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ESSAYS ON EFFICIENCY IN SERVICE OPERATIONS: APPLICATIONS IN HEALTH CARE

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ESSAYS ON EFFICIENCY IN SERVICE OPERATIONS: APPLICATIONS IN HEALTH CARE

John B Norris
Dissertation Defense: August 8, 2007

Committee:
Herbert Moskowitz (Co-Chair)
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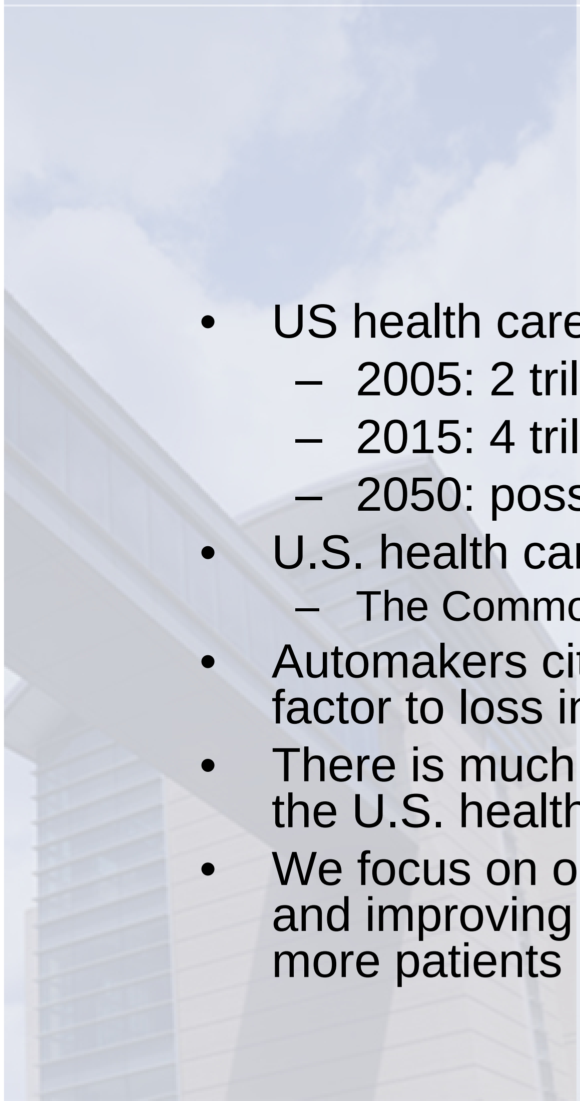
Jen Tang
Mark Lawley

Outline

- Background
- Problem Definition
- Essays:
    - Patient Attendance
    - Variability in Patient Flow
    - Call Volume Management
- Dissertation Contributions



Background

- US health care system
  - 2005: 2 trillion dollars, or 16 percent of GDP (Catlin, 2006)
  - 2015: 4 trillion, rising at twice the rate of inflation (Borger, 2006)
  - 2050: possibly reach 35 percent of the GDP (Warner, 1996)
- U.S. health care 6 out of 6 developed nations; “Simply unacceptable”
  - The Commonwealth Fund 2006 Annual Report
- Automakers cite rising health care costs for retires as a contributing factor to loss in competitiveness
- There is much room for improvement in efficiency and effectiveness of the U.S. health care system
- We focus on outpatient clinics, where many individuals have choice and improving clinic efficiency can improve profitability and attract more patients

