

CFord Enrolment Modelling and Forecasting with @RISK – OURA 2017

1. For the software and support - @RISK as part of the Decision Tools Suite by the Palisade Corporation www.palisade.com. Free trials and discounted academic subscriptions available.
2. References and readings of interest:

Boeckenstedt, J. (2016, May 11). *Yield Rates are Declining - Why?* Retrieved from Academic Impressions: <http://www.academicimpressions.com/news/yield-rates-are-declining-why>

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Goyal, M., & Vohra, R. (2012 March). Applications of Data Mining in Higher Education. *International Journal of Computer Science Issues*, 9(2), 113-120.

Langston, R., & Scheid, J. (2014). Strategic Enrollment Management in the Age of Austerity and Changing Demographics: Managing Recruitment, Leveraging Revenue and Access in Challenging Economic Times. *Strategic Enrollment Management Quarterly*, 2, 191-210. doi:10.1002/sem3.20048

Langston, R., Wyant, R., & Scheid, J. (2016). Strategic Enrollment Management for Chief Enrollment Officers: Practical Use of Statistical and Mathematical Data in Forecasting First Year and Transfer College Enrollment. *Strategic Enrollment Management Quarterly*, 74-89.

Patel, P., Thompson, W., & Stephens, C. (2010, June). *Data mining 101: How to reveal new insights in existing data to improve performance*. Cary, NC: SAS Institute.

Noel Levitz. (2013). *2013 Cost of Recruiting an Undergraduate Student Benchmarks for Four-Year and Two-Year Institutions*. Noel Levitz. Retrieved from www.noellevitz.com

Noel Levitz. (2013). *Seven categories of admissions data to guide decision making*. Coralville, Iowa. Noel Levitz. Retrieved from www.noellevitz.com/AdmissionsData

Noel Levitz. (2014). *2014 Recruitment Funnel Benchmarks Report for Four-Year Institutions*. Noel Levitz. Retrieved from www.noellevitz.com

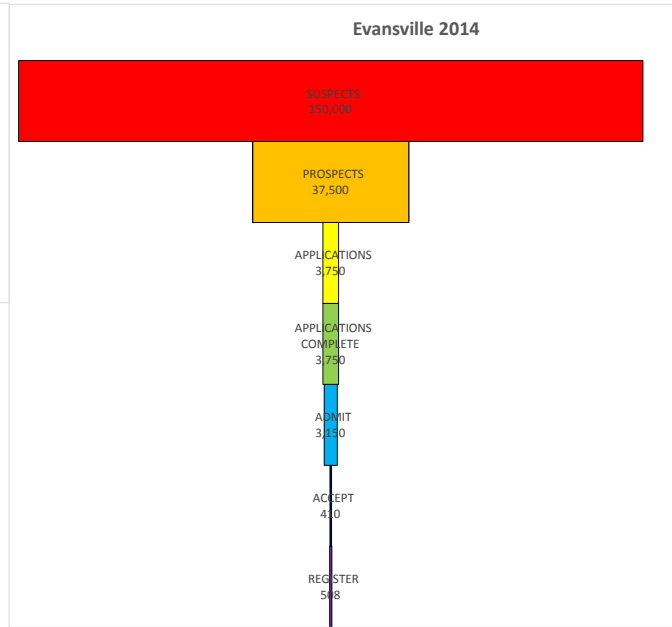
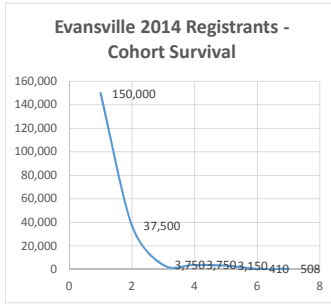
Sugrue, P. (2014). A model for predicting enrollment yields. *International Journal of Operational Research*, 19(1), 60-67. doi:<http://dx.doi.org/10.1504/IJOR.2014.057845>

Supiano, B., & Myers, B. (2015, May 26). *What it takes to make the class*. Retrieved from The Chronicle of Higher Education: <http://chronicle.com/interactives/What-It-Takes-to-Make-the>

3. Thoughts regarding getting to the next levels of enrolment prediction models

You may need to start with a smaller model instead of immediately aiming for prospect-to-enrol or lead-to-enrol, as your in-house statistician likely already uses an applications-to-enrol model. With time and gain in skills move to a larger, longer timeline model, prospect to enrol, and the largest most ambitious model would be leads to enrol.

Enrolment Stage - Fall 2014	Filler Series	Number of People	Conversion %	2013 Ranges (%)	Low	Likely	High	Cost per unit	Cost per stage	Cumulative cost
SUSPECTS	0	150,000	25%		22	27	30	\$2	\$270,000	\$270,000
PROSPECTS	56,250	37,500	10%		2	7	10	\$9	\$332,813	\$602,813
APPLICATIONS	73,125	3,750	100%		100	100	100	\$60	\$225,000	\$827,813
APPLICATIONS COMPLETE	73,125	3,750	84%		81	84	89	\$0	\$0	\$827,813
ADMIT	73,425	3,150	13%		13	18	21	\$53	\$166,950	\$994,763
ACCEPT	74,795	410	124%		117	122	125	\$138	\$56,511	\$1,051,274
REGISTER	74,746	508						\$0	\$0	\$1,051,274



NOTE: Pressing F9 will recalculate by sample

Enrolment Stage	Number of People
SUSPECTS	150,000
PROSPECTS	37,500
APPLICATIONS	3,750
READY FOR DECISION	3,750
ADMIT	3,150
ACCEPT	410
REGISTER	508

ing new values



Ontario University Registrars' Association

A decorative graphic of stylized leaves in shades of green is located in the top right corner of the header banner.

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February 15-17, 2017
Toronto

Enrolment modelling and forecasting with @RISK

Carolyn Ford, Western University

The reputation of modelling...



... and forecasting is not so good
right now

2016 US presidential election – the better
forecaster?

- The New York Times poll up to day prior, with prediction 82% probability of a Clinton win, 18% of a Trump win, OR
- “Trump win predicted by sheep entrails”

Source: Dr Selena Wisnom, The University of Oxford, May 2016

Carolyn Ford, Western University

TRUMP WIN PREDICTED BY SHEEP ENTRAILS

When the ancient Babylonians made predictions in politics they didn't take opinion polls, they asked the gods. Asking the question over a sacrificial sheep, they believed that the gods would write the answers in the entrails. Back in May Dr Selena Wisnom gave a talk on this subject at the British Museum, illustrating the process with a question of her own: Will Donald Trump take the kingship? The answer was yes.

Rather than sacrificing a sheep in the lecture theatre she used photographs of an Armenian sheep liver. These sheep are not fed antibiotics, so their livers still have many of the strange markings left by parasites and disease that produce the 'ominous signs'. The Babylonian omen series explains what they mean, for example: 'If the Dyeing Vat is concave on the right, the army of the prince will go on a terrifying campaign,' and 'If there is a long Presence, the days of the prince will be long'.

