# RUTGERS

Rutgers Business School Newark and New Brunswick

#### RARC / CarLab

**Research Center Presentation** 

Miklos A. Vasarhelyi KPMG Professor of AIS, Rutgers Business School Director of RARC / CarLab



#### Outline

- Structure
- Funding
- Advisory Board
- Continuous Assurance
  - Continuous data assurance
  - Continuous control monitoring
  - Continuous risk management and assessment
- Evolving towards the future



## Funding

- Very limited
- About 250K a year
- Currently
  - KPMG
  - Itau Unibanco
  - Annual conference
  - Small donations

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#### **Advisory Board**

- Mr. Robert Elliott Advisory Board Chairman Partner (Retired) KPMG
- Alan W. Anderson, CPA ACCOUNTability Plus, LLC President
- Dr. Gerard Brennan, CAFÉ Risk & Internal Control Officer USA Siemens Corp.
- Stuart V. M. Campbell KPMG, National Managing Partner Assurance and Advisory Services Center KPMG LLP
- Michael P. Cangemi, CPA, CISA President & CEO Cangemi Company LLC
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- Sam Parker Director, Management Systems Division AT&T
- Amy Pawlicki Director Business Reporting Assurance & Advisory Services and XBRL - AICPA
- Bill Titera Partner Ernst & Young Chairman Assurance Services Executive Committee
- Lily Shue Director WISS Business Solutions LLC
- Joe Steakley Senior VP Internal Audit HCA Hospital Corporation of America
- John Verver Vice President, Services and Product Strategy ACL Services. Inc.



# The CarLab Research Efforts

- Siemens
  - Continuous control monitoring (CCM)
  - Audit automation
  - Authorization and control structure project
- Continuity equations at HCA
- Itau Unibanco
  - Branch monitoring and analytics
  - Transitory Accounts
  - Product sales monitoring
- Insurance company
  - Forensics as CA -> the wires project
  - Claims

Adobe Acrobat Standard - [Accounting Program Research Rankings by Topical Area and Methodology SSRN-id1337755.pdf]	- 7 🗙
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#### TABLE 2

#### Rankings (Number of Publishing Professors) of Accounting Institutions by Topical Area

_		AIS				Audit	
The second	19 Yrs	12 115	Vre	– University	19 Yrs	12 Yrs	6 Yrs
Rutgers	1 (5)	1 (4)	1(3)	Ariz St	1 (11)	12 (6)	39 (2)
Ariz St	2 (3)	ə (3)	18(1)	Tx-Austin	2 (10)	9 (6)	15 (4)
Bentley	2 (4)	2 (4)	3 (2)	So Calif	3 (10)	6 (8)	20 (5)
Cen Fla	4 (3)	3 (3)	10(2)	Northeastern	4 (5)	3 (5)	4 (5)
Missouri	4 (3)	3 (3)	3 (3)	Illinois at Urbana Champaig	5 (13)	2 (11)	3 (10)
So Illinois	4 (6)	5 (4)	2(3)	Wisconsin	6 (9)	1 (7)	2 (5)
So Florida	7(4)	8 (4)	10(3)	Bentley	7 (6)	5 (6)	6 (6)
Ty Tech	8 (4)	5(4)	6(3)	Fla Internat	8 (4)	4 (4)	1(4)
Florida St	0(4)	0(7)	3(2)	New So Wales	9 (10)	7 (9)	5 (8)
Vornosow St	9(3)	9(2)	$\frac{5(2)}{75(0)}$	Cornell	10(3)	29 (3)	39 (2)
Kennesaw St	9(3)	9(3)	73(0)	Florida	10(5)	16(5)	$\frac{27}{2}$
Melbourne	9(2)	28(1)	18(1)	IX A&M Bright Nouna LI	10(9) 12(8)	10(7)	13(3)
Michigan St	9(3)	9 (2)	18 (2)		13(0) 12(4)	7 (8)	9(3)
Portland St	9 (4)	9 (3)	6(3)	Indiana Indiananalia	15(4)	9(4)	11(4) 11(2)
Brigham Young U	14 (4)	28 (2)	75 (0)		15 (8)	14(6)	11 (2)
Georgia St	14 (3)	14 (3)	18 (2)		17(6)	14(0) 21(6)	
Kansas	14 (4)	14 (3)	10 (2)	Nanyang Tech	17 (6)	9(6)	$\frac{20}{7}(5)$
No Arizona	14 (2)	20 (2)	10 (2)	Missouri	19(2)	14(2)	7(3)
Tx A&M	14 (2)	9 (2)	18(1)	Arizona	20(6)	37(4)	$\frac{7}{39}(3)$
Utah	14(1)	28 (1)	37 (1)	Kentucky	20(0) 20(4)	20(4)	27(3)
Arkansas	20(1)	14(1)	10(1)	Vanderbilt	20(3)	29 (3)	57 (3)
Auburn	20 (3)	20 (2)	10 (2)	Boston Coll	23 (5)	44 (3)	78 (1)
Cal St Long Bch	20 (2)	14 (2)	6 (2)	Alabama	24 (4)	16 (4)	15 (3) 6
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#### The CarLab Research Efforts (2)