Problem Definition

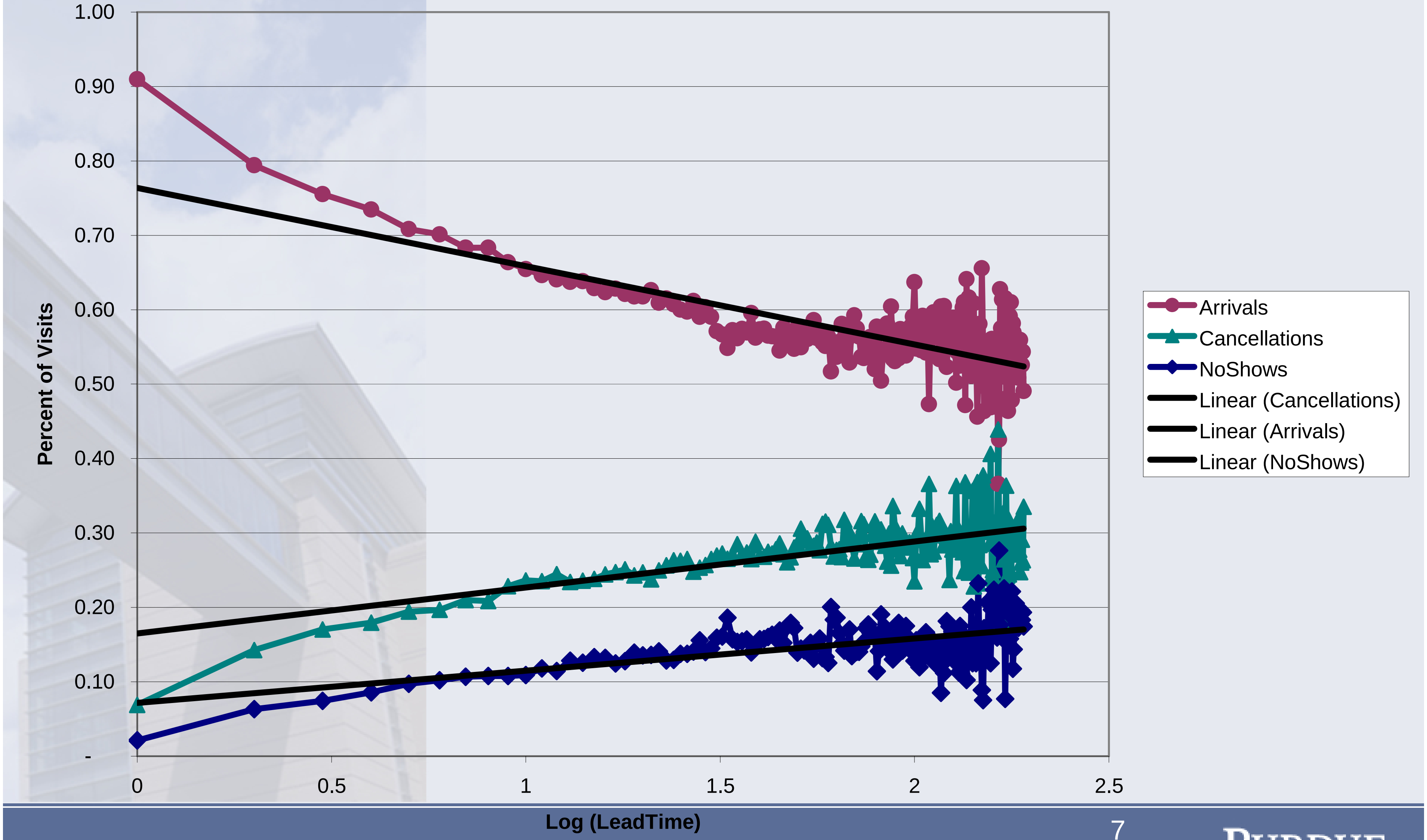
- Partnering with Indiana University Medical Group (IUMG), we focus on outpatient care
  - Address the issue of missed appointments
  - Analyze variability in patient flow
  - Analyze performance of phone system

Essay 1: The Effects of Lead Time and Prior Patient Behavior on Cancellations and Missed Appointments at Outpatient Clinics

Patient Attendance

- To date, most of no-show modeling has been in physician journals; many focusing on epidemiological factors (demographic and medical), which may lead to “profiling” patients. Operations Research can provide insights into no-shows.
- Few articles, if any, have considered cancellations.
- Few articles, if any, have used training and validation data and reported classification results
- We analyze an extensive data set with 5 years of data, 9 clinics, 130 physicians, and 87,000 patients

Transformation of LeadTime



Patient Attendance

- Data set for May 1, 2003 to April 30, 2006 excluding First Visit (35,379 Observations, using 30% for validation)
- Our models correctly predict 49.5% of the no-shows, but only account for 35.6% of actual no-shows.
- Most of cancellations are predicted as arrivals; not predicting cancellations very well.

% of Predicted	Multinomial	Binary
No-Show	49.5%	64.8%
Cancel	45.2%	
Arrive	72.7%	84.1%

% of Actual	Multinomial	Binary
No-Show	35.6%	36.1%
Cancel	8.0%	
Arrive	93.1%	94.5%
Overall correct classification percent	68.8%	81.7%

Patient Attendance Contributions

- Disproportionate amount of no-shows
  - 6% of patients miss 4 or more times; account for 43% of all no shows
  - Recommend program targeted at frequent no shows
- Among the various ways of measuring prior behavior, we test multiple methods and find weighting last 5 visits monotonically decreasing (30%, 25%, 20%, 15%, 10%) produces best results
- We find the lead time (call appointment interval), the largest contributing factor to missed appointments. Log of lead time provides near linear relationship with percent of no-shows. Lead Time is a controllable factor; matching supply with demand will reduce waste.

