# Choosing An Automated People Mover

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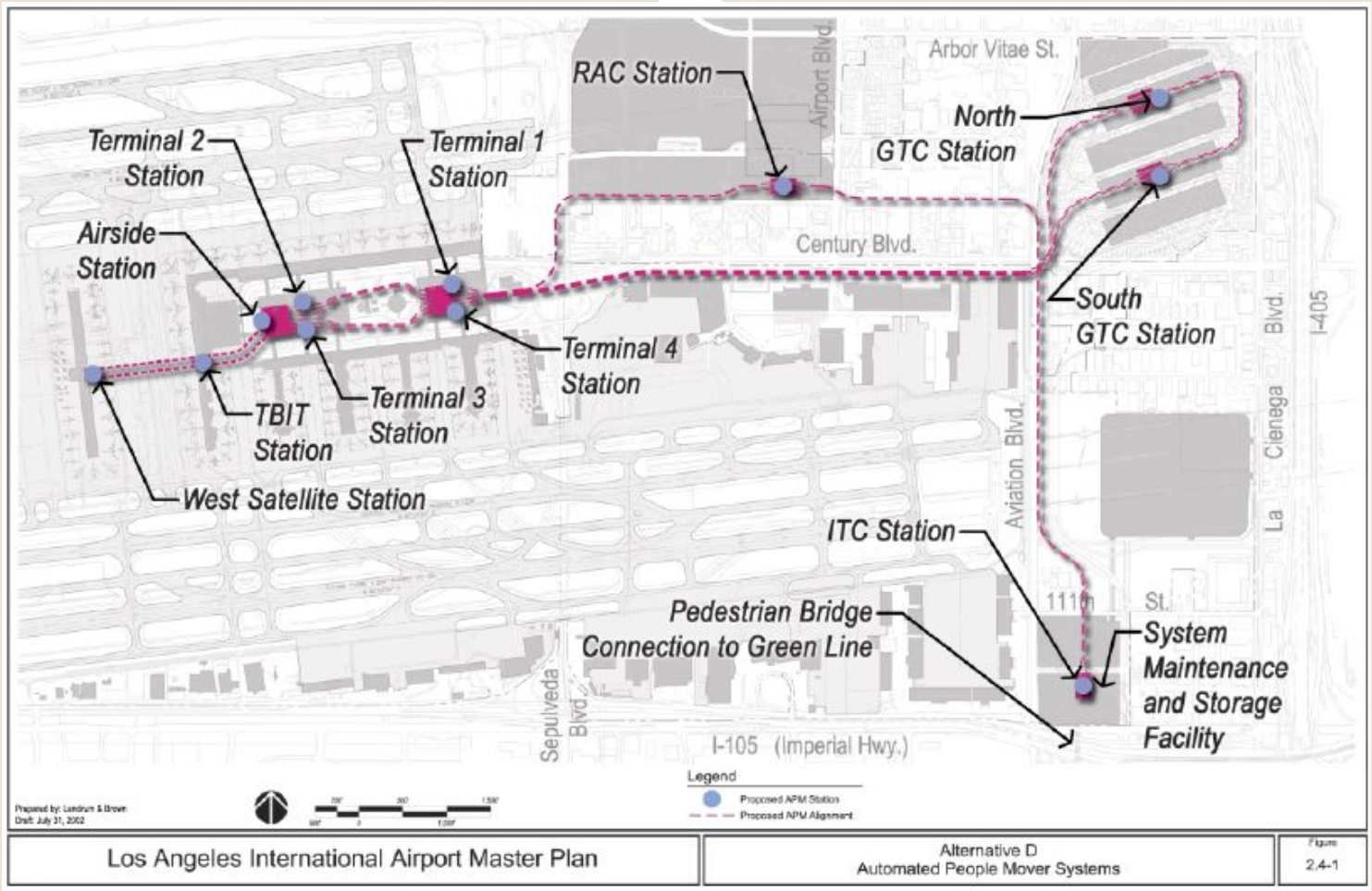
# Introduction