- P&G
  - KPI project
  - Order to cash project -> selective automation
  - Vendor / payments project
- KPMG projects
  - Technology adoption at CPA firms
  - Technology adoption at IA departments
  - The future of audit
  - Rapid Prototyping Environment for data research (RPE)
  - Dashboard / visualization / Advanced Analytics Representation (DVAA)
- Telecom and Real Estate Co (TRE)
  - Duplicate Payments detection



#### **Carlab Research Efforts (3)**

- AICPA ASEC
  - Common Data cube
    - Visionary effort for providing a common auditor data platform and a multiplicity of apps
    - Partnership with many vendors
  - ERM assurance
    - Assurance on the processes of risk management
  - Continuous audit
    - Rewrite of red book and conceptualization and principles and criteria for continuous audit



#### **RARC and Our Teaching Mission**

- The VPA effort
  - Automatic course recording experiment just started
  - A vision of free unencumbered educational stream for less developed nations
- Clickers
  - Experimentation with response system uses in different contexts



#### Out of the box

• Standards Formalization: issuing standards in autocode



## **AAA Impact of Research Taskforce 2009**

 Perhaps the most important contribution of accounting information systems research to practice in the auditing and assurance domain is in continuous assurance. The work of Vasarhelyi and his colleagues on continuous assurance demonstrates the application of strong theoretical foundations to the practical problems of the auditor; in this case the internal auditor.



## Innovations in Continuous Auditing

- Modeling: continuity equations (HCA)
- Discrepancy detection -> multidimensional clustering
- Process mining -> at international bank in Holland
- Remote audit conceptualization Siemens, P&G, Itau Unibanco
- Automatic taxonomy creation
- Multiple multivariate applications



#### Monitoring and Control: 5 levels of activity

Continuous Report Continuous Assura Transacti Judgmen Analytic monitorin	ting ance on assurance, t evaluation g level	Estimate assura	nce, Compliance as	ssurance,  •Drill Down
KPIs: Marketing/Sales Ratio Inventory turnover •Distribution				
Relationship level Sales change = E-Care queries Delay relations	Incremental M = number of sa	arketing cost * 2 ales * 4.1	.7 +- 12%	•Drill Down •History •Distribution
Data level •Investment •Regions •Clients •Dynamics	<ul> <li>Product detail</li> <li>Regions</li> <li>Clients</li> <li>Dynamics</li> </ul>	•Collection •Aging of receivables •Clients •Dynamics	<ul> <li>Inventory</li> <li>Distribution</li> <li>Ownership</li> <li>Dynamics</li> </ul>	•Drill Down •History •Distribution
Structural level Marketing	Sales	Cash A/R	Bad Debts Provisio	E-Care



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# **Continuous Assurance**



## An Evolving Continuous Audit Framework





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## **Continuous Data Assurance**



#### Rutgers

**Rutgers Business School** 

#### Newark and New Br Continuity Equations / Long Distance Billing

#### reservations





Receiving Call detail data from independent telephone companies in mag. tapes Creating datasets one-to-one many-to-many one-to-many' Splitting call detail into files to be posted to different billers

Posting from oneRating eabiller file to accountsBillablein several billingCustomercycles











#### RUTGERS Rutgers Business School PAS OVERVIEW





#### Lessons from HCA project

- Intricate processes can and must be monitored
- This may be done at the transaction levels, in addition to more aggregate levels
- Models are necessary that are adaptive and can react to current circumstances
- Errors may be automatically corrected
- A tool may be derived from the performed work that could be superior to existing tools



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# Metlife

- Data stream of 200K wire transfers
- Data only currently milable for the wires and the records possess little information
- Little context k wordge can major feeding streams
- No fraud training day zvailable
- Worked during the audit spolemer a the audit team work
- Developed a series of data to s relate to specific conditions and trends
- Working on an aggregate weighting martel
- Need in the field verification of picked data

anno.



