The Optimization Edge: The Next Business Imperative

New York City INFORMS

Steve Sashihara
President and CEO

www.princeton.com
Problem: Human frailty and bias in decision making

Opportunity: Winning (especially in business) with more rigorous techniques

Nassim Taleb

Michael Lewis

Daniel Kahneman

Tom Davenport
In April 2009, IBM unveiled a new services unit called Business Analytics and Optimization.

As part of this coordinated strategy, IBM also cranks up an aggressive “analytics software” acquisition spree, which includes SPSS and Ilog both in 2009.

“In IBM's biggest foray in business consulting since it acquired PricewaterhouseCoopers Consulting in 2002, the company announced on Apr. 14 that it is setting up a 4,000-person organization focused on helping corporations analyze data better and make smarter decisions.

The new business unit, IBM Business Analytics & Optimization Services, is the first major move by Frank Kern since he was shifted to lead the $19.6 billion Global Business Services division. "We're at the beginning of a new wave," Kern says. "We're beginning to instrument the world, but we have to take the data and analyze it to make a better bank, a better electric utility, a better planet."

INFORMS, the academic society for Operations Research and Management Science, publisher of “Analytics” magazine, recognizes that “analytics” is hot and creates the Analytics Section in 2011 to center scholarly research around Advanced Analytics, which they define as the top 2 layers of a 3 layer structure:

We recognize that analytics is defined by three categories:

3. Prescriptive analytics
   • Evaluates and determines new ways to operate
   • Targets business objectives
   • Balances all constraints

2. Predictive analytics
   • Predicts future probabilities and trends
   • Finds relationships in data that may not be readily apparent with descriptive analysis

1. Descriptive analytics
   • Prepares and analyzes historical data
   • Identifies patterns from samples for reporting of trends

The SAS and INFORMS Analytics stacks actually line up quite nicely.

Also note: both put optimization / prescriptive analytics at the top of the stack (more on this later).
The IBM BAO maturity model lines up quite nicely with SAS and INFORMS. Notably, “Prescriptive” is saved for the top of the stack and is highlighted as responsible for Breakaway performance – the core finding of their study.
So whether you stack it up as 4 levels (Davenport 1), 8 levels (SAS), 3 levels (INFORMS), 5 levels (IBM), or 6 levels (Davenport 2) – they all concur on the basic hierarchy, and they all concur that **Optimization is at the Top, the Highest Value, and is the thus the potential Game Changer.**

Which begs the question.. What exactly is “**Optimization**?”

---

**1. Descriptive analytics**
- Prepares and analyzes **historic**
- Identifies patterns from sample

**2. Predictive analytics**
- Predicts **future** probabilities
- Finds relationships in data that are apparent with descriptive analytics

**3. Prescriptive analytics**
- Evaluates and determines **new ways to operate**
- Targets business objectives
- Balances all constraints

---

**OK, So What Exactly is “Optimization”?**
The Optimization Edge:
Reinventing Decision Making to Maximize All Your Company's Assets
(McGraw-Hill 2011)

Explain *Optimization* to business executives

Encourage them with stories of successful optimization

Warn them about pitfalls and lessons learned

Support them with structured project approaches that have worked for us.

To help Business Executives “see” Optimization Opportunities in their businesses, and to know to ask for it.
We are at the forefront of a something really big…

The Optimization Revolution

A fundamental change in how organizations (businesses, governments, not-for-profits) and individuals will:

- Take in and process large amounts of data
- Evaluate choices and make good decisions

about their “assets” – the things of value one has some control over.
In every aspect of business…

The World is becoming more and more Digitized

1. A Tsunami of Data: increasingly, everything is being tracked in real-time… “Big Data”

2. Ubiquitous Computing: fast, cheap, everywhere… “Mobile” and “The Cloud”

3. Global competitors of all sizes are entering every market and competing on being smart, fast, agile
Don’t Just Analyze Your Business, Optimize It

Jul. 21 2011 - 6:08 pm

Major corporations have spent so much on technology over the years that they tend to think their systems are a lot more sophisticated than they really are, argues Steve Sashihara, the CEO of Princeton Consultants, Inc. and the author of “The Optimization Edge: Reinventing Decision Making to Maximize All Your Company’s Assets” (McGraw-Hill, February 2011).

“The biggest mistake we’ve seen is the assumption lot of company leaders have that they have made such massive investments in IT that they must have optimization all over the place,” Sashihara says. I interviewed Sashihara several months ago but only recently got arou finishing his book (I have my own bus optimization issues, you see).

