate that this number is no longer increasing.

Can we develop an agricultural machinery industry patterned after the jeepney experience? I believe, we can because it is so natural.[10] It is only necessary for us to determine the vital ingredients in the "mix" that promote growth.

1) Availability of enterprising artisans with small shops—In any developing country, there can be found a proliferation of individuals who have considerable skill with their hands. In the Philippines specially, because of the jeepney industry, many artisans in metal forming and welding have established small shops in the country. The local manufacture of hand tractors in Taiwan and Thailand is also done purely by artisan-businessmen. The agricultural machinery field offers good opportunity and challenge for engineers, and yet when I visited these manufacturers, I never met a single engineer! Considerable advances could have been achieved had there been some technical guidance in machine development. It is odd too that financial aid to small shop endeavors are so insignificant while, it is clear that it is these small shops that have the potential and, are making the machines. Financing for development in the Philippines is concentrated in large investments which are so top heavy that the effective use of this resource is inefficient. The interest rate at present is 12% but through commissions and services the borrower eventually pays 14-%. Imagine the difficulties the small enterpreneur in the artisan level must overcome to make the required project study to acquire a loan!

2) A simple product—not necessarily for production reasons but more to suit the technical level of the farmer is a major consideration. The hand tractor was introduced in the Philippines more than 10 years ago and has gained wide acceptance. Almost all types of hand tractor have been tried (4-speed, plate clutch, all gear drive, steering clutches, reverse etc.) but the farmer still prefers a machine that he understands. It is hard to measure in concrete terms the level of sophistication machines from the developed countries have reached -but one should try disassembling the latest Japanese hand tractor and see for himself. It is clear that the tropical farmer is paying for so many "extras". Furthermore, these machines are imported without adequate service backing. I believe the agricultural machine for the tropical farmer should just be a step higher than the bicycle but less comlicated than the motorcycle in the mechanism hierchy. This may be fortunate because local manufacturers cannot as yet manufacture with high degree of precision. A good gauge of the level of manufacturing skill available in the Philippines can be obtained by again looking at the jeepney industry. At present almost all the parts of the jeep are being manufactured locally except for the engine, transmission gears, differential gears, steering gear assembly and bearings. The casting of transmission and differential housings is starting in 1971. This implies that precision in the less than one thousandths of an inch measurements and finer than sandpaper finishing operations is still rare. The supposedly reliable machine shops in the provinces still fit ball bearings by "feel". This indicates that local manufacturing should avoid components that require accurate alignment, such as gears. The introduction of "go" and "no go" gages is timely. In the Philippines, as well as in many developing countries, casting is still an art, both in the pattern design and metalurgy aspects. Sheet metal forming can be accomplished by the artisan. More complicated shapes can be made by the proper design of forming frames and clamps as in the jeepney industry. Some re-orientation in design is

A jeepney running on the street

needed in this respect-there may be functional forms that are difficult to fabricate by machine but easy by hand.

3) Standardization of parts --this ingredient of the mix is rather difficult to achieve because artisans are by nature individualistic. However, parts such as chains, sprockets and bearings which are interchangeable parts may be used to cause standardization. A good example is the rugged hand tractor of Thailand: the use of 1" chains and the same sprocket sizes are common, thus ensuring the availability of spare parts. In the Philippines, many jeep parts can be used in agricultural machinery.

4) A product that is both functional and durable for tropical farming must consider not only specific purposes but other probable uses the farmer might think of and the machine should be designed to withstand abuse.

If the four basic ingredients are present, I believe the agricultural machinery industry will develop naturally-just like the jeepney industry.

1) Ceylon, India, Indonesia, Pakistan, Philippines, Thailand, and South Vietnam. Japan, Republic of China and Nepal are above the critical 0.5 hp/ha considered by McColly (Professor emeritus Michigan State University) as the least hp/ha of main crops area that should be available to expect some increase in productivity.

2) The figures are from an exercise made by Teddy Wikramanayake, senior lecturer in agricultural engineering, University of Ceylon.

