FROM DATA TO VALUE

THE ROLE OF BENEFITS ASSESSMENTS IN PRODUCT DEVELOPMENT

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TALK OUTLINE

- Introductory comments
- Benefits assessments
- Case studies
  - JFK Airport departure metering
  - IAH Airport coded departure re-routes
  - DXB Airport construction planning
- Wrap-up
- The future

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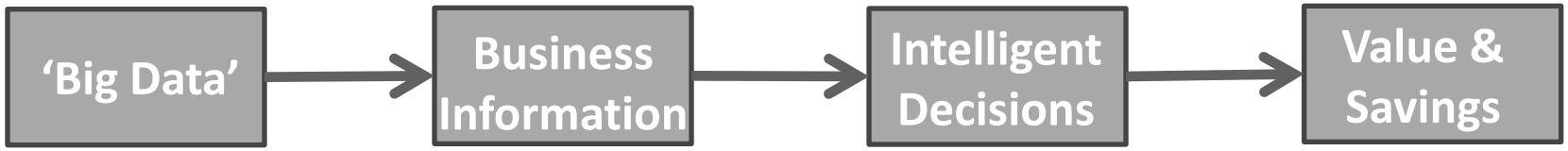
HOW SAAB SENSIS SEES THE WORLD



- Three case studies will be presented:
  - JFK Airport departure metering
    - Stroiney, Levy, Balakrishnan, Khaldikar (2013)
  - Coded departure re-routes at IAH Airport
    - Carpenter, Levy, Eastus (2013)
  - Planning for construction at DXB Airport
    - Stroiney, Carpenter, Levy, DeHart

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INTRODUCTORY COMMENTS

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THE ELEMENTS OF A GOOD ABSTRACT

- 1. State of the art
- 2. Its deficiencies
- 3. The goal of the work
- 4. Methodology and objectives
- 5. Quo bono (The Value Proposition)?

- Most people don’t put a good statement of the last element in their abstract.

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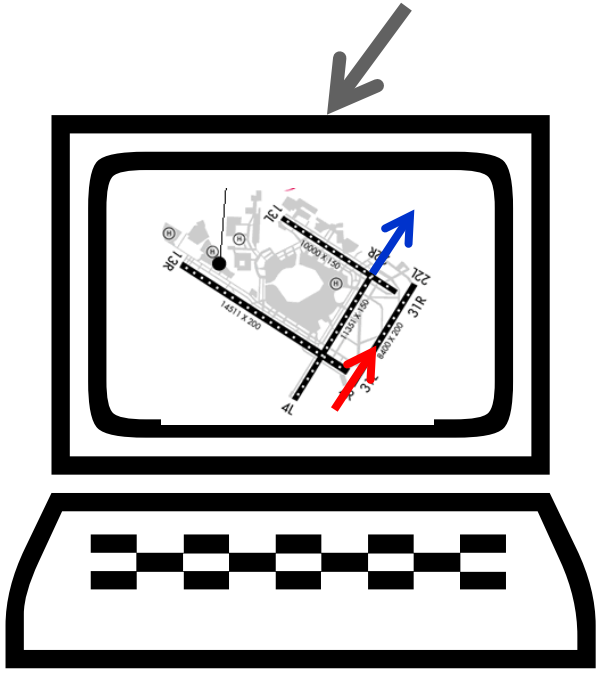
BENEFITS ASSESSMENTS

This is ***NOT*** an airport



- What do you learn?
  - Your customer's needs
- Who do you meet?
  - The people in the field
- When should it be done?
  - Before, during, after
- Why should you care?
  - "Because that's where the money is". -Willy Sutton

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POTENTIAL VS. BEFORE/AFTER STUDIES

- Potential benefits
  - Future, posited upper-limit on benefit
  - Based on current conditions
- Before/After benefits
  - Before vs. after intervention
  - Attribution of effect to intervention
  - Experimental design
  - Cost of operations & passenger time

Airport Name(s)	
Before/After	Potential
ATL	LAX
ATL/ZTL	LGA
IAH	MEL, SYD, BNE
IAH	ORD
JFK	PHL
MCO	DXB
MSP	9 US airports

	Annualized Benefits	
Cost Type	Before/After Time (years)	Potential Time (years)
operating	3.9	13.2
passenger	506.8	1895.6

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POTENTIAL BENEFITS STUDIES

Airport Name(s)	Operation Type	Cost Type	Time Period of Study	Project Name	Study Type
LAX	Arrivals	operating passenger	Jun-10	Surface delays in mvt area	Future
LGA	Departures	operating passenger	2012-2013	ASPM/Gridlock	Future
MEL, SYD, BNE	Departures	operating passenger	2012 (5d-20d)	AsA	Future
ORD	Arrivals, departures	operating passenger	2009 (7d)	Surface delays in ramp and mvt area	Future
PHL	Departures	operating passenger	11/12-3/13	De-icing	Future
DXB	Departures	operating passenger	80 d	Construction	Future
9 US airports	Departures	operating passenger	30 d	DMAN benefits	Future