One of his most interesting arguments is the great deal of the effort spent on inform
MANAGING FOR SUCCESS

How To Align Businesses For Maximum Efficiency

Companies tap optimization techniques to boost results

By Brian Deagon, Monday July 25, 2011 A5

Intel (INTC) Chairman Craig Barrett hired Karl Kempf in 1987 with instruction to make the chipmaker's plants run more efficiently.

Kempf, now Intel's chief mathematician and head of Intel's Chief Decision Group, started out by placing a laser-sharp focus on a single shift manager at an Intel factory. He observed how operational decisions were made, gradually recommended changes and expanded the process to other shift managers.

Sashihara, president and CEO of Princeton Consultants, a consulting firm specializing in business optimization, says the approach employs mathematics and algorithms packaged with specialized software to sort and organize data. They use it to make recommendations faster and better than humans can.

"Optimization is not phony baloney, mumbo jumbo," he said. "It is very tangible and extremely valuable and I pity the companies that have to compete against it."
A Real ‘Optimization Imperative’

*The upper echelons of analytics is where winning companies gain competitive advantage*

In economic times trying even for the most efficient companies, some still manage to outshine and outsmart their competitors time after time. How do they do that? Optimization is the answer, says expert Steve Sashihara, President and CEO of Princeton Consultants, an 85-person firm that helps clients optimize their assets through a blend of information technology and management consulting. In *The Optimization Edge: Reinventing Decision Making to Maximize All Your Company’s Assets*, Sashihara argues that downsizing is no way to grow a company. Instead, the smart firms have figured out a better way to make business decisions. In the book and his practice, he shows clients how to squeeze every ounce of value from their company, even under the perfect storm conditions of the last few years. Today, Sashihara argues optimization is no longer a “nice-to-have” for companies but a categorical imperative.
Princeton Consultants: Elevator Slide

- **Boutique consulting firm** specializing in game-changing performance improvements through **Custom Optimization**

- 85 full-time consultants in two offices (Princeton NJ, NYC), over 40% have Ph.D.s

- **Industries:** Transportation/Supply Chain and Financial Services.

- Blend Information Technology *and* Management Consulting

- 30 years of successful business under the same leadership. Over 1000 successful projects delivered.
What is Optimization? (In the context of Business Analytics)

Optimization

Decision Making | using Software that makes Recommendations | Integrated into the organization
Optimization Defined

in Plain English:

Optimization

Decision Making

using Software that makes Recommendations

Integrated into the organization

about Assets

- People
- Raw Materials/Finished Goods
- Containers
- Vehicles/Machinery
- Land/Facilities
- Digital
- Other Intangibles
### Optimization Defined in Plain English:

- **Decision Making** using **Software that makes Recommendations** Integrated into the organization

<table>
<thead>
<tr>
<th>“Asset”</th>
<th>Type of Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>o People</td>
<td>o Production/Acquisition</td>
</tr>
<tr>
<td>o Raw Materials/Finished Goods</td>
<td>o Assignment</td>
</tr>
<tr>
<td>o Containers</td>
<td>o Scheduling</td>
</tr>
<tr>
<td>o Vehicles/Machinery</td>
<td>o Network Routing</td>
</tr>
<tr>
<td>o Land/Facilities</td>
<td>o Pricing</td>
</tr>
<tr>
<td>o Electronic</td>
<td>o Policy Creation</td>
</tr>
</tbody>
</table>

- **Type of Decision**
  - How much to get/have?
  - Who gets what?
  - When, in what order?
  - Where, which path?
  - At what price?
  - What are the rules?
Optimization Defined
in Plain English:

Optimization

Decision Making
using Software that makes Recommendations
Integrated into the organization

Data → Optimization Software → Recommendations for What’s Best

1. Objective Function
   How do we “keep score”?  

2. Decision Variables
   What do we have control over?  

3. Constraints
   What are the game rules?  

4. Algorithms
   What’s our game plan  

5. User Interface
   How does one see/validate the recommendations?
Optimization Defined in Plain English:

**Optimization**

<table>
<thead>
<tr>
<th>Decision Making</th>
<th>using Software that makes Recommendations</th>
<th>Integrated into the organization</th>
</tr>
</thead>
</table>

1. **Objective Function**
   - How do we “keep score”? 

2. **Decision Variables**
   - What do we have control over?