3) It is difficult to ascertain the extent of corruption in the government but it will suffice to say that each and every candidate for election to the legislature vows to fight corruption during his campaign.

4) Agricultural Census of the Philippines, 1960.

5) I am reminded of a $3,600,000 10ton/hr rice processing complex located in the Philippines. The design was based on an exhaustive study and recommendations of a team of national and international experts. It is one of the most modern. And it is so highly automated that only 3 men are required to run it. The manager can control everything through a closed circuit TV system. Unfortunately, enough paddy cannot be found to operate it continuously. Even to operate it intermittently, their trailers have to travel up to 500 km to gather paddy. Viewed in the context of mechanization blunders of this type make one worry about the sincerety of expert advice.

6) Machinery Development for Tropical Agricultural Mechanization of Southeast Asia. Amir U. Khan

7) The jeepney is an adaptation of the US Army World War II 1/4 ton 4 x 4 jeep for public conveyance. (see picture)

8) Modern Small Industry for Developing Countries by Staley and Morse.

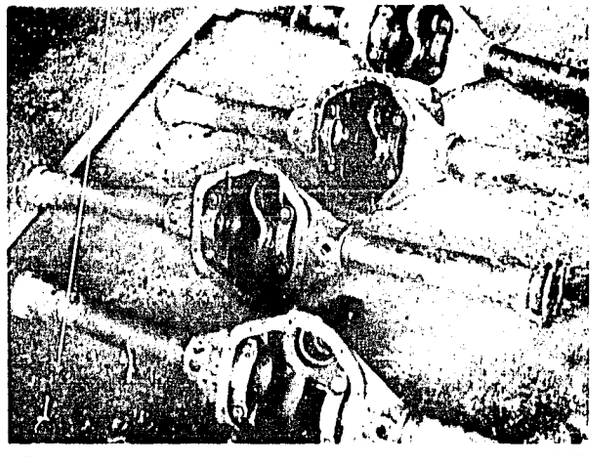
9) Public Service Commission, Department of Justice, Republic of the Philippines.

10) The word "natural" is vague but I want to imply that the jeepney industry is an industry that has grown with practically no prodding or constraints. ■ ■

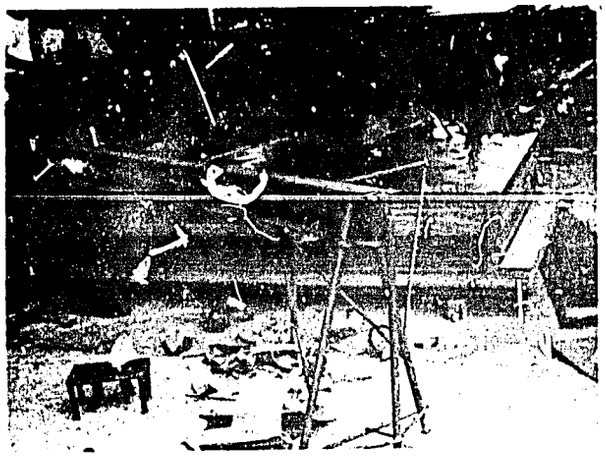
SARAO MOTORS (left)

The chassis stacked in the yard of Sarao Motors are supplied by one of the three jeep chassis manufacturers in the Philippines. In the background is the body assembly shed. As one gets accustomed to the noise of hammer on sheet metal, one will recognize a loose arrangement according to activity.

