Virtual science: Lessons from the UARC experience

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CEDAR Tutorial
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Outline

I. The collaboratory concept
II. UARC design philosophy
III. Lessons from the UARC experience (so far...)
IV. Future directions
The collaboratory concept

- *people-to-people*
- *groups-to-information*
- *groups-to-facilities*

Communication and collaboration services

Distributed, media-rich information technology

Digital libraries

"knowledge bases"

Interaction with the physical world

"labs without walls"
UARC design philosophy

Conceptualize: observe and define objects in current practice; establish baseline

Build: rapid prototype in OO framework

Modify: extend design, evolution

Trials: Deploy, use, evaluate

Multi-disciplinary team ("Collaborative coalition")

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Lessons from the UARC experience

Lesson 1: Collaboration over real-time data is not the most important component of current research practice among space scientists

Mean percent of effort allocated to research activities (n=65)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Percent of effort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data reduction</td>
<td>36</td>
</tr>
<tr>
<td>Planning</td>
<td>19</td>
</tr>
<tr>
<td>Data collection</td>
<td>13</td>
</tr>
<tr>
<td>Modeling</td>
<td>12</td>
</tr>
<tr>
<td>Theory development</td>
<td>11</td>
</tr>
<tr>
<td>Training</td>
<td>10</td>
</tr>
<tr>
<td>Instrument development</td>
<td>8</td>
</tr>
</tbody>
</table>
Lesson 2: Multi-user access to multi-instrument platforms is useful

Mean percent of data use by data source (n=65)

<table>
<thead>
<tr>
<th>Data source</th>
<th>Percent of data use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground, operator</td>
<td>44</td>
</tr>
<tr>
<td>Ground, unattended</td>
<td>38</td>
</tr>
<tr>
<td>Spacecraft</td>
<td>32</td>
</tr>
<tr>
<td>Other</td>
<td>8</td>
</tr>
</tbody>
</table>
Lesson 3: UARC is a powerful educational tool

Proportion of scientist and graduate student communication about science during three campaigns: April, 1993; June, 1993; and May, 1994

Percentage of communication about science over three UARC campaigns

<table>
<thead>
<tr>
<th></th>
<th>Scientists</th>
<th>Grad students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science, Apr '93</td>
<td>0.3</td>
<td>0.1</td>
</tr>
<tr>
<td>Science, Jun '93</td>
<td>0.6</td>
<td>0.4</td>
</tr>
<tr>
<td>Science, May '94</td>
<td>0.5</td>
<td>0.4</td>
</tr>
</tbody>
</table>
Lesson 4: The UARC interface is less obtrusive over time

Proportion of scientist and graduate student communication about UARC technology during three campaigns: April, 1993; June, 1993; and May, 1994.

Percentage of communication about UARC technology over three campaigns:

- **Technology, Apr 93**
- **Technology, Jun 93**
- **Technology, May 94**

- Scientists
- Grad students

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Lesson 5: Users report that UARC use has positively changed their research practices

Senior scientist -- Watching the observations on UARC adds new features to my work. When you sit there and watch in real-time, you develop your own expectations and predictions, which are then validated or invalidated. When you watch a campaign this way, for some reason, you remember interesting situations better and you can recognize them easier later on.

Graduate student -- I enjoy talking to Peter [Stauning] on the system. Peter provides answers for me when Bob [Clauer] is unavailable. This is a good way to learn because I can try out an idea and get a response quickly about whether it is good or bad. Also, UARC gives me the chance to learn how to run experiments. It is good to watch Bob [Clauer] run one. Without UARC I doubt that I would have participated in an experiment this early in my graduate career.
Lesson 6: Use of UARC for retrospective, collaborative data analysis is a useful new application

Example -- March, 1994 “replay campaign”

Participants: Peter Stauning in Denmark; Rick Doe in California; Cesar Valledares in Massachusetts; Odile de la Beaujardiere and Bob Robinson in Washington, D.C.; Rick Niciejewski and Craig Rasmussen in Michigan; and Ted Rosenberg in Maryland

Instruments: ISR, IRIS, All-sky imager

Data: PATCHES campaign, February 7 to 9, 1994
Future directions

Planned UARC development (1994 to 1997):

- enhance capabilities for support of retrospective, collaborative science (e.g., Atul Prakash’s effort to develop shared windows, pointers, and annotations)

- produce standard interface for adding additional instruments (e.g., effort directed by Terry Weymouth and Craig Rasmussen)

- expand educational use -- perhaps following Mike Kelley’s recent classroom demonstrations with UARC

- generalize findings and specifications -- but NOT particular technology -- to other collaborative scientific applications (e.g., evolution of the PCO)