The Power of Expressions

AVEVA™ Historian & AVEVA™ Insight

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Specific Use Cases Targeted

**Simple Engineering**
- Pump Efficiency
- Find process lag based on flow rate
- Compensate for a process lag

**Logical Expressions**
- Simple comparisons
- Time “true”
- “True” for min/max time

**Exception Handling**
- Substitute bad/stale values
- Find last good value
Questions

1. Who should be allowed to create them?

2. What relevant skills do they have?

3. Why not use general-purpose tools?

My Answers

All users
(not just administrators)

Excel
(not C#, C++, SQL)

Time-series,
Industrial distinctives
(not the same as accounting & IT)
## Time-series & Industrial Distinctives

<table>
<thead>
<tr>
<th>Time-Series</th>
<th>Industrial</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Date/time syntax</td>
<td>1. Volume of data</td>
</tr>
<tr>
<td>2. Time units are</td>
<td>2. Data quality</td>
</tr>
<tr>
<td>3. Time zones</td>
<td>3. Production vs. calendar</td>
</tr>
<tr>
<td>4. Daylight savings</td>
<td>4. Rates vs. quantity</td>
</tr>
<tr>
<td>5. Sample rates</td>
<td>5. Boolean information</td>
</tr>
<tr>
<td>6. Latency</td>
<td></td>
</tr>
</tbody>
</table>
What is the value range of the results of this expression?

\[\text{SysTimeSec} + \text{SysTimeMin}\]

- a. 0 – 118
- b. 0 - 3599

The correct answer is b. 0 - 3599 seconds.
Unit Conversion

Might be confusing, but consider this:

\[
\text{FI101.PV + FI202.PV} \\
0-35.0 \quad 0-0.58 \\
liters/minute \quad liters/second
\]

Result will be in units of first tag:

\[
0-70.0 \quad \text{liters/minute}
\]

Alternative puts burden on user to convert:

\[
\text{FI101.PV + FI202.PV} / 60.0 \quad \times \\
\text{FI101.PV + FI202.PV} \times 60.0 \quad \checkmark
\]
# Ad Hoc Expressions

<table>
<thead>
<tr>
<th>Arithmetic</th>
<th>Scalar</th>
<th>Statistics</th>
<th>Time Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>SIGN</td>
<td>AVERAGE</td>
<td>TIMESHIFT</td>
</tr>
<tr>
<td>-</td>
<td>ABS</td>
<td>AVERAGES</td>
<td>DURATION</td>
</tr>
<tr>
<td>/</td>
<td>SQRT</td>
<td>TOTAL</td>
<td>PREV</td>
</tr>
<tr>
<td>*</td>
<td>LOG</td>
<td>TOTALS</td>
<td>PREVGOOD</td>
</tr>
<tr>
<td>^</td>
<td>ROUND</td>
<td>MIN</td>
<td></td>
</tr>
<tr>
<td>%</td>
<td>TRUNCATE</td>
<td>MAX</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>COUNT</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>COUNTALL</td>
<td></td>
</tr>
</tbody>
</table>

**Units**

- UOM
- CASTUOM

**New in Historian 2023**

- IFLONGER
- IFSHORTER
Statistics

AVERAGE( M21.Temp, 1 hour )
Returns time-weighted average

TOTAL( M21.FlowOut > 54.0, 15 minute )
Returns a time-weighted “integral”, converting a rate to a quantity

METER( CasePacker10.Cases, 1 day )
Returns “counter” retrieval value, considering “rollover” settings
Aggregate Periods

\[
\text{AVERAGE( A, 1 hour )}
\]

...FROM History WHERE wwRetrievalMode='AVG'
AND wwResolution=3600000...
Named Periods

AVERAGE( M21.Temp, 1 hour )

- Based on 23-25 hour days
- Based on 24-hour days
Aggregate Time Stamps

AVERAGE( A, 1 hour )
COUNT vs COUNTALL

COUNT( M21.Temp > 54.0, 1 hour )

- Only counts filled green points (e.g. “1”)

COUNTALL( M21.Temp > 54.0, 1 hour )