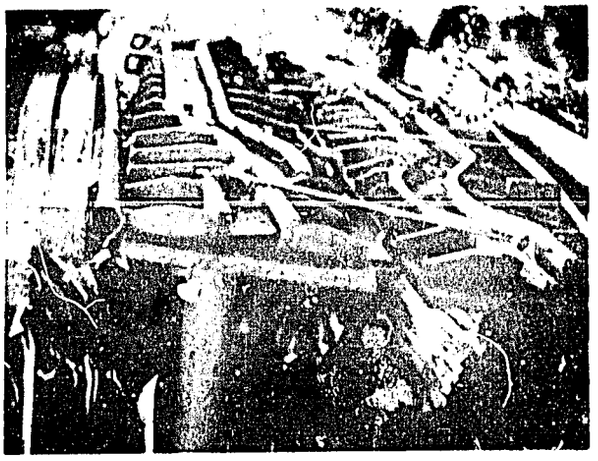
FRANCISCO MOTORS (right)



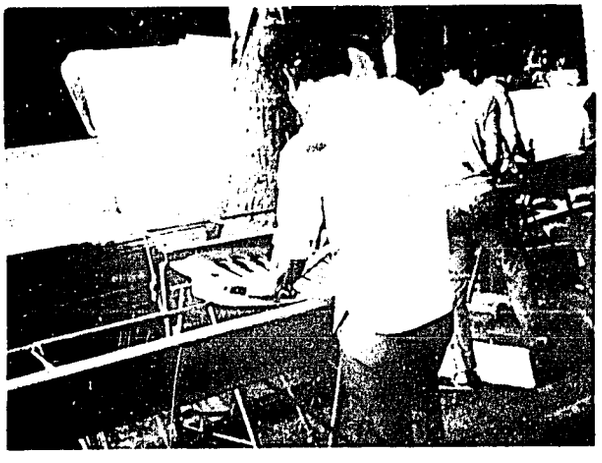
Conversion of the jeep axle from semi-floating to full-floating axle is one of the modifications made by the engineering and design department in order to reduce stresses on the axle and to facilitate disassembly. Another activity in this department is the fitting of the jeep transmission to the bell housing of a Japanese made engine. This requires precision work and the use of special welding material.



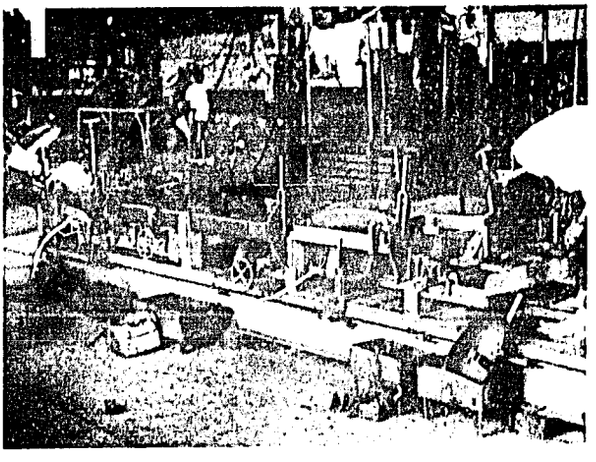
All parts are hand formed using indigenous tools. Sheet metal is still cut by hand shears. Above is shown a forming frame. By the shape of the frame it can be deduced that the quality of the part produced will depend to a great extent on the skill of the worker. Many forming frames are used in the industry in varying degrees of sophistication with the one shown as the simplest. In other small shops the blank is clamped between positive and negative forming frames. Relatively complicated forms are possible with this method.



The die for chassis forming was fabricated by hand from armor steel. The forming and fitting of the dies took them more than a month to complete by just heating and welding. Compared to dies produced in the industrialized countries, this is primitive, but structurally and functionally, the chassis produced is compatible with the load. The dies are mounted onto a 100 ton multi-purpose press. Cylinders and control box were imported from Switzerland. The cylinders can be operated simultaneously as a group or individually. The press is used intermittently for chassis forming according to demand. Down time is used for stamping the grill and other smaller parts.



The artisan hammering the jeepney grill into its final form. The design has not changed since the World War II days. This persistence in style has facilitated the setting up of relatively low cost manufacturing concerns using heavy duty presses.