## Metlife (Project 2-3)

- Usage of clustering techniques to extract aberrations in data in parallel to the above discussed effort
- Usage of clustering techniques in the evaluation of exceptions in life insurance claims

Weka Clusterer	Visualize: 09:	31:32 - FM	(SmallClaimse	t1 csv)
The first characteries	The difference of the second		(onnanciannise	

	inter obististe Em (onite	inclumbers_cst/		
X: Insured_CLI_MARIT_S	TAT_CD (Nom)		•	Y: INSRD_JOB_STAT_CD (Nom)
Colour: Cluster (Nom)			•	Select Instance 🗸
Reset	Clear	Open	Save	Jitter

#### Plot: SmallClaimset1\_csv\_clustered



cluster1





We can cluster claims using different groups of attributes and flag the claims from specific groups in specific clusters.

Several clustering of different groups of attributes can make up the score.



## P&G (work with the audit inpovation team)

- KPI projects
- Automating order to cash
- Vendorfiles / Auplicate payments
- Risk dasaboard



## **KPI** project

- Company has facilities in over 160 countries
- Some facilities are manufacturing, some are pure distribution and sales
- Content is local and world sourced
- Substantive part of the work is building models for inventory and sales flow and trying to understand / model the level and flow variables
- The objective is to detect out of the normal events both of business and exception nature (errors and fraud)
- There are 4 large ERPs feeding the data / data is extracted in ACL and modeled in SAS
- 16 different models have been developed and are being tested



## Order to Cash Project -> Selective Automation

- This project aims to selectively automate parts of the audit using order to cash as the context
  - Audit action sheets
  - Taxonomization of protocols
  - Change of nature of evidence
  - Classification of automation level
    - Manual
    - Deterministic
    - Table comparison
    - Historical / stochastic
  - Architecture of the Structure
  - Prototyping of selected models



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#### **Continuous Control Monitoring**



#### **Siemens Projects**

- Focused on audit automation
  - First project looked at automating CCM in SAP
  - Second project focused on a wider scope of automation
  - A third project would think about reengineering the audit action sheets
  - The **fourth project** aims at formalizing SOD, activities, and control structures



#### **The Siemens Project Learnings**

- ERPs are very opaque
- Ratings schema are used and desired.
- 20-40% of the controls may interministically monitored
- Maybe other 20-4 may by vertible to be monitorable
- New form of alarm enderice that do not know how deal
- Continuor in k management and assessment needed for weigher evidence and choice of procedures



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#### **Continuous Risk Monitoring and Assessment**

#### **Assurance on Risk Management**



## Continuous Risk Monitoring and Assessment (CRMA)

- CRMA is a real time based integrated risk assessment approach, aggregating data across different functional tasks in organization to assess risk exposure, providing reasonable assurance on firm's risk assessment.
- CRMA continuously computes key risk indicators (KRIs) with firm's cross-functional data from its key business processes, as well as from external sources and validates them against whether they are linked to the firm's risk exposure.



# Key Risk Indicator (KRI)

- KRI provides early warning systems to track the level of risk in the organization
- KRI can be identified through analysis of key business activities
  - 6 steps for KRI identification (Scandizzo, 2005)
- Well identified and computed KRIs provide a reliable basis for computing the riskiness of firm for specific risk, such operational risk, liquidity risk, as well as the overall riskiness of firm.
  - f(KRI(i),KRI(ii),...KRI(n))= Risk exposure
  - External risk factors may be mapped manually into the computation of KRIs and risk exposure.



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## **CRMA** Architecture





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#### **Process Mining**

Mieke Jens (Hasselt University) Michael Alles (Rutgers Univ.)



#### What is Process Mining of Event Logs?

- The basic idea of process mining is to extract knowledge from event logs recorded by an information system. Until recently, the information in these event logs was rarely used to analyze the underlying processes. Process mining aims at improving this by providing techniques and tools for discovering process, control, data, organizational, and social structures from event logs. Fuelled by the omnipresence of event logs in transactional information systems... process mining has become a vivid research area.
- <u>http://is.tm.tue.nl/staff/wvdaalst/BPMcenter/process%20mining.htm</u>



#### An Example of An Event Log of an Invoice

#### **Invoice number 003 Invoice number 003** Input Supplier: AT&T Supplier: AT&T Posting date: Feb 10th 2010 Posting date: Feb 10th 2010 120 USD 120 USD data Description: internet services Jan 2010 Description: internet services Jan 2010 'Signature of John' 'Signature of John' 'Signature of Pete' 'Signature of Pete' PLUS - 'Create Invoice' Timestamp: Feb 12<sup>th</sup> 2010; 08:23 AM Originator: Mike Fields: supplier: AT&T, posting date: 02-10-2010, value: 100 USD, Description: internet services Jan 2010 Meta-data - 'Change' Timestamp: Feb 12<sup>th</sup> 2010; 08:43 AM Originator: John Field changed: Value Value old: 100 USD Value new: 120 USD -'Sign' Timestamp: Feb 12<sup>th</sup> 2010; 08:44 AM Originator: John Figure 1: Visualization of Input Data and Event Log Data of an Invoice

