Water conservation with novel application of fault detection diagnostics (FDD) applied to a rain water harvesting system in Ireland

Presenter: Niall Chambers, Masters Student.

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PRESENTATION OUTLINE

1. Introduction to *Waternomics* Project

2. Fault Detection & Diagnosis (FDD) & Case Study

3. Methodology & Results

4. Conclusions
1. Introduction
Project co-funded by the European Commission within the 7th Framework Program (Grant Agreement No. 619660)
Buildings use 21% of all water in the EU

Estimated 20-30% of this wasted or leaked
ICT SOLUTION

Leakage and Fault Detection

Linked Water Dataspase

Sensors Adapters
2. Fault Detection Diagnostics (FDD) & Case Study
FAULT DETECTION AND DIAGNOSTICS (FDD)

- Measurement Science/Analytic tool
- Applied in space industry, Automated systems, HVAC etc.
- Reduces Downtime
- Improves Maintenance Effectiveness
IRELAND’S PILOT SITE / CASE STUDY

National University of Ireland, Galway  
Engineering Building

- Commissioned and Occupied in 2011
- ~1,000 Students & 100 Staff
- 5200 m² Plan Area, 4 Storeys
- Labs, Classrooms, Café, Toilets & Showers etc.
ENGINEERING BUILDING
RAINWATER HARVESTING SYSTEM

Roof Rain Catchment Area

Underground Storage Tank (75 m³)

Pump

Filter

Roof Header Tanks (8 m³)

Toilets/Urinals

MWS Backup Supply

Meter
4. Methodology & Results
Signals and readings from the system can be utilised to identify a fault within the system.
<table>
<thead>
<tr>
<th>No.</th>
<th>RWH Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rain Water meter = 0 m³/week</td>
</tr>
<tr>
<td>2</td>
<td>Rainfall = 40 m³/week</td>
</tr>
<tr>
<td>3</td>
<td>Pressure Indicator in Storage Tank Specifies = 0 m³</td>
</tr>
</tbody>
</table>

= Blockage in Pipe
Fault Found

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</table>
ENGINEERING BUILDING RWHS
FAULT FOUND

Rainfall
Rainwater Used

~€200/Month

Month

Volume (m$^3$)

0 100 200 300 400 500 600 700 800

2012 2013 2014
5. Conclusions and Questions
CONCLUSIONS

• *Waternomics* will provide a software platform to improve building water management by:
  - Affecting behavioural Changes
  - Increasing user awareness
  - Correcting leaks and malfunctions through FDD

• FDD is a proven methodology applied to many systems industries

• FDD was applied to a RWHS in a novel way

• Various levels of FDD can be applied to the system

• The most basic level of FDD identified a significant and persistent fault which will save €200/month in the Ireland Pilot site
ACKNOWLEDGEMENTS

Project co-funded by the European Commission within the 7th Framework Program (Grant Agreement No. 619660)

Co-Authors: E. Clifford, D. Coakley, M. Keane

OÉ Gaillimh
NUI Galway
FURTHER DETAILS

www.waternomics.eu
info@waternomics.eu
### Outline of FDD Rules

<table>
<thead>
<tr>
<th>Rule No.</th>
<th>Rules, Based on Conditions</th>
<th>Conditions are Either True, False or Irrelevant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>First Alarm</td>
<td>✓</td>
</tr>
<tr>
<td>2</td>
<td>Insufficient Stored Water</td>
<td>✓</td>
</tr>
<tr>
<td>3</td>
<td>Insufficient Rainfall</td>
<td>✓</td>
</tr>
<tr>
<td>4</td>
<td>Roof to Storage Tank Pipe Blockage</td>
<td>✓</td>
</tr>
<tr>
<td>5</td>
<td>Power to Pump issue</td>
<td>✓</td>
</tr>
<tr>
<td>6</td>
<td>Pump Blockage/Mechanical Failure</td>
<td>✓</td>
</tr>
<tr>
<td>7</td>
<td>Filter is Broken/Requires Servicing</td>
<td>✓</td>
</tr>
<tr>
<td>8</td>
<td>Leak in Pipeline/Pump Malfunction</td>
<td>✓</td>
</tr>
</tbody>
</table>
OUTSTANDING QUESTIONS

• How can I calculate the money that is being lost when I don’t know how much water that the toilet and Urinal system (GWS) use in the building?

• There is a meter on the RWHS top up to the header tanks, but I’m not sure if this system ever worked to capacity i.e. serviced all of the GWS needs

• The only way that I could really find out is to place a meter on the CWS top up to one of the tanks
OUTSTANDING QUESTIONS

• Where did the idea of applying FDD to water networks in the project come from?
• Was it in the brief, are other projects under this framework doing the same?
ASSESSMENT AND PLANNING

**PHASE 0**
- **ASSESS**
  - Water Review, Audit, Diagnosis and Commitment
  - ISO 50002

**PHASE 1**
- **PLAN**
  - Organizational Procedures + Baseline
  - ISO 50001 IPMVP

**PHASE 2**
- **DO**
  - Implementation and operation
  - ISO 50001 IPMVP

**PHASE 3**
- **CHECK**
  - Management and verification
  - ISO 50001 IPMVP

**PHASE 4**
- **ACT**
  - Certification & Review
  - ISO 14046 Water Footprint

**Grey Water Panel Monitoring**
- Common Fault: O.K.

**Grey Water Meter**
- Hourly Rate: 0.0L/hr
- Daily Total: 5606.0L
- Monthly Total: 5606.0L
- Accum. Total: 5606.0L
- Accum. Reset: Off

**Grey Water Tank**
- Capacity: 8000 Litres
- Low Level Alarm: O.K.
- High Level Alarm: Alarm

**Grey Water West Tank**
- Capacity: 8000 Litres
- Low Level Alarm: Alarm
- High Level Alarm: O.K.
FAULT DETECTION AND DIAGNOSTICS (FDD)

- Energy in Buildings
- Provided 10-30% Energy Savings
 EXAMPLE FAULT #2

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<td>3</td>
<td>Pressure Indicator in Storage Tank Specifies = 40 m³</td>
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<tr>
<td>4</td>
<td>Power to Pump Operational? Yes</td>
</tr>
</tbody>
</table>

= Pump Mechanical Fault