Dr Wisnom joined Queen's this year as our first Junior Research Fellow in Manuscript and Text Cultures. Her research tries to



Dr Selena Wisnom

dismantle the rules of this system, to understand why the Babylonians thought in this way and the logic of their scholarly

thinking. These texts constitute some of the earliest evidence in the world for the history of science. The Babylonians made a systematic attempt to classify signs in the world around them and explain what they mean. Dr Wisnom explains: "we can think of these signs as 'data', which are organised into large and complex series according to certain principles, and come up with theories about what they mean. It is a scientific project in the sense that it attempts to make sense of the world through systematic data gathering and interpretation. The world view underpinning this is the idea that the gods send signs as warnings, and

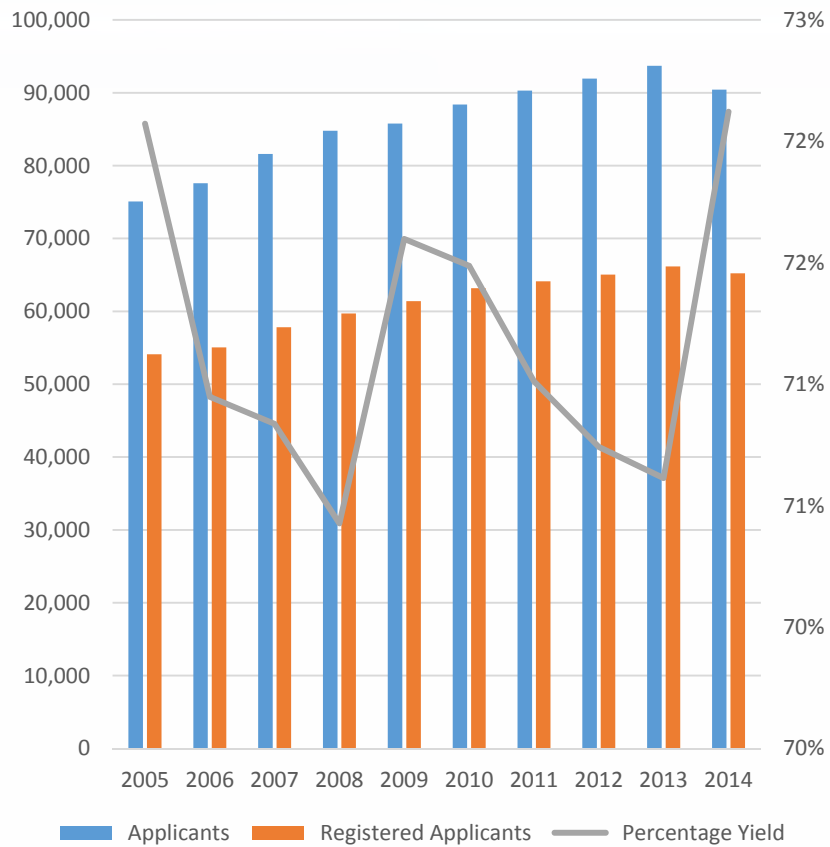
we must pay heed so that we can take action. Strange as it may seem to us, it is perfectly logical from a Babylonian standpoint."

Consequently, for the Babylonians, fate was not fixed but could be changed: these signs were not thought to cause the events that follow, only to forewarn us of them.

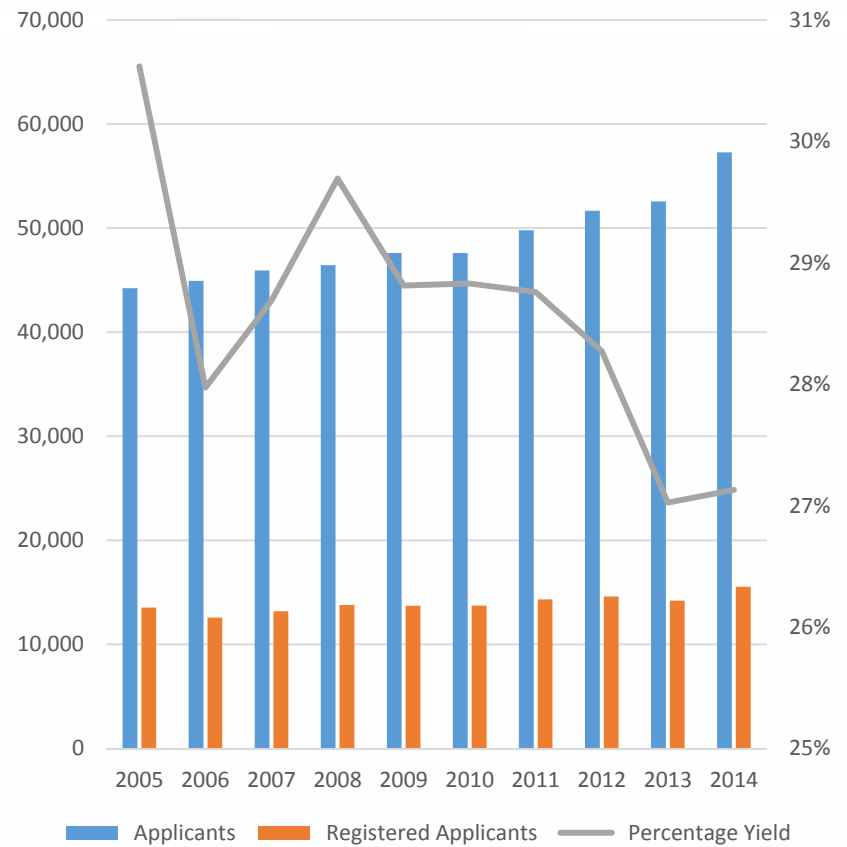
The realities of higher education marketing and enrolment...

- Dwindling supply of high school graduates
- Yield rates or return on investment falling year on year
- Costs to acquire enrolled student rising year on year
- Rising competition and other external factors

101s - System



105s - System



Would your willingness to consider modelling and forecasting change if I share with you...

- SUNY Brockport claimed to have an enrolment prediction model that's 90.7% accurate?
- Slow yet perceptible rise in publications claiming to have created and used enrolment prediction models down to level of individual decision?

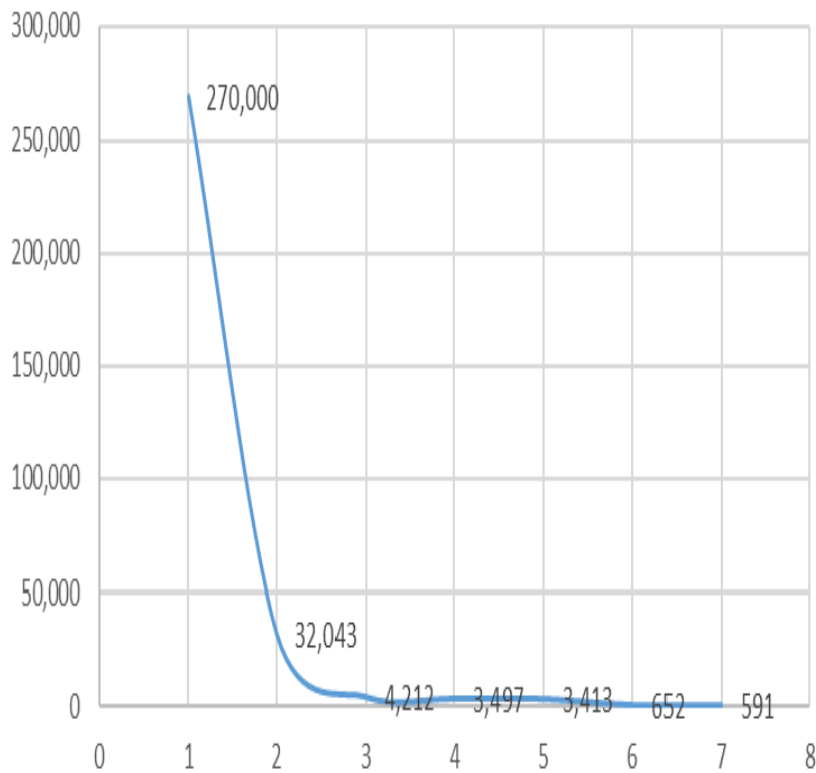
Goals of this session

- Modelling, simulation and visualization of the range of outcomes can help us understand our processes better and support our decision making
- The beginning of a community of practice using these tools?
- Setting the stage for more powerful models

