Innovative CAD-based application for parking lot design

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ABSTRACT

A good parking lot design practice is as much an art as it is science. The design of larger parking lots is often a tedious and highly iterative process. Further, in most situations, the stall count for a parking facility is never fully known until the final layout is actually completed. Over the years' parking lot designers have migrated from rough hand sketching to using CAD blocks to layout parking concepts. For several years now, CAD applications have played a major role in advancing, simplifying, and developing cost-effective transportation design practices.

This technical paper describes an innovative approach to designing parking lots and the benefits that one can derive especially when dealing with larger projects. This new approach takes advantage of the inherent power of CAD to semi-automatically develop parking layouts in considerably less time and with potentially more accuracy than other traditional design methods.

The proposed approach comprises of:

- Applying predefined parking layout dimension standards to application design parameters based on turnover and user characteristics
- Automatically generating layout options with various stall configurations, stall sizes, and circulation patterns founded on predefined layout construction lines and physical parking lot constraints
- Using intelligent parking lot objects where the application provides an instant stall tally allowing for more effective evaluation of layout alternatives

Because the application develops parking modules instantaneously, changes to the "predefined layout construction lines" means changes to the parking lot can be made just as quickly.

This new design approach demonstrates similar benefits to parking lot designers that roadway and other civil designers have benefited from – those being the ability of producing comprehensive parking layout options quickly and accurately.

PROJECT

Site Background and Location

This study highlights how an innovative CAD-based application can quickly creating the various parking layout configurations. The study compares the estimated time to complete these layout configurations using the application versus completing the same layouts using manual methods in conjunction with basic CAD tools. The existing short term parking facility (Figure 1) adjoining the YVR terminal building, has been used to demonstrate this application and the time comparisons.

Figure 1 – Aerial view of the parking lot

Shield by access roadways, the current parking layout is approximately eight years old and has been modified continuously since that time. The existing parking supply is approximately 1400 and the facility serves as a short-term parking area. The parking lot is constrained (Figure 2) by the following:

- the external vehicle circulation, the entry and exit points
- the central pedestrian walkway that facilitate pedestrian access
- concrete barriers
- mass lighting structures
- a sewer pump station, and
- specified staff parking areas

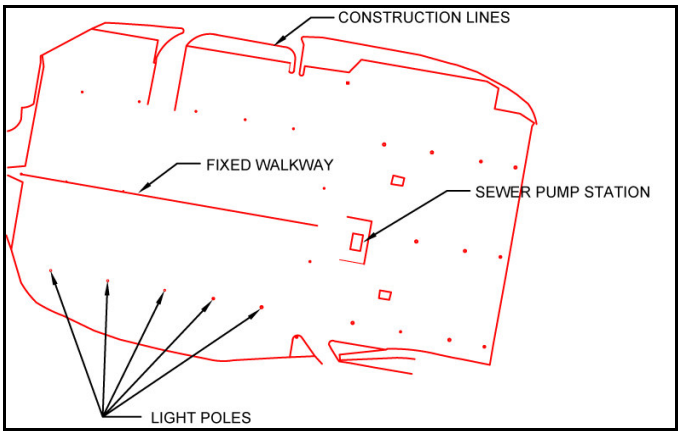

Figure 2 - Parking Lot Constraints

Layout Options

Given these project constraints and required parking geometric guidelines, Two parking arrangements were studied - Options A and B as described below:

- Option “A” (Figure 3) has been designated to utilize existing two-way traffic flow into normal angled parking spaces and maintains the current parking row arrangements. As such the current parking capacity, vehicular circulation and pedestrian flow remain unchanged.

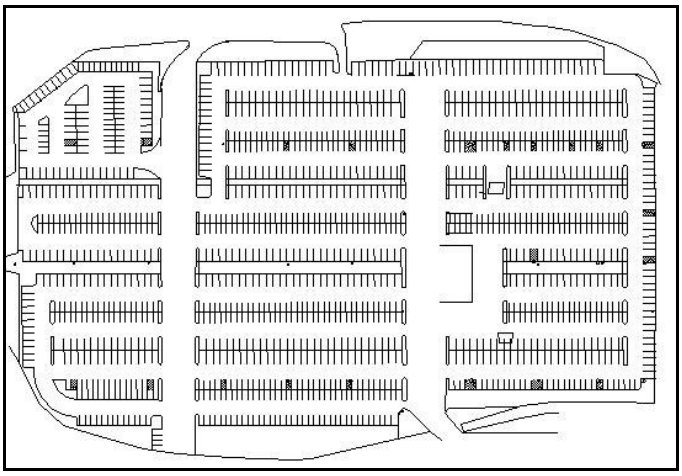

Figure 3 – Parking Layout “Option A”

- Option “B” (Figure 4) consisting of a complete re-orientation of the parking row arrangements. In this configuration pedestrian access has been enhanced by orienteering it towards the existing central pedestrian corridor.

