Performance Measurement & Data Warehouse

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Performance Measurement – Outline

• Why performance measurement? Why now?
• Internal measurement
  o What to measure
  o How to measure
  o Data Warehouses (etc.)
• External measurement
The Value of a Blocked Shot
Not All Blocked Shots Are Equal

Analysis of blocked shots in the NBA by a sports statistician and a U-Chicago professor
- Shots blocked into the stands with bravado allow opposition to retain possession.
- Shots blocked to breakaway teammate not only deprives the opposition of points but almost assuredly means two points for us; a “Bill Russell”.
- Seven entire seasons of NBA data analyzed
- Points assigned to blocks based on value instead of counts. For example:
  - Blocking to an opponent
  - Blocking out of bounds; opponent still has to inbound
  - Blocking to teammate (+)
  - Goaltending (-)
  - Goaltending and a foul (- -)

Source: Scorecasting; Moskowitz and Wertheim; 2011

Dwight Howard’s 232 blocked shots are “valued” less than Tim Duncan’s 149

<table>
<thead>
<tr>
<th>TEN MOST VALUABLE SHOT BLOCK PERFORMANCES FROM 2002 TO 2009</th>
<th>TEN LEAST VALUABLE SHOT BLOCK PERFORMANCES FROM 2002 TO 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLAYER</td>
<td>SEASON</td>
</tr>
<tr>
<td>Tim Duncan</td>
<td>2008</td>
</tr>
<tr>
<td>Andrew Bogut</td>
<td>2008</td>
</tr>
<tr>
<td>Rasho Nesterovic</td>
<td>2003</td>
</tr>
<tr>
<td>Zydrunas Ilgauskas</td>
<td>2006</td>
</tr>
<tr>
<td>Ben Wallace</td>
<td>2007</td>
</tr>
<tr>
<td>Ben Wallace</td>
<td>2008</td>
</tr>
<tr>
<td>Tim Duncan</td>
<td>2005</td>
</tr>
<tr>
<td>Chris Kaman</td>
<td>2006</td>
</tr>
<tr>
<td>Tim Duncan</td>
<td>2006</td>
</tr>
<tr>
<td>Tim Duncan</td>
<td>2009</td>
</tr>
</tbody>
</table>

- Howard’s 232 blocks contributed largely to his MVP award in 2008
- He leads all blockers but often blocks into the stands and has more goaltending calls
- Duncan blocked 83 fewer shots but often blocks to a teammate; few goaltending calls
- Why does the NBA count blocks rather than value blocks?
- “Relatively speaking, counting is easy, measuring value is difficult”

Source: Scorecasting; Moskowitz and Wertheim; 2011
Performance Measurement

• What is performance measurement?

• Forces driving us to measure
  – External forces
    • Federal and state government accountability interests
    • Higher Education Opportunity Act (HEOA)
    • Accreditation organizations
    • Parents and prospective students
  – Internal forces

• What should we look for and where and how do we get the data?

• Data warehouse discussion & dashboard demo

Performance Measurement Defined

Performance measurement – A process of developing measurable indicators that can be systematically tracked to assess progress made in achieving goals. A performance gap is the gap between what stakeholders expect and what each process produces in terms of quality, quantity, time, and cost of services and products.
Federal Government Interest and the Increasing Importance of Higher Education to the Nation

• The U.S. is falling behind other OECD countries in many measures commonly used to evaluate higher education.
• Increased demand for accountability and performance assessment.

Projected Tertiary Type-A Degree Attainment Rates for 25 to 34 Year Olds in OECD Countries 2020

[Bar chart showing projected attainment rates for different countries, with the United States at 34.3% and OECD average at 41.0%]
Projected Tertiary Type-A Degree Attainment Rates for 25 to 34 Year Olds in OECD Countries 2026

Percentage of students seeking a bachelor's degree at 4-year degree-granting institutions who completed a bachelor's degree within 6 years, by control of institution and sex: Starting cohort year 2006 (source NCES)
### Median Earnings and Tax Payments of Full-Time Year-Round Workers Ages 25 and Older, by Education Level, 2011