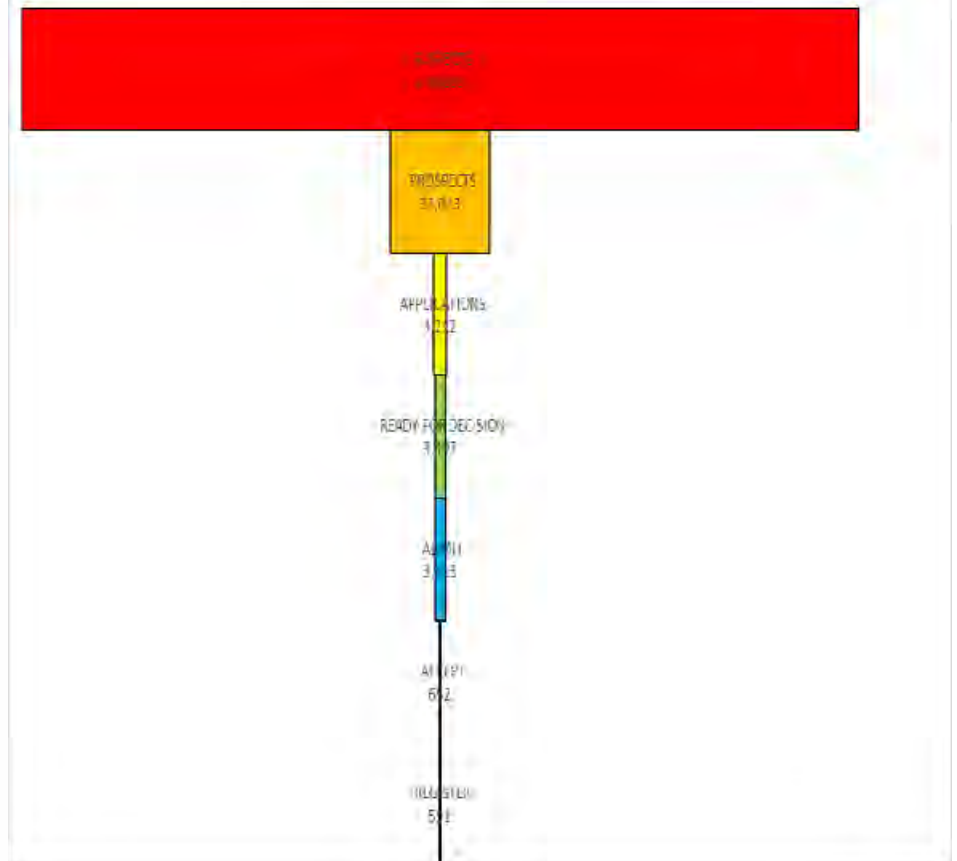
Agenda

- Use of the Evansville case study
- Introduction to the @RISK add-in for Excel, using a simple enrolment funnel

Number of Registrants - Cohort Survival



Enrolment funnel - REGISTER Calculation



Observations about use of funnels

- The era of one funnel to rule them all is over
- Use of multiple funnels to ensure awareness of the dynamics and trends for each admit type, program of enrolment, OUAC preference, geography, etc.
- Nevertheless, use of one overall funnel for this demonstration for ease of analysis

University of Evansville

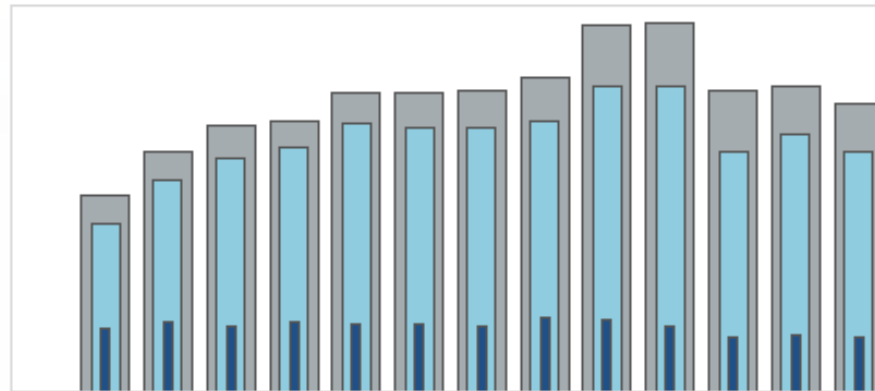
- Private university in Indiana
- Sharing their enrolment funnel for Fall 2014
- Enrolment target never explicitly stated
- Level of selectivity is low, no mention of file completeness
- Low level of stealth applications – 6%
- Nice to have – more details of response to summer melt

Carolyn Ford, Western University

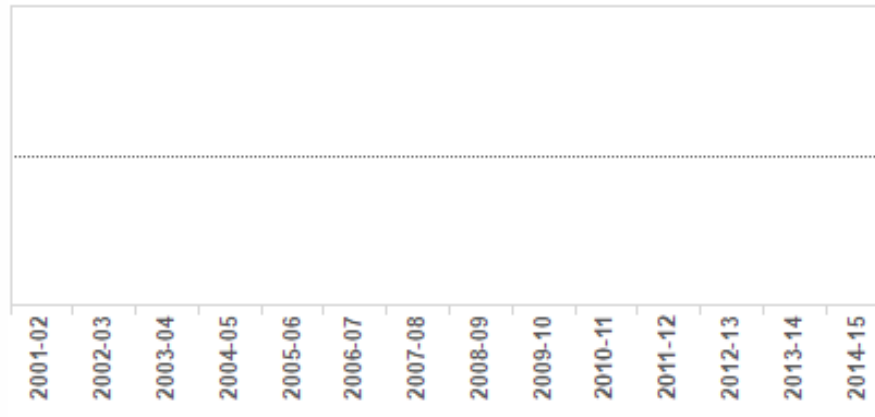
Source: What it takes to make the class, www.chronicle.com, 2015

Evansville

Change in Applicants, Admits, and Enrollers, 2001-2014



Percent Change in Applicants, Admits, and Enrollers, 2001-2014



Source: Jon Boeckenstedt, [Why are yield rates declining?](#)

What is @RISK?

- A product by the Palisade company, HQ New York state
- An add-in to MS Excel, with syntax akin to Excel functions, great ease of use
- Part of a suite of decision making tools – Decision Tools Suite, with precision trees, statistics, optimizers and genetic algorithms
- Random number generation and statistical distributions are key to modelling, simulation and forecasting - @RISK is better than Excel only RNG

Source: www.palisade.com

Summer 2013, Evansville knows its Fall 2013 metrics

Enrolment Stage - Evansville 2013	Number of People	Conversion %	2013 RNL (%)		
			Low (25th)	Medium (50th)	High (75th)
SUSPECTS - Identifying a broad pool	Unknown	Unknown	Unknown	Unknown	Unknown
PROSPECTS - Narrowing the field	Unknown	Unknown	9%	15%	24%
APPLICATIONS - Taking the leap	2,935	100%	61%	72%	82%
APPLICATIONS COMPLETE	2,935	84%	83%	89%	95%
ADMIT - Opening the door	2,468	18%	24%	30%	41%
ACCEPT - Making the commitment w/deposit	444	122%	85%	90%	95%
REGISTER - Welcoming the freshman class	543				

