Two Ontology Design Patterns toward Energy Efficiency in Buildings

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**Requirements**

* What are the Qualities of a Feature of Interest?
* What are the Qualities that affect a given Quality of a Feature of Interest?
* Which Feature of Interest does a given Quality belongs to?
* What are observations/actuations performed by a given Procedure?
* What are observations/actuations performed by a given sensor/actuator?
* What are the Procedures implemented by a given sensor/actuator?
* What are the Feature of Interests of a given observation/actuation?
* What are the Qualities sensed/actuated by a given observation/actuation?
* What are the Feature of Interest of a given sensor/actuator?
* What are the Qualities sensed/actuated by a given sensor/actuator?
Requirements

* What are the Qualities of a Feature of Interest?
* What are the Qualities that affect a given Quality of a Feature of Interest?
* **Which Feature of Interest does a given Quality belongs to?**
* What are observations/actuations performed by a given Procedure?
* What are observations/actuations performed by a given sensor/actuator?
* What are the Procedures implemented by a given sensor/actuator?
* What are the Feature of Interests of a given observation/actuation?
* What are the Qualities sensed/actuated by a given observation/actuation?
* **What are the Features of Interest of a given sensor/actuator?**
* What are the Qualities sensed/actuated by a given sensor/actuator?
1\textsuperscript{st} Competency Question:

“Discover the relevant qualities that affect the environment of a given space”
The AffectedBy ODP

aff:hasQuality o aff:affectedBy

aff:FeatureOfInterest

aff:belongsTo [1..1]

aff:hasQuality

aff:Quality

aff:belongsTo some
aff:FeatureOfInterest

aff:affectedBy

aff:affectedBy

The AffectedBy ODP

aff:hasQuality o aff:affectedBy

aff:belongsTo [1..1]

aff:belongsTo some
aff:FeatureOfInterest

aff:affectedBy
The AffectedBy ODP

aff:hasQuality o aff:affectedBy

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aff:belongsTo some
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The AffectedBy ODP

aff:hasQuality o aff:affectedBy

aff:belongsTo [1..1]

aff:belongsTo some
aff:FeatureOfInterest

aff:affectedBy

aff:hasQuality

aff:FeatureOfInterest

aff:Quality
The AffectedBy ODP

aff:hasQuality o aff:affectedBy

aff:belongsTo [1..1]

aff:affectedBy

aff:belongsTo some

aff:FeatureOfInterest

aff:Quality

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aff:hasQuality o aff:affectedBy

aff:belongsTo [1..1]

aff:belongsTo some
aff:FeatureOfInterest

aff:hasQuality

aff:affectedBy

aff:Quality

aff:FeatureOfInterest
The AffectedBy ODP

aff:hasQuality o aff:affectedBy

aff:belongsTo [1..1]

aff:belongsTo some
aff:FeatureOfInterest

aff:affectedBy

aff:Quality

aff:FeatureOfInterest
2\textsuperscript{nd} Competency Question:

“Discover the sensors/actuators that observe/act on a given space”
The EEP (Execution-Executor-Procedure) ODP

eep:Execution \[\text{madeBy} [1..1]\] eep:Executor \[\text{usedProcedure} [1..1]\] eep:Procedure

eep:hasFeature OfInterest

aff:Feature OfInterest

aff:Quality \[\text{affectedBy}]

aff:belongsTo [1..1]

aff:hasQuality

aff:forFeature ofInterest

aff:forQuality

aff:onQuality [1..1]
The EEP (Execution-Executor-Procedure) ODP

aff:Feature OfInterest

aff:Quality

aff:affectedBy

aff:belongsTo [1..1]
The EEP (Execution-Executor-Procedure) ODP

- eep:Execution
- eep:Executor
- eep:Procedure

aff:FeatureOfInterest

aff:Quality

aff:belongsTo [1..1]

aff:affectedBy
The EEP (Execution-Executor-Procedure) ODP

- **eep:Execution**
  - **eep:madeBy** [1..1]
  - **eep:usedProcedure** [1..1]
  - **eep:onQuality** [1..1]

- **eep:Executor**
  - **eep:madeBy** [1..1]
  - **eep:procedure** [1..1]
  - **eep:onQuality** [1..1]

- **eep:Procedure**
  - **eep:madeBy** [1..1]
  - **eep:usedProcedure** [1..1]
  - **eep:onQuality** [1..1]

- **aff:Feature OfInterest**
  - **aff:belongsTo** [1..1]

- **aff:Quality**
  - **aff:affectedBy**

- **aff:belongsTo** [1..1]
The EEP (Execution-Executor-Procedure) ODP

- **eep:Execution** → **eep:Executor** via **eep:madeBy [1..1]**
- **eep:Executor** → **eep:Procedure** via **eep:usedProcedure [1..1]**
- **eep:Execution** → **aff:Feature OfInterest** via **aff:belongsTo [1..1]**
- **aff:Feature OfInterest** → **aff:Quality** via **aff:belongsto [1..1]**
- **aff:Quality** → **aff:affectedBy**
The EEP (Execution-Executor-Procedure) ODP

- eep:Execution
  - eep:madeBy [1..1]
  - eep:forFeatureOfInterest
  - eep:hasFeatureOfInterest
  - eep:hasQuality
  - eep:onQuality [1..1]
  - eep:usedProcedure [1..1]

- eep:Executor
  - eep:madeBy [1..1]
  - eep:forFeatureOfInterest
  - eep:hasQuality
  - eep:forQuality

- eep:Procedure
  - eep:implements

- aff:FeatureOfInterest
  - aff:belongsTo [1..1]

- aff:Quality
  - aff:affectedBy

- aff:belongsTo [1..1]
Property Chain Axioms

The AffectedBy ODP

- \text{aff:hasQuality} \circ \text{aff:affectedBy}
- \text{rdfs:subPropertyOf} \text{aff:hasQuality}

The EEP ODP

- inverse (\text{eep:madeBy}) \circ \text{eep:usedProcedure}
- \text{rdfs:subPropertyOf} \text{eep:implements}

- \text{eep:onQuality} \circ \text{eep:belongsTo}
- \text{rdfs:subPropertyOf} \text{eep:hasFeatureOfInterest}

- inverse (\text{eep:madeBy}) \circ \text{eep:onQuality}
- \text{rdfs:subPropertyOf} \text{eep:forQuality}

- \text{eep:forQuality} \circ \text{eep:belongsTo}
- \text{rdfs:subPropertyOf} \text{eep:forFeatureOfInterest}
Competency Questions Solved

The AffectedBy ODP

**CQ1:** What are the Qualities of a FoI?
**CQ2:** What are the Qualities that affect a given Quality of a FoI?
**CQ3:** Which FoI does a given Quality belongs to?

The EEP ODP

**CQ1:** What are observations/actuations performed by a given Procedure?
**CQ2:** What are observations/actuations performed by a given sensor/actuator?
**CQ3:** What are the procedures implemented by a given sensor/actuator?
**CQ4:** What are the FoIs of a given observation/actuation?
**CQ5:** What are the properties/qualities sensed/actuated by a given observation/actuation?
**CQ6:** What are the FoI of a given sensor/actuator?
**CQ7:** What are the properties/qualities sensed/actuated by a given sensor/actuator?
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The AffectedBy ODP
https://w3id.org/affectedBy

The EEP ODP
https://w3id.org/eep