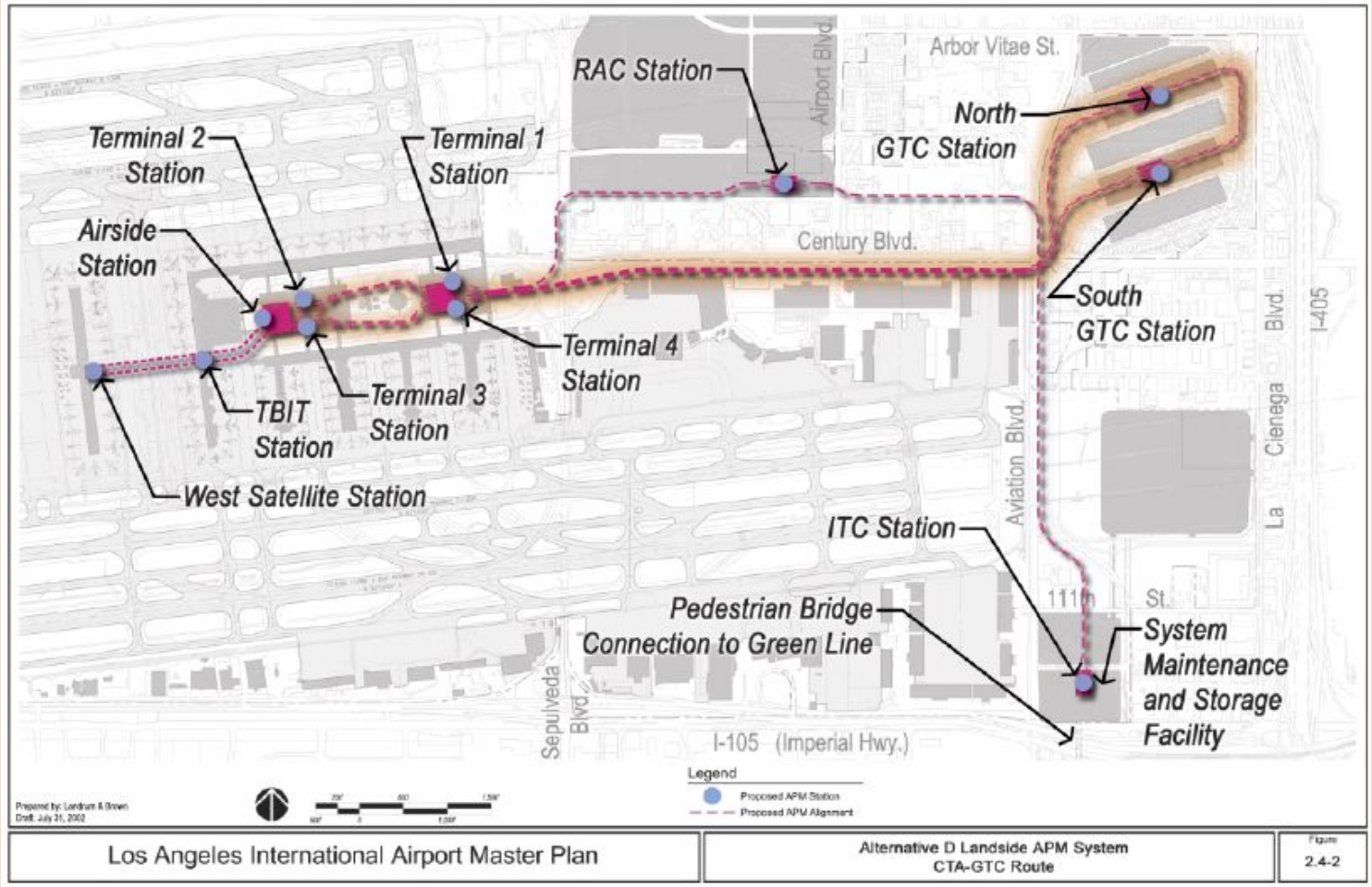
- Basics of the LAX APM system
- Why choose an APM over another system?
  - Mode Choice Model
- Flaws and Improvements
- Hong Kong International Airport Case Study
  - Factoring in passenger satisfaction
- How does the HKIA  case study affect LAX?

# LAX APM System




http://www.ourlax.org/docs/final_mp/013_MainDocument_Ch_2.04.pdf

# CTA – GTC Route

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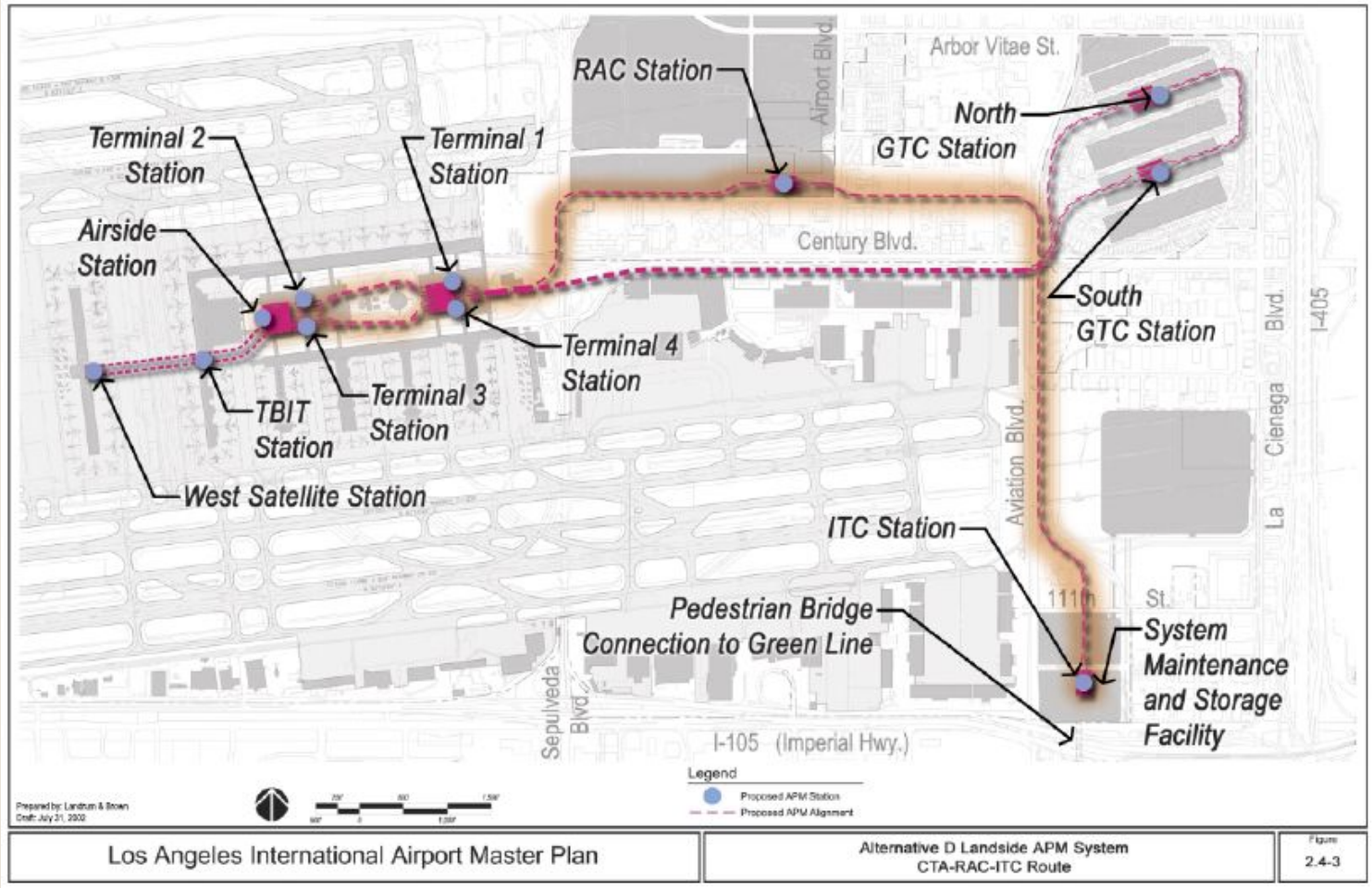
# CTA – RAC – ITC Route

