Simulation/Validation Methods in Data Analytics

Panel on SIMUL/VALID

Marek Bauer, Cracow University of Technology, Poland

Arash Ramezani, University of the Federal Armed Forces, Germany

Edward Williams, University of Michigan - Dearborn, USA

Philipp Helle, Airbus Group Innovations, Germany

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Background

- Research Engineer at Airbus Group Innovations since 2003
- Member of the Model-based Systems and Software Engineering team
- Studied Linguistics, Computer Science and Media Culture

Current research activities:

- Increase test automation
- Use models to ensure correctness of system specification and design
- Integration of development and testing activities during product development
- Testing of autonomous systems

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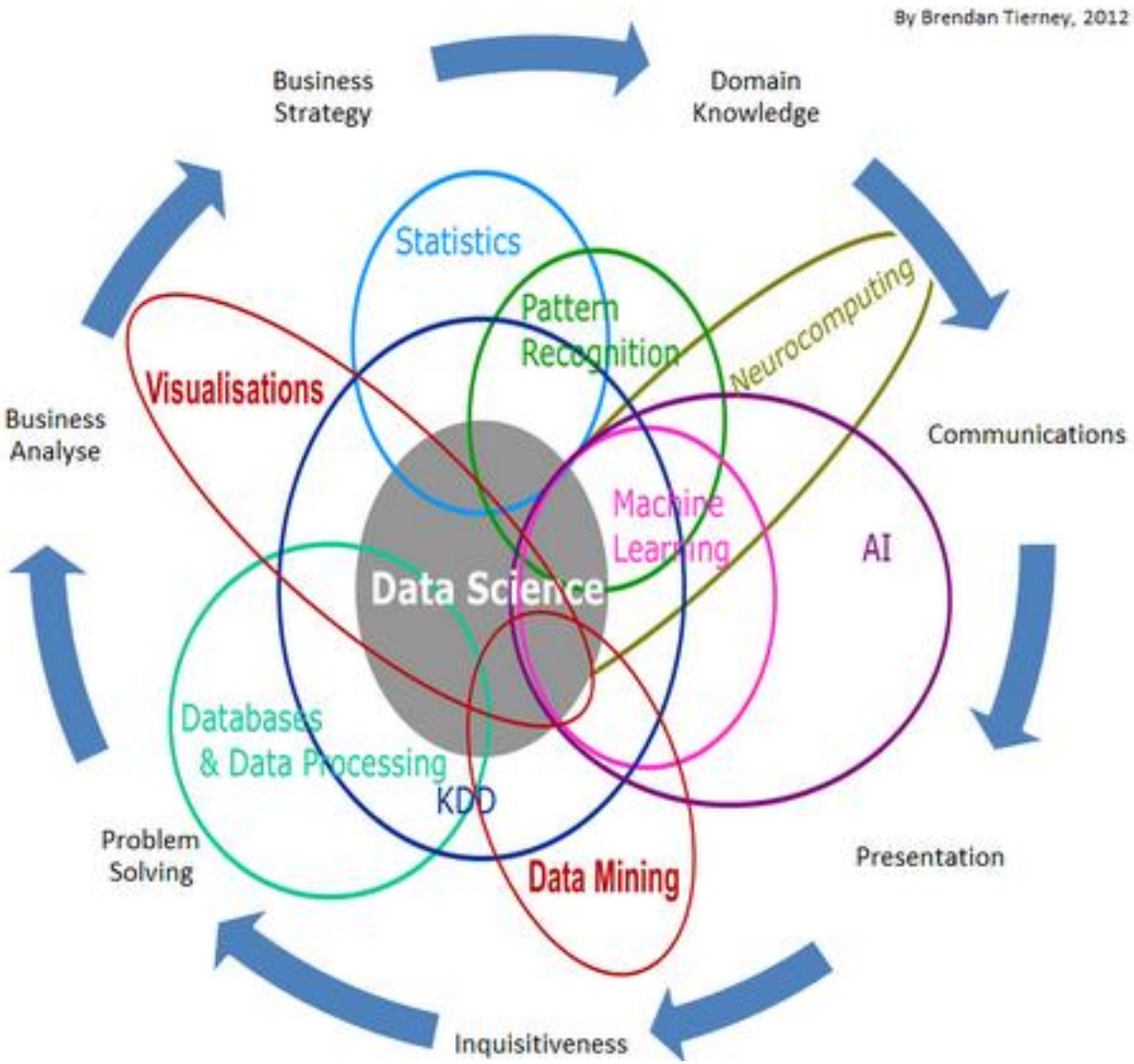
Data science is multidisciplinary