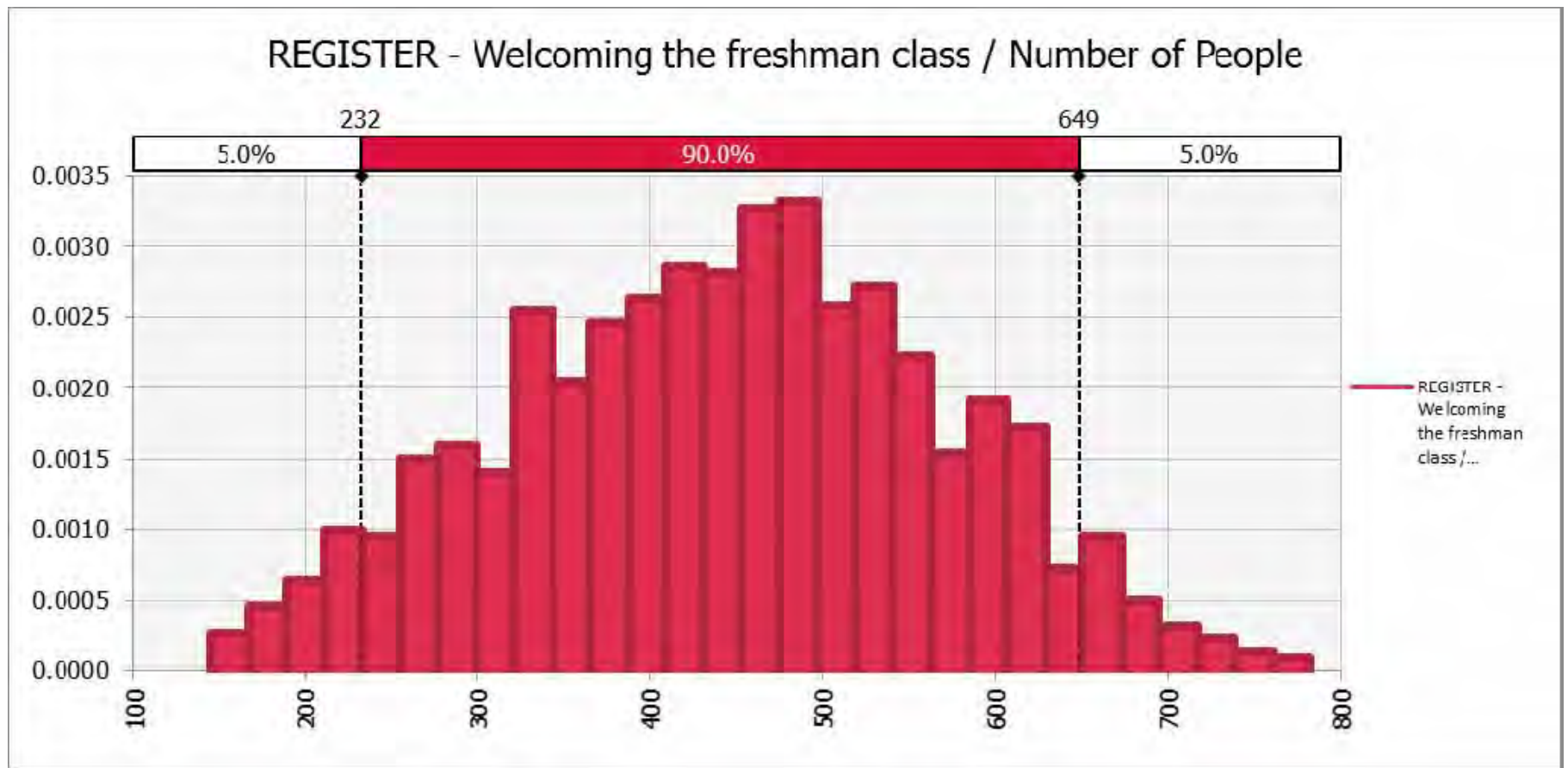
Sources: Why are yield rates declining?, www.noellevitz.com

May 2013 simulation – assume 150K leads

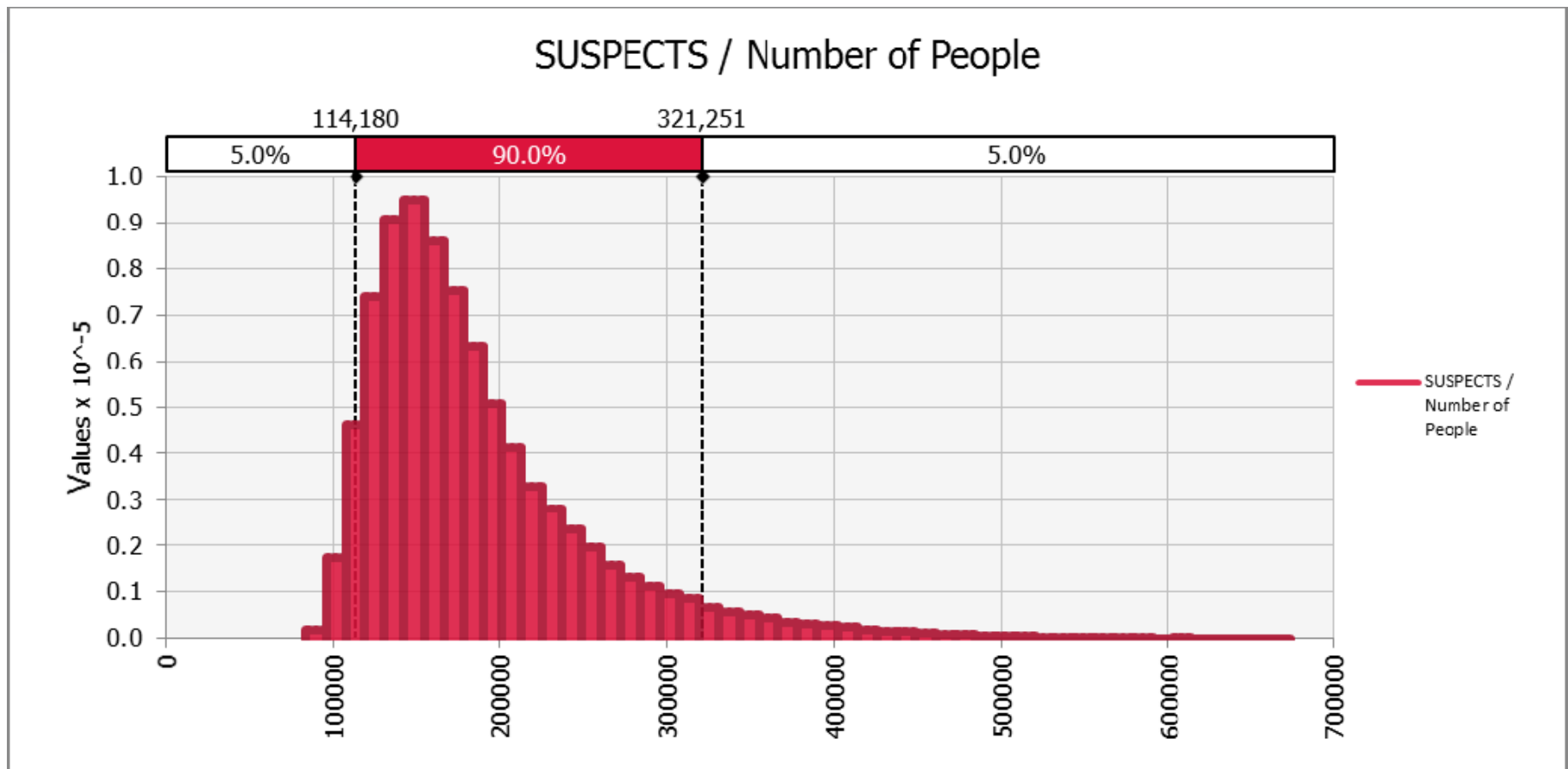
Enrolment Stage - May 2013 simulation	Number of People	Conversion %	Estimates from Evansville 2013 (%)	Low	Likely	High
SUSPECTS	150,000	26%		22%	27%	30%
PROSPECTS	39,500	6%		2%	7%	10%
APPLICATIONS	2,502	100%		100%	100%	100%
APPLICATIONS COMPLETE	2,502	85%		81%	84%	89%
ADMIT	2,118	17%		13%	18%	21%
ACCEPT	367	121%		117%	122%	125%
REGISTER	445					

Now let's take a look at a funnel model for Evansville in Excel, with @RISK distributions to sample the range of possible outcomes.

