MARKETING SPATIAL DIFFUSION

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Laboratory for Manufacturing and Productivity
Massachusetts Institute of Technology

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I. Laboratory for Manufacturing and Productivity

II. Today’s Topic

III. Information Technology

IV. Data and Models

V. Conclusion
INTERDISCIPLINARY

nano  macro  info  bio  eco

Adapted from Prof. Jung-Hoon Chun, MIT
RESEARCH

• Process & Equipment
  – micro- and nano-scale, control, and precision engineering

• Green
  – photovoltaic's, environmentally-benign manufacturing, design for the environment

• Information
  – RFID, sensor networks, design of complex systems, supply chain and factory design and management, data management
  – Auto-ID Labs and Field Intelligence Lab

Adapted from Prof. Jung-Hoon Chun, MIT
Adapted from Prof. Jung-Hoon Chun, MIT
II. TODAY’S TOPIC
SPATIAL DIFFUSION

• Geographic forces that affect adoption by individual customers
  – Rate and pattern of adoption
  – Based on type of advertising, demographics, distance to retail outlets
  – Pricing, promotion, tactical product positioning

• “a friend, expert, or relative” influences up to 80% of all purchases.”

• A need for information technology and models of spatial diffusion
“Managers who understand the geography of the processes by which consumers change their behaviors can be much more successful in launching new initiatives and can make much better use of their resources while doing so.”

• Bass models and the analysis of product “take-off” in developing markets
  - Approaches rely on the aggregation of data

• The First Study
  - The first treatment of space as part of marketing
  - The importance of “clusters”
THREE STEPS

1. Lead adopters

2. Neighborhood effects

3. Consolidation of adoption

From Rogers et al., 2006
IMPLICATIONS

• Rate of diffusion and success of a new product
  – Early warning of a success or a “dud”

• Adapt advertisement, in-store promotion, and pricing

• New product forecasting
  – Time series method
  – Inventory, obsolescence, and out-of-stock

• Optimization of spending on advertisement
  – The stage of diffusion?
Allaway, Berkowitz, and Giles 2003
THE BAR CODE

- Product data on the volume sold through retailers
- Market mix models
  - Measure customer response to promotion and advertising
  - Data for better trade-offs
- Marketing remains a “fact-based art.”
DIGITAL MAPS
III. INFORMATION TECHNOLOGY
THE DATA

• Sales - time and location for a specific geographical area.

• Single Source Data (including independent variables)
  - impact of promotions, advertising, coupons, or the local competitive dynamics between stores.
  - The level - individual product basis.

• The credit card approach
  - Video and the Holiday Season

• Spatial sampling the best practical approach
  - Prof. Sanjay Sarma, Ajay A. Deshpande, and the Field Intelligence Lab
Eliminate the boundaries between the Internet and Enterprise computing.
INTERNET EVOLUTION

• The Web of Information
  – HTML, static web pages, www

• The Web of Things
  – Linking physical objects together, RFID
  – EPCglobal Network

• The Web of Abstractions
  – Interoperability, data and mathematical models
  – Computer languages and protocols for connections
  – Software as a Service (SaaS)

\[
E(ACL) = \int_{L=-x}^{L=x} \left\{ \int_{H=RL}^{H=x} (H - RL) f(H) dH \right\} f(L) dL \quad (4)
\]
Each year, the amount of data grows by as much as 40 – 60% for many organizations.

In 2004 alone, shipments of data storage devices equaled four times the space needed to store every word ever spoken during the entire course of human history.


“data, data everywhere but not a byte to use.”

Sunil Gupta of SAP paraphrasing Samuel Taylor Coleridge during *Smart World 2004*, sponsored by the MIT Industrial Liaison Program.
Industry needs a new form of organization for data to speed search and make connections quickly.

Models are the means of analyzing data.

Research, design, and implement a system for data and model integration that solves practical problems.

The focus is manufacturing, agriculture, defense, and other industries.
RESEARCH GOALS

• Solve the issue of semantics and syntax for XML
• Achieve interoperability for data and mathematical models
• Create an auxiliary language to integrate models/data
• Apply to industry
• Kratulos
  (TLO Case No. 13752)
  – Data integration
  – Machine understandable semantics
  – Connect models and data across the Internet
  – Lee & Schuster

• Lee-Schuster Semantic Enterprise Architecture
  (TLO Case No. 13754)
  – Intranet application
  – Low cost alternative for ERP
  – Minimal implementation
  – Lee & Schuster
For information on licensing, contact:

Technology Licensing Office
Massachusetts Institute of Technology
Five Cambridge Center, Kendall Square
Room NE25-230
Cambridge, MA 02142-1493

Tel: 617-253-6966
Fax: 617-258-6790

Email: tlo@mit.edu
BOSTON COMMUTE

Live Traffic Data

Live Weather Data

Construction Location

Adapted from D.L. Brock
Merging XML data requires a “hub translator.”