- Counts all green points (e.g. “5”)
- Only returns logical changes (filled points)
- Works similar to wwEdgeDetection = 'both'
Considering Duration

\( M21.\text{Temp} > 54.0 \)

\[ \text{IFLONGER( } M21.\text{Temp} > 54.0, 10 \text{ minute } \) Returns value for yellow points\]

\[ \text{IFSHORTER( } M21.\text{Temp} > 54.0, 10 \text{ minute } \) Returns value for purple points\]
IFLONGER( M21.Temp > 54.0, 5 minute )
Returns TRUE or FALSE

IFLONGER( M21.Temp > 54.0, 5 minute, 27.0 )
Returns 27.0 or null

IFLONGER( M21.Temp > 54.0, 5 minute, 27.0, 3.14 )
Returns 27.0 or 3.14
API Support for Expressions

**SQL**
- “wwExpression” column
- Only in “History” view

**API {REST}**
- “Expression” property
- Only on “ProcessValues” endpoint
- Only in “POST” queries
- Up to 10 tags per expression
- Retrieval Modes: Full, Delta, Best Fit, Cyclic

**C#**
- “Expression” property
- Only on “HistoryQuery”
Engineering Unit Labels

- Name: Flow.PV
- Description: Actual flow rate
- Data type: Float
- Writeability: User writeable
- Initial value: 0.0

Eng units options: 1pm, L/min, l/min
Making Sense Of Engineering Units

String Labels

Label | Symbol | Formal Definition
--- | --- | ---
m³/sec | m³/s | "Catalog" or "Canonical Unit"
l/s | L/s | Volumetric Flow
L/sec | L/min | "Dimension"
lpm | gal/sec | gpm

<table>
<thead>
<tr>
<th>Unit</th>
<th>Symbol</th>
<th>Scale Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>cubic meters/second</td>
<td>m³/s</td>
<td>base</td>
</tr>
<tr>
<td>liters/second</td>
<td>L/s</td>
<td>0.0010000000000</td>
</tr>
<tr>
<td>liters/minute</td>
<td>L/min</td>
<td>0.0000166666667</td>
</tr>
<tr>
<td>gallons/second</td>
<td>gal/s</td>
<td>0.0037854117840</td>
</tr>
<tr>
<td>gallons/minute</td>
<td>gal/min</td>
<td>0.0000630901964</td>
</tr>
</tbody>
</table>

all of the above are Volumetric Flow “Dimension”
Mapping Engineering Units

On-Premises: AVEVA Historian

Online: AVEVA Insight
Feedback On Implicit Unit Conversion
Expression Feedback Examples

- **Implicit unit conversion**
  
  - Build an expression:
    
    \( \text{gps} \text{l/min} \text{LRP201.InletFlow - LRP101.OutletFlow} \)
    
    Returns \text{gps}
  
  - Build an expression:
    
    \( \text{L/min} \text{DegC SP101.Flow.PV - SP101.Temp} \)
    
    | Error: \( \text{DegC} \) is not directly compatible

- **Units not understood**
  
  - Build an expression:
    
    \( \text{m3} \text{LRP101.PipeVolume / LRP101.DoesNotExist} \)
    
    | Error: Tag not found LRP101.DoesNotExist
Units Of Measure (UOM)

Sets units without applying any conversion

\[ \text{L/s} \quad \text{CASTUOM(M21.FlowIn * 30, liters)} \]

Applies conversion to produced units

\[ \text{L/s} \quad \text{UOM(M21.FlowIn * CASTUOM(30, minutes), m\textsuperscript{3})} \]

Result Units

→ L/s

→ liters

→ m\textsuperscript{3}
Performance Considerations

• Every stored value is processed: No benefit from auto-summary
• Consider data rate, not just results & retrieval mode

• Expressions with multiple tags can compound the volume of data
• Values injected when values aren’t time-aligned
Aligning Sample Times

- A - B
- generally "fast changing"
- Optimistic
  - generally "slow changing"
- Stair Step
- Pessimistic
- $t_{\text{now}}$
Please remember to...

Navigate to this session in the mobile app to complete the survey.

The Power of Expressions

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