An Application of Computer Graphics to Renewal Planning Process of Railway Station Plaza

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abstract : The study is to develop the flexible process for renewal planning of a railway station plaza. The concept of the rehabilitation of a limited space is especially necessary in Japan under the strict constraint of land acquisition. The process here is supported by Computer Graphics which help the convergence of various alternatives with much easier understandings to related people. The study concludes that the process is a soft process of urban planning orienting to manage the activities on a plaza, which is compared with conventional one, a hard process, orienting to expand the space itself.

1. Introduction

Inefficiency or deficiency of the usage on the plaza of a railway station especially in the suburbs of Tokyo has been seen due to the excessive population growth more than that of expected of the hinterland. The plaza functions as a following space: for commuters who take K&Rs,buses, bicycles and their own feet, for bus berths, taxi bays and bicycle parking, for vehicles that are passed through or parked and for visitors who enjoy shopping or playing pachinco games around the plaza. Larger and largêr numbers of those demands increase, more and more the renewal planning will be necessitated.

Conventional concept of the planning in Japan has been simply to enlarge the space itself since the War Damage Rehabilitation Project(1). In this context, three guidelines with regard to the minimum area (m^2) of a required space were proposed on the basis of the number of railway passengers. These guidelines in Japan are referred as 1953 Model, Konami Model and 1973 Model respectively, which have been applied to a lot of actual planning up to now(2).

On the other hand, land acquisition for the enlargement is not so easy in Japan

especially in a highly urbanized area including the station plaza. Therefore, implementation of urban planning techniques such as urban redevelopment planning is suggested to produce some additional public space. This, however, takes usually so long time to be realized, because the consensus among various bodies who relate directly to their interests and losses is very difficult or sometimes almost impossible. Such physical planning, which definitely intends to promote drastic land use change, needs to require some additional lands with extreme difficulty.

It is important, hence, to manage behavior of various users on the plaza without any enlargement of the space. The guidelines mentioned above, which may be too old, do not describe this kind of behavioral characteristics[3][4][5]. The other urban planning methods simply take into account of the static volume[6][7] without consideration of the dynamic aspect. This study aims to newly develop the management oriented concept of planning process with the help of Computer Graphics (hereinafter CG). In other words, it focusses on renewal planning based on the rearrangement of facilities on the plaza under the sever constraint of the space.

2. Shin-Matsudo Station Plaza

2.1 State of the art of the Plaza

On the occasion of the development of a new method, Shin-Matsudo Station Plaza is selected as a typical example of the renewal planning. Fig.-1 shows the geographical relation between Shin-Matsudo and whole Tokyo Metropolitan Area (TMA). Shin-Matsudo is located around 20 Kms to the north east from Ootemachi where is one of CBDs of the TMA. Shin-Matsudo area was developed as a new residential town in the late of 1970s. After opening the railway station, population growth started from 1978 with annual rate of about 5,000 dwellers initially. The total number of the population at present counts around 50,000.

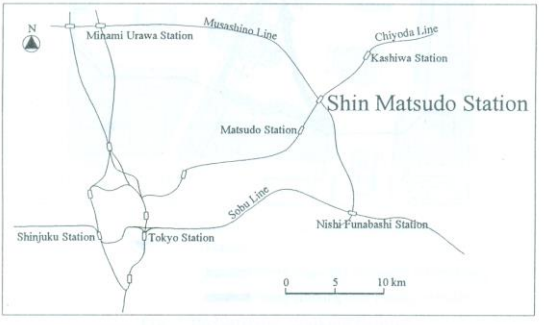

Fig.-1 Geographical Location of Shin-Matsudo

Fig.-2 displays present physical situation of the Plaza. The JR Chiyoda Line runs to the east and west on the 2nd floor level, and the JR Musashino Line to the north and south on the 4th level. The station is located on the crossing of both Lines. The Plaza, which is divided into 2 zones (north and south) by the elevated Musashino Line, occupies the area of 7,900 m²s spreading to the west from the station. Taxi bay is located on the north zone and bus berth on the south. 4 lanes road passes through the Plaza, of which half with 2 lanes from the north to the south faces on the east edge of the Plaza. Another half from the south to the north which is not adjacent to the other one faces on the west edge. Facilities for pedestrian exclusive use are supplied not only on the fringe of the Plaza but also under the elevated railway like an island surrounded by the above isolated roads.

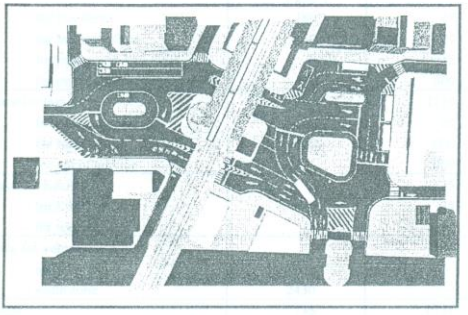

Fig.-2 Present Station Plaza

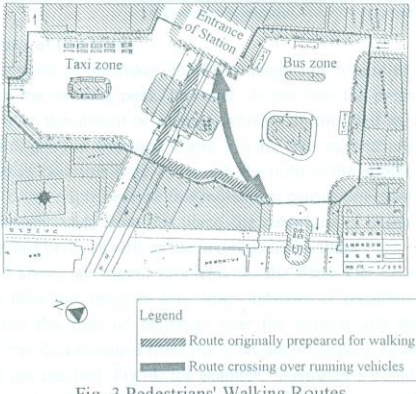

Fig.-3 Pedestrians' Walking Routes

71,000 passengers daily use the station excluding those who change between Lines here. A required space due to this figure is calculated as 8,514 m² of the 1953 Model and

5,854 m² of the Konami Model respectively. This means the whole space of the Plaza is satisfied according to the guidelines. The comparison of the state of the art with the Konami Model is shown in Table, which summarizes that the space for taxi and K&R is not sufficient but that for pedestrians is almost twice supplied.

Table Space of the Plaza

	Present Space (m²)	Konami Model (m²)
Space for pedestrian	1675	891
(for bus rider flow)	(250)	(75)
Space for bus	890	719
	(250)	
for bus berth	180	75
for bus rider flow	250	29
for passengers who wait	0	15
for out of service	460	600
Space for taxi	260	1220
for riding on and off	40	20
for waiting	220	600
for out of service		600
Space for K&R	0	635
for K&R	0	35
for waiting	–	600
Space for vehicle road		
north zone	2160	–
south zone	2430	–
Others	735	1037
Total	7900	5854 *

* Total area is estimated with 30% of redandancy

2.2 Urgent Problems of the Plaza

From the viewpoint of the space, the Plaza might not be said to have any problem. Most pedestrians in the morning peak, however, do not take the provided route for their walking, but cross over the stream of running vehicles on the road as shown in Fig.-3. In fact, during certain 5 minutes between 7 and 8 a.m., 246 pedestrians, 94% of the total orienting to the station take this way. Although the path is the shortest to the station, it must be said not to be desirable because this movement causes not only generation of delay but also traffic accidents. Aside from this place, the same kind of undesirable crossing over is observed near the bus berth as well as the taxi bay on the Plaza.

As mentioned above, all urgent problems on the Plaza can be said as this kind of mingling with each flow line more or less. Such behavior is recorded by the video tape recorder (VTR) from the roof of buildings near the station and the platform of the Musashino Line. After data obtained from the VTR are processed, some relations between different flow lines are clarified. Fig.-4, for example, illustrates a certain trade-off relation on the place shown in the Fig.-3, from which the indifferent curve is obtained. The upper curve corresponds to more than 30 times of stops forced of pedestrians and the lower does to less than 30 times respectively. This means that the same amount of delay (the number of stops forced of pedestrians) is indifferent on the same curve even in different

combination of the traffic volumes of pedestrians and vehicles (called as a marginal rate of substitution in economics).

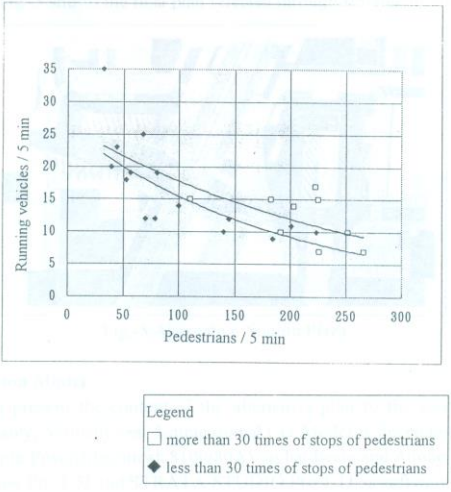

Fig.-4 Relation between Volume of Pedestrians and Vehicles

3. Preparation and Comparison of Alternative Plans

3.1 Alternatives and Factor Profile

Alternative plans without any expansion of the whole apace of the Plaza, are prepared under the concept of improvement of crossing over the running vehicles, i.e. creation of safer and more comfortable space for pedestrians. For this purpose, a round-le conference was organized consisting of the related bodies (railway, bus and taxi enterpriser, representative of inhabitants and local and national government officers) as members. Squeezing and refining several feasible alternatives through the discussion, some of them were summarized and proposed.

