Pedestrian Movement at the 1980 Winter Olympics Ski Jump

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This paper describes and evaluates options for the location of bus staging areas and the movement of pedestrians between bus staging areas and the Intervalle ski jump site at the 1980 Winter Olympic Games at Lake Placid, New York. These options are analyzed in terms of impacts on the environment, spectators walking under winter conditions, traffic flow and accidents, cost, maintenance, and post-Olympic implementation considerations. A comparative analysis is made of these impacts on each of four options for pedestrian flow. Results show that either a pedestrian bridge or signal across the main route appears superior, because it minimizes pedestrian-vehicle conflicts, separates spectators from dignitaries and officials, and consolidates bus staging activities in a single adequately sized location. Options that assume joint use of the road by vehicles and pedestrians should be avoided because of the crucial requirement for maximum road capacity to handle bus circulation.

Lake Placid, a small community in the Adirondacks of upstate New York, will be the site of the 1980 Winter Olympic Games. It is located approximately 140 km south of Montreal and 400 km north of New York City (Figure 1). Highway access to Lake Placid is limited to two routes: NY-86 and NY-73. Because of significant capacity and flow problems anticipated from the planned daily influx of spectators, a 450-bus circulation system feeding peripheral parking lots has been proposed as the basic spectator transportation system for the games (1).

The Intervalle ski jump, the site of the 70- and 90-meter ski jump competitions, is located at the point where NY-73 crosses the west branch of the Ausable River (Figure 2). Estimated peak periods of use of the facility...
Figure 1. Olympic transportation region.

Figure 2. Olympic primary area.
Figure 3. Options for pedestrian movement.

The ski jump site is bordered by the Ausable River on the east, NY-73 on the north, and steep ridges on the south (Figure 3). The spectator area at the base of the jump is about 212 x 60 m. Since adequate space does not exist for the loading and unloading of spectators at the immediate site, it will be necessary for spectators to move on foot between bus staging areas and the ski jump site. At peak periods this will involve the flow of 15,000 pedestrians within a desired time period of 1.5 h, or at a rate of 10,000 pedestrians/h.

ISSUES

The issues involved in the implementation of a pedestrian system at Intervale can best be made clear through a discussion of the impacts that fall into each issue category. Thus each issue will be broken down into individual impacts.

Environmental

As stated by the Olympic Transportation Committee, all transportation work and development must be performed with an extreme sensitivity to environmental impacts (1). Although the site-related impacts at Intervale that fall into this category are not great, they must be considered in order to gain an environmental perspective of the pedestrian options. The impacts of the environmental category are explained below.

1. Trees, shrubs—This involves the degree to which implementation of an option (say, by widening a pedestrian path) would necessitate the removal of surrounding trees and shrubs.
2. Salt, sand—The degree to which salt or sand will be needed to properly maintain the road and walkways and the resulting average walking rates from such maintenance.
3. Staging areas—The number of and total area of staging areas used in each option. The less area used and maintained, the less the environmental impact. Different staging area options also differ in impact.

Walking

The conditions of the walk pedestrians must undertake between spectator facilities and the bus staging areas constitute the second issue. Harsh winter weather conditions of mid-February could severely jeopardize the proper functioning of the pedestrian system. The average February temperature is -6°C, and temperatures of -26°C occur nearly every February. It is speculated, however, that the colder temperatures will have little
significant effect on average walking speeds. Average
February snowfall is 0.5 m; the seasonal average is
2.8 m (1). It is also assumed that proper maintenance
of the pedestrian system will keep it free of snow and
ice obstacles, which would decrease system capacity
and pedestrian speed. The impacts included in the
walking category are explained below.

1. Distance—The distance each pedestrian must
walk between the Intervale and spectator facilities and
the bus staging areas.

2. Capacity—The walking area available for each
system. The options using NY-73 as pedestrian access
will encounter slope difficulties on a walk between
Intervale and the bus staging areas.

3. Slope—The relative degree to which a pedestrian
will encounter slope difficulties on a walk between
Intervale and the bus staging areas.