- May 2013 simulation – range of outcomes @RISK



May 2013 – reverse funnel – calculate SUSPECTS





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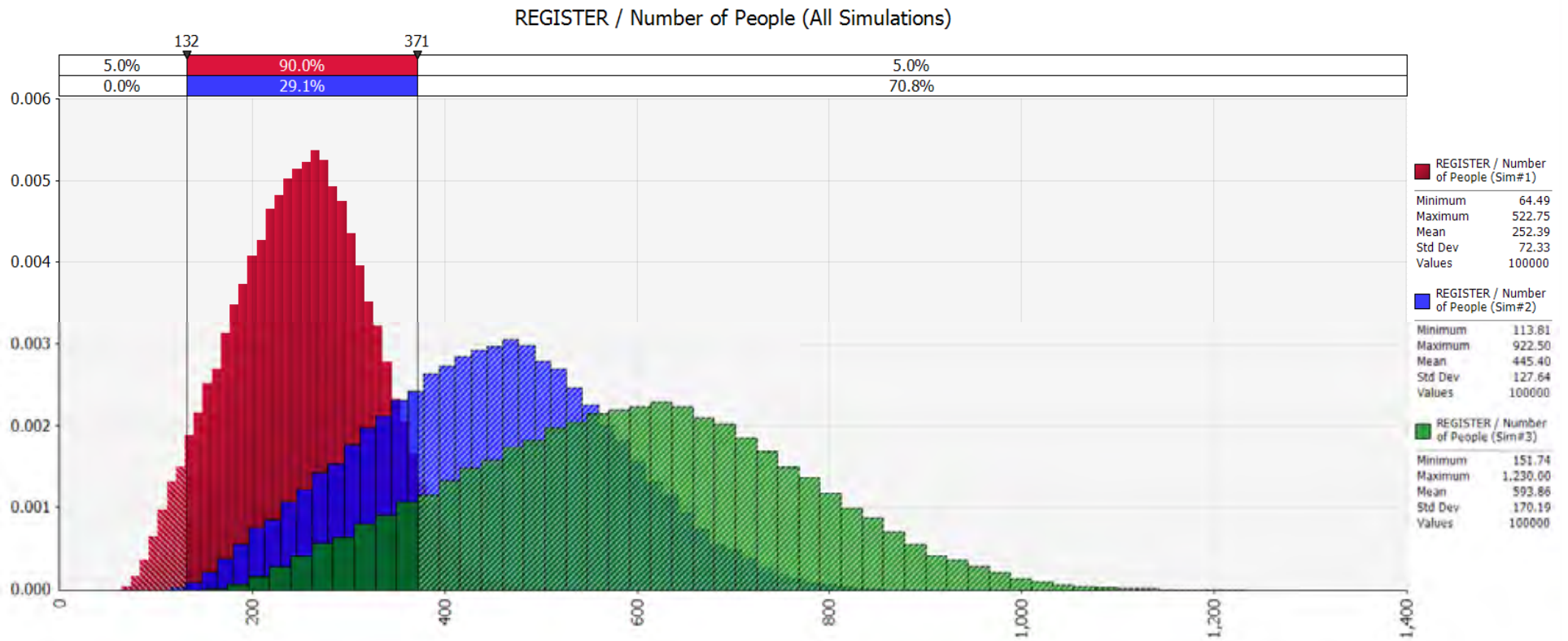
Toronto

Summary Statistics for SUSPECTS / Number of People			
Statistics		Percentile	
Minimum	83,828	5%	114,215
Maximum	676,401	10%	122,489
Mean	185,941	15%	129,092
Std Dev	66,902	20%	134,833
Variance	4475879486	25%	140,195
Skewness	1.714764978	30%	145,456
Kurtosis	6.948044638	35%	150,693
Median	167,920	40%	156,117
Mode	141,720	45%	161,830
Left X	114,215	50%	167,920
Left P	5%	55%	174,620
Right X	321,903	60%	182,022
Right P	95%	65%	190,458
Diff X	207,687	70%	200,062
Diff P	90%	75%	212,014
#Errors	0	80%	226,774
Filter Min	Off	85%	246,160
Filter Max	Off	90%	274,068
#Filtered	0	95%	321,903

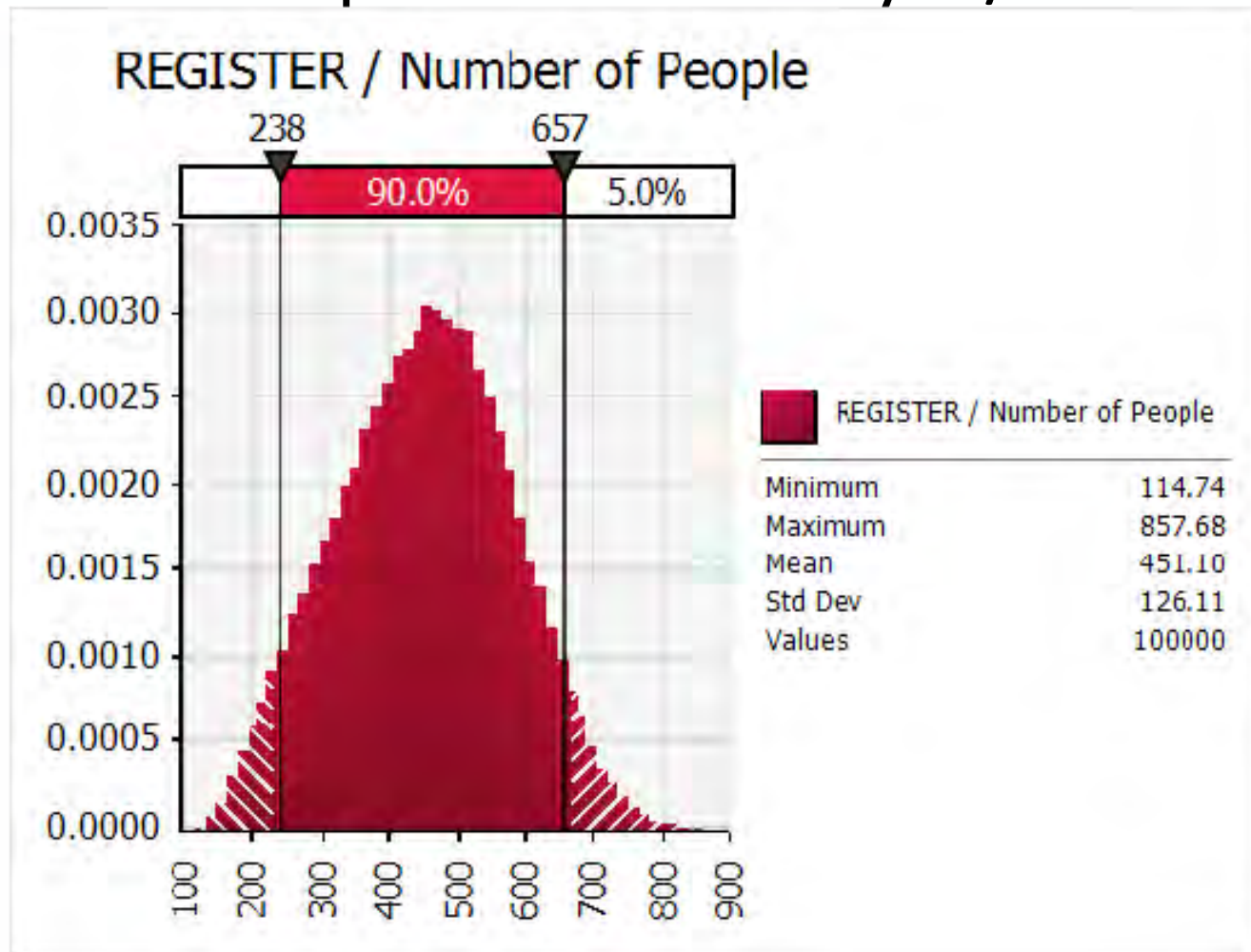
Carolyn Ford, Western University

Alternately, we can pretend we're the marketing manager for Evansville in May 2013 and ask the question:

What would the possible range of registrants be if I could choose between purchasing suspect/lead data for 85,000 people versus 150,000 versus 200,000? => Use RiskSimTable