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Data Analytics for Testing

The advance in technology has allowed the aircraft testers to achieve their dream:

- Recording of almost all relevant data during testing

But: this comes with a downside

- The amount of data collected is huge
- Amount of data per flight test: 30-120 GB
- Amount of data per year: 20-60 TB

Finding the right information in this amount of data is equivalent to finding a needle in a haystack.

Source: aero.de

Data Analytics for Testing

Current test processes still old-fashioned:

- Evaluation of pass-fail criteria according to the defined test case
- In case of problems: manual investigation of the data around the time of the occurrence of the problem
- Additionally: Using basic statistics on individual signals to find outliers (e.g. deviation from mean)

Possible uses of data analytics for testing:

- Test data evaluation (data mining, pattern recognition, clustering, advanced statistics,…)
- Test data generation (adaptive testing, see VALID 2014)

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Further uses for Data Analytics

Customer support & maintenance engineering

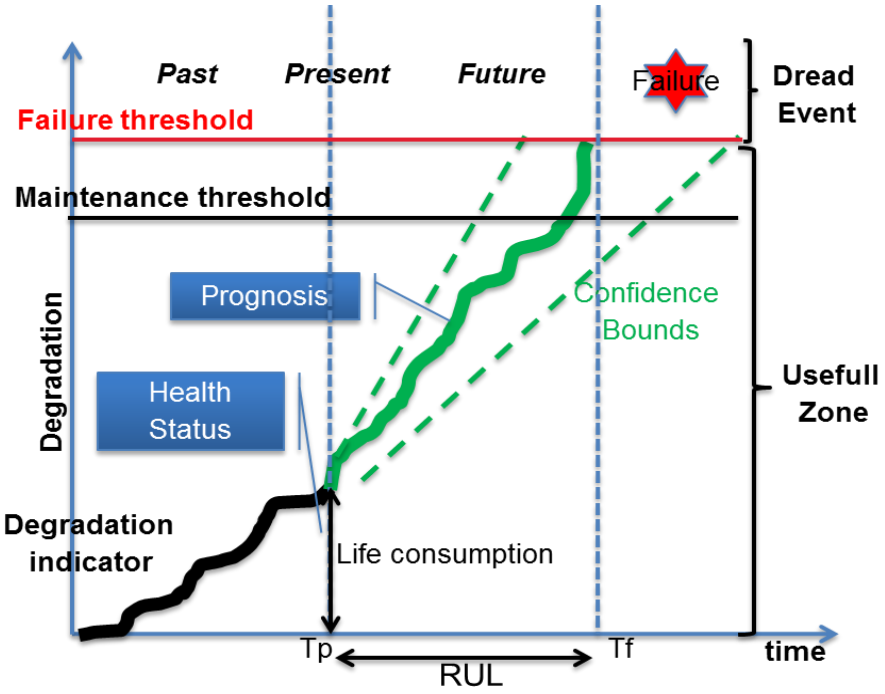
- Product health management
- Predictive maintenance