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BEFORE/AFTER BENEFITS STUDIES

Airport Name(s)	Operation Type	Cost Type	Time Period of Study	Project Name	Study Type
ATL	Arrivals, departures	operating passenger	2009 v. 2012	Aerobahn, etc.	Before/after
ATL/ZTL	ZTL Arrivals to ATL	operating passenger	2011 - 2012	TMA	Before/after
IAH	Re-routed departures	operating passenger	2009 v. 2012	Aerobahn/CDR	Before/after
IAH	Arrivals in ramp	operating passenger	2008 v. 2009	Aerobahn	Before/after
JFK	Arrivals, departures	fuel passenger	2009 v. 2012	Aerobahn, Phase A	Before/after

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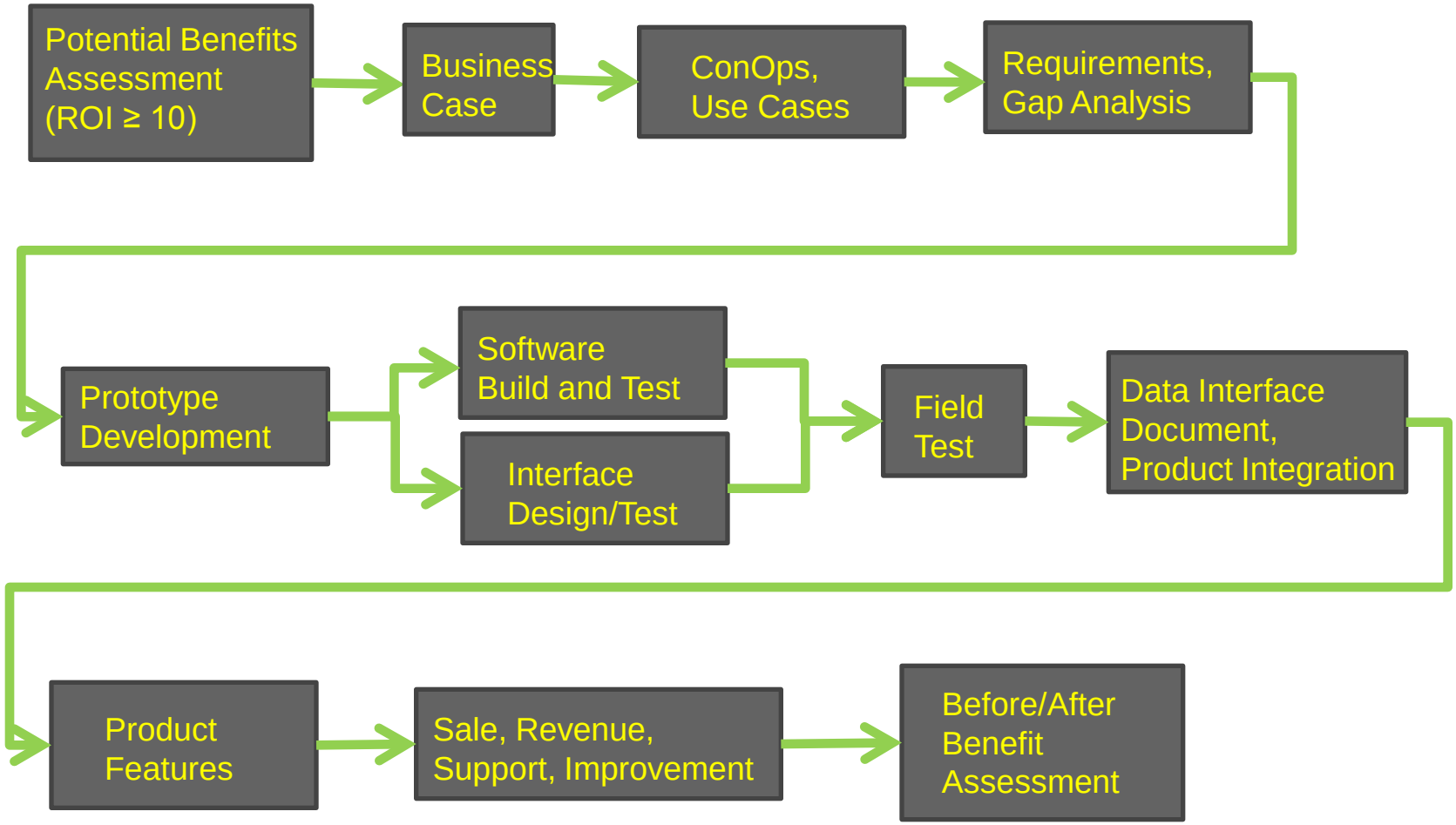
THE PROCESS AND THE REAL REASON



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POTENTIAL vs. BEFORE/AFTER BENEFITS STUDIES