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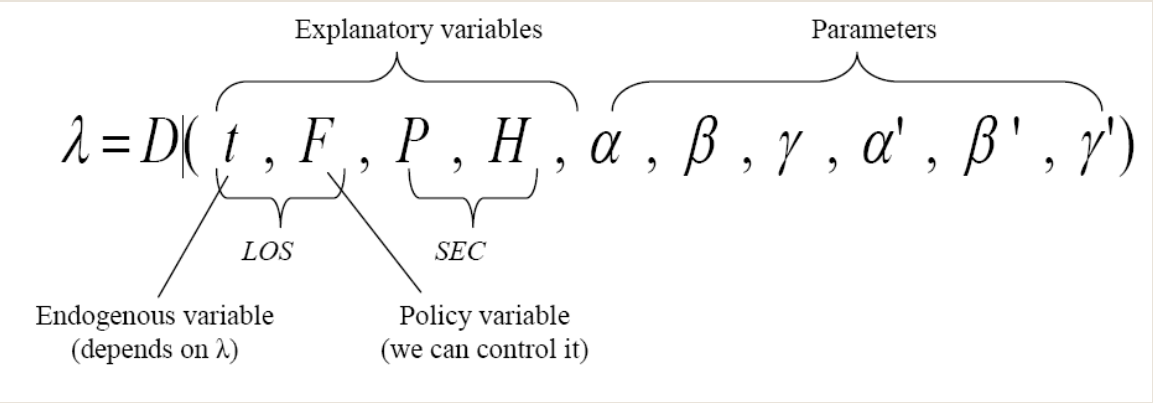
# Mode Choice Model

# How do you predict mode choice?

- Use of regression models are most common
- A regression model is a way to model the relationship between a dependent variable and explanatory variables




http://www.answers.com/topic/regression-analysis

# How do you make a regression model?

- Categorize Mode Choice Options
  Public Transit, Taxi, Private Vehicle, Other
- Focus on Specific Attributes of Users
  Income, Business vs. Vacation Travel
- Survey Users to Obtain Empirical Data
- Run Regression to Calculate Coefficients

# Types of Regression: Probit

- Pros
  - Outcome don't need to be binary
  - Good for moderate sized data sets
- Cons
  - May take longer to reach convergence
  - Assumes underlying distribution is normal

# Types of Regression: Logit

- Pros
  - Distribution doesn't need to be normal
  - Reach convergence quickly
- Cons
  - Tends to overestimate Beta coefficients in small to medium sized data sets
  - A minimum of ten events per independent variable is recommended.

http://www.ncbi.nlm.nih.gov/pubmed/8970487

# Issues with Linear Regression Models

- Dependent on parameters chosen
- Can get a "good fit" by adding excess parameters
- Assumes linear trend between variables
- Can be affected by outliers (Influential Observations)

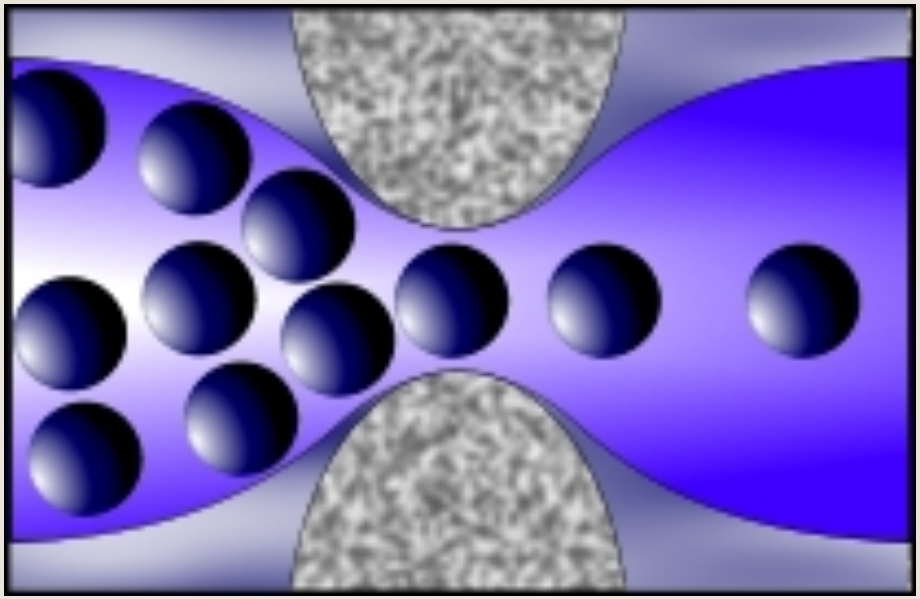
http://www.stat.yale.edu/Courses/1997-98/101/linreg.htm

http://www.ce.berkeley.edu/~daganzo/Public/MultinomialProbit_Daganzo.pdf

# Mode Choice Model: Flaws and Improvements

# Bottleneck Idealization

Modeled – Free flow before, congested speed after



Reality – Congested before, free flow after

# Dynamic Representation

Model does not account for user feedback

Experience on one day may affect later travel choices

# Trip Assignment Assumptions

Model assumes all trips must take place regardless of road capacity

Unreal representation of network

# Acknowledge User Preferences

Understand how user preferences affect travel choices

Challenging to quantify

# Satisfaction in the Modal Split

HONG KONG INTERNATIONAL CASE STUDY

# Setup

- Initial Modal Split Survey conducted in 1999
- Two more surveys conducted in 2004-2005
- Modal split performed for 5 forms of arrival
  - Airport Express
  - Bus
  - Taxi
  - Private car
  - Hotel shuttle/tour bus
- Wanted to collect information about origin, travel cost, party size, number of luggage
  - Also include satisfaction of each service mentioned

# Survey Results

- 77% used a single mode, others used combination of modes
- Satisfaction results
  - High reliability, travel time because 90% did not see any traffic
  - Lowest ratings came from waiting time for buses, travel cost for other modes
  - Best relative service came from taxis
- How to accurately predict results?

# MIMIC

- Special case of the general structural equation models, only one variable:
  - influenced by multiple factors
  - shown in more than one indicator
- Factors in Satisfaction: travel time, gender, age, education level
- Indicators: Passenger satisfaction levels on the 5 modes of arrival

# MIMIC Model

Parameter estimates for structural equations of MIMIC models.

| | Airport Express | Bus | Taxi and Private car | Courtesy vehicle |
|---|---|---|---|---|
| $X_1$ **Time** | −0.0070 (−2.73) | −0.0045 (−3.84) | −0.0054 (−2.53) | −0.0045 (−2.53) |
| $X_2$ **Male** | 0.0520 (0.56) | 0.0093 (1.52) | 0.0840 (1.83) | 0.0730 (1.36) |
| $X_3$ Age 36–55 | 0.0025 (1.03) | −0.0180 (−1.94) | 0.0680 (1.46) | 0.0240 (1.63) |
| $X_4$ Education | 0.1800 (2.69) | −0.0200 (−1.54) | 0.0580 (1.81) | 0.0190 (1.73) |
| *Goodness of fit statistics* | | | | |
| $\chi^2$-value (degrees of freedom) | 147.69 (21) | 75.30 (21) | 42.60 (21) | 22.51 (21) |
| Root mean square error of approximation (RMSEA) | 0.12 | 0.07 | 0.04 | 0.03 |
| Standardised root mean square residual (RMR) | 0.08 | 0.05 | 0.04 | 0.06 |
| Goodness of fit index (GFI) | 0.93 | 0.97 | 0.98 | 0.96 |
| Adjusted Goodness of Fit Index (AGFI) | 0.85 | 0.93 | 0.96 | 0.91 |

Note: *t*-values in parentheses.

