Dynamic Web Based Methods and Tools for Multi-University I/UCRC Management, Data Integration and Decision Support

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Outline

• Project Objective
• Brief Background on Center for e-Design
• Project Tasks and Approach
• Progress and Future Work
Project Objective

Creation of a web-based environment that host methods and tools that are *generalized* and *customizable* to support the management and collaboration needs of multi-university centers.
Ontology Development and Utilization for Knowledge Management in Product Design

Step 1: Classes and Slots Categorization

Step 2: Ontology Structure Design

Step 3: Relations Retrieval and Realization

Step 4: Knowledge Base Development by Protégé

Step 5: Protégé Based Search and Reasoning

Search and reason related data based on step 1−4 to help designers to get and compare alternatives

Step 6: Ontology-based Decision Support Tool for Design for Manufacturing (DfM)

Choose the best design alternative by considering the criteria concurrently

I/UCRCTIE Grant 0632758
Project Tasks and Approach

- Decision Support for Multi-University Centers
  1. New Project Selection or Evaluation of Project for Continuation
  2. Match Project and/or Company Needs with Specific Center Site(s)
- Environment to Integrate Heterogeneous Distributed Resources
Decision Support for Multi-University Centers
Sources of Costs

\[ C_M = \frac{[W_T \times n] + T_s + T_{ch]} \times C_{MR}}{MR \times 60} \]

\[ C_L = \left( \frac{W_T \times n}{OF} + T_{WP} \right) \times \frac{C_{LR}}{60} \]

Where, \( W_T = \) Time to weld; \( n = \) Number of weld passes; \( T_s = \) Setup Time (min);
\( T_{ch} = \) Tool change-over time (min); \( MR = \) Machine Reliability (Assuming 95%);
\( C_{MR} = \) Machine Rate ($/hr); \( OF = \) Operation Factor;
\( T_{WP} = \) Time for weld preparation (min); \( C_{LR} = \) Labor Rate ($/hr)
Sources of Benefits

Project benefit

Centers

Center Members

Research Contribution

- Publications
  - Journal paper
  - Conference paper

- Presentations

Students receiving degrees
- Ph.D
- Master
- Undergraduate

Intellectual Property

R&D
- Increased technical awareness
- Accelerated or new project
- Development of Intellectual property

Commercialization
- Improved products
  - New products
  - Process
  - Service
  - Sales
- New or Retained jobs

Professional Networking
- Improved ability to recruit students
- Increased cooperation with other industrial members and scientists

Invention Disclosures

Patent Applications

Software copyrights

Patents Granted/ Derived

Licensing Agreement

Royalties Realized

Professional Networking
- Improved ability to recruit students
- Increased cooperation with other industrial members and scientists
Decision Support

Two types of approaches for project selection:

1) Rule-based decision making
   - If (Conditions), then (action)

   For example:

   A class ‘Project’ will be defined with attributes, such as cost (equipment cost and Personnel cost). The projects that will be evaluated are instances of class ‘Project’.

   **Rule 1:** If (Cost<=$15,000) & (Number of Patents>=1), then ‘Start project’;

   **Rule 2:** If (New product=‘available’), then ‘Start Project’
2) Algorithm-based decision making
Weighted Sum (weights determined by decision makers)

\[ U(A) = w_1 \times U(\text{Cost}) + w_2 \times U(\text{Project benefit}) \]

Where,

A= Project ‘A’;

\( w_1 \)=Weight for criteria ‘cost’; \( w_2 \)=Weight for criteria ‘Project benefit’;

\( U(\text{cost}) \)=Utility value for total cost;

It is a decreasing function, the less the cost is, the larger the utility value, e.g. \( u(\text{Cost}) = -e^{-a \times \text{Cost}} \);

\( U(\text{Project benefit}) \)=Composite utility value for the project benefit.

\( U(\text{Project benefit}) = U(\text{Project contribution in Research}) + U(\text{Intellectual Property}) + U(\text{R&D}) + U(\text{Commercialization}) + U(\text{Professional networking}) \)
Rank and Order

- Rank the criteria and order the projects

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<tr>
<td>Cost</td>
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<tr>
<td>Research Contribution</td>
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<td>Good</td>
<td>Excellent</td>
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Integration Environment

Structure of Local Ontologies
Background: Phoenix Integration

- Provide engineering software and services to customers in aerospace, defense, and related industries

- 14 year history

- Evolved out of a research program at Virginia Tech

- Office locations
  - Philadelphia, PA (Corporate)
  - Blacksburg, VA (R&D)
  - California (Sales)
  - North East (Sales)

- World-wide sales in North America, Europe, and Asia

www.phoenix-int.com
Core Product: ModelCenter®

- Visual environment for process integration
- Graphically link analyses together
- Automatically transfer data from analysis to analysis
- Reduce data transfer errors
- Save time
- Perform trade studies to find better designs

1. Create Models
2. Generate Data
3. Interpret Results
CENTER CONNECTIVITY GOALS

- Technology Readiness
- Educational Contribution
- Economic Benefit
- Share Best Practices
- Decision Support
- Linking NSF Centers
- Linking Center Sites
- Reporting Among Centers & NSF
- Synergy Within Multi-University Centers
- Open Architecture
- Knowledge Mining

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Progress and Future Work

- Working closely with CFSP to identify criteria, data sources (automated and manual) for decision support
- Extending prior work in web-based ontological approach to the integration of heterogeneous distributed resources
- Evaluating feasibility and trade-offs of using commercially available tools (e.g., partnering with Phoenix Integration)
Example Questions

1. Factors to consider in the economic evaluation of projects?
2. How to measure these criteria: convert all criteria into $ or utility or measure with nominal scales?
3. What is the commonly used method for decision making? (rule based or multi-criteria such as 'rank and order' or attribute aggregation)
4. When deciding which center site for a project, what attributes are considered (expertise, geographical proximity, etc)?
5. What other measures are used to quantify the attributes of a center site?
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