- Potential benefit studies
  - Challenge: positing a benefit for a future intervention
  - Challenge: having a good plan that's poorly followed vs. having a poor plan that is carefully followed
- Before/after benefit studies
  - Challenge: designing a controlled experiment
  - Challenge: controlling for other influences

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DATA ISSUES

- Many data formats
  - e.g., CAT-32, CAT-11, CAT-10
- Many data sources
  - Aerobahn, BTS, ASPM, ASDE-X, NESG, DDU, wx, schedule, ASDI
  - Pre-fusion/post-fusion
  - MLAT vs. ASDE-X vs. ASCC vs. A-SMGCS
- Data quality checks
  - Completeness, consistency, rationality (e.g., outlier management)
- Non-demonic influences (e.g., random acts of the Warsaw Pact)
  - “Known unknowns” vs. “Unknown knowns”
- Canonical data sets with known outcomes
  - Instruction, homework

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CASE STUDIES

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STUDY PHASES

- Problem statement
  - Hypothesis test
- Data collection
  - *a priori* vs. *a posteriori*
- Evaluation criteria
  - P-value (α)
- Data evaluation
  - Statistical test
- Interpretation
  - Significant?
  - Type I vs. II error

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JFK AIRPORT DEPARTURE METERING (BEFORE/AFTER STUDY)

- Did metering reduce departure queue length?
- Was the queue too short?
- Did per-flight delay (push-ready to take-off) drop?
- Did taxi-out duration decrease?
- Did metering shift delay from taxi to the gate?
- Did metering save taxi time and fuel?
- Did overall departure throughput increase?

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DATA COLLECTION

- Periods compared:
  - No Metering – summer 2009 (June-August)
  - Original Metering – summer 2011 (June-August)
  - Integrated Metering – summer 2012 (June-August)
- Data used:
  - BTS On-Time Performance Data & ASPM (SOBT, AOBT, ATOT)
  - ASDE-X (AMAT, runway queue entry, ATOT)
  - Aerobahn (TMAT, ROBT, TOBT, compliance – for 2012 only)
- Quantities measured:
  - Gate delay, taxi duration
  - Departure queue length & queue duration
  - Runway throughput

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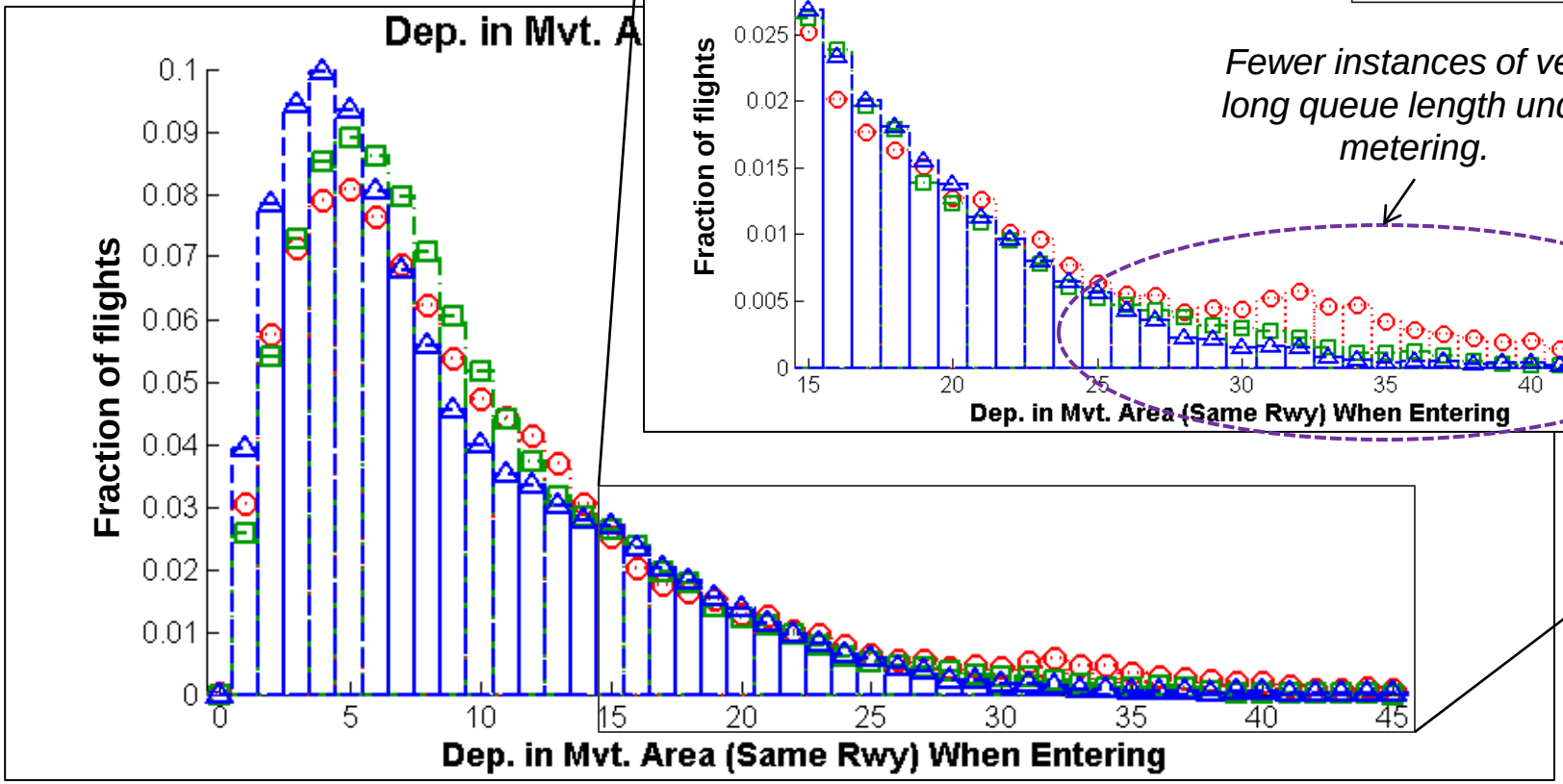
METERING DECREASED DEPARTURE QUEUES