Before comparison of alternatives, the route choice behavior of pedestrians was analyzed and modelled in the reference(8). According to the model, even though the width of a side walk is imply expanded to 2 or 3 ms, around 20% of pedestrians change their route and more than 70% still keep the shortest path. This means only such simple expansion does not offer an appropriate solution.

Several important factors of each alternative plan such as the route choice result estimated by the abovementioned model, the trade-off relation estimated from the Fig.-4 and so on are quantified. These calculated scores of each factor are standardized from 100 (maximum) to 0 (minimum) and plotted by factor on a 2-dimensional plane (factor x score). A Factor Profile(9) is, then, obtained linking all plotted points by alternative. The

Factor Profile, not only enables visual comparison with each alternative and makes convergence to single alternative easy, but also involves expectation to find more advanced new alternative. Fig.-5 shows the final plan selected through aforementioned process.

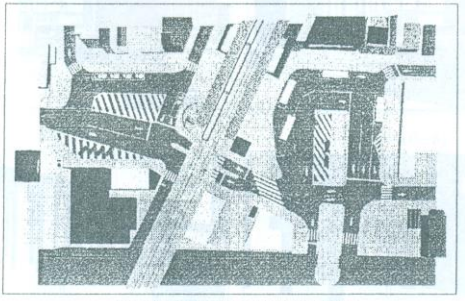

Fig.-5 Alternative Station Plaza

3.2 CG Animation Model

In order to present the content of the alternative plan to the related bodies much more understandably, Virtually real 3-dimensional CG Model is developed. The system is composed of Apple PowerMacintosh 8100/80AV as hardware and Adobe Photoshop 2.5J, CLARIS MacDraw Pro 1.5J and STRATA STUDIO Pro 1.1J as software[10].

Fig.-6 displays the whole scene of the alternative plan selected as a projection chart, and Fig.-7 illustrate time serial pedestrian movements going to the station. Thus, practical application of the CG animation as a tool of the planning process assists much deeper understandings of the result of comparison between alternative plans.

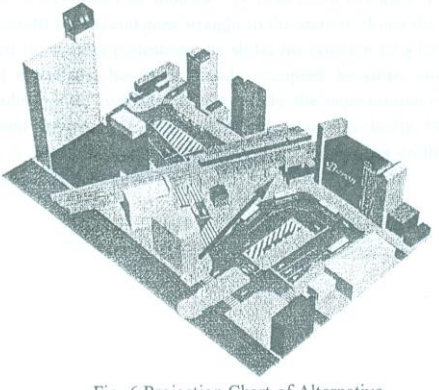

Fig.-6 Projection Chart of Alternative

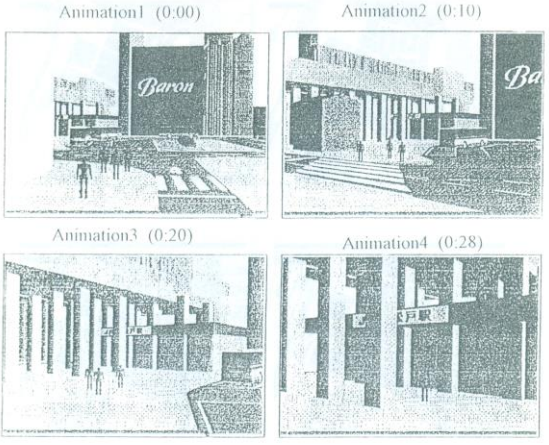

Fig.-7 Animation of Pedestrians for Alternative

4. Verification of Pedestrian Flow Line

4.1 Animation for Pedestrian Flow

It is necessary in each alternative plan to verify easily whether pedestrians change their route or not and how effectively improved in mingling with different flow lines. Therefore the pedestrian flow line is tried to be animated time serially, in which a route chosen by an individual pedestrian is estimated applying the model mentioned in 3.1. In this case, the routine which describes that a pedestrian avoid a collision with others or running vehicles is developed as follows : A pedestrian occupies a pixel on the screen (whole pixels are 640 x 480) and goes straight to the station. When the front pixel has been already occupied by another pedestrian, he shifts his position to a left or right side pixel. When the pixel either side has been already occupied, he stops and waits to the next sequence. Regarding to the avoidance with a vehicle, the same routine is applied in addition to pre-determined territory of the vehicle and relative velocity between vehicle and pedestrian. Fig.-8 displays time serial movement of pedestrians on the present Plaza (• mark represents each pedestrian in the Figure).

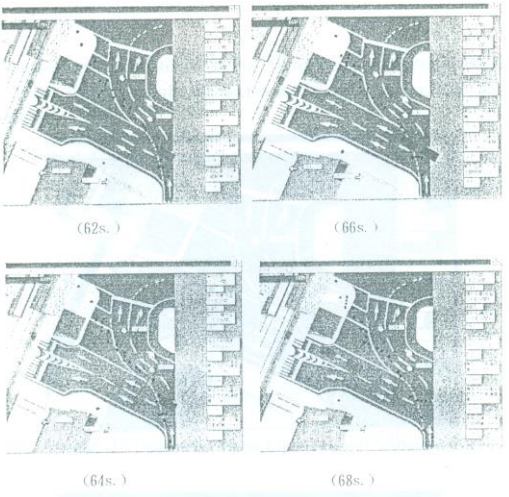

Fig.-8 Simulated Present Time Serial Movement of Pedestrians

4.2 Comparison of Pedestrian Flow Lines

The place in Fig.-3 is finally planed as shown Fig.-9. The alternative plan has following features :

(1) Expansion of side walk(①) : 3.65ms-----10ms
(2) Expansion of side walk(②) : 2.7ms------3.0ms
(3) Expansion of island(③) : 1.6ms------5.3ms
(4) The road reduces the lanes from 4 to 2 and is brought to the west edge of the Plaza.

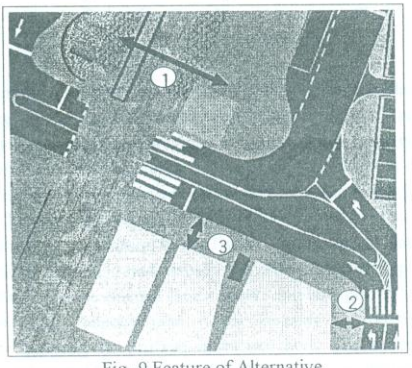

Fig.-9 Feature of Alternative

Pedestrian behavior is illustrated in Fig.-10 of the present Plaza and in Fig.-11 of the planned one. These Figures inform the decrease of illegal crossing over and more smooth running of vehicles.

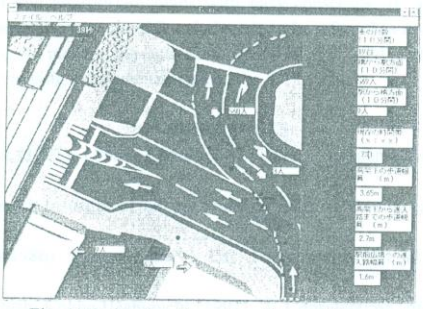

Fig.-10 Pedestrian Flow Line (Present Situation)

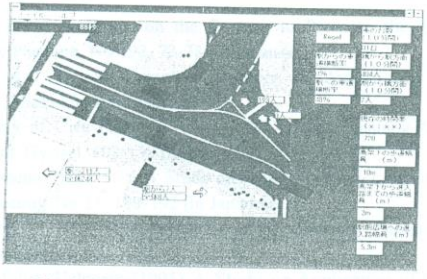

Fig.-11 Pedestrian Flow Line (Alternative Plan)

5. Conclusion

On the basis of the above process, a concrete planning for the Plaza of Shin-Matsudo station is now going on deriving much better rearrangement plan of facilities from various feasible alternatives. This study is proposing a new approach supported by CG techniques under the strong constraint regarding to the space, of which concept is completely different from the conventional one. The alternative plans corresponding to the place where mingling with different flow lines is seen near a bus berth and a taxi bay are also converged the same process of Factor Profiles. In addition to the Factor Profile, the advantage or disadvantage points of each alternative is illustrated visually ad understandable implicitly with the help of CG animation. Even if some external factor works and unexpected situation occurs after the implementation of the selected plan, it will be easy and possible to find another alternative plan by applying the process developed here. The process producing much better rearrangement plan enables trials corresponding to various changing situations, which

can be said as a flexible process. The time will come in the future when any trials reach to the limit and a large scale operation intending such as the implementation of an urban redevelopment plan is really necessary. Even so, the above experience will expect to establish smooth and appropriate plans with easy consensus. It is concluded that the flexible process supported by the CG technique is to be referred as a soft process of urban planning orienting to manage the activities, which is compared with a hard process of conventional of orienting to enlarge the space.

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