3. **Constraints**
   - What are the game rules?

4. **Algorithms**
   - What’s our game plan?

5. **User Interface**
   - How does one see/validate the recommendations?

**Recommendations**

- Reduced waste
- Lower costs
- Higher profits
- Increased sales
- Customer attraction
- Customer retention
- Employee satisfaction
- Employee retention
- Greater utilization
- More balanced utilization
- Greater compliance
- Faster response time
- Reduced risks …
Optimization Defined in Plain English:

Optimization

| Decision Making | using Software that makes Recommendations | Integrated into the organization |

Data → Optimization Software → Recommendations for What’s Best

Some Common Optimization Complexity Factors

- Big Data
- Real-time data
- Noisy/incomplete data
- Stochastic

- Competitive Gaming
- Black Box
- Static/Dynamic
- Human In The Loop
Optimization Defined in Plain English:

- **Decision Making**
- using Software that makes **Recommendations**
- Integrated into the organization
Successful Optimization

4 Attributes

- **Clear**
- **Fast**
- **Accurate**
- **Robust**

Successful Optimization

RAD Methodology

1. **The Charter**
   - Choose the right areas of opportunity
   - Assemble the right team

2. **The Vision**
   - Select the top candidates, use real data to prove solution is possible and it’s value

3. **The Early Win**
   - Pick entry point; get into production with real users; create bottom up enthusiasm

4. **The Scale-Up**
   - Broaden into full field as default behavior

5. **The Harvest**
   - Expand functionality; use savings to lower prices/expand share; sell capabilities
Successful Optimization: 
4 Attributes: 
#1: Accurate

An Accurate Recommendation is
- **Valid** (follows agreed upon rules and constraints)
- **High quality** (high scoring solution)

**Challenges**
- Forces quantification of difficult-to-quantify items
- Can touch on “sacred cows”, expose platitudes, and threaten *status quo*
- Mixture of short-term and long-term objectives

**Winning Strategies**
- ✓ Calibrate against existing decisions – use “pairs trading” to find sensitivities
- ✓ Find the right executive sponsorship
- ✓ Provide ranked alternatives along an efficient frontier
Successful Optimization: 4 Attributes:
#2: Clear

A Clear Recommendation is
- Unambiguous
- Precise
- Concise

Challenges
- Users want to understand “why” not just “what”
- But the winning choice may be complex (“it has the shortest set of n-dim arcs”)
- The entire solution may be too large to inspect and validate easily

Winning Strategies
- Build and install the model incrementally; solve the way they do at first
- Avoid “black boxes” – focus user interface design on solution validation
- Allow the user to easily inspect and edit input data and parameters
Successful Optimization:
4 Attributes:
#3: Fast

A Fast Recommendation is
- **Low latency** (up-to-date data, gives answers quickly)
- **Rapid throughput** (solves quickly)
- **Scalable** (has capacity for more)

**Key Challenges**
- As real-world, non-linear factors are added, the solve time explodes
- “Big Data”: data volumes keep increasing, especially with success
- The solver must be fast to reflect “what if” type of usage

**Winning Strategies**
- ✔ Avoid one-size-fits-all software tools
- ✔ Avoid one-person teams: combine state-of-the-art approaches
- ✔ Use spare cycles: continuous improvement of solution
Successful Optimization: 4 Attributes: #4: Robust

A Robust Recommendation
- Detects faults/failures
- Avoids faults/failures
- Low bug count

Key Challenges
- Market conditions may change rapidly
- Simple heuristics often fail when conditions change
- Data can be late, missing, or erroneous

Winning Strategies
- Make real-time data and solution validation part of the core model
- Use self-tuning parameter techniques
- Give the users attractive choices instead of single recommendation
Successful Optimization: 4 Attributes 5 Steps

4 Attributes

- Clear
- Accurate
- Fast
- Robust

Successful Optimization

RAD Methodology

1. The Charter
   - Choose the right areas of opportunity
   - Assemble the right team

2. The Vision
   - Select the top candidates, use real data to prove solution is possible and it’s value

3. The Early Win
   - Pick entry point; get into production with real users; create bottom up enthusiasm

4. The Scale-Up
   - Broaden into full field as default behavior

5. The Harvest
   - Expand functionality; use savings to lower prices/expand share; sell capabilities
1. The Charter
   - Choose the right areas of opportunity
   - Assemble the right team

2. The Vision
   - Select the top candidates, use real data to prove solution is possible and it’s value

3. The Early Win
   - Pick entry point; get into production with real users; create bottom up enthusiasm

4. The Scale-Up
   - Broaden into full field as default behavior

5. The Harvest
   - Expand functionality; use savings to lower prices/expand share; sell capabilities

✓ Pick an area where the people are hungry for improvement
✓ Look for an area that is not already over-committed with other large IT or change management projects
✓ Assemble your best team of Exec Sponsor, SMEs, inside and outside optimizers
The Charter
Choose the right areas of opportunity
Assemble the right team

The Vision
Select the top candidates, use real data to prove solution is possible and it's value

The Early Win
Pick entry point; get into production with real users; create bottom up enthusiasm

The Scale-Up
Broaden into full field as default behavior

The Harvest
Expand functionality; use savings to lower prices/expand share; sell capabilities

- Do field R&D and find top candidate projects
- Build fast proof-of-concepts to validate technical feasibility and quantify the potential “size-of-the-prize” over baseline
- Project management metaphor: not a construction project, but a behavior modification project
Successful Optimization: 5 Steps:
#3: The Early Win

1. The Charter
   - Choose the right areas of opportunity
   - Assemble the right team

2. The Vision
   - Select the top candidates, use real data to prove solution is possible and it’s value

3. The Early Win
   - Pick entry point; get into production with real users; create bottom up enthusiasm

4. The Scale-Up
   - Broaden into full field as default behavior

5. The Harvest
   - Expand functionality; use savings to lower prices/expand share; sell capabilities

- Pick the right first users
- Solve a problem *they* have, not one you want to solve
- Give them something early they’re going to love
- Focus on the people side, not just the technical side
Successful Optimization: 5 Steps:
#4: The Scale Up

1. The Charter
   - Choose the right areas of opportunity
   - Assemble the right team

2. The Vision
   - Select the top candidates, use real data to prove solution is possible and it’s value

3. The Early Win
   - Pick entry point; get into production with real users; create bottom up enthusiasm

4. The Scale-Up
   - Broaden into full field as default behavior

5. The Harvest
   - Expand functionality; use savings to lower prices/expand share; sell capabilities

- Gain line-level field commitment for process change
- Ensure people’s measurements and incentives are aligned
- Avoid collision or confusion with other projects
- Look for fastest Total Time to Payback (TTP) over Total Time to Delivery (TTD)
Successful Optimization: 5 Steps:

#5: The Harvest

- **The Charter**: Choose the right areas of opportunity. Assemble the right team.
- **The Vision**: Select the top candidates, use real data to prove solution is possible and it’s value.
- **The Early Win**: Pick entry point; get into production with real users; create bottom up enthusiasm.
- **The Scale-Up**: Broaden into full field as default behavior.
- **The Harvest**: Expand functionality; use savings to lower prices/expand share; sell capabilities.

- ✓ Guard against recidivism – old habits die hard
- ✓ Look for logically adjacent areas to expand the breadth and value of the optimization
- ✓ Tell the story throughout the enterprise. Look for other businesses where the success can potentially be replicated. The best reward for optimizers: new opportunities!
1. Optimization is a competitive advantage

- Optimization is unmatched in its ability to extract maximum value from assets with a rigorous decision making process.

- Optimization driven decision making is better, faster, and cheaper. It can be a total game changer wherever it’s applied.

- Use off the shelf optimization applications for non core areas, where available.

- Engage your best teams to build and improve custom optimization for your core value-added areas.

- Optimization is not just about software – it’s about changing the decision making process. Those that get this right can soar above their competitors.
2. Successful Optimization Projects are Evolutionary

- Business engagement at all stages is critical.

- Large “Big bang” projects rarely yield successful optimization.

- Focus on getting value to actual users in live operations. Build on that success.

- Experiment with small solutions that grow, evolve, and gain momentum.

- Think of successful optimization not as a “construction” project, but a behavior modification project – and that takes time.
3. Successful Optimization is a Team Sport

• Build strong and positive partnerships between business users, IT and optimization specialists

• Engage the business at both the user, the manager, and the executive levels to gain maximum perspectives

• Periodic communication on what’s working, what needs to be improved, and potential areas of strategic opportunity

• Look for user lack of use – investigate: model needs changes; data / cost tuning; training; management support

• Keep the optimization software up-to-date with market changes affecting the business
Optimization

Decision Making using Software that makes Recommendations Integrated into the organization