Number of flights in movement area bound for same runway



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JFK AIRPORT DEPARTURE METERING (BEFORE/AFTER STUDY)

Metric	Improvement in 2012 over 2009 conditions
Taxi-out Time	2,100 hours
Fuel	1.0 million kg
Fuel Cost ($1/kg)	$1.0 million
CO_2 Emissions	3,200 metric tons
Take-off Delay	2,400 hours
Passenger Time	12,600 person-days
Passenger Time ($30/hr)	$9.0 million

- Improvements in 2012 over Summer 2009
- Multiply by 10 for approximate annual savings

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JFK AIRPORT DEPARTURE METERING (BEFORE/AFTER STUDY)

- Did metering reduce departure queue length? (Y)
- Was the queue too short? (N)
- Did per-flight delay (push-ready to take-off) drop? (Y)
- Did taxi-out duration decrease? (Y)
- Did metering shift delay from taxi to the gate? (Y)
- Did metering save taxi time and fuel? (Y)
- Did overall departure throughput increase? (Y)

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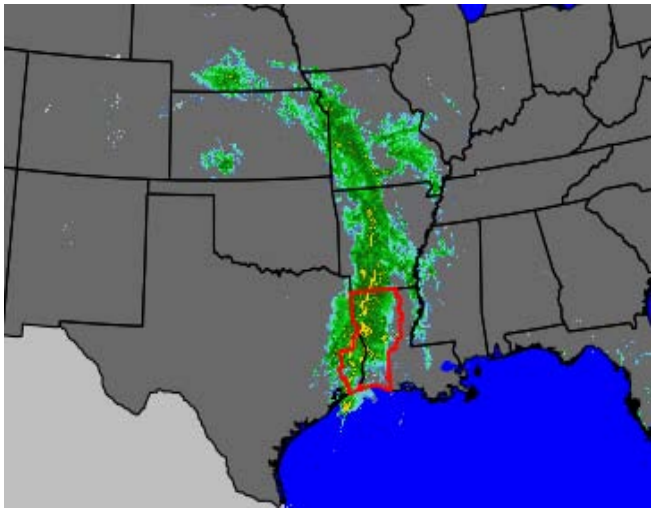
CODED DEPARTURE RE-ROUTES AT IAH AIRPORT (BEFORE/AFTER STUDY)



11 Mar 2012 5:00 PM CDT

Source: http://mesonet.agron.iastate.edu/current/mcview.phtml

- Sudden, fast-moving convective storms warrant “gate” closures
- ATC controllers must react tactically, reroute departures around storms

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COLLABORATIVE DEPARTURE RE-ROUTES AT IAH AIRPORT (BEFORE/AFTER STUDY)

- Does new C-PDR process reduce taxi-out delays for affected departures?
  - Any indication the C-PDR process also supports more consistent performance?
  - Does C-PDR have observable secondary benefits?

- Other “soft” improvements resulting from the C-PDR process?
  - Reduced workload needed to manage reroutes?