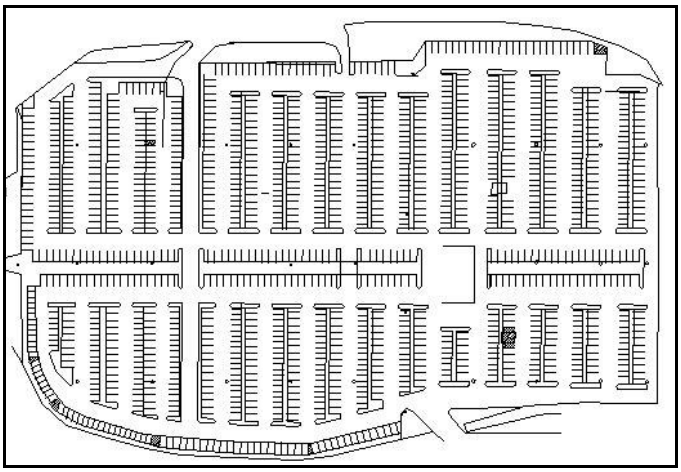

Figure 4 – Parking Layout “Option B”

In this study, the design parking layout options are developed solely for the purpose of comparing two design methods; the traditional manual/CAD-based method and the innovative CAD-based application. This ensures that the two layout options produced by the two different design approaches are consistent in form and hence the time to develop the design remains the primary variable. No preference is being made for any option.

PROJECT DEVELOPMENT

A concept plan for both design layout options was developed by a senior designer which provided the necessary layout configuration consisting of the six sub-lot configurations for the Option A (Figure 5), and the four sub-lot configurations for the Option B (Figure 6).

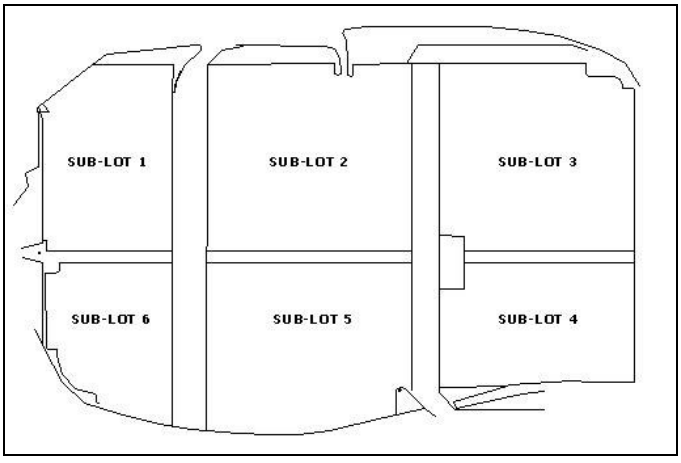

Figure 5 – Sub-lots for “Option A”

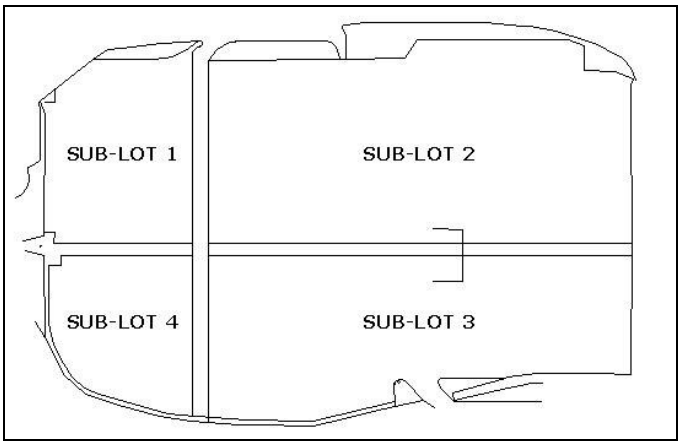

Figure 6 – Sub-lots for “Option B”

As the foundation for all surface parking layout designs begins with a review of the local parking ordinances and design standards, the designer based his concepts on the Institute of Transportation Engineers - ITE (1) and the Americans with Disabilities Act – ADA (2) guidelines. Based on these guidelines, each parking layout option has been prepared on tracing paper at a 1:500 scale. While the design options maintained all of the parking constraints noted previously, the designer adopted parking module dimensions associated with moderate turnover at airports.