Manufacturing & manufacturing engineering

- Adaptive planning
- Intelligent dashboards

Autonomous Systems

- Autonomous flight
- Self-awareness, self-healing



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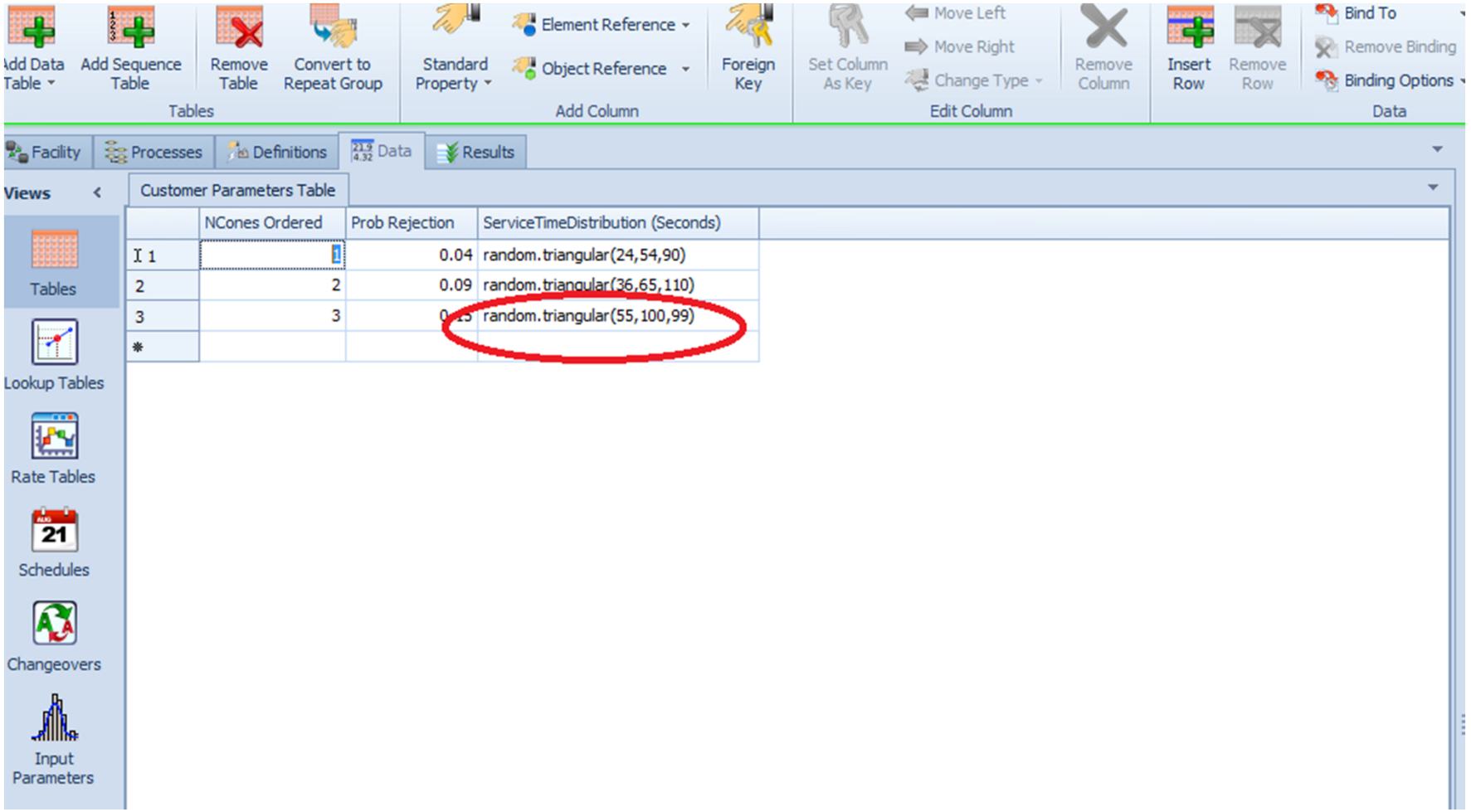
Simulation/Validation Methods in Data Analytics