4. Pedestrian walking speed—The average pedes-
trian walking speed is dependent on the area available
to each pedestrian, termed the module. A high
speed is desirable.

5. Pedestrian delays—The delay caused to pedes-
trians by stops at signals located at crosswalks.

6. Pedestrian safety—The relative degree of safety
to pedestrians on the different systems, taking account
of use of NY-73 by both pedestrians (along or crossing)
and vehicular traffic.

7. Bus Loading—The degree to which bus loading
facilities and ease of pedestrian loading can be sited
and arranged.

Traffic Flow on NY-73

The use of NY-73 for access to Intervale by pedestrians
or the crossing of NY-73 by pedestrians will cause sig-
nificant delays to bus traffic along NY-73 as well as
impede official and emergency vehicle access to the
ski jump site. For these reasons, options that use
the road as a walkway may not be feasible.

1. Vehicle delay—The delay caused to vehicular
traffic on NY-73 by signals located at pedestrian cross-
walks or by pedestrian use of the road itself.

2. Emergency access—The degree of access and speed
at which emergency vehicles can enter the Intervale area,
given pedestrian and vehicular queuing at or near the site.

Cost

The relative construction and maintenance costs of pedes-
trian access systems must be considered.

Post-Olympic Use

The impact of permanence is considered as well as the
use of a system in the post-Olympic period by 5000
spectators.

1. Permanence—The degree to which components of
each option will remain after the games and continue to
produce impacts, environmental and otherwise.

2. Use of existing facilities—The degree to which
existing facilities at or near the Intervale site are used
(NY-73, existing Intervale entrance).

3. Post-Olympic usage—The degree to which a
facility will be used for expected post-Olympic flow
volumes (5000 spectators) and to what degree any
changes will be necessary.

Maintenance

Since it is assumed that the pedestrian system will be
properly maintained in order to ensure planned capacity
and flow rates and the highest degree of safety possible,
a comparison of how much maintenance each option would
require is made. Degree of need is the amount of
maintenance necessary to prevent pedestrian obstacles
from snow and ice, which would reduce capacity and
average walking rates.

OPTIONS

Four options exist as to where the buses will unload the
15,000 spectators who will attend the ski jump events.
Each option is comprised of several components, some
of which are unique to a specific system, others super-
pose in two or more of the options (Table 1 and Figure 3).

Over the Road and Through the Woods

Option 1 entails a bus staging area located at the Horse
Show Grounds (HSG) north and upgrade of the Intervale
site. The three components of this system are the
staging area, the pedestrian bridge over NY-73 with
stairway access 5.5 m wide, and the path through the
woods.

The HSG is located on the opposite side of NY-73 from
Intervale; approximately 360 m separates their entrances
along NY-73. In this option, a pedestrian bridge over
NY-73 would provide access to HSG. Assuming that the
pedestrians enter the system at a flow rate of 10,000/h
or 167/s, and the system will operate at a level of
service D, as defined by Fruin (5), the stairway that
connects ground level to the above-grade crossing will
need to be about 5.5 m wide. The shortage of space
would render a stairway access more feasible than ramp
access, but ramps would permit easy light-truck
maintenance.

Across the Road and Through the Woods

Option 2 also makes use of the HSG as a bus staging
area and a path through the woods to provide access to
Intervale. However, pedestrians would cross the road
on a crosswalk, rather than on a bridge. A signal system
and perhaps a warming shelter and traffic control people
would be necessary to allow pedestrians to cross the
road, and a pedestrian queuing area will be necessary
on each end of the crosswalk. The queuing area will
have to provide each pedestrian with 2.1 m² of area,
given a level of service D. Since 2.78 pedestrians/s
will be entering the queuing area, a queuing area of
5.8 m²/s of pedestrian delay will be needed.

Down the Road

Option 3 makes use of NY-73 for pedestrian flow between
the Intervale site and the bus staging area, again located
at HSG. The width of NY-73 at this point (two lanes plus
two shoulders) is 8.5 m (6). Therefore, one lane plus one
shoulder (4.25 m) could easily handle a flow of 10,000
pedestrians/h.

This option may be broken into two options for east-
side and westside use of NY-73. A double signal system
will also be necessary to allow pedestrians to cross one
of the lanes to keep the lane used by the pedestrians clear
of traffic during the critical period. Even with such pre-
cautions, impacts on traffic flow would be high, as would
be impacts on pedestrian safety. Because of the long
length of the walkway and stragglers, NY-73 would have
to be closed to traffic for significant periods.
Table 1. Components of options.

<table>
<thead>
<tr>
<th>Option</th>
<th>Pedestrian Bridge Over NY-73</th>
<th>HSG Staging Area</th>
<th>Lower Staging Area</th>
<th>Path Through Woods</th>
<th>Pedestrian Traffic Conflict For Use on NY-73</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Over the road</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>2. Across the road</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
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<tr>
<td>3a. Down the road (east-side)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>3b. Down the road (west-side)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>4a. Across the bridge (east-side)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>4b. Across the bridge (west-side)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

*Two crosswalks required. *Conflict along NY-73.

Table 2. Comparative analysis.

<table>
<thead>
<tr>
<th>Impact</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
<th>Option 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental</td>
<td>4 4 10 10</td>
<td>5 5 2 2</td>
<td>8 8 8 8</td>
<td>8 8 8 8</td>
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<tr>
<td>Pedestrian bridge</td>
<td>5 6 7 7</td>
<td>5 6 7 7</td>
<td>5 6 7 7</td>
<td>5 6 7 7</td>
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<td>Pedestrian delay</td>
<td>10 5 6 6</td>
<td>10 5 6 6</td>
<td>10 5 6 6</td>
<td>10 5 6 6</td>
</tr>
<tr>
<td>Pedestrian safety</td>
<td>10 8 1 1</td>
<td>10 8 1 1</td>
<td>10 8 1 1</td>
<td>10 8 1 1</td>
</tr>
<tr>
<td>Average</td>
<td>5.7 5.7 6.7 6.7</td>
<td>5.7 5.7 6.7 6.7</td>
<td>5.7 5.7 6.7 6.7</td>
<td>5.7 5.7 6.7 6.7</td>
</tr>
<tr>
<td>Walking</td>
<td>6.8 6.0 5.8 5.8</td>
<td>6.5 6.5 6.5 6.5</td>
<td>6.5 6.5 6.5 6.5</td>
<td>6.5 6.5 6.5 6.5</td>
</tr>
<tr>
<td>Traffic on NY-73</td>
<td>10 8 1 1</td>
<td>10 8 1 1</td>
<td>10 8 1 1</td>
<td>10 8 1 1</td>
</tr>
<tr>
<td>Emergency access</td>
<td>10 9 2 2</td>
<td>10 9 2 2</td>
<td>10 9 2 2</td>
<td>10 9 2 2</td>
</tr>
<tr>
<td>Average</td>
<td>10.0 8.5 1.5 1.5</td>
<td>10.0 8.5 1.5 1.5</td>
<td>10.0 8.5 1.5 1.5</td>
<td>10.0 8.5 1.5 1.5</td>
</tr>
<tr>
<td>Cost</td>
<td>2 2 5 5</td>
<td>3 3 4 4</td>
<td>5 5 6 6</td>
<td>7 7 8 8</td>
</tr>
<tr>
<td>Construction</td>
<td>5 5 6 6</td>
<td>3 3 4 4</td>
<td>5 5 6 6</td>
<td>3 3 4 4</td>
</tr>
<tr>
<td>Maintenance</td>
<td>3 3 4 4</td>
<td>5 5 6 6</td>
<td>7 7 8 8</td>
<td>7 7 8 8</td>
</tr>
<tr>
<td>Degree of need</td>
<td>3 3 4 4</td>
<td>5 5 6 6</td>
<td>7 7 8 8</td>
<td>7 7 8 8</td>
</tr>
<tr>
<td>Post-implementation permanent</td>
<td>3 3 4 4</td>
<td>5 5 6 6</td>
<td>7 7 8 8</td>
<td>7 7 8 8</td>
</tr>
<tr>
<td>Use of existing facilities</td>
<td>3 3 4 4</td>
<td>5 5 6 6</td>
<td>7 7 8 8</td>
<td>7 7 8 8</td>
</tr>
<tr>
<td>Post-Olympic use</td>
<td>3 3 4 4</td>
<td>5 5 6 6</td>
<td>7 7 8 8</td>
<td>7 7 8 8</td>
</tr>
<tr>
<td>Average</td>
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<td>3.0 4.0 7.1 7.1</td>
<td>3.0 4.0 7.1 7.1</td>
<td>3.0 4.0 7.1 7.1</td>
</tr>
</tbody>
</table>