Essay 2: Improving Patient Flow at an Indiana University Medical Group Outpatient Clinic: An Application of Six Sigma Concepts with Simulation Modeling

Variability in Patient Flow

- Study the effects of variability in registration on waiting time; variability propagates through the system (Factory Physics, Hopp & Spearman)
- Interruptions in registration affect rest of process (preemptive outage or unscheduled downtime)

Variability in Patient Flow

- Literature provides many scheduling models, but most treat patient visit as a 1 step process.
- Registration process is seldom mentioned and can be a significant source of variation
- Our simulation model includes:
  - No-shows probability
  - Randomness in arrivals
  - Multiple physician practice

Variability in Patient Flow

- Improvement factors:
  - Staggered arrivals (reduced inter-arrival variability); additional time for new patients
  - Pooling of personnel at registration process
  - No batching of patient files; 1 piece flow
  - Reduce interruptions from phone calls

Variability in Patient Flow

Scenario	Pool Physicians	% of Physicians with Same Day Scheduling for Open Access (results in fewer no-shows)	Arrival Mean (minutes)	Arrival Standard Deviation (minutes)
A	No	60	-2 [stationary]	1.5
B	No	60	-2 [stationary]	5.0
C	No	60	-2 [stationary]	10.0
D	Yes	60	-2 [stationary]	1.5
E	Yes	60	-2 [stationary]	5.0
F	Yes	60	-2 [stationary]	10.0
G	No	30	-2 [stationary]	1.5
H	No	30	-2 [stationary]	5.0
I	No	30	-2 [stationary]	10.0
J	No	60	Random Uniform (-5,+5) [non-stationary]	1.5
K	No	60	Random Uniform (-5,+5) [non-stationary]	5.0
L	No	60	Random Uniform (-5,+5) [non-stationary]	10.0

Simulation model tests improvement factors across 12 scenarios (A-L)

Variability in Patient Flow Contributions

- Recommendations improve 5 key metrics:
  - Time to Enter – all patients
  - Time to Enter – old (existing) patients
  - Time to Enter – new patients
  - AM Physician Finish Time
  - PM Physician Finish Time
- Conclusion: Reducing variability in arrivals and registration and reducing interruptions benefits patients and physicians, while allowing clinic to see more patients

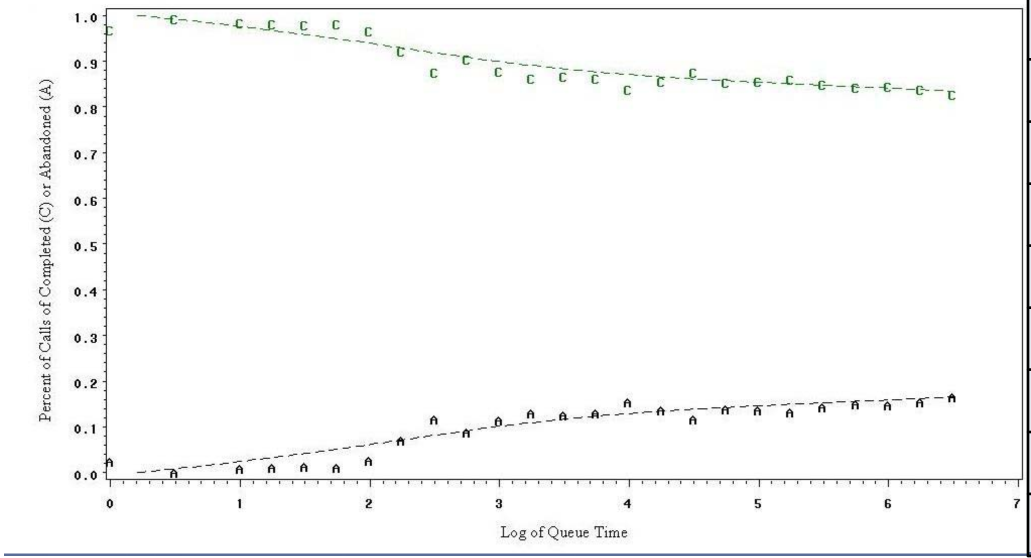
Essay 3: Call Volume Management at Outpatient Clinics