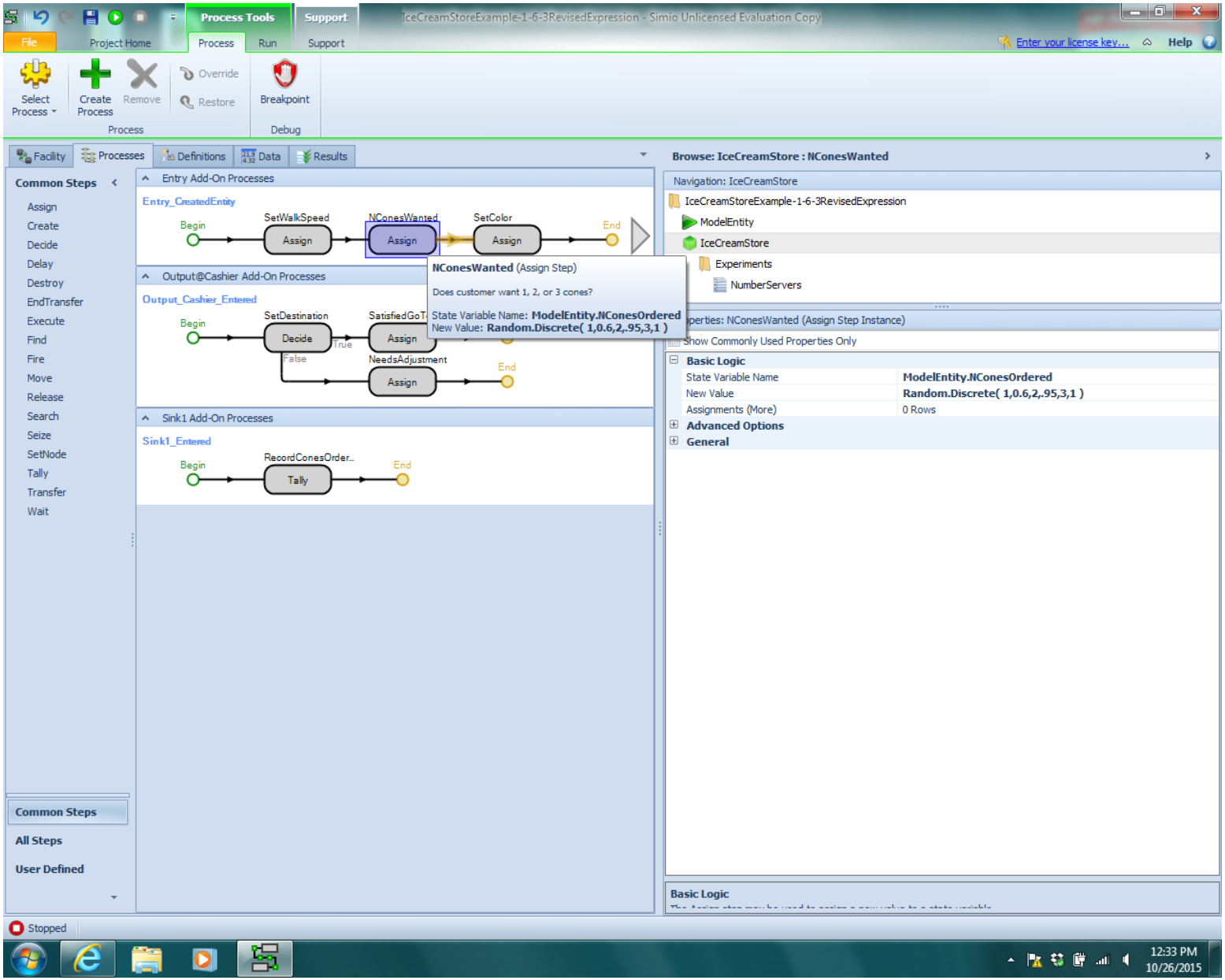
Edward Williams
University of Michigan – Dearborn[1]
PMC[2]
Dearborn, Michigan USA

[1]Teach master's-level course in simulation
[2]Undertake industrial engineering consulting work