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ORIGINAL REROUTE “PROCESS”

HOUSTON ARTCC

Calls IAH Tower, conveys need to close departure ‘gate(s)’

IAH ATC TOWER

Provides list of departures for reroute, might not specify priorities

HOUSTON ARTCC

Issues reroutes - best guess at departure priority and/or calls to IAH Tower

HOUSTON ARTCC

Eventually issues reroutes for each affected departure

IAH ATC TOWER

Coordinates departure priority one by one or in groups

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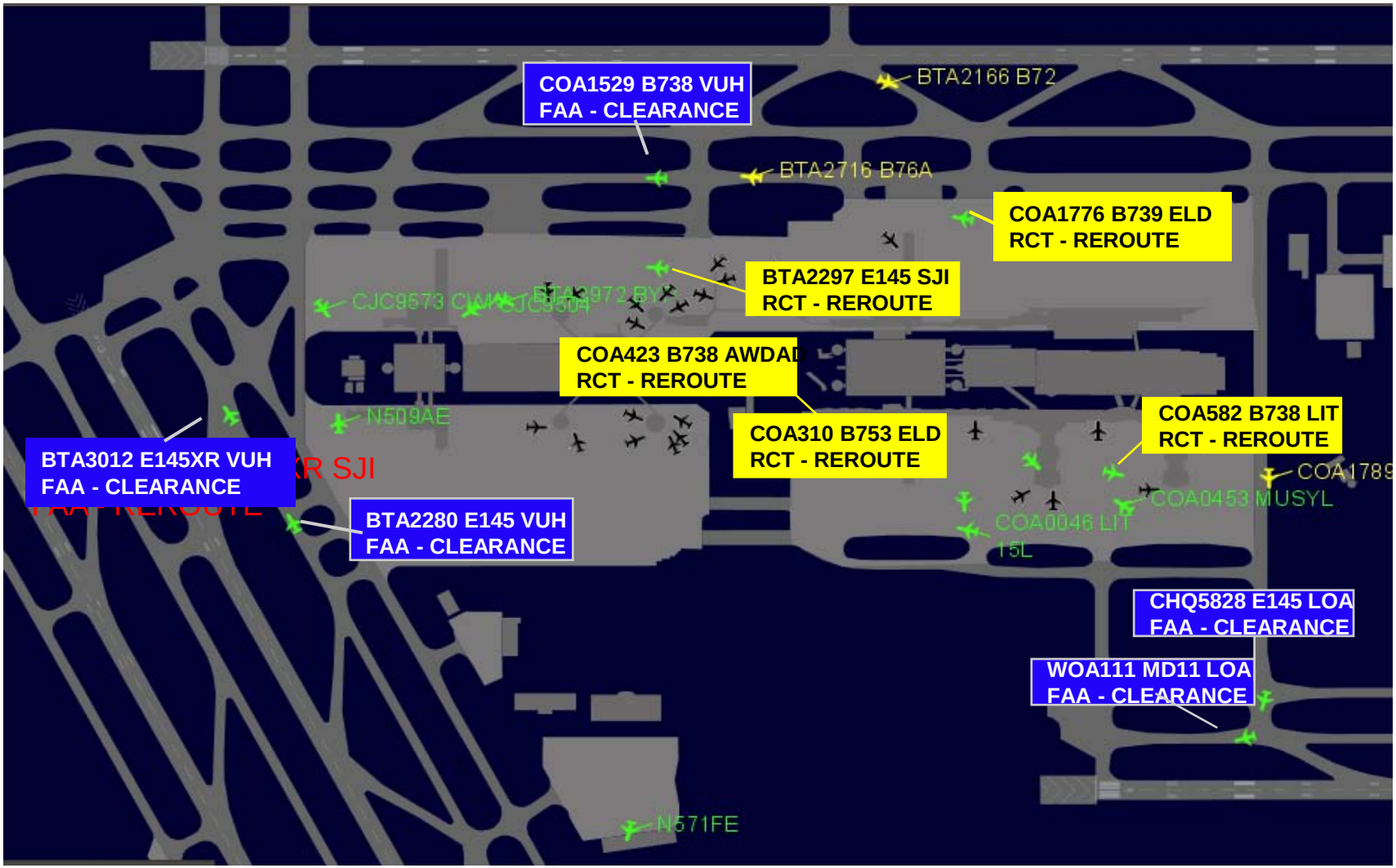
PROCESS IMPROVEMENT



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REVISED REROUTE PROCESS

HOUSTON ARTCC

Calls ATC/Ramp Towers, conveys need to close departure to 'gate(s)'

IAH RAMP TOWERS

"Flips" affected departure's call sign block color to yellow on surface display, priority order

HOUSTON ARTCC

Issues reroute, "flips" call sign block color to blue on surface display

IAH ATC TOWER

Aware of "gate" closure(s)

IAH ATC TOWER

Departure under ATC control. Tower provides new clearance and taxi instructions

IAH RAMP TOWERS

Departure not under ATC control. Pilot receives new clearance. Ramp "flips" departure call sign block color to green on surface display

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METHODOLOGY

- Compute and compare relevant metrics for…
  - All IAH departures on clear-weather days before and after introduction of C-PDR process
    - Did departure operations improve overall?
  - IAH reroutes and non-reroutes on bad-Wx before/after introduction of C-PDR
    - Compute same operational metrics

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DATA COLLECTION

- Periods investigated
  - Before introduction of C-PDR
    - 32 clear-Wx days in Feb, Mar, and Apr 2009
    - 6 bad-Wx days Mar and Apr 2009
  - After introduction of C-PDR
    - 31 clear-Wx days in Mar and Apr 2012
    - 9 bad-Wx days Mar and Apr 2012
- Sources of data
  - Aerobahn: Departure gate, gate-out time, departure runway, wheels-off time, rerouted departures (2012)
  - Subject matter expert: Rerouted departures (2009) (O/D pairings and ‘gates’)
  - Weather radar imagery
    - Verified clear- and bad-Wx days using RADAR/satellite imagery

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IAH TAXI-OUT STATISTICS, CLEAR-WX AND BAD-WX DAYS

Metric	No C-PDR (2009) Clear day	No C-PDR (2009) Bad-Wx day Re-routes	C-PDR (2012) Clear day	C-PDR (2012) Bad-Wx day UAL Re-routes
Mean taxi-out duration (min)	13.9	79.0	13.2	24.2
Taxi-out duration variability (min)	7.1	40.5	5.8	12.5
No. of departures	14,438	60	16,436	42
95th percentile taxi-out duration (minutes)	27.5	163.3	23.8	49.3

95th percentile taxi durations reduced significantly: 114 minutes

C-PDR performance on bad-Wx days not as good as for departures on clear-Wx days, but C-PDR helps appreciably

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2012 REROUTES BY DEPARTURE PHASE

- Strategic reroutes: 5 [12.8%]
  - Initiated at least 30 minutes prior to gate out time
- Gate reroutes: 9 [23.1%]
  - Initiated no more than 30 minutes prior to gate out time
- Ramp-area reroutes: 14 [35.9%]
  - Initiated while departure taxied in ramp area
- Movement-area reroute: 10 [25.6%]
  - Initiated while departure taxied in movement area

Implies some workload distribution across ATC and Ramp controllers?

- ~ 75% of reroutes initiated while departure under Ramp Tower control

Emphasizes value of ramp-area situational awareness to prioritization

- In general, reroute “back to the gate”

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WHAT WE LEARNED

- C-PDR process reduces taxi-out delays for affected departures, supports more consistent performance
- C-PDR has observable secondary benefits
  - On bad-weather days, non rerouted departures exhibit reduced taxi duration
- C-PDR contributes to “soft” improvements
  - Well-defined process and shared situational awareness eases pre-departure reroute coordination
  - Reroutes more often initiated when departure is in ramp – distributes some workload across IAH Tower and Ramp controller positions

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PLANNING FOR CONSTRUCTION AT DXB AIRPORT (POTENTIAL STUDY)

- DXB Airport plans to close runways in 2014 for construction with a 25% cut in schedule

- Can these impacts be mitigated?
  - Can we make trade-offs for schedule cut during future and planned construction?
  - Can we use DMAN to ‘buy back’ schedule?

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SIMULATION USE CASES

- Avoiding airport surface gridlock
- Pavement design and future traffic loading and maintenance impact mitigation
- Configuration management
- Capacity planning
- Metroplex DMAN and capacity trade-offs and timing between airports
- Arrival/departure management coordination
- Airport construction management

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DATA COLLECTION

- Pre-fusion A-SMCGS data from MLAT system at DXB Airport
  - Generate OOOI times, taxi-paths, taxi-durations, and departure queues
- Planned schedule cut from DXB Airport authority
- Simulation methodology
  - Run simulation with different parameters
  - Collect output summary metrics (e.g., average taxi time, average gate delay)
  - Make plots to illustrate the trade-offs
  - For instance, can increase schedule volume at a cost in extra gate delay