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# Research Team (all in AIS department but multidisciplinary background)

- Miklos A. Vasarhelyi, Prof. II (Continuous Auditing)
- Alex Kogan, Prof. (Computer Scientist)
- Michael Alles, Professor –( Economics)
- Helen Brown (Auditing)
- Don Warren, Professor (Audit Practice)
- Trevor Stewart, Professor (Retired D&T partner)
- Silvia Romero faculty Montclair University
- Yong Bum Kim PhD Student (Statistics)
- Daewoon Moon PhD Student (Risk Management)
- Ryan Teeter PhD Student (Computer Science)
- Qi, Liu– PhD Student
- Hussein Issa– PhD Student
- David Chen– PhD Student (Knowledge Engineering)
- Danielle Lombardi PhD student
- JP Krahel PhD student
- Karina Chandia PhD Student



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# Rapid Prototyping Environment for Data Research



#### **RPE** Overview

•Client Challenge: External audit work and audit-related advisory services progressively incorporate advanced analytics and knowledge bases.

•Area of Research: Evolved application of analytic methods

•Potential Use: Building on CAR-Lab experience from client projects (general ledger, transitory accounts, claims, wires, audit automation, loans, credit, with representative datasets for experimentation and demonstration) and employing existing public domain packages (such as WEKA or D), perform the following:

- Create masked datasets for demonstration of different techniques.
- Focus on technologies to deal with real-time and archival data feeds, in particular screening and automatic pattern recognition. A wide set of management problems falls into this domain which is being changed by the constant updating of data.
- The software tools, data, and models available will allow for testing the adequacy and demonstration of capabilities of advanced analytics.

•Example of Output: Use continuity equations, automatic error correction, delayed time contingent equations, and other linear methods to represent HCA transaction flow

\*See CAR-Lab-related qualifications and experiences on following pages



#### **RPE** New Analytic Methods for Data Research

Develop applications for continuous transaction monitoring, continuous controls monitoring, and continuous risk assessment/monitoring using:

- Continuity equations
  - Predictive modeling
  - Automatic data correction
  - Time lag / time series / crosssectional modeling
- Machine learning
  - Trained / untrained
  - Neural networks
- Genetic algorithms
- Logic / probit / and other regression techniques

- Rule based systems
  - Pure rules
  - Hybrid
  - Forensic ex-ante settings
- Clustering technology
  - Fraud identification
  - Identification of related processes in a BI context
  - Graphic demonstration / item identification / semantic domain usage demonstration



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#### Dashboard / Visualization / Advanced Analytic Representation



#### **DVAA** Overview

•Client Challenge: Develop dashboards for risk monitoring / develop other visualization prototypes for continuous assurance (CA), continuous monitoring (CM), continuous risk measurement and assessment (CRMA), and continuous controls monitoring (CCM)

•Area of Research: Risk and transaction monitoring and human-computer interaction

•Potential Use:

- Creation of KPI- and KRI-based views of the world in a continuous audit environment including status-quo, projection, and interpretations
- Management routines / internal audit response to continuous assurance alerts / alarm events
- KPIs and KRIs for selected major business processes and/or regulated industries such as financial services or energy (trading businesses)



#### **DVAA Overview (2)**

#### •Examples of Output:

- Tied to the management of unobservable controls at a large ERP in an industrial setting -> special artifacts for the representation of different controls, alarms for control deficiencies, indices of control coverage, other graphics action objects
- Aimed at controlling the different dimensions of risk measurement encompassing direct links to quantitative models as well as arbitrary qualitative items
- Tied to the management of large volumes of data in the understanding, management and transaction investigation in a transitory account setting within a financial institution



#### **DVAA** At-a-Glance

•Estimated Hours to Accomplish Project:

•Expected completion date:

•Key Activities:

a)Design scenarios of audit support

b)Survey for existing products and research (EWP, EIS)

c)Understand key decisions supported

d)Match to analytical techniques

e)Create demonstration prototypes for 3 key dashboards (audit operations, KPIs and KRIs)

f)Understand interactions between dashboards and management / audit reaction

g)Create control representation in dashboards

h)Test procedures

i)Write up results

#### **Deliverables:**

•CAR-Lab dashboard and visualization prototypes

•White Paper on the usage of dashboards as the working papers of the future

730 Hours April 2011



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#### **Evolving Towards the Future**



## **Opportunities for Monitoring and Audit**

- Creating Control system measurement and monitoring schemata (control dashboard)
- Creating standards for Business Process Monitoring and Alarming (to be able to detect variance)
- Exclude not time sensitive variables (e.g. depreciation, airport fees, etc)
- Creation of alternative real-time audit reports for different compliance masters



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