Call Volume Management

- IUMG implemented call center software at 4 commercial clinics at the end of 2006.
- IUMG has 1 central location for overflow
  - Level 2 queue for calls held > 75 seconds
- Performance Metrics
  - Average queue time (< 1 minute)
  - Average handle time (typically 2-3 minutes)
  - Percent of calls abandoned (<10%)
  - Percent of calls answered at local site (>75%)

Call Volume Management

- Feinberg et al. (2000) call center survey
  - Caller satisfaction (2 of 13 significant)
    - % of calls closed on first contact
    - Average Abandonment



Multiple calls per day from same person

Calls Per Day	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	27,643	77.2	27,643	77.2
2	5,752	16.1	33,395	93.3
3	1,559	4.4	34,954	97.6
4	456	1.3	35,410	98.9
5	160	0.5	35,570	99.3
6	72	0.2	35,642	99.5
7	42	0.1	35,684	99.6
8	22	0.1	35,706	99.7

These clinics suffer similar problems as larger call centers,

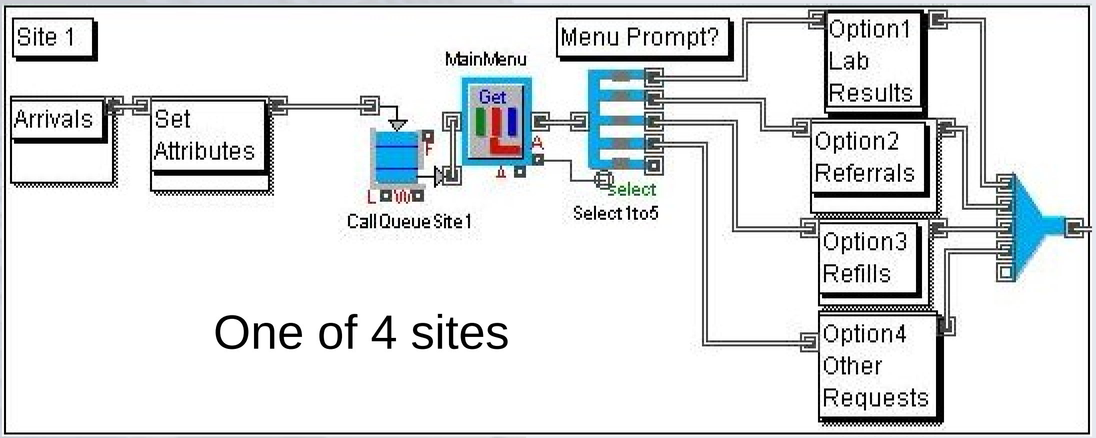
However multiple attempts is rarely monitored

Call Volume Management

- Literature Review
  - Gans and Zhou (2002) address the topic of staffing considering learning and turnover.
  - Zohar *et al.* (2002) discuss time a caller is willing to wait, patience, is adaptive based on prior expectations and current system performance; could explain multiple calls per day; unusual to wait so call back later
  - Armony and Maglaras (2004) smooth demand by providing a call back guarantee; staff return calls when loads have subsided.
  - Harrison and Zeevi (2005) describe the hierarchical nature of (1) longer term issues like staff hiring and scheduling and (2) dynamic routing.

Call Volume Management

- Simulation based on 10 weeks of phone call logs, across 4 sites and an overflow facility
- Fitted distributions for
  - Call frequency by site, day, & hour
  - Talk times
- Practice operations manager provided estimates of staffing by site
- Used simulation model results to compare to phone logs


Site 1
Arrivals
Set Attributes
MainMenu
Get
F
A
L
W
CallQueueSite1
Menu Prompt?
Select
Select1to5
Option1 Lab Results
Option2 Referrals
Option3 Refills
Option4 Other Requests

One of 4 sites

Of the 4 menu options,
Primary focus is option 4,
Secondary focus is option 2,
Since these are staffed by
people rather than recordings