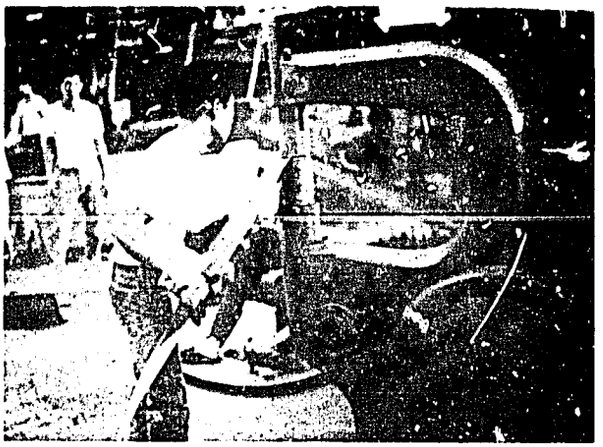
Chassis assembly is done on an adjustable jig which accommodate different chassis lengths (for 10, 12 and 14 passengers). Components are fixed in position by home-made over center clamps for assembly by welding Quality of press formed parts are not as good as the imported ones (due to unequal bend radii) but compliance to pertinent dimensional specifications are strictly obseved. Good chassis appearance is a consequence of good die dimensions. However it does not add to performance.

The rear fender is pre-formed by welding a strip at the edge where the curve will be sharpest. Final form is attained by hammering. Note shape of the almost completed fender held by artisan.

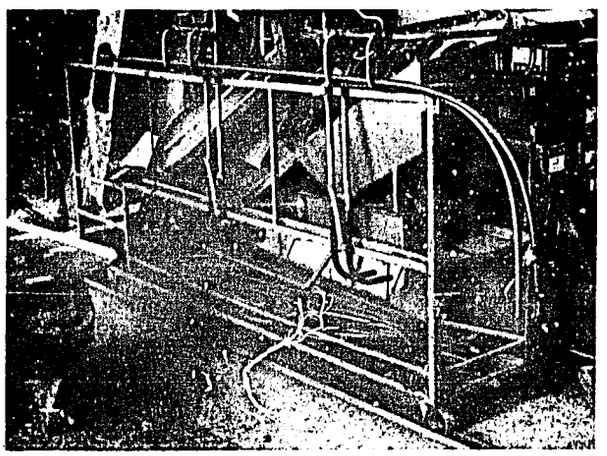
All cut forms are made from patterns developed through the years. This section of the shed has an earth floor because it is also used as a soft backing for the hammer. The ground also absorbs sound.

An interesting statement about men and machines is the following from Leonardo Sarao-president and general manager:

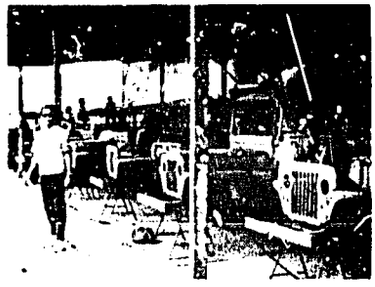
"Recently a Japanese equipment manufacturer tried to convince me to mechanize some of my operations. He offered to sell me a press for 200,000peso (about $-50,000 in 1969) and a sheet bender for 100,000peso. These two pieces would perform most of the work required to make a fender, grill, steel top, cowling flooring and engine cover. I could probably reduce my labor force by about 100 men with that equipment, but I do not want to lay them off. This would cause too many headaches. My entire labor force would resent this kind of lay off. I have never laid people off before. I do not want borrow either, to buy the equipment. I want to sleep at night. Suppose the machine breaks down? My entire operation would come to a halt. I could not rehire the skilled men I would have laid off. They would already be working somewhat else. Skilled workers are scarce. To be certain that I could produce constantly, I would have to buy two of each piece of equipment, a regular and a spare! No, the only time that I may purchase this kind of equipment will be if I am forced to expand in the future. Then I will consider it…"



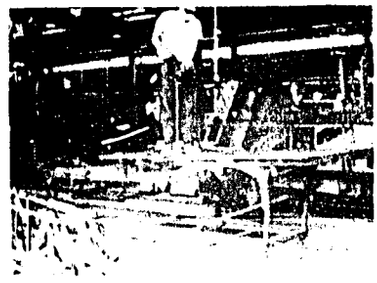
Sheet metal forming of the fender is done by a unique forming process. It is actually a mechanical adaptation of hammer and dolly. Reciprocating motion of the hammer is by cam action, and hammering force is controlled by an adjustable compression spring on the dolly side. The technique improves smoothness of curved sections and eliminates pre-forming operations by cutting and welding. The machine is also used to form the jeepney roof.