<table>
<thead>
<tr>
<th>Education Level</th>
<th>Median Earnings</th>
<th>Taxes Paid</th>
<th>After-Tax Earnings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional Degree (13%)</td>
<td>$121,960</td>
<td>$28,290</td>
<td>$93,670</td>
</tr>
<tr>
<td>Doctoral Degree (2%)</td>
<td>$120,300</td>
<td>$30,700</td>
<td>$89,600</td>
</tr>
<tr>
<td>Master's Degree (17%)</td>
<td>$71,066</td>
<td>$19,266</td>
<td>$51,800</td>
</tr>
<tr>
<td>Bachelor's Degree (27%)</td>
<td>$47,488</td>
<td>$13,368</td>
<td>$34,120</td>
</tr>
<tr>
<td>Associate Degree (11%)</td>
<td>$16,196</td>
<td>$4,840</td>
<td>$11,356</td>
</tr>
<tr>
<td>Some College, No Degree (17%)</td>
<td>$16,608</td>
<td>$4,840</td>
<td>$11,768</td>
</tr>
<tr>
<td>High School Diploma (27%)</td>
<td>$20,410</td>
<td>$6,040</td>
<td>$14,370</td>
</tr>
<tr>
<td>Less than a High School Diploma (27%)</td>
<td>$18,916</td>
<td>$5,880</td>
<td>$13,036</td>
</tr>
</tbody>
</table>

**Sources:** U.S. Census Bureau, 2012, Table P35-10; Internal Revenue Service, 2013, Davis et al., 2015; calculations by the authors.

For detailed data, see: trends.collegeboard.org.
Educational demand for employment has grown; we expect that trend to continue.

Societal Benefits Derived From a Well-Educated Population are Numerous and Include...

**An Increase In:**
- Tax revenue
- Individual health and well-being
- Volunteer work
- Voting participation

**A Decrease In:**
- Poverty levels
- Unemployment rates
- Social safety-net programs (e.g., food stamps)
- Narcotics addiction
- Alcoholism
- Incarceration rates
- Obesity rates
- Smoking rates
Federal Involvement – From the Spelling’s Report to HEOA

  - A Test of Leadership: Charting the Future of U.S. Higher Education
  - “Lack of useful data and accountability hinders policymakers and the public from making informed decisions and prevents higher education from demonstrating its contribution to the public good.”

http://collegecost.ed.gov/catc/
Increased focus by regional accreditors on measurable, quantifiable achievement of goals and objectives related to student learning and institutional effectiveness.

**Regional Accrediting Agency**
- Middle States Commission on Higher Education
- New England Association of Colleges and Schools
- North Central Association of Colleges and Schools
- Northwest Commission on Colleges and Universities
- Southern Association of Colleges and Schools Commission on Colleges
- Western Association of Colleges and Schools

**Assessment of Institutional Effectiveness**
- Systematic Strategic Planning
- Assessment of Student Learning

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**Measuring Up – Student Learning**

"I don't know. What did you learn?"

Source: National Center for Public Policy and Higher Education
Other Factors Motivating Measurement

EXTERNAL
• Families facing much higher tuition & fee charges
• Budget pressure in states which must balance budget
• States linking performance to allocations
• Meet accreditation standards

INTERNAL
• Board Accountability
• Institutional self-improvement – CQI
• Academic or Administrative Program Review
• Compliance with mission and strategic planning initiatives, ERM

Data Warehouse

A data warehouse is a collection of data pulled together primarily from operational business systems, organized into subsets called data marts, structured and tuned for easy access and use by information consumers and analysts, especially for the purpose of decision making.
Why a Data Warehouse

Transactional vs. Analytical Systems

<table>
<thead>
<tr>
<th>Transaction Processing</th>
<th>Analytical reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Organized and managed to support transaction processing</td>
<td>• Organized and managed based on the reporting and analytical needs</td>
</tr>
<tr>
<td>• Efficient, fast inserts and updates</td>
<td>• Efficient, fast retrieval</td>
</tr>
<tr>
<td>• Requires certain level of computing skills</td>
<td>• Appeal to wide range of computing skills</td>
</tr>
<tr>
<td>• Application specific: were designed and built separately (FAIMS, Student, FA, Alumni Systems...)</td>
<td>• Integrated – designed or “architected” at one time, implemented iteratively over short period of time.</td>
</tr>
<tr>
<td>• Primarily concerned with current data.</td>
<td>• Time Variant – often more concerned with historical data</td>
</tr>
</tbody>
</table>

Reasons for Data Warehouse

• RPI president’s strategic vision calls for improved decision support across the university
  – “The Institute’s strategic blueprint” for the coming years.

• Under the Plan, RPI will...
  – **Streamline** administrative processes
  – **Centralize** information systems
  – **Refine** or **reinvent** the budget model

  – **Provide managers at every level with accurate, timely, and relevant performance management information**
Business and Technical Barriers

- Lack of decision support tools
- Limited ad hoc query access to data
  - Operational systems not designed for reporting and analysis
- No direct access to performance and management information
  - Hardcopy and static on-line reports do not meet all the specific reporting and analytical needs
- Lack of unified approach in data definitions and classifications

Recognizing Cultural Barriers

- Resistance to learning & using a new tool
- Expectations on information availability and usability for decision making are low
- Habit of relying on Central Administration to provide information, or on their own sources, leading to multiple versions of the ‘truth’
- People need to acquire new job skills
- Job expectations need to change
- Evergreen process
Cultural Barriers

- Departments operate independently relying on separate systems for reporting and analysis
- Shadow systems, multiple truths
- "One version of the truth" implies culture change
- Culture change promotes fact-based decisions where value is placed on decisions made through use of information vs. supply of data
- Culture change lowers walls and promotes understanding across different functional areas

Summary of Solutions

**Business Intelligence***

- **Data Warehouse**
  - To provide decision support

**BI Tools**

- **Hyperion / Brio / Interactive Reporting**
  - To address need for decision support tools

**DW Utilization**

- **In-House Training**
  - Address skill requirements & culture change

*Business Intelligence (BI) – catch-all term that describes an institution's harvest of data from disparate systems to aid in operational and strategic decision-making.*
RPI’s Data Warehouse

- A read-only, centralized repository of the Institute’s data
- Organized by subject area (i.e., data marts)
- Conformed dimensions allow analytics across data marts
- Populated from transaction systems and refreshed nightly
- Based on reporting and analytical needs

Rensselaer’s Data Warehouse

- 600+ Business Users
  - 500+ Consumers of data
  - 60 Advanced business users
  - 40 Power business users
- Organized by subject area (Data Marts)
  - Finance (Operating & GL)
  - HR/Position Control/Payroll
  - Enrollment Management
  - Academic History
  - Research Administration
  - Advancement
  - Student AR
  - Key Performance Indicators
  - Faculty Activity
### Business Intelligence - Core Team

#### Technology Representatives
- **Business Systems Analysts (2)**
  - Data Warehouse Design
  - ETL Design & Development
  - Light Business User Support
- **Business Support Analysts (1.5)**
  - Daily business support
  - Query/dashboard development
  - Business user training
- **Database Administrator (1)**
  - Oracle database administration
  - Administration BI platforms
- **Manager of Business Intelligence**
  - Requirements Analysis/Design
  - Support & training
  - Project Planning/Resource Mgt.

#### Business Representatives
- **Departmental Business Analysts**
- **Business Managers**
- **Institutional Research**
- **Financial/Budget Analysts**
- **Human Resource Analysts**

#### Analytic/Reporting Functions
- **Budget Monitoring**
- **Forecasting**
- **Statistical Modeling**
- **Predictive Modeling**
- **Retention and Graduation Analysis**
- **Discount Rate / Net Tuition Revenue**

**Past**

**Future**

![Wisdom Hierarchy Diagram](image)
Data Warehouse Governance

- Sponsorship Committee
- Steering Committee
- Implementation and Test Groups
- Data Warehouse Team
- Data Warehouse Users/Experts

Who *uses* & *has access* to what?

- Cabinet; Deans; Department Chairs; Center Directors
- Department level
- Core Administration Portfolio/Division level
- High
- Low
- Data in the Warehouse
- Dash Board
- Information published in Brio queries
- Data Policies
"A dashboard is a visual display of the most important information needed to achieve one or more objectives; consolidated and arranged on a single screen so the information can be monitored at a glance."

Stephen Few

“Dashboard Confusion”
Intelligent Enterprise
March 20, 2004
Also, reprinted in his book: Information Dashboard Design
Types of Performance Dashboards

- **Operational** – frontline workers manage and control operational processes
- **Tactical** – managers monitor and optimize processes; measure efficiencies
- **Strategic** – senior executives monitor the execution of strategic objectives. Management is emphasized more than analysis.

Wayne Eckerson – Performance Dashboards – 2011

Characteristics of Performance Dashboards

<table>
<thead>
<tr>
<th></th>
<th>Operational</th>
<th>Tactical</th>
<th>Strategic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose</strong></td>
<td>Control Operations</td>
<td>Optimize Processes</td>
<td>Manage Strategy</td>
</tr>
<tr>
<td><strong>Scope</strong></td>
<td>Operational</td>
<td>Departmental</td>
<td>Enterprise</td>
</tr>
<tr>
<td><strong>Users</strong></td>
<td>Staff+</td>
<td>Managers+</td>
<td>Executives+</td>
</tr>
<tr>
<td><strong>Primary Activity</strong></td>
<td>Act</td>
<td>Analyze</td>
<td>Review</td>
</tr>
<tr>
<td><strong>Focus</strong></td>
<td>Current</td>
<td>Past</td>
<td>Future</td>
</tr>
<tr>
<td><strong>Data Refresh</strong></td>
<td>Daily/Intraday</td>
<td>Daily/Weekly</td>
<td>Quarterly/Annually</td>
</tr>
<tr>
<td><strong>Information</strong></td>
<td>Detail</td>
<td>Detail/Summary</td>
<td>Summary</td>
</tr>
<tr>
<td><strong>Architecture</strong></td>
<td>Source Systems</td>
<td>Warehouse Queries</td>
<td>Scorecards</td>
</tr>
<tr>
<td><strong>Metrics</strong></td>
<td>Transactions</td>
<td>Dept Goals</td>
<td>Scorecard KPIs</td>
</tr>
</tbody>
</table>

Wayne Eckerson – Performance Dashboards – 2011
Dashboards at Rensselaer

- At RPI, the term **dashboard** defines various kinds of applications
  - **Data mart-specific dashboards**
    - Finance, Research, Enrollment, Advancement, Undergraduate Admissions, Graduate Admissions, Financial Aid
  - **Reporting applications**
    - Faculty Research
      - Similar to a checkbook ledger with table reports
      - Available to Faculty and their business managers
      - Incorporates data from multiple data marts

Dashboard Content & Design Thoughts

- **Determine your primary audience**
  - Trustees
  - Cabinet
  - Deans/Directors

- **Choose and display your indicators**
  - Be concise
  - Be institutional in scope/tie to the strategic plan
    - Engage others in the discussion and obtain consensus
  - Show trends wherever possible
  - Select only a few essential KPI’s – fewer than 20
  - Keep the dashboard to one page – provide drilling/links
    - Colors and design are important
    - Avoid complex designs – 3d graphs, TMI
Institutional Readiness
If We Build it Will They Come?

1. Clearly defined strategy
2. Strong, committed sponsorship
3. A clear and urgent need
4. Support of mid-level managers
5. Appropriate scale and scope
6. A strong team and available resources
7. A culture of measurement
8. Alignment between business and information technology
9. Trustworthy and available data
10. A solid technical infrastructure

Wayne Eckerson – Performance Dashboards, 2011

Demonstration

• Rensselaer dashboards
• But what if we don’t have resources necessary for a comprehensive, enterprise data warehouse?
  – Options – tools
  – Define access and review use, lower costs – Pareto Principle
### Undergraduate Freshman Retention (Fall to Fall)

**Metric Descriptions**

- **Freshman Attrition (Fall to Fall)**: Percentage of freshmen from the prior year cohort who do not return for the subsequent fall term.
- **Percentage of Freshmen Retained (Fall to Fall)**: Percentage of freshmen from the prior year cohort who return for the subsequent fall term.

#### 2004-2005 to 2009-2010

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage of Freshmen Retained</th>
<th>Percentage of Freshman Retained (Fall to Fall)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004-2005</td>
<td>51.7%</td>
<td>6.1%</td>
</tr>
<tr>
<td>2005-2006</td>
<td>52.3%</td>
<td>6.5%</td>
</tr>
<tr>
<td>2006-2007</td>
<td>54.0%</td>
<td>6.1%</td>
</tr>
<tr>
<td>2007-2008</td>
<td>51.0%</td>
<td>5.9%</td>
</tr>
<tr>
<td>2008-2009</td>
<td>51.7%</td>
<td>6.1%</td>
</tr>
<tr>
<td>2009-2010</td>
<td>51.3%</td>
<td>6.6%</td>
</tr>
</tbody>
</table>

#### Click to Select Peer Institution Comparison Data

- **Click to Open and Select Female**

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**Click to Open and Select Female**

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**Click to Open and Select Female**
Cohort Survival dashboard allows us to follow a cohort and monitor attrition, retention, and transfer rates internally from school-to-school.

Next, Select Six-Year Graduation Rate
Select Six-Year Grad Rates for Peer Institutions, First Total then by Gender.
Select the five that is associated with one course and $1-$100k research.

Here we have filtered for the fall term, and by School of Science, Comp Sci, and T&TT

Matrix reorganizes to 21 T&TT faculty

Selecting five from the matrix produced individual faculty information for those teaching one course and with $1-$100k research.

Select one faculty member about whom you wish to know more.

Number of sections, courses taught by each of these faculty appears, as does student and research activity.