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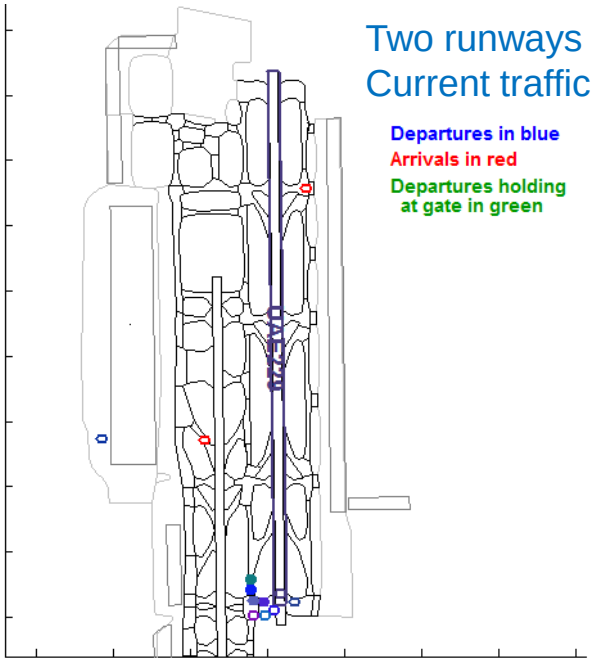
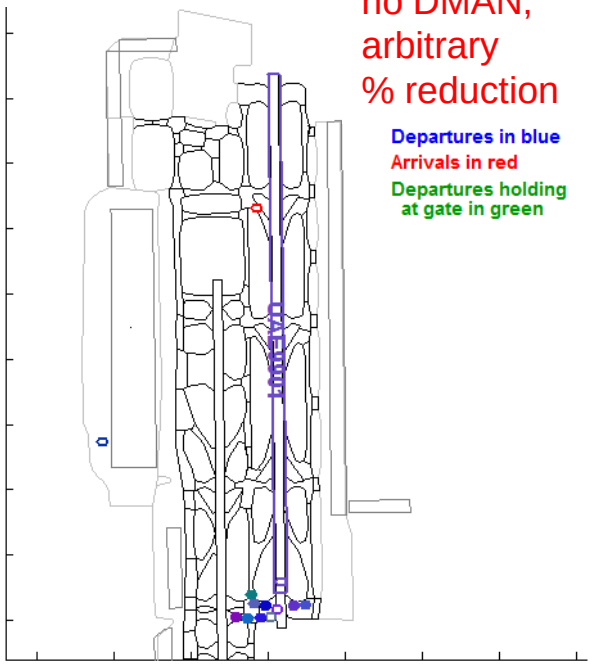
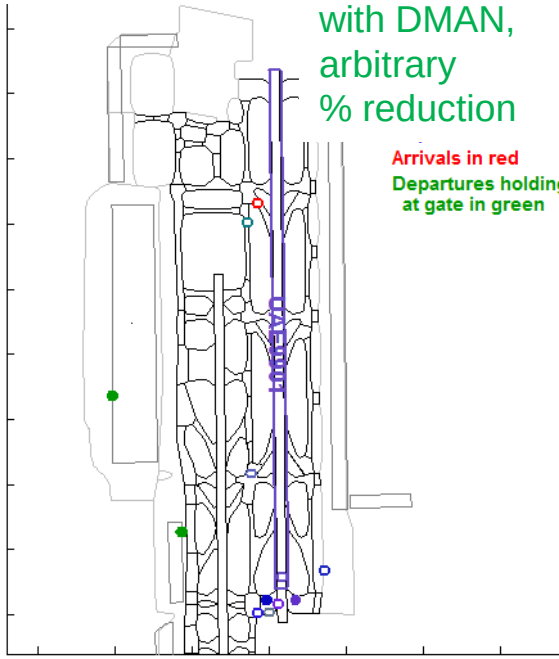
DXB AIRPORT SIMULATION GUI







Airport DXB

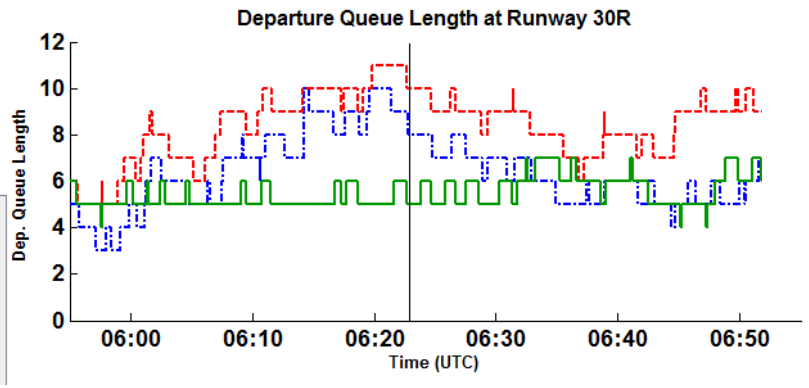
Simulate

Playback
Play Stop
Resume
Slow Fast

Parameters

Arrival Throughput	Default
% Schedule Reduction with One Runway	15 %
% Departure Throughput Increase with DMAN	2 %
DMAN Target Queue Length	5

	Two Runways	One Runway, Sch Reduced	With DMAN, Sch Reduced
# Departures	31	26	26
Taxi-Out Duration	21.2	28.7	19.9
Excess Taxi-Out	12.8	20.9	12.1
Gate Delay	0.0	0.0	7.5
Total Delay	12.8	20.9	19.6



