Extensible Semantics for Representing Electromechanical Assemblies

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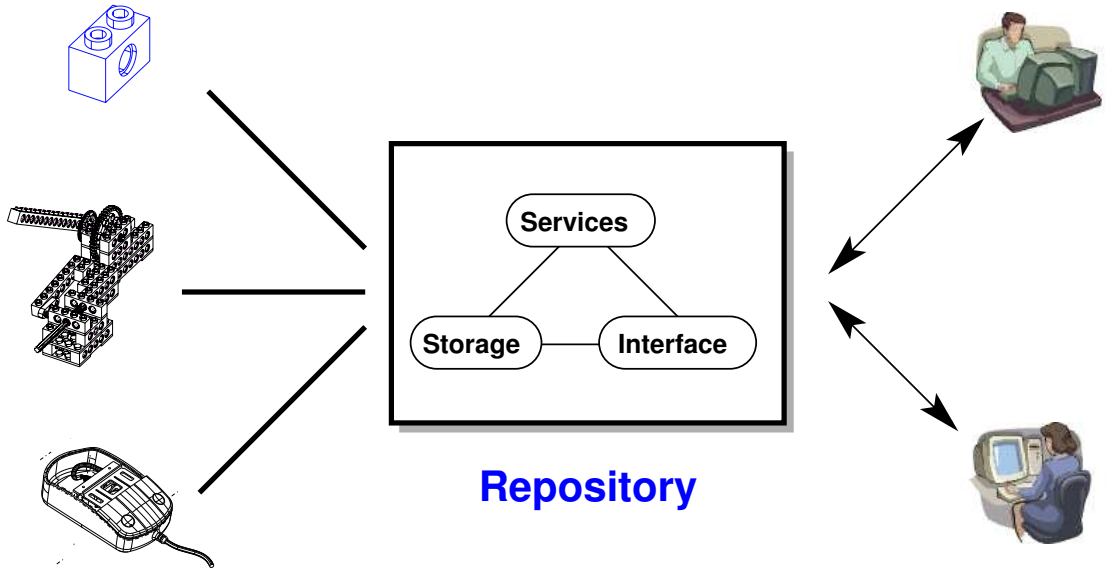
Design Repositories

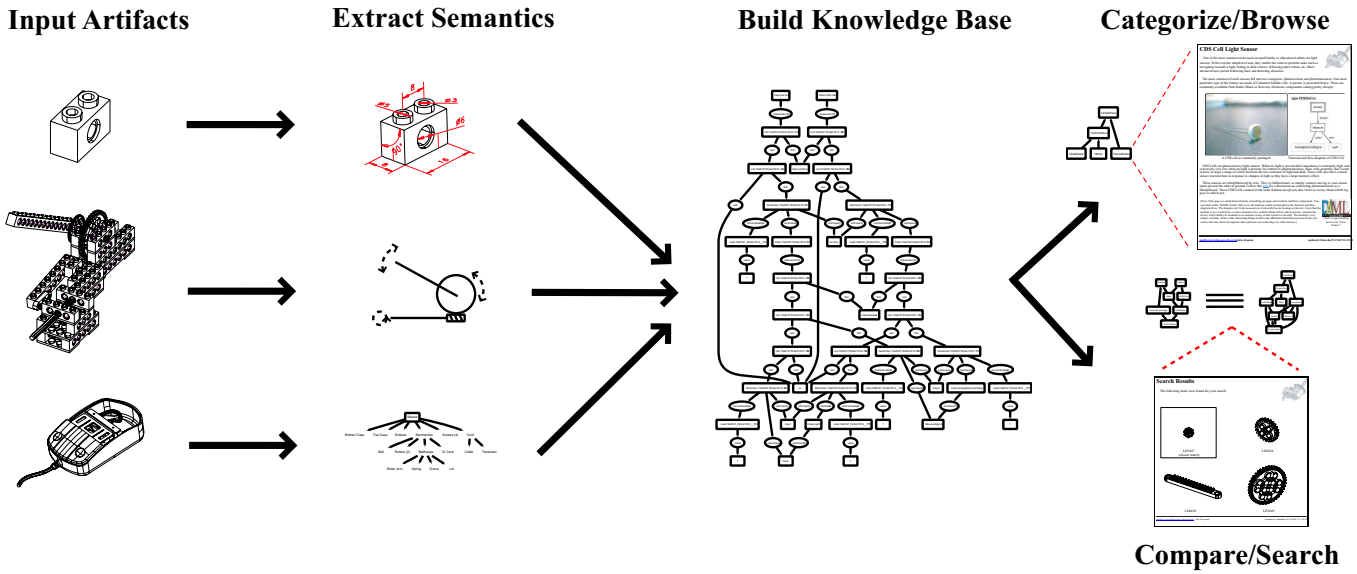
Design repositories—an evolution of traditional design databases