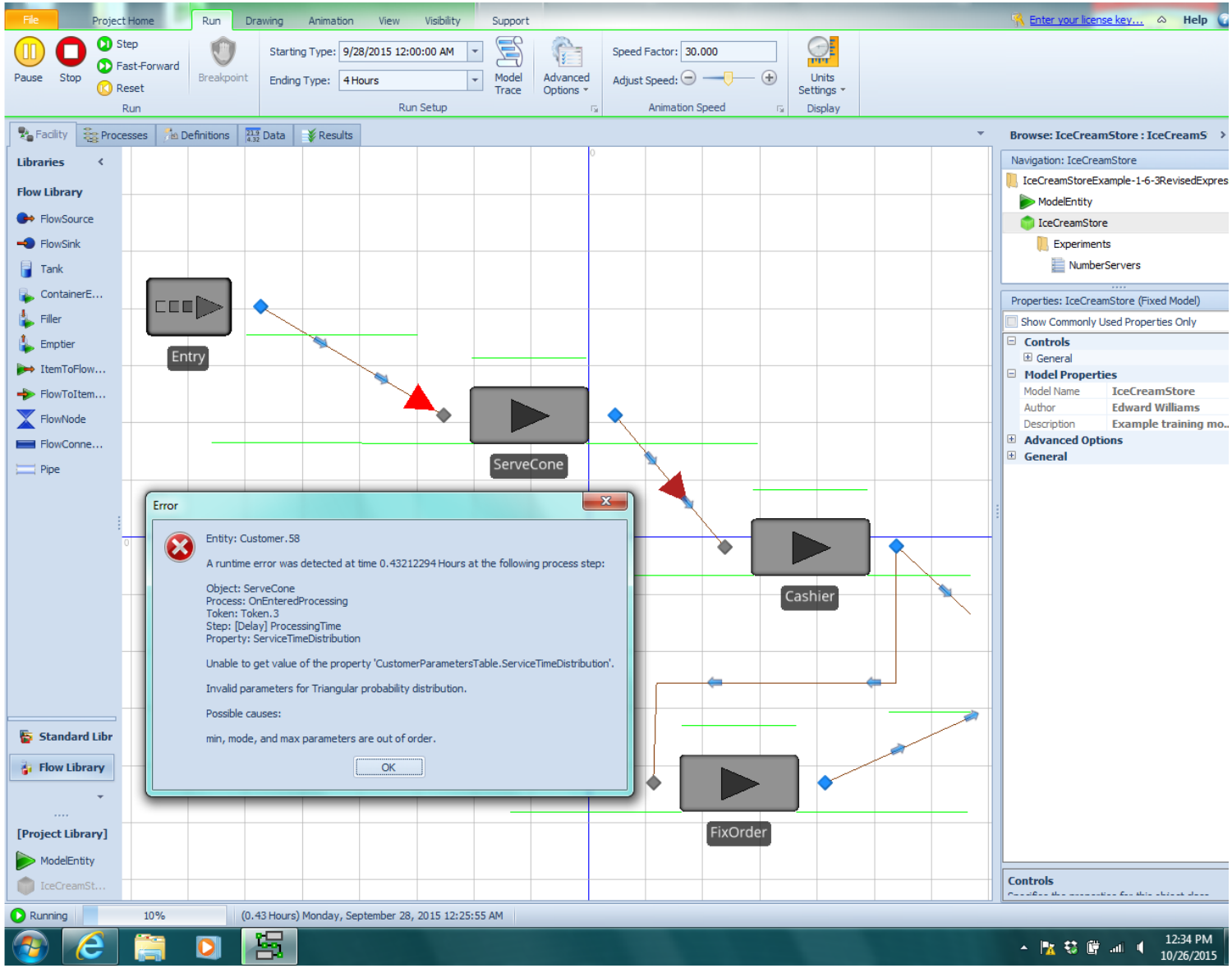
Laying the Error Trap



Setting the Parameters



Error Realized



A Useful Technique

- Fosters a healthy suspicion – what can go wrong?
- Yes, the lookup data table is being used
- Yes, Simio® notices the invalid parameters of the triangular distribution – eventually!
- Yes, the assignment of number of cones wanted seems to be working (few customers want 3 cones)

Questions and Discussion

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The Seventh International Conference on Advances in System Simulation SIMUL 2015
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Simulation/Validation Methods in Data Analytics
Verification vs validation
(in modelling transportation systems)

PhD Marek Bauer
Cracow University of Technology
Faculty of Civil Engineering
Institute of Road and Railway Engineering
Department of Transportation Systems

General modelling procedure in transportation planning

TRAFFIC ZONES

I. DEMAND MODELLING

NETWORK (PuT, PrT)