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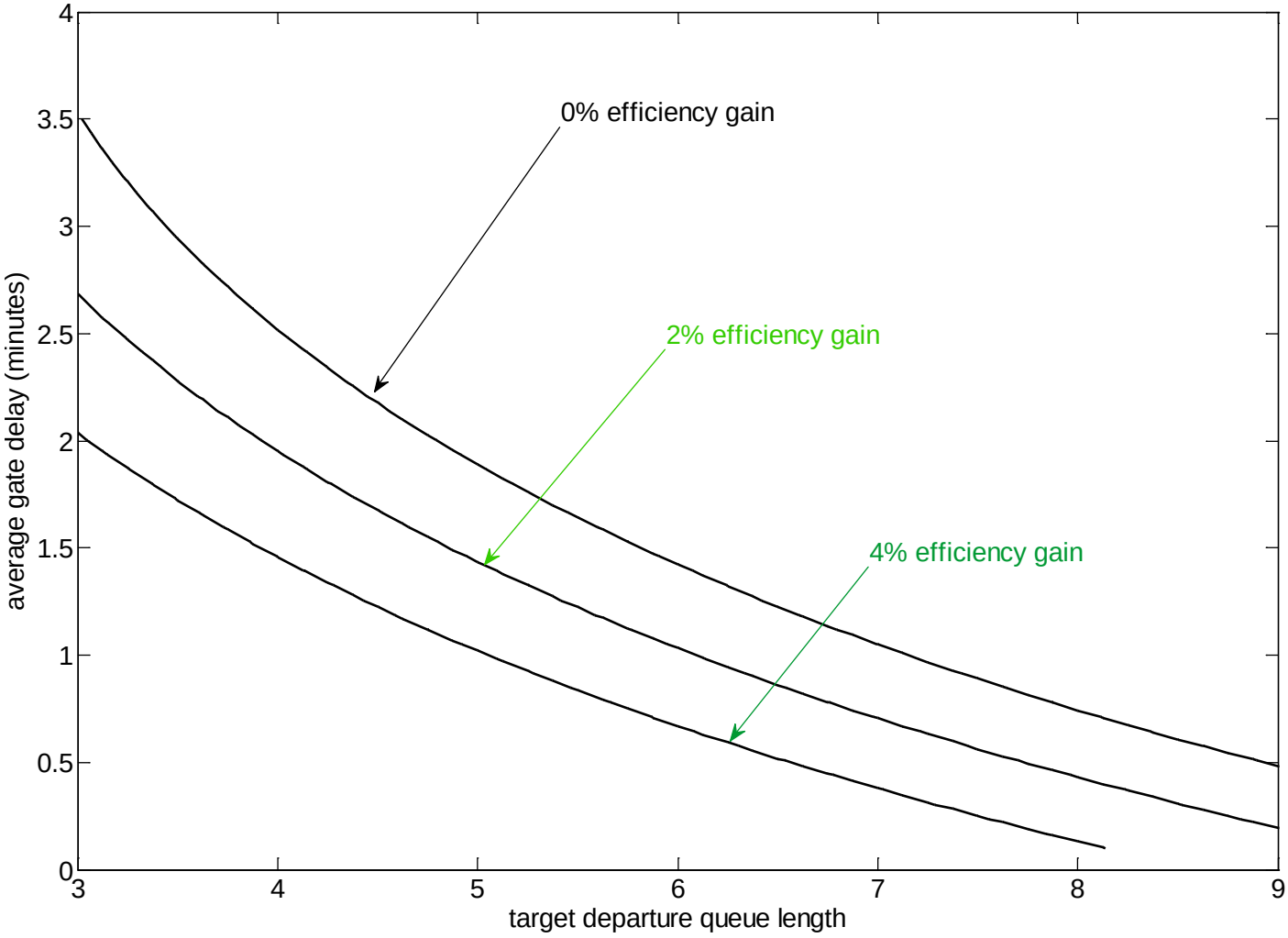
ASSUMED THROUGHPUT GAIN IMPACTS THE TRADE-OFF



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SUMMARY

- Rather than show you another slide, how about a simulation?

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WRAP-UP

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REMEMBER THIS…

- Your customer knows more about their ‘pain’ points and internal costs than you do, even if they can’t or won’t articulate the need.
  - Listen and collaborate.
  - Know your customer’s needs.
- Try to take a *holistic* approach to solving the *systems* problem to create a *resilient* solution.
- Conduct your own ROI estimates.

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AND THIS…

- Benefits assessments offer:
  - Opportunity to work with many data sets
  - Learning about data-set joining, validation, and data completeness
  - Pricing of the product or feature
  - Development of new products, features, improvements
  - Adoption of new concepts and technology
- Benefits assessment should be part of a RFP, validation of an investment decision, or decision to renew a contract.

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CHALLENGE QUESTION TO FACULTY AND STUDENTS

- How can you measure the benefit of technology?
  - Dr. Sherry knows the answer already
- Hint:
  - Gregory (Scotland Yard detective): "Is there any other point to which you would wish to draw my attention?"
  - Holmes: "To the curious incident of the dog in the night-time."
  - Gregory: "The dog did nothing in the night-time."
  - Holmes: "That was the curious incident."

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THE FUTURE…

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AND NOW A WORD FROM OUR SPONSOR…

- DASC2014
  - Antlers Hilton
  - Colorado Springs
  - October 5-10, 2014
- Theme: “Designing an Air Transportation System with Multi-Level Resilience”
  - Intersection of policy, economics, and technology in making appropriate investment decisions to build such a system
- Abstracts and web-site
  - www.dasconline.org
  - Abstracts of no more than 750 words before 1 March 2014

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EQUITY AND CDM EXPLAINED

FCFS

CDM

Inequity

Compliance

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