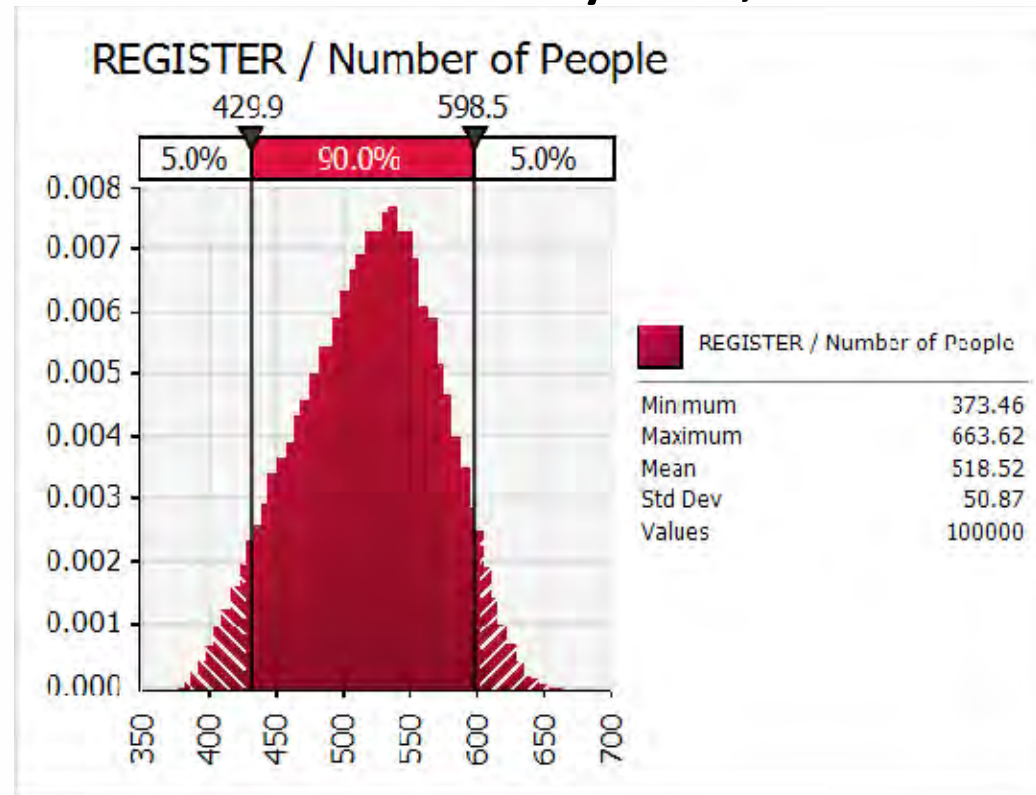
August 2013 – replace uncertainty w/ 40K



August 2013 – with 40K PROSPECTS

Summary Statistics for REGISTER / Number of Peo			
Statistics		Percentile	
Minimum	115	5%	238
Maximum	858	10%	279
Mean	451	15%	311
Std Dev	126	20%	337
Variance	15904.00177	25%	361
Skewness	-0.029260567	30%	382
Kurtosis	2.503009597	35%	402
Median	455	40%	420
Mode	473	45%	438
Left X	238	50%	455
Left P	5%	55%	471
Right X	657	60%	488
Right P	95%	65%	505
Diff X	419	70%	522
Diff P	90%	75%	541
#Errors	0	80%	561
Filter Min	Off	85%	585
Filter Max	Off	90%	615
#Filtered	0	95%	657

December – now we know the number of applications with certainty – 2,912

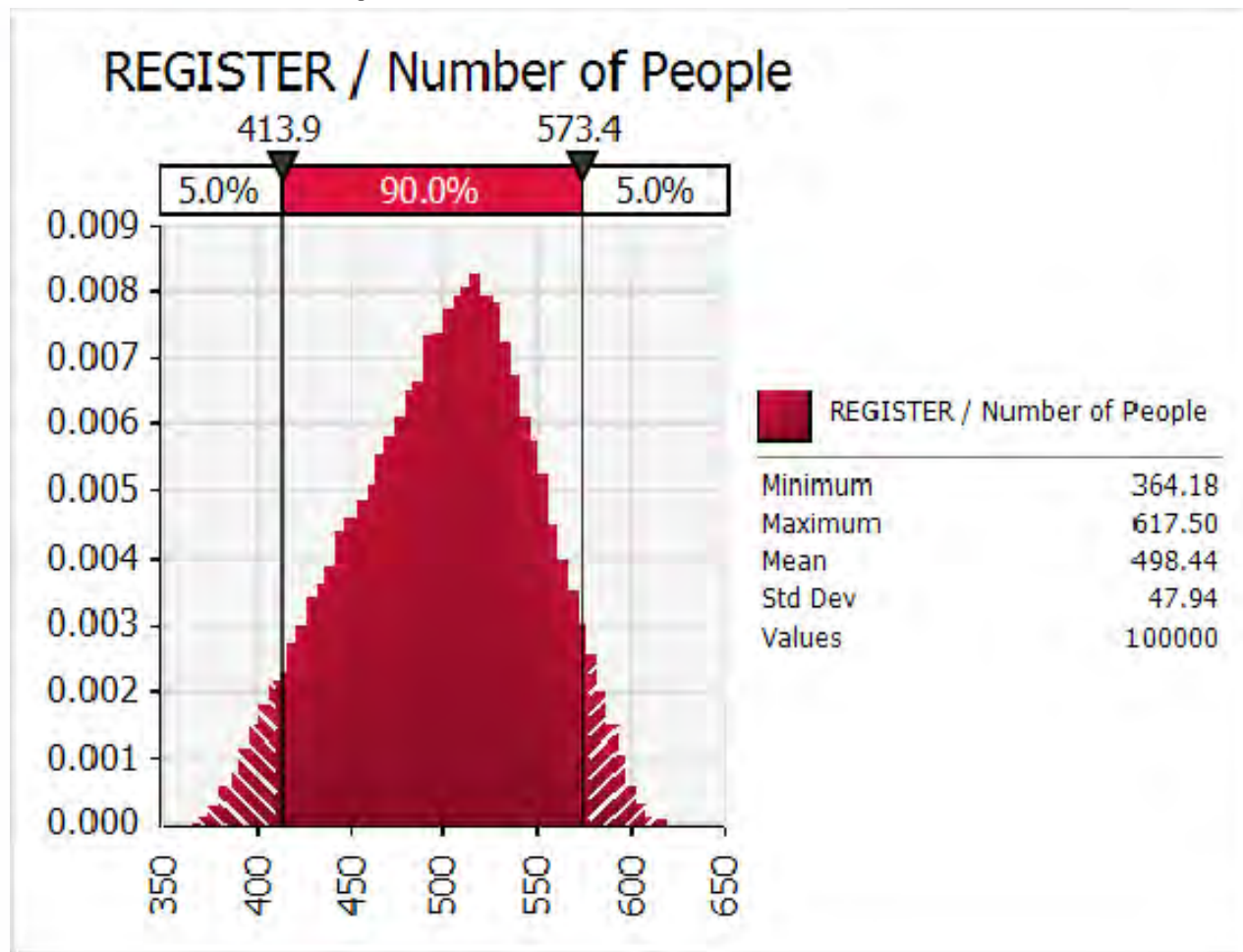


December 2013 continued

Summary Statistics for REGISTER / Number of Peo

Statistics		Percentile	
Minimum	373	5%	430
Maximum	664	10%	448
Mean	519	15%	461
Std Dev	51	20%	472
Variance	2587.684231	25%	482
Skewness	-0.17907006	30%	492
Kurtosis	2.455791549	35%	500
Median	522	40%	508
Mode	534	45%	515
Left X	430	50%	522
Left P	5%	55%	529
Right X	598	60%	535
Right P	95%	65%	542
Diff X	169	70%	549
Diff P	90%	75%	556
#Errors	0	80%	564
Filter Min	Off	85%	573
Filter Max	Off	90%	584
#Filtered	0	95%	598