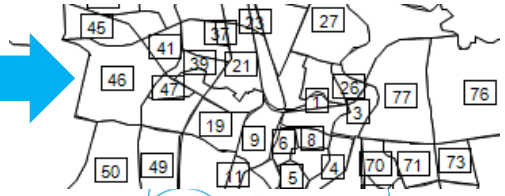
II. TRIP DISTRIBUTION

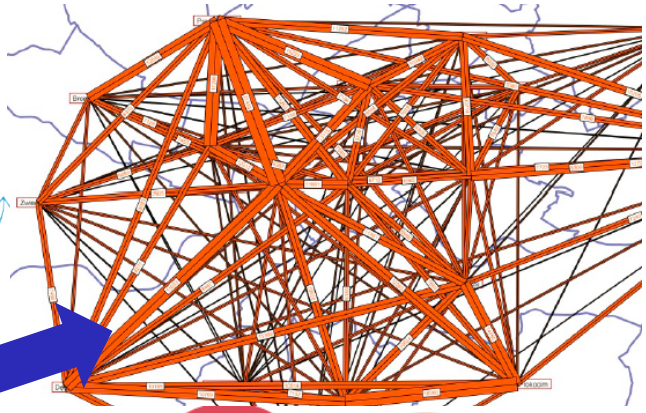
SKIM MATRICES

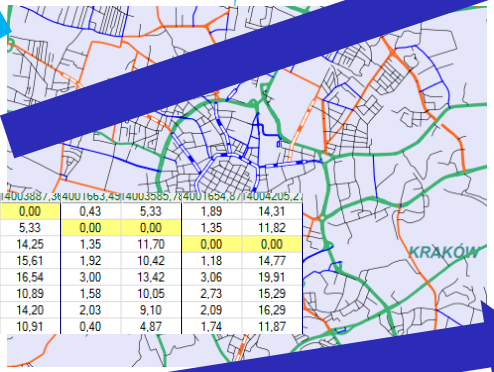
III. MODAL SPLIT

CONNECTING

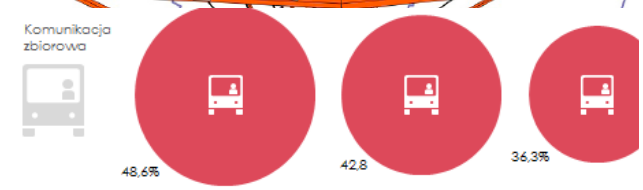
IV. ASSIGNMENT

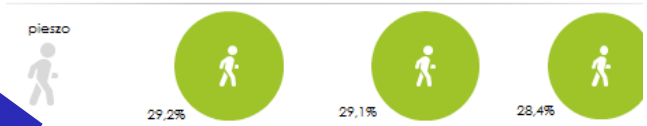


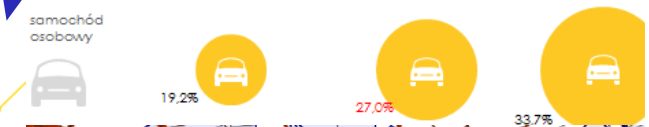




0,00	0,00	0,43	5,33	1,89	14,31
0,43	5,33	0,00	0,00	1,35	11,82
1,90	14,25	1,35	11,70	0,00	0,00
3,99	15,61	1,92	10,42	1,18	14,77
3,17	16,54	3,00	13,42	3,06	19,91
3,27	10,89	1,58	10,05	2,73	15,29
4,20	14,20	2,03	9,10	2,09	16,29
3,71	10,91	0,40	4,87	1,74	11,87







Verification vs validation: measures/indicators

Modelling stage	Kind of data
Traffic zones defining	Socio-demographic data (number of inhabitants, employees, students, services, …)
Demand modelling	Number of trips beginning and ending in traffic zone with division onto trip motivations (all trips)
Network building	Capacity, speed, time losses, … (PrT) Standard running time, dwell time, offered capacity, … (PuT)
Trip distribution	Number of trips between traffic zones (all trips)
Skim matrices calculating	Travel times between traffic zones for different means of transport (empty network - PuT, PrT)
Modal split	Number of trips between traffic zones (PuT, PrT, non-motorized)
Traffic connecting	Procedure parameters (PrT, PuT)
Assignment	Traffic volume, speed, transportation work, … (PrT) Passenger volume, number of transfers, travel time, transportation work, … (PuT)

Verification vs validation: importance

Modelling stage	Verification	Validation
Traffic zones defining	+	++
Demand modelling	++	+
Network building	++	++
Trip distribution	++	+
Skim matrices calculating	+	-
Modal split	++	+
Traffic connecting	+	-
Assignment	++	++