- **Capture and utilize more design knowledge**
  - **Function, behavior, structure, rationale**
- **Enable enhanced services**
  - **Sophisticated search, browsing, interfaces**
- **Provide storage for and effective access to heterogenous information**
  - **CAD data, documentation, simulations, animations, analyses**



Repository Operations

Knowledge-based repository overview:



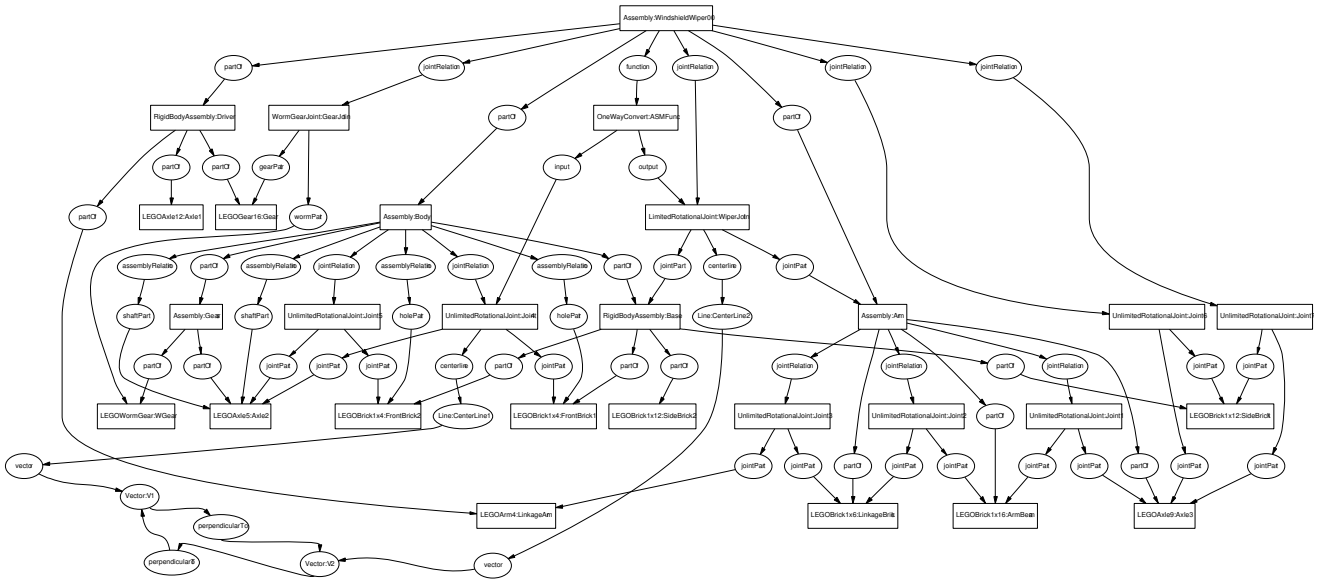
Major services of interest that a repository may provide:

- **Search**: Finding designs that meet criteria
- **Classification**: Placing designs into a hierarchy
- **Categorization**: Inducing a hierarchy automatically

Design Representation

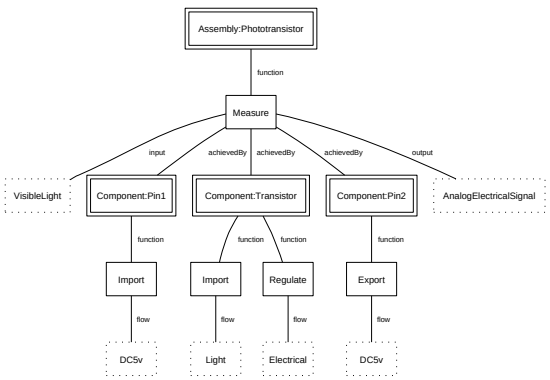
Need to capture design knowledge in an extensible, unified, formal manner