March 2014 – replace with 2,370 Admits

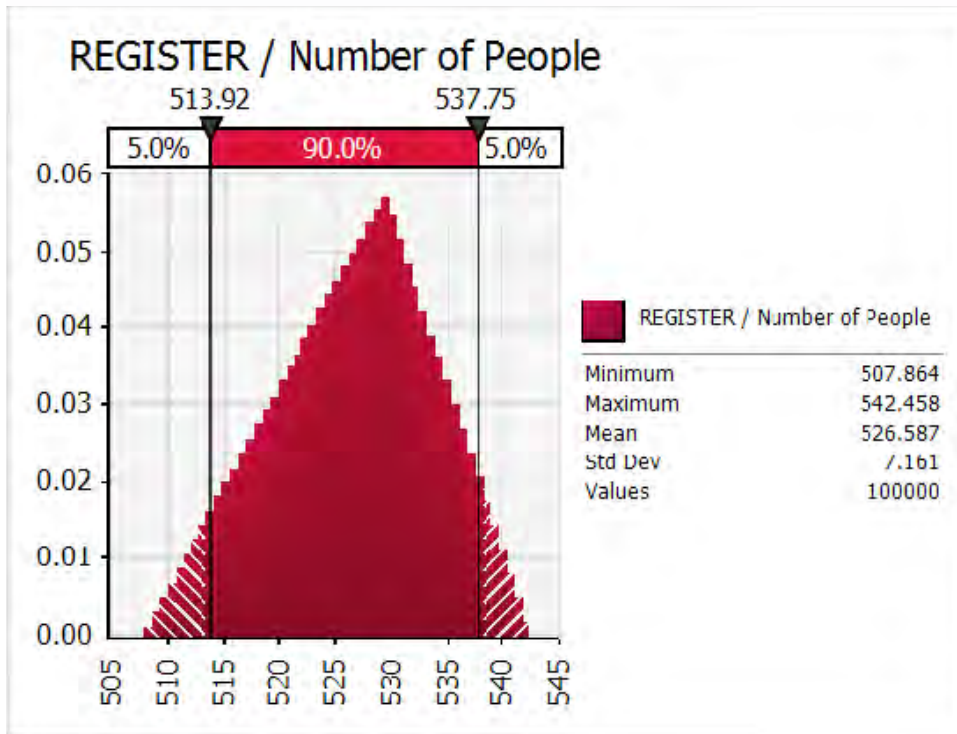


March 2014 – replace with
 2,370 Admits

Summary Statistics for REGISTER / Number of Peo

Statistics		Percentile	
Minimum	364	5%	414
Maximum	617	10%	431
Mean	498	15%	444
Std Dev	48	20%	455
Variance	2298.187298	25%	464
Skewness	-0.218869048	30%	473
Kurtosis	2.420747841	35%	481
Median	502	40%	489
Mode	519	45%	496
Left X	414	50%	502
Left P	5%	55%	508
Right X	573	60%	515
Right P	95%	65%	521
Diff X	159	70%	527
Diff P	90%	75%	534
#Errors	0	80%	541
Filter Min	Off	85%	550
Filter Max	Off	90%	560
#Filtered	0	95%	573

And by the time we get to May 2014....



Summary Statistics for REGISTER / Number of Peo

Statistics		Percentile	
Minimum	508	5%	514
Maximum	542	10%	516
Mean	527	15%	518
Std Dev	7	20%	520
Variance	51.27521465	25%	522
Skewness	-0.235842427	30%	523
Kurtosis	2.400029848	35%	524
Median	527	40%	525
Mode	529	45%	526
Left X	514	50%	527
Left P	5%	55%	528
Right X	538	60%	529
Right P	95%	65%	530
Diff X	24	70%	531
Diff P	90%	75%	532
#Errors	0	80%	533
Filter Min	Off	85%	534
Filter Max	Off	90%	536
#Filtered	0	95%	538



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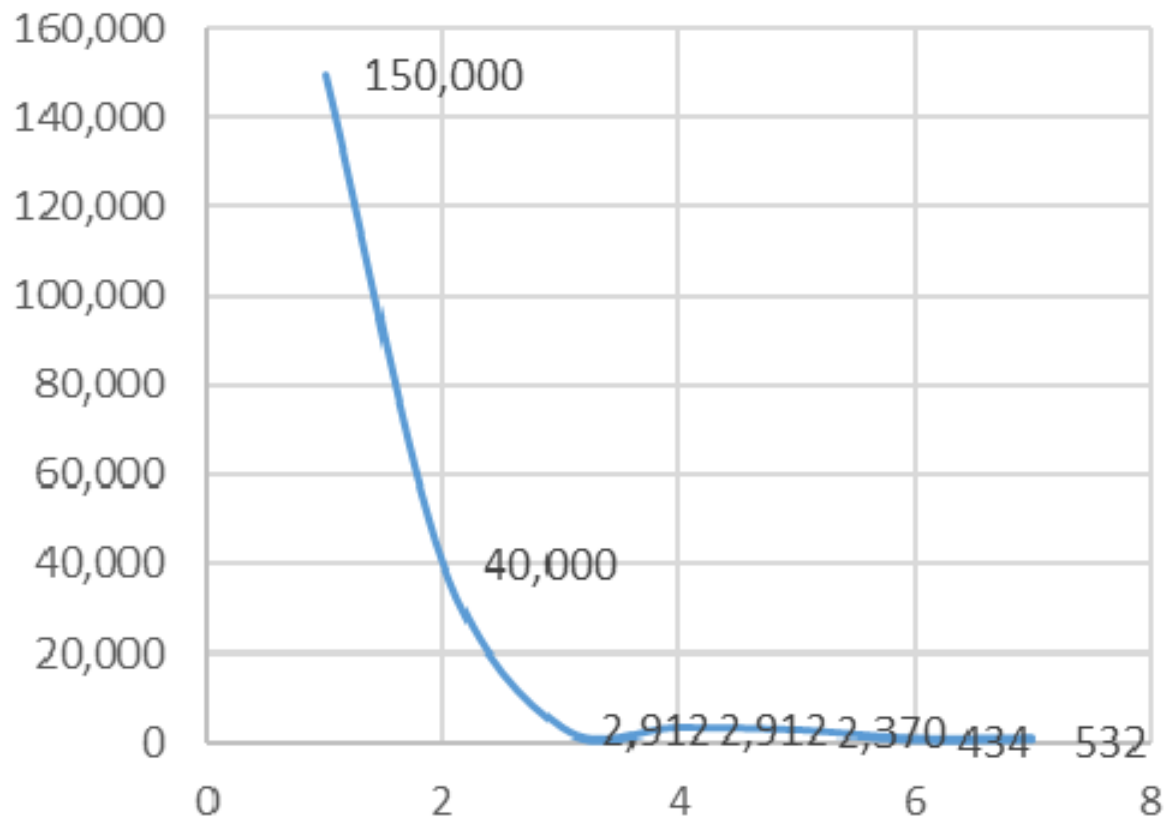
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PROSPECTS - Narrowing the field	40,000	7%		9%	15%	22%
APPLICATIONS - Taking the leap	2,912	100%		61%	73%	82%
APPLICATIONS COMPLETE	2,912	81%		83%	89%	95%
ADMIT - Opening the door	2,370	18%		24%	28%	39%
ACCEPT - Making commitment/deposit	434	122%		87%	91%	94%
REGISTER - Welcoming freshman class	532					