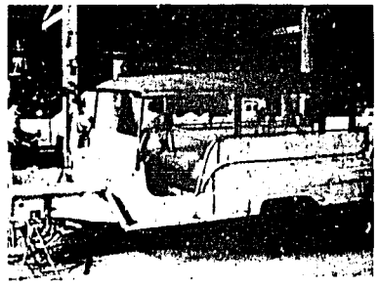
As soon as the jeepney parts have been formed, they are loaded into an open cart preparatory to assembly to the chassis. Notice the wheels on one side running on a channel rail which guides the cart through the assembly line. This cart always moves with the assembled chassis which is also running on another parallel rail. This procedure is followed because no two carts always contain identical parts due to differences in customer specifications.



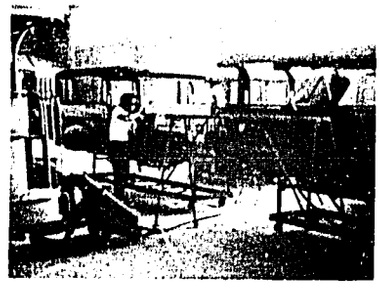
Ernesto Sarao, one of the Sarao Brothers, considered to be the most skilled worker in the company, is now in charge of body assembly. Close contact with the men is one of the major factors for the absence of labor disputes in the company. Inside the assembly area are about thirty jeepney bodies being simultaneously assembled. Welding comprises almost all assembly operations even for making holes. At the time of the photograph there were 30 jeeps on the stationary stands and 140 men working on them. It takes about three days for the assembly to be completed.



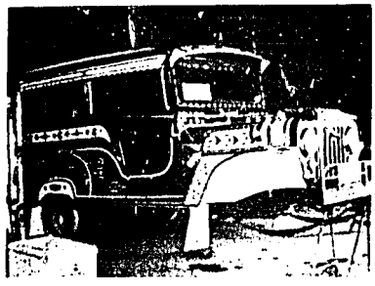
The floor is assembled on the chassis also by welding. The main floor beam structurally takes some of the load from the chassis. Because the chassis metal locally available is not of the same strength as that of imported ones, without this strengthening, the chassis may collapse at critical loads. The lateral distance between rear spring brackets have been increased by relocating the brackets outside the chassis instead of under. This modification regains the lateral stability lost as a consequence of increasing the wheelbase.



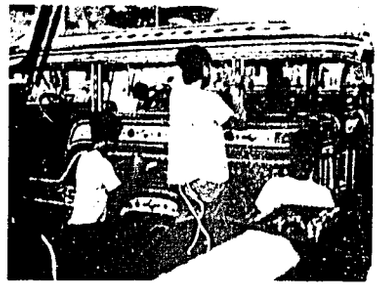
The style of the jeepney may vary drastically from the usual product due to customer specifications. Note the rear fender of the jeepney shown above. Most of the special styling is patterned after American cars (tail lights of the original car are installed).



Body is assembled with hammer and dolly, minor adjustments are done to fit each part. At the time of this photograph there were about seven jeepneys along this line.



A finished jeepney body waiting for engine and undercarriage installation. The one shown above is the usual model. The deluxe models are more festive and elaborate. The styling also gives expression for customers individual taste preferences. This luxury which can be obtained at practically no extra cost is possible only in this type of production.



After a final body checking, the jeepney body is washed with chemicals and detergent. Body painting is done in an inclosure equipped with heater lamps. Then the final touches that give the jeepney its unique appearance are applied by painters who are given more or less a free rein.