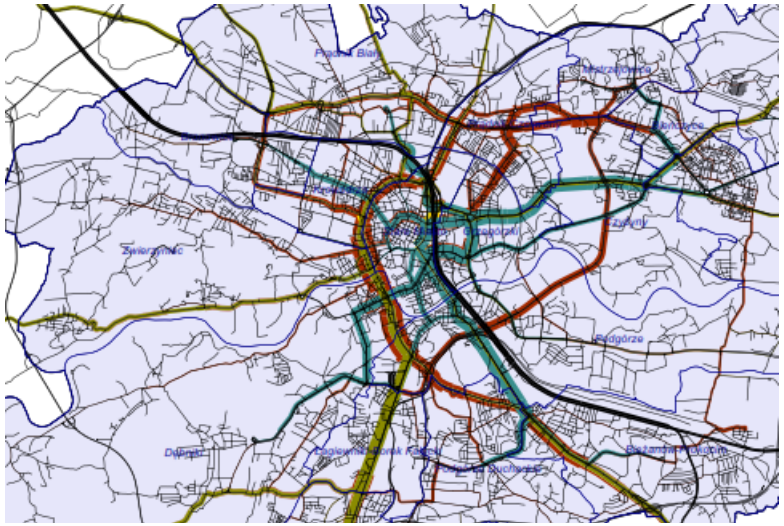
Verification vs validation: Level of accuracy

❑ General approach:

- ➢ Individual transport (PrT)
  (cars, passengers)
- ➢ Public transport (PuT)
  (passengers)

❑ Detailed approach:

- ➢ Individual transport (cars)
- ➢ Public transport – separately: rail, metro, tram, bus,… (passengers)
- ➢ Non-motorized (bikers, pedestrians)



HELMUT SCHMIDT UNIVERSITÄT
Universität der Bundeswehr Hamburg

Messtechnik Informationstechnik

The Seventh International Conference
on Advances in System Simulation

PANEL on SIMUL/VALID

Topic: Simulation/Validation Methods in Data Analytics

November 18, 2015

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Helmut-Schmidt-University
University of the Federal Armed Forces Hamburg
Holstenhofweg 85, D-22043 Hamburg

Biography

- Arash Ramezani currently works for the Federal Ministry of Defence.
- He has studied Applied Mathematics at the University of Bremen and the University of Queensland in Australia and received his Diploma degree in 2010.
- In 2015 he received his doctor's degree in engineering science with his studies on
  - "Numerical Simulation of Terminal Ballistic Processes for the Analysis of Selected Armor Structures and the Optimization of Modern Security Vehicles".
- His research interests include modeling, simulation and visualization of ballistic problems.

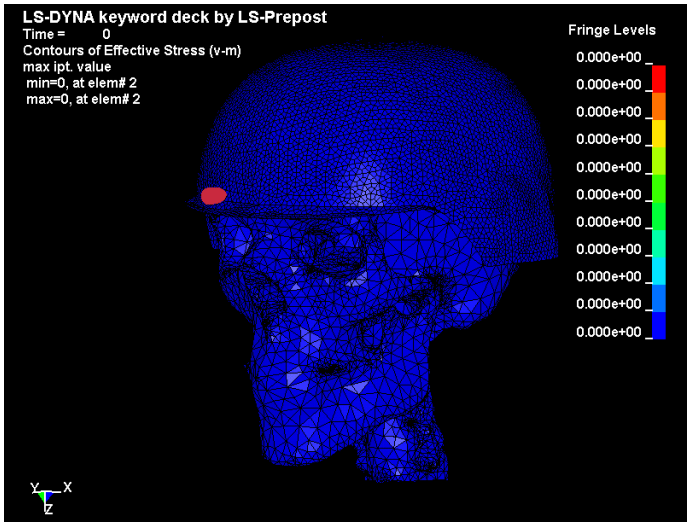
Investigation of Modern Armor Structures with Numerical Simulations