- **Represent: Features; relations; joints; function; links to CAD, images**
- **Formalism: conceptual graphs**

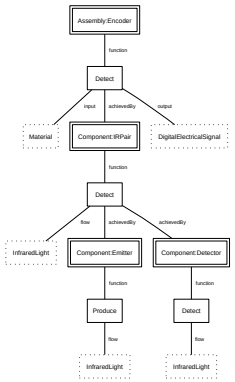


Function and Flow Signatures

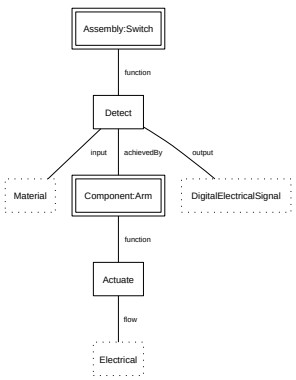
Tailor the representation (employ a sub-graph) for repository operations:
function and flow signatures



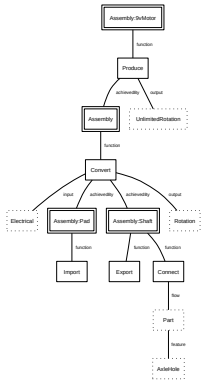
Phototransistor



Break-Beam

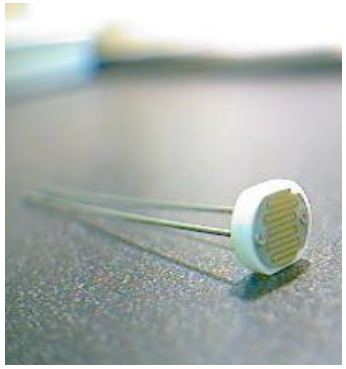


Switch

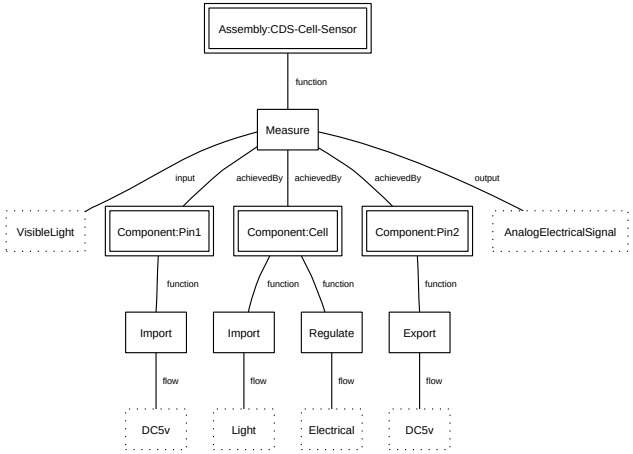


9V Motor

Signature Formalization in Description Logic



CDS Cell



Function and flow signature

$$CDS\text{-}Cell\text{-}Sensor \equiv Assembly \sqcap \exists function.[Measure \sqcap \exists input.VisibleLight \sqcap \exists achievedBy.[Component \sqcap \exists function.[Import \sqcap \exists flow.DC5v]] \sqcap \exists achievedBy.[Component \sqcap \exists function.[Import \sqcap \exists flow.Light] \sqcap \exists function.[Regulate \sqcap \exists flow.Electrical]] \sqcap \exists achievedBy.[Component \sqcap \exists function.[Export \sqcap \exists flow.DC5v]] \sqcap \exists output.AnalogElectricalSignal].$$

Function and flow signature as class description

Repository Operations Revisited

Standard capabilities provided by description logic formalization:

- **Search: Query is defined using a class description**
- **Classification: Hierarchy is defined *a priori* through class descriptions**

Novel capabilities provided by description logic formalization:

- **Search: Browse relationships between query and hierarchy**
- **Classification: Knowledge discovery through unanticipated classifications**
- **Classification: Provide for loose construction of hierarchy**
- **Categorization: Induce hierarchy from given designs**

Repositories on the Semantic Web

Can embed representation into web content

- Enable repository engine to operate across the Semantic Web

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  xmlns:eng  = "&eng;#" xmlns:func = "&func;#" xmlns:flow = "&flow;#"
  xmlns =
 "http://edge.mcs.drexel.edu/assemblies/tests/iaai03/cds-cell.daml#">

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  <daml:imports rdf:resource="&func;" />
  <daml:imports rdf:resource="&flow;" />
</daml:Ontology>

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      </eng:Component></eng:achievedBy>

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      </eng:Component></eng:achievedBy>

      <eng:output><flow:AnalogElectricalSignal /></eng:output>
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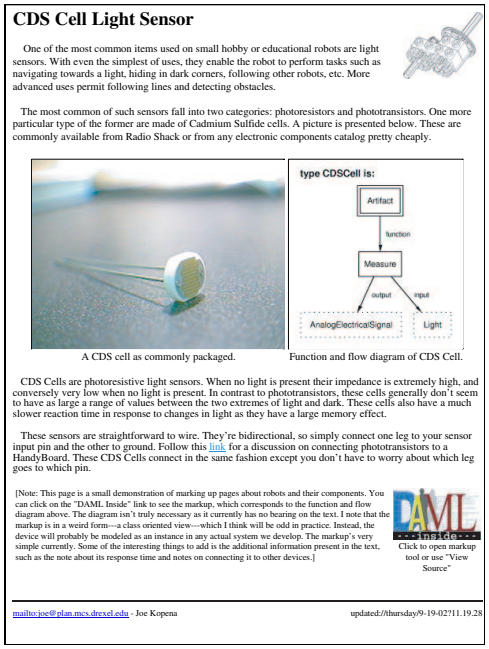
</eng:Assembly>
</rdf:RDF>
```

RDF/DAML source for CDS Cell signature



CDS Cell Light Sensor

One of the most common items used on small hobby or educational robots are light sensors. With even the simplest of uses, they enable the robot to perform tasks such as navigating towards a light, hiding in dark corners, following other robots, etc. More advanced uses permit following lines and detecting obstacles.

The most common of such sensors fall into two categories: photoresistors and phototransistors. One more particular type of the former are made of Cadmium Sulfide cells. A picture is presented below. These are commonly available from Radio Shack or from any electronic components catalog pretty cheaply.

A CDS cell as commonly packaged. Function and flow diagram of CDS Cell.

CDS Cells are photoresistive light sensors. When no light is present their impedance is extremely high, and conversely very low when no light is present. In contrast to phototransistors, these cells generally don't seem to have as large a range of values between the two extremes of light and dark. These cells also have a much slower reaction time in response to changes in light as they have a large memory effect.

These sensors are straightforward to wire. They're bidirectional, so simply connect one leg to your sensor input pin and the other to ground. Follow this link for a discussion on connecting phototransistors to a HandyBoard. These CDS Cells connect in the same fashion except you don't have to worry about which leg goes to which pin.

[Note: This page is a small demonstration of marking up pages about robots and their components. You can click on the "DAML Inside" link to see the markup, which corresponds to the function and flow diagram above. The diagram isn't truly necessary as it currently has no bearing on the text. I note that the markup is in a weird form—a class oriented view—which I think will be odd in practice. Instead, the device will probably be modeled as an instance in any actual system we develop. The markup's very simple currently. Some of the interesting things to add is the additional information present in the text, such as the note about its response time and notes on connecting it to other devices.]

Click to open markup tool or use "View Source"

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updated://thursday/9-19-02?11.19.28

Webpage with embedded signature

Summary

Design repositories require a unified, extensible representation

- **Enables: multiple sources, multiple accessing schemes**

Introduced design representation by function and flow signatures

- **Formal definitions enable new repository capabilities**

Discussed repositories as part of the Semantic Web

- **Enables: easy publishing, portals, interaction with other access methods**

In Closing...

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- National Institute of Standards and Technology (NIST) Grant #70NAN33H1026 (funded by NSF)

More information:

- **Project homepage:** http://edge.cs.drexel.edu/assemblies/
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Questions?