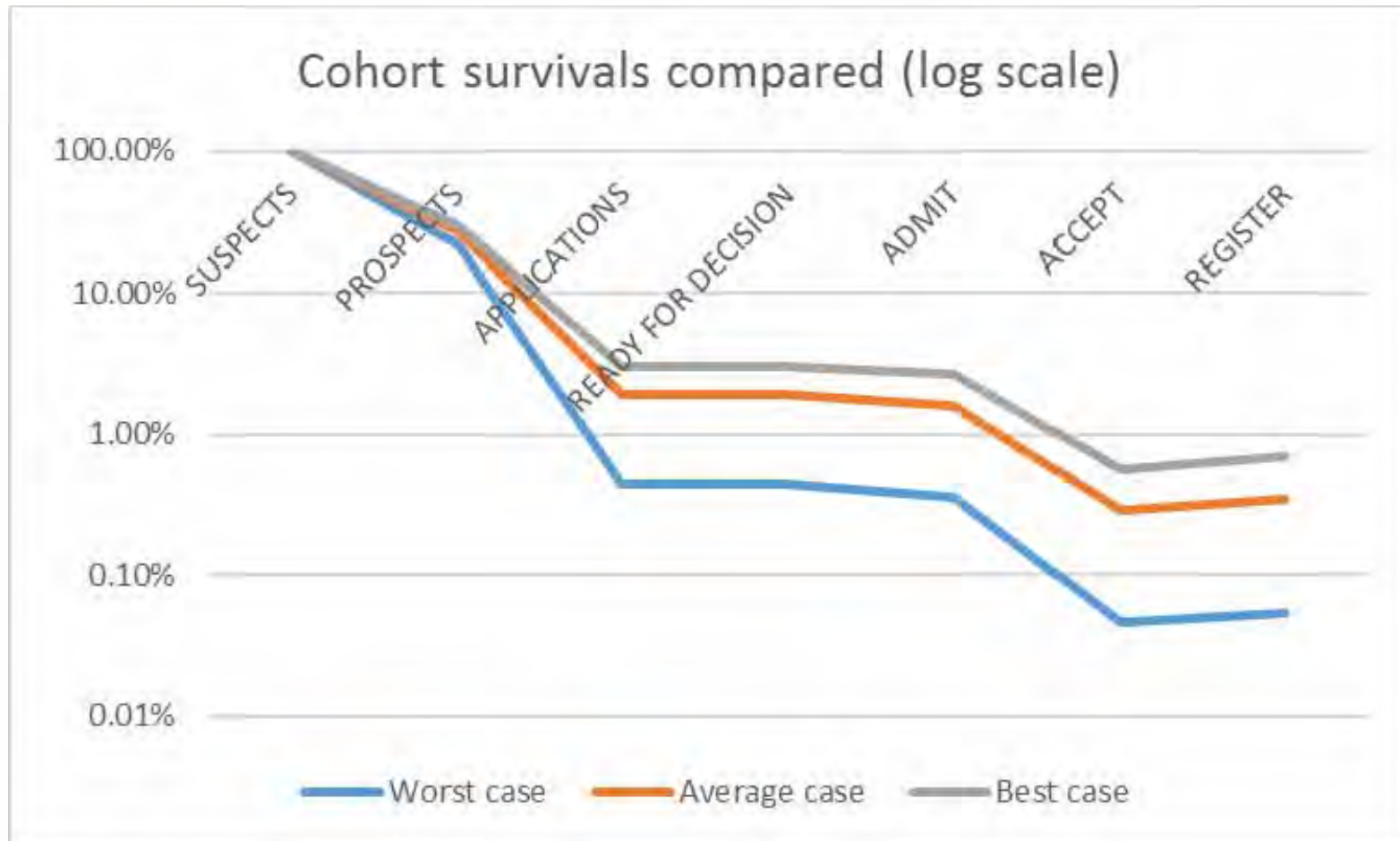
Carolyn Ford, Western University

Evansville 2014 - Fall 2014 actual



Evansville 2014 Registrants - Cohort Survival





Areas for improvement?

- Improve prospect to applicant conversion rates
- Application to Application Complete – track if not doing
- Complete to Admission Offer – could raise this, but already not selective
- KEY – Improve Admit to Deposit!

What they're doing well

- Appear to be doing a great job of combatting summer melt
- As well as late cycle enrolment top up (those net gains of 98 enrolments)

Where to go from here?

Set of references with conference slides, and trial @RISK



The Decision Tools Suite

Complete risk and decision analysis toolkit



@RISK

Risk analysis software using Monte Carlo simulation for Excel and Project



BigPicture

Mind Mapping and Data Exploration for Excel



PrecisionTree

Decision trees for Microsoft Excel



NeuralTools

Sophisticated neural networks for Microsoft Excel



StatTools

Advanced statistics toolkit for Microsoft Excel



Evolver

Innovative optimization for Microsoft Excel

Where to go from here?

- It is incumbent upon all of us in enrolment management functions to become more numerate, quantitative, aware of the range of the outcomes, etc.
- Don't get rid of your in-house statistician(s)!
- Useful tools for the marketer at the 8-16 months out stage, with uses in budgeting

For those looking to work immediately on enrolment prediction models:

- From admit pool to registrant
- From application pool to registrant
- From prospect pool to registrant
- From suspect pool to registrant

=> You'll be looking for binary probit or logistic models



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A decorative graphic of a stylized leaf or branch in a light green color, positioned in the upper right corner of the banner.

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Enrolment modelling and forecasting with @RISK

Thank you! I hope you enjoyed learning about the potential of some of these techniques.

Clearly (at least based on the publications available thus far), our comparator institutions in the U.S. have a head start on loading lots of variables that could be used to create the draft enrolment prediction model for a binary probit or logistic type model that would return an output variable of 1 – ENROL or 0 – NOT ENROL.

Some of the great data sets U.S. institutions are able to leverage in their strategic enrolment management efforts:

- A. Acxiom and Personix data. Based on nine digit ZIP code clustering, comprising 70 segments and 21 life stage groups. A consumer segmentation and visualization system.
- B. National Research Center for College and University Admissions. Aka “Clearinghouse” with access to over 5 million name of students in over 22,000 high schools across the country.

As you build a model, it will be important to score individual applicants and put them in one of ten bins, from which there is a specific propensity to enrol or not. Knowing which bin a group of applicants is in, the team can target which bins are most amenable to lift their propensities to enrol from one bin to the next, and which actions are likely to make that lift possible. As mentioned in the presentation, State University New York - Brockport claims to have an application – enrol model that is 90.7% accurate in predicting enrolment.

As I think of what on Ontario university could use, at a minimum, to build an application - enrol model that goes beyond current models, these data fields or variables come to mind:

- Source of initial contact
- Initial application date
- Application complete date
- Decision date – ADMT date
- OUAC position for 1, 2, 3, 3+
- Engagement score per applicant provided from CRM
- Visit campus – Yes/No
- Gender
- Geography or predefined recruitment region – Country of education
- Admission average
- Admit type or basis of admission
- Number of applicants from same school as reference id
- Number admits from same school as reference id
- Preferred program/faculty of enrolment
- Country of citizenship
- Ease of obtaining a study permit with a background from said country of citizenship
- Dollar value of scholarship and financial aid
- +/- change year on year CAD/USD F/X rate
- Travel distance from campus
- Date of notification of scholarship and financial aid

- Athlete, if recorded in student information system (SIS)
- Legacy, if recorded in SIS
- Extent of engagement actions taken by institution with respect to the reference ID to date

Results should be that the team only spends the minimum amount of money needed to shape the cohort, and matches the techniques that will work, be effective with the type of prospect or applicant. First key decision being how to choose an initial number of suspects or leads such that costs to acquire are lower, yet the marketing team still meets its enrolment goals.

Finally, some blue sky, blue ocean thinking. When will strategic enrolment management techniques advance to the point where a university's SEM team will make its offers of admission by letting a neural network make the admissions and enrolment decisions? One of the example models in the Palisade software shows a neural network program rating applicant credit files, and making credit decisions after having been trained on a prior data set of applicant loan histories and repayment records.