This is a non real-time process.

The number of “many to many” combinations is polynomial, as a function of the number of nodes.

An auxiliary language reduces the combinations.
AUXILIARY LANGUAGE

Enterprise Data

Edge Translation

Internet or Intranet

Interoperable data

M-XML

Mathematical Model

Enterprise Data

Edge Translation
An auxiliary language is the glue that holds things together.

It is not a formal code like Java or C++.

The purpose is to make XML more effective.
INTERNET ARCHITECTURE

Source

Internet

Target

M-XML

M Dictionary

M-XML
SUMMARY

- An improved method for XML semantics and syntax
- Base for interoperable data
- Exact search
IV. DATA AND MODELS

Kratulos

Example: Agricultural Data
PROBLEM DEFINITION

Combine surface observation data of disease with temperature data from NOAA.

Both data sources are available via the Internet.

Form a set of data.
Field Scouting

DATA INTEGRATION

• Two separate streams of data
  – Observations from the field
  – Weather data from NOAA

• Form an integrated data set for analysis
  – Attach a logit model
  – Project disease growth rate

• Weather data
  – Point observation
  – Interpolation required
Kratulos is the underlying architecture and code that powers WeatherMerge™.

The core is Oracle 11g.

*Kratulos* is a general approach for merging data and connecting models.

*WeatherMerge™* is specific to agriculture.
Semantic Conversion

Syntactic Conversion

Model Execution

Oracle 11g

Data Interpolation

WeatherMerge XML

Microsoft Excel Spreadsheet

M Converter Factory

M-XML

Data Provider

NOAA

.NET™ Framework

Dictionary
View Machine: Weather Merge

Weather Merge (id:83, category:translators)
Replace text with Machine details.
Rating: ★★★★★ Views: 0 Builder: Hyo ung-Gon Lee (hg_lee)
Raw Input Required:
Web Service Link: http://mlanguage.mit.edu/services/index.php?service=RunMachine&machine.9_id.2=83&date.1=your data here

Run Machine
Machine Input:

```xml
<Rows>
  <Row>
    <WBAN_number>12842</WBAN_number>
    <YearMonthDay>20070701</YearMonthDay>
    <MaxTemp>91</MaxTemp>
    <MinTemp>76</MinTemp>
    <WindAvgSpeed>5.9</WindAvgSpeed>
    <PrecipitationWaterEquiv>0</PrecipitationWaterEquiv>
  </Row>
</Rows>
```

Add Comment

Run Machine

Machine Output:

```xml
<row.5>
  <WBAN_number>12842</WBAN_number>
  <date.1>20070701</date.1>
  <maximum_temperature.1>91</maximum_temperature.1>
  <minimum_temperature.1>76</minimum_temperature.1>
  <average_wind_speed.1>5.9</average_wind_speed.1>
  <precipitation.4>0</precipitation.4>
</row.5>
```

Switch to Easy Input Mode
### Pest Data

<table>
<thead>
<tr>
<th>field_name</th>
<th>farm_name</th>
<th>event_date</th>
<th>pest_common_name</th>
<th>pest_form_name</th>
<th>pest_type_name</th>
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<th>longitude</th>
<th>max_temperature</th>
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Click on a word and the exact definition appears as a pop-up.

On the following slide, `field_name.1` appears as an embedded word.

It is linked directly to the M Dictionary, located on a remote server.
**Definition:** The name given to a field by a grower. This is part of the set-up procedure.

| field_name | farm_name | event_date | pest_common_name | pest_form_name | pest_type_name | date
<table>
<thead>
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<th></th>
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SUMMARY

• New approach for projecting disease growth in agriculture
  – Weather/surface observation data set created instantaneously

• WeatherMerge™ intended as a form of ERP for agriculture

• Long-term, replace human scout with robot

• Broader applications in ecosystems services
IV. CONCLUSION
RESEARCH PROBLEM

• Durable consumer goods
  - Appliance or automotive

• Supply chain analysis - China

• Temporal data for sales

• Develop new models of spatial diffusion

• Create IT infrastructure using current tools developed at LMP