# Discrete Choice Factors

| | Model with Latent Variable | Model without Latent Variable |
|---|---|---|
| **Satisfaction** | 1.9403 (3.971) | – |
| Cost | −0.0866 (−10.136) | −0.0858 (−10.088) |
| Time | −0.0094 (−2.281) | −0.0193 (−5.857) |
| **Time (Business)** | −0.0197 (−4.222) | −0.0229 (−4.956) |
| Transfer | −0.3326 (−2.349) | −0.3148 (−2.257) |
| Party size (specific to AE) | −0.0388 (−1.246) | −0.0448 (−1.419) |
| Baggage (specific to AE) | −0.1806 (−1.454) | −0.1966 (−1.583) |
| Party size (specific to bus) | −0.0817 (−2.621) | −0.0819 (−2.690) |
| Baggage (specific to bus) | −0.1637 (−1.363) | −0.1439 (−1.205) |
| Long-haul (specific to bus) | −0.5929 (−3.147) | −0.6051 (−3.231) |
| Age 25 (specific to bus) | 0.2800 (1.494) | 0.4572 (2.526) |
| HK (specific to AE and bus) | 0.8381 (4.305) | 0.8128 (4.184) |
| Age 65 (specific to taxi, private car and courtesy vehicle) | 0.8959 (1.975) | 0.8212 (1.812) |
| Alternative specific constant for AE | 0.2504 (0.752) | 1.0822 (4.209) |
| Alternative specific constant for bus | 1.4628 (3.225) | 1.1824 (4.399) |
| Alternative specific constant for taxi | 0.6087 (2.824) | 0.8465 (4.077) |
| Alternative specific constant for private car | 0.9929 (3.704) | 1.2301 (4.702) |
| *Summary statistics* | | |
| Log-likelihood at zero | −1639.7625 | −1639.7625 |
| Log-likelihood at convergence | −917.9332 | −926.0474 |
| Likelihood ratio index | 0.4402 | 0.4353 |

# Discrete Choice Analysis

- The travel time becomes prime concern for air passenger mode choices
  - Can perform a sensitivity analysis to see if effective pricing can be employed
- Other factors would then be included for further study to make the model more accurate
  - Large luggage sizes, safety, relaxation

# Applications to LAX

- Changing the flow of people from direct access towards the people mover will alter the satisfaction of each mode choice
- Modal split should be employed with this new factor to determine how/where trains should be run

# Conclusion

MODE CHOICE MODEL AND AIRPORT PLANNING

# General Applicability to Airport Planning

- Mode Choice Model Applications:
  - Off-Site Facility Planning
  - Passenger Flow Patterns
- Applicability:
  - Facility Capacity
  - Transportation System Capacity
  - Traffic Flow  and Access Patterns
  - Isolates Factors Influencing Mode Choice

# APM System Decision at LAX

- Mode Choice Model
  - Model Predicted
    - Traffic Flow Patterns
    - Passenger Flow Patterns – Facility Capacities
  - Prompted Off-Site Facility Decision
  - Necessitated Intra-Airport Transit System

# Transferability and Limitations

- Application to Intra-Airport Transportation Options
  - Necessary Interpolation of Mode Choice Model Information to Intra-Airport Transportation System
- Limitations
  - Incorporation of Passenger Satisfaction
  - Failure to Include Missing Design Parameters

# Final Conclusions

- Mode Choice Model
  - Model with Limitations and Opportunities for Improvement
  - Key Component of Airport Transportation Planning
  - Secondary Applicability to Intra-Airport System Planning