Traditional CAD-based method

A consultant was retained to prepare both parking layout options according to the concept plans. Addressing the needs of two-way vehicle circulation, pedestrian flow and creating parking modules, the consultant utilized the traditional manual/CAD-based method to layout the parking configurations as proposed. This process involved using CAD drawing tools to prepare construction (boundary) lines for each sub-lot, and then within the sub-lots developed the parking stall arrangements through use of parking blocks etc with extensive “trimming” and editing chores until the final layout was established.

Innovative CAD-based application

Utilizing an innovative CAD-based application, an in-house designer developed the optional layouts using a similar but more automated approach built within the application. The following outlines the steps taken:

1. Utilizing standard CAD drawing tools, the designer established and placed the peripheral boundary of the parking lot

2. Based on the peripheral boundary, sub-divided the entire facility taking into account parking constrains, vehicular and pedestrian flow pattern

3. Utilizing specific CAD layer system, the designer assigned each boundary of sub-lots to a specified CAD drawing layer as required by this application indicating physical curbs, access and entrance points. By assigning the layers the CAD application determined if the sub-lot boundaries are crossable (e.g. painted drive aisles or entrance) or non-crossable (e.g. curbs or walls)

4. The designer selected the parking module layout dimensions from pre-set ITE guideline that are already built into the application. Based on the typical turnover and user classification, the following parking dimensions were used (the basic stall width of 8.5 feet; stall length of 18 feet; and aisle width of 26 feet)

5. As sketched on tracing paper, the designer generated parking rows within previously created sub-lot enclosed by boundary lines by simply:
    - selecting a point within each sub-lot
    - by rotating and moving the mouse, an infinite array of parking row arrangements was obtained
    - then placed the desirable sub-lot configuration by dragging the mouse until the desirable parking row arrangement was attained
    - afterwards reported the maximum capacity of the parking lot by simply selecting each sub-lot

In summary, Table 1 shows time required to create the parking layout design options for each development method where the numbers are typically rounded to the nearest minute.

	DESIGN TIME (MIN.)	
Layout method	Innovative CAD	Manual/Traditional CAD
Option A	48	190
Option B	54	194

Table 1 – Comparison of Design Time

PROJECT FINDINGS AND CONCLUSIONS

Both development approaches, the traditional manual/CAD-based method and the innovative CAD-based application, were limited to conceptual design layouts. In addition, both approaches would be subjected to additional design developments in order to produce detailed construction layouts.

The traditional manual/CAD-based method comprises of the following characteristics:

- Heavy emphasis on “construction (boundary)” lines is required to set parking modules and involves tedious drafting of parking stalls and parking islands, and frequent use of the CAD copying, offsetting, moving, and trimming features.

- Stall tallying is an intensively manual process, particular when dealing with non-uniform configurations
- Considerable referral to design standards

The design approach using the innovative CAD-based application entails:

- Minimal use of “construction boundary” lines
- Automatic stall module and stall drafting
- Built-in editing capability that automatically readjusts the design and stall counts
- additional editing capabilities also include the ability to locate specific parking stalls for the disable
- ease of reference to pre-stored design standards which minimized dimensional errors, and
- automatic stall tally

While ultimately the design layouts produced by both methods were similar, the times to develop the layouts were significant. In this area, the innovative CAD-based application clearly provided distinct advantages in speed and accuracy, producing as much as 75% time savings over the traditional manual/CAD-based method. These time savings can be enjoyed even during editing and alternative layout arrangements, for example studying “what if” scenario such as changing the parking layout from 90 degree stalls to 60 degree configurations.

REFERENCES

(1) ITE Technical Committee; Guidelines for Parking Facility Location and Design, Institute of Transportation Engineers, 1994
(2) U.S. Architectural and Transportation Barriers Compliance Board; Americans with Disabilities Act Accessibility Guidelines. Washington, DC: ATBCB, 1992