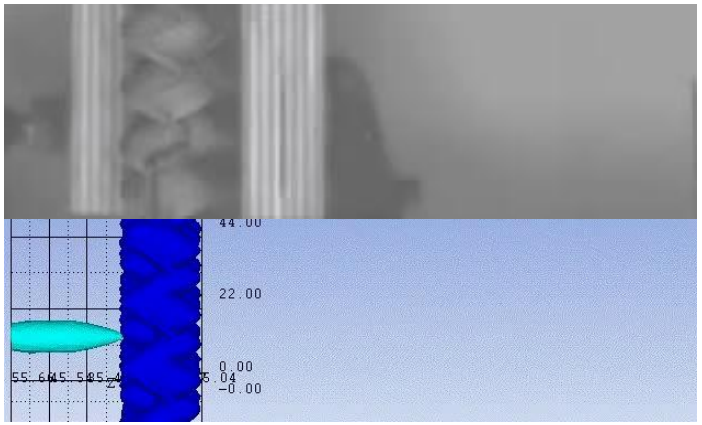
- The threat imposed by terrorist attacks is a major hazard for military installations, vehicles and other items
- An important endeavor of international research and development is to avert danger to life and limb
- Ballistic testing is limited due to costs and permissions for experimental results
- This is why numerical simulations are more frequently applied than experimental tests which are thus being replaced gradually

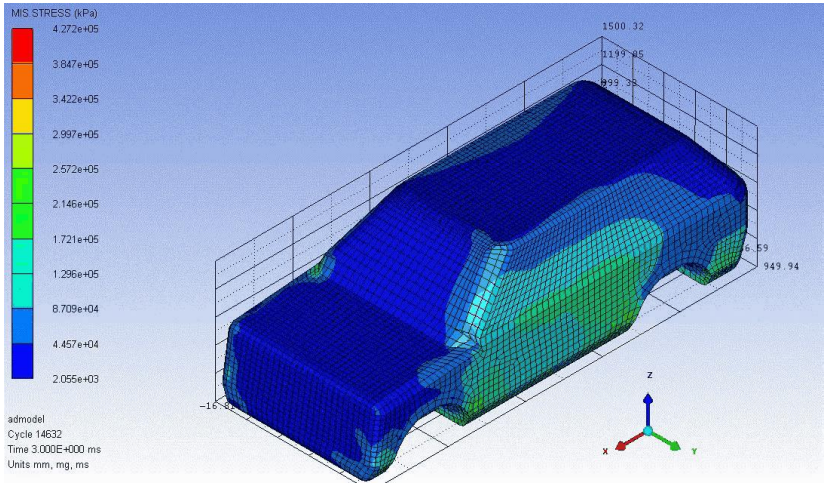
Investigation of Modern Armor Structures with Numerical Simulations

Fields of application:

- Simulation of impacts
- Ballistic protection
- Energetic systems
- Wave propagation
- Force of detonation
- Testing of materials



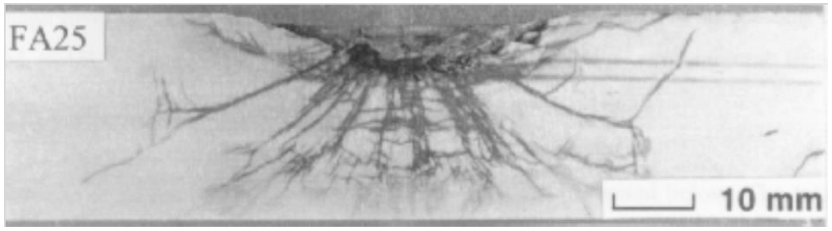




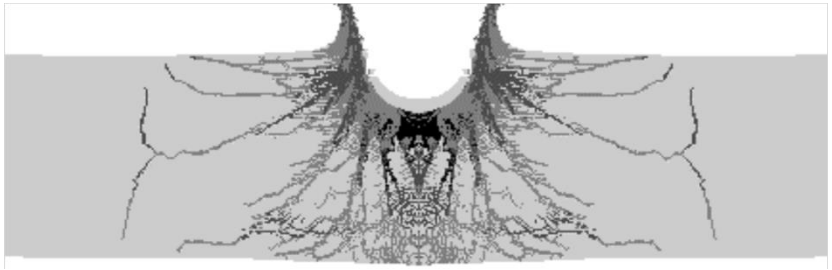
Investigation of Modern Armor Structures with Numerical Simulations

Challenge:

- The materials of the test objects are normally unknown – they have to be created and optimized for the calculation, so that the material behavior in the simulation can be conveyed in an exact manner
  - ➢ Data analysis for a statistical certainty
    - ➢ High susceptibility to errors
      - ➢ High safety hazard



Experiment



Simulation

Investigation of Modern Armor Structures with Numerical Simulations

Traditional ballistic testing: