A

Petitioners trouble the Consul. He has realised that the ones who cause him most trouble are those who arrive early to be sure of beating the rush, so he wishes to make them wait the longest. He wishes also to deflect criticism of himself, personally, for this way of attending to their requests, by having an automatic scheduling mechanism built that can take the blame.

It will work like this… On arrival, the petitioners will be issued with a numbered card which they will feed through a reader at the entrance to the waiting room, to register with the system. As it turns out, many petitioners will fail to insert their card correctly, and will not register, so they will be forced to wait outside the waiting room forever. Their corpses will be removed by the consular staff. That, however, is not your concern. You must simply design a mechanism to deal with correctly registered arrivals. All petitioners must sit in the waiting room before they are ushered into the Consul’s presence. The waiting room has 30 seats. Petitioners will not be issued with a registration card if all the seats are full.

Your mechanism will be a piece of digital logic which receives a binary number from the reader, and stores it. When the Consul has dealt with the current petitioner, he will press the next button, and the most recent arrival’s registration number will be retrieved from the storage device and output to a display device (not your responsibility) which will display the number on a screen in the waiting room. Two guards will then verify that the number on the petitioner’s registration card matches the displayed number, and frog-march her or him into the Consul’s presence. The fate of petitioners whose registration card does not match the number displayed, but who claim to be next in line, is not a pleasant one.

The next time the Consul presses a button, the number of the most recent arrival of those who are in the waiting room (which might be someone who has arrived in the meantime) is retrieved from the storage mechanism and displayed.

You don’t have to worry about reading the numbers or displaying them. Your device only needs to input a binary number, when the control signal load is made true, and output the most recently stored binary number when another control signal, unload, is made true. Your device should continue to output the number until the next time unload is pressed (irrespective of the whether or not load is pressed in the meantime).

B

Your system has now been installed and has worked satisfactorily for many years. However, over the years, the Consul has grown more conscientious about dealing with the cases that come before him – or possibly just slower - and the average length of time spent in the waiting room by petitioners has grown correspondingly longer.

At some point, when the average waiting time reached a critical value – social historians argue vehemently about the exact length of time, and have even gone to the extent of setting up experimental Consular Waiting Rooms, reproducing the interior decoration, furniture, even, in one extreme case, the distinctive and not unpleasant smell of the room, to replicate the waiting conditions exactly for their experimental petitioners – at that indeterminate point, a curious phenomenon occurred. The inhabitants began to develop ways of entertaining themselves and each other while they waited for their number to be displayed. By chance, some of the most long-term inhabitants were entertainers, desperate to leave their poor country and move to the Consul’s rich homeland. There were half a dozen members of a dance company, and several musicians who had brought their instruments with them in the childlike belief that they would obtain a visa immediately. There was a jazz guitarist, a harmonica player, a cellist and an opera singer or two. There was also a drummer, who had some sticks and brushes. He had no drums, but when requested he was happy to play the chair, when an empty one was available. Aside from the opera singers, most of them could perform fairly quietly, which, in the closed confines of the waiting room, was beneficial. Also, the Consul was thought to be sensitive to loud noises, and the petitioners did not wish to upset him.

From such disparate elements, and under the pressure of necessity, a subtle new form of music began to crystallise in this isolated crucible, part jazz, part gypsy-inspired violin, part blues, with a hint of Verdi from when the opera singers were allowed to contribute. Although subdued, it was of a rhythmic and sensuous nature, and very suitable as an accompaniment for dancing. So, while they waited, the petitioners played music and danced. Sometimes the Consul watched through a one-way-mirror from the guards’ office, which slowed matters even more.
Word of the musical waiting room spread through the country. The professor of musicology of the best university in the country, passing through, one day – he was a late arrival, and his request for a visa was dealt with quickly, to his subsequent dismay, for later developments prevented his ever regaining entry to the waiting room – experienced this new music, and on his return, wrote about it in terms of the highest praise. His approval popularised the artform, for though poor, the country valued education, and took note of what professors had to say.

People began to invent reasons for requesting visas, simply to hear the music and see the dance. The Consul was unaware of this, for he did not speak the language of the country, and was unaware of most local news. After a period, the population of the waiting room stabilised. There were 10 artists, the artisti, more or less permanently in residence, who had given up almost all hope of obtaining their visas, and spent two hours a day performing, and three hours practising new material. There were 15 people, the privilegi, present to experience and occasionally participate in the new artform. They kept their registration cards for a period of days, sometimes weeks, and then handed them on, as a precious item, to another devotee of the artform. Sometimes they would arrange to have the card returned to them after a period, so that they could witness a new work. The remaining 5 places were reserved for genuine visa applicants, the peripateti. When there were no genuine peripateti, professional peripateti were paid to apply for, and use, visas, so that the performers and their audience would not come to the top of the stack, and be required to leave the country (for once the Consul had issued a visa, it had to be used, or the applicant’s potplants would mysteriously disappear, the brakes on the applicant’s car would fail or the applicant would develop a strange affliction characterised by a broken leg, or legs). Occasionally the system of employing professional peripateti collapsed, and a member of the artisti or the privilegi would be forced to leave the waiting room and the country. There was always great disruption when this happened, and especially when it was a member of the artisti who had been lost, a difficult period till a new member was brought in or the reduced company settled into an equilibrium.

At the present time, a new and complex dance, the Central City Dance, which glorifies the lot of the inhabitants of a large city, such as the capital city of the Consul’s country (many of the dances and musical construction have themes from the Consul’s country – the artists have not completely forgotten their original purpose, and, against all evidence, believe that glorifying the Consul’s country may help their cause) is being worked out. There are many components to this dance, which lasts for two hours, and you have been asked to help with one. This is the intersection interaction, which occurs at many times during the two-hour period. In this interaction, two groups of dancers each follow a predetermined path. Members of the privilegi, who are of course not professional dancers and are only capable of quite simple movements, travel rapidly along one path with arms linked, in groups of two or three, to represent cars. Members of the artisti, representing pedestrians, perform more complex movements as they travel along the other path. The two paths intersect at right angles. Because the music used in the waiting room is mainly quiet, the choreographer has elected to use visible signals to control movement through the intersection.

Normally the privilegi may pass straight through this intersection. The privilegi can tell that their passage through the intersection is allowed because they can see a green light, Gp.

Members of the artisti press a button when they reach the intersection, and the Gp turns off within two seconds, to be replaced by an amber light Ap. Four seconds thereafter, Ap turns off, and a red light, Rp, turns on. At that moment, Ra another red light, which has been visible to the artisti waiting at the intersection turns off, and Ga a green light turns on. Ga remains on for 6 seconds, and is followed by Ra and Gp.

Design an ASM (chart, transition table, circuit diagram) to control the lights. Choose (and specify) a clock speed that will make the system work simply. You may assume that all input signals and output signals conform to digital logic conventions.

Paul Lyons
Based very loosely on The Consul
With apologies to Gian-Carlo Menotti