Organizational Design Optimization
Using Genetic Algorithms / Programming

CIFE Seed Research Proposal
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Evolutionary Methods
### Evolution of Organization Design

<table>
<thead>
<tr>
<th>Trial-and-Error Project Design</th>
<th>Project Design: VDT/SimVision</th>
<th>Project Design: VDT+Optimizer</th>
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</thead>
<tbody>
<tr>
<td>1. Set project objectives.</td>
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<td>2. Propose organization.</td>
<td>2. Propose alternative organizations.</td>
<td>2. Propose initial organization as starting point for optimization.</td>
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<td>3. Complete project using proposed organization and observe outcome.</td>
<td>3. Model alternative organizations and simulate each one to predict outcomes.</td>
<td>3. Evolve many alternative organizations; predict performance of each one; evaluate “fitness”.</td>
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<tr>
<td>4. Succeed or fail. Try to learn and adapt.</td>
<td>4. Choose solution that optimizes outcomes.</td>
<td>4. Evolve optimal organizational configuration by “selective breeding” and mutation of alternatives.</td>
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Motivation

- Organization Design is a complex multi-dimensional global optimization problem
- No known automated routine that optimizes organizational design project
- VDT predicts schedule, cost, and process quality performance - but has no ability to improve or optimize current design
- Exhaustive task to find a good design, even an experienced manager might fail to find optimal or near optimal solution + time consuming
- Evolutionary approaches offer the potential for discovering near-optimal designs regularly, and for suggesting new organizational theories
Objectives

- Design and implement a post processing optimizer for VDT using evolutionary techniques that can help project managers find near optimal designs for their project organizations.

- Validate the postprocessor by comparing its recommended organization designs to predictions of organizational “contingency” theory.

- Conduct organization design *charrettes* at the 2004 CIFE Summer Program to validate whether a post processor can help project managers design better project organizations.
Two Phase Optimization

**Scheduling & Resources (S&R) Phase**

- Focuses on:
  - How many people to hire in each functional group
  - When each task gets done by a functional group

**Structure & Policies (S&P) Phase**

- Focuses on:
  - Decision making policy properties
  - Individual/sub-team properties
  - Communication properties
S&R / S&P Model

- Similar concept used in circuit design
Organizational optimization is too complex to be solved with a single approach

- Divide problem into different phases using different abstractions and optimization techniques
- S&R model uses AI and OR on deterministic model to do macro resource sizing and scheduling to eliminate most backlog.
- S&P model uses GA/GP on stochastic model to optimize organizational structure, and other organizational parameters
- S&R model passes candidate solution to S&P model for further optimization
S&P Model Focus

- Decision making policy properties
  - Centralization
  - Formalization
  - Matrix strength

- Individual/sub-team properties
  - Skill Level
  - Application Experience
  - Team Experience

\[ 3^4 \times 3^{(2 \times 10)} = 282,429,536,481 \]
Analogy
Genetic Algorithms (GA)

- Pioneered by John Holland in 1960’s
- Search Algorithm that iteratively transforms a set (population) of mathematical objects into a new set of offspring objects
- Patterned after Darwinian principal of survival of the fittest and after naturally occurring genetic operations such as:
  - Regeneration
  - Crossover (sexual recombination)
  - Mutation
Genetic Programming (GP)

- A new field, defined by John Koza in 1987 at Stanford
- How can computers learn to solve problems without being explicitly programmed?
- Extension of GA, Individual objects are programs
- Non-Linear, Widely Applicable
- Competitive with human-produced results
GA/GP Success Stories

- Selected video clips from Professor John Koza Genetic Programming video tapes
Project Design Optimization

Generation 0

Generation 1

Generation 2

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Organizational Design Optimization
Why GA/GP?

- Large Multidimensional Search Space
- Design and Creativity vs. Logical thinking
- Non-numerical / Non-linear Optimization
- Design of Unknown Size and Shape
- Problem Independent
- Scalability
Research Questions

Possible research questions we try to answer?

- Are optimal solutions found by GP in-line with organizational theories and practices?
- Can GP help a highly experienced manager in designing an organization project design?
- Have we partitioned the optimization problem correctly?
- What are the limits of GA/GP?
Questions?