Call Volume Management

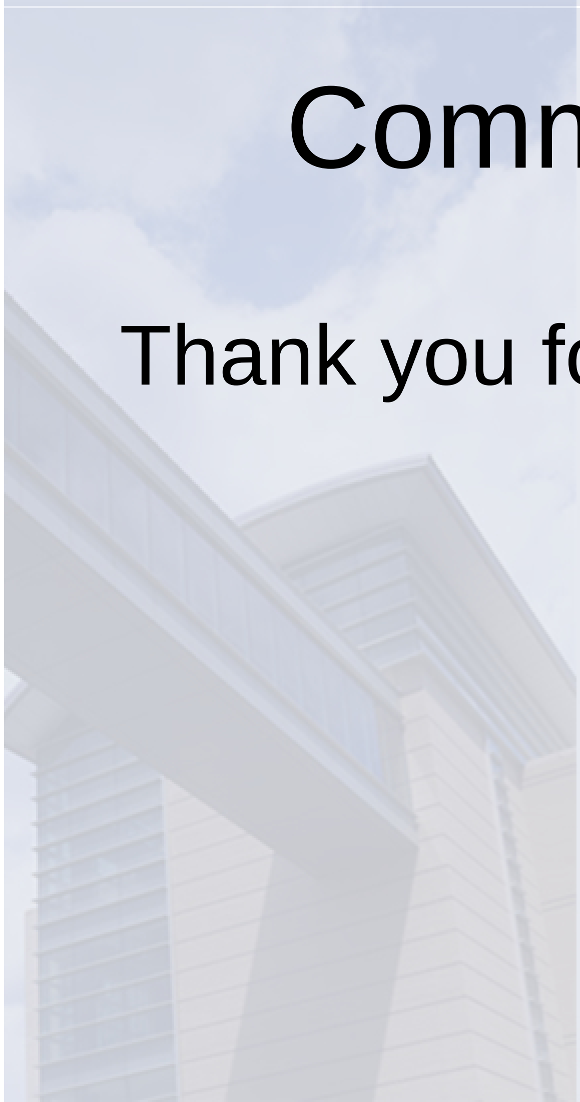
- Discrepancies in simulation model and phone logs lead to discussions of employee performance
- Large variability exits in capability and responsiveness of representatives
- Most successful site: site director benchmarks staff performance and coaches underperforming staff
- Least successful site: lack of discipline and understanding of system leads to poor performance
- Study also determined a large number of external calls were coming from providers through customer service lines rather than direct lines
- Call back option would currently provide only slight reduction in queue times, since few calls experience queue time

Call Volume Management Contributions

- Call management at multitasking facilities need performance benchmarks for staff, similar to large call centers; necessary to coach employees
- Call back option provides benefits to facilities that typically have long or highly variable waits
- Cancellation voice mail should be available at all times without delay; attempt to recover missed appointments should be convenient for caller

Dissertation Contributions

- No-Shows most affected by long lead time; emphasizes supply & demand mismatch (delay) on patients missing appointments (waste)
- Reducing variability and interruptions early in patient flow significantly reduces waiting times & improves operational efficiency of clinic
- Medical clinics need training and consistency among phone reps; benchmark performance



Comments and Questions

Thank you for attending my presentation

Cancellation Voice Mail

Follow-up question:

We had discussed the idea of a 24 hour voice mail box for after hour and weekend cancellations. I was wondering if that has provided any benefit and or use.

Answer:

Yes it has – it has been implemented and I understand that we are getting some use on it and it at least gives us an opportunity to attempt to schedule another patient into a cancelled time slot.

John – thanks for all your assistance and help….I hope participating in our project was beneficial to you and Ji (please pass along my thanks to him as well).

Jim Brunnemer (Clarion Arnett) August 3rd, 2007

DeDe Willis, MD, IUMG

-----Original Message-----
From: Willis, Deanna Ruth [mailto:drwillis@iupui.edu]
Sent: Friday, July 20, 2007 2:58 PM
To: Norris, John B
Subject: Patient no show data

Dear John,

I thought I would pass on something exciting.....sitting in our IUMG All Leaders mtg and we just talked about your data results and how enlightening it is to us....COOL!

DeDe

Phone Call Analysis

From: Jill Carter [mailto:JCARTER@iumg.com]
Sent: Tuesday, July 17, 2007 2:53 PM
To: Norris, John B
Cc: Lynsey Watson
Subject: RE: Phone Simulation

Hello John. I wanted to thank you for coming down and showing us your findings. As discussed in our last meeting at OCP I would like to have some graphs and data that is in an easily read format to show our colleagues.

1. Largest volume of calls by 30 minute increments.

If we can see where these calls siphon off it may be helpful. Example, option 1 lab, option 2 referral, 3 refills or 4 staff member.

Then if we can see how many of the option 4 calls are transferred to other numbers it would be helpful.

2. I would like to have the peak sessions. We have 10 sessions in a week Monday - Friday AM 8-12 and PM 1-5. Which one receives the largest volume of calls?

3. I would like to have the biggest veritable in abandonment.

I am still thinking about the flow data you showed us. I will get back to you on this.

Thanks, Jill Carter