Note: 0 = very high (negative) impact and 10 = very low (positive) impact.

Table 3. Comparative scores.

<table>
<thead>
<tr>
<th>Option</th>
<th>Score</th>
<th>Positive Impacts</th>
<th>Negative Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pedestrian bridge</td>
<td>95</td>
<td>Vehicle delay and pedestrian safety</td>
<td>Cost and post-Olympic use</td>
</tr>
<tr>
<td>2. Crosswalk</td>
<td>94</td>
<td>Vehicle delay and pedestrian safety</td>
<td>Maintenance and post-Olympic use</td>
</tr>
<tr>
<td>3. Down the road</td>
<td>10</td>
<td>Cost and post-Olympic use</td>
<td>Vehicle delay</td>
</tr>
<tr>
<td>4. Lower staging area</td>
<td>88</td>
<td>Cost, walking, post-Olympic use</td>
<td>Vehicle delay</td>
</tr>
</tbody>
</table>

Across the River

The river referred to here is the Ausable River, just below the Intervale entrance. Option 4 also makes use of NY-73 as pedestrian access to the Intervale entrance, but from the south direction. This option is also broken down into two options for eastside and westside use of NY-73. The staging area is located approximately 180 m south of the Intervale entrance, on the opposite side of NY-73. The two options also necessitate a double signal system to allow pedestrians to cross one of the lanes and to keep the lane used by pedestrians clear of traffic during the critical period. As above, traffic impacts are high. The proposed staging area is steeper, smaller, and generally less accessible than the HSG area.

ANALYSIS AND CONCLUSION

The analysis of the different options must begin with a statement of assumptions to be made about the options and the situations each option is designed to handle. The assumptions made are as follows:

1. Pedestrians will enter the system from buses at a rate of 10000/h or 167/min.
2. There will be little or no reverse traffic flow during high-volume periods. Pedestrian flow entering Intervale at the beginning of an event and leaving Intervale at the end of an event will be one directional. During the event, however, two-directional flow will occur.
3. There will be no pedestrian cross-conflicts or interference between pedestrians and vehicular flow, except when pedestrians cross or walk on NY-73.
4. A minimum number of handicapped persons will be in the flow.
5. Pedestrians in the flow will carry only lightweight, hand-carried items of small bulk.
6. An exercise of control in the form of signs and barriers will ensure orderly flow.
7. There is an assumed dead width of 0.3 m on each side of a pedestrian walkway and of 0.15 m on stairways to account for railings and containment barriers. Therefore, the net effective width will be assumed to be equal to the gross width minus 0.6 m on the pedestrian walkway and gross width minus 0.3 m on stairways.
8. Flow will be steady and even, with no mini-peaks (except where caused by signaling).
9. Isolated signaling is assumed, except for the interconnected signals for use of NY-73 as a pathway.
10. The signaling at pedestrian crosswalks would be activated only for the 1.5-h critical periods, and then would follow a preplanned pattern. However, it should be able to be activated for individual crossing during a noncritical period.
11. There will be proper maintenance of the system so walking speeds and system capacity will not be decreased.