# Fundamentals of Asset Management

*Step 3. Determine Residual Life*

*A Hands-On Approach*

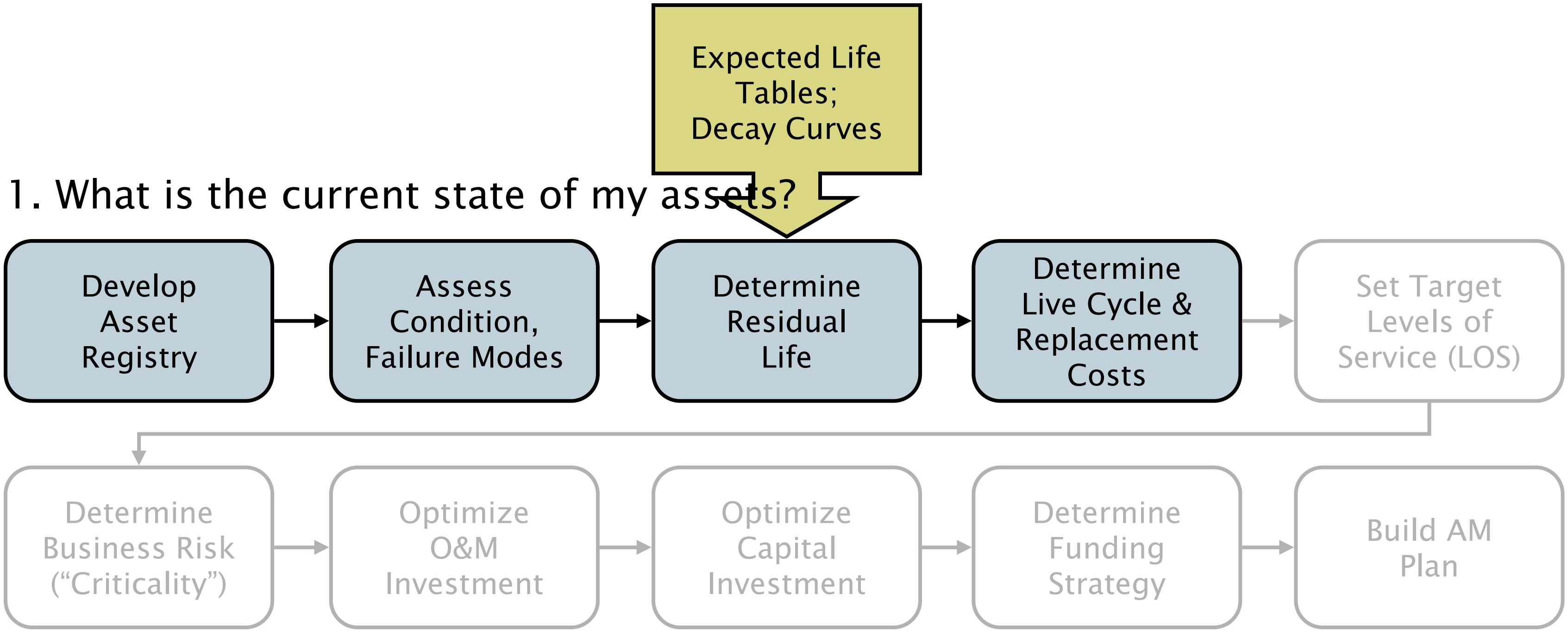
# Tom's bad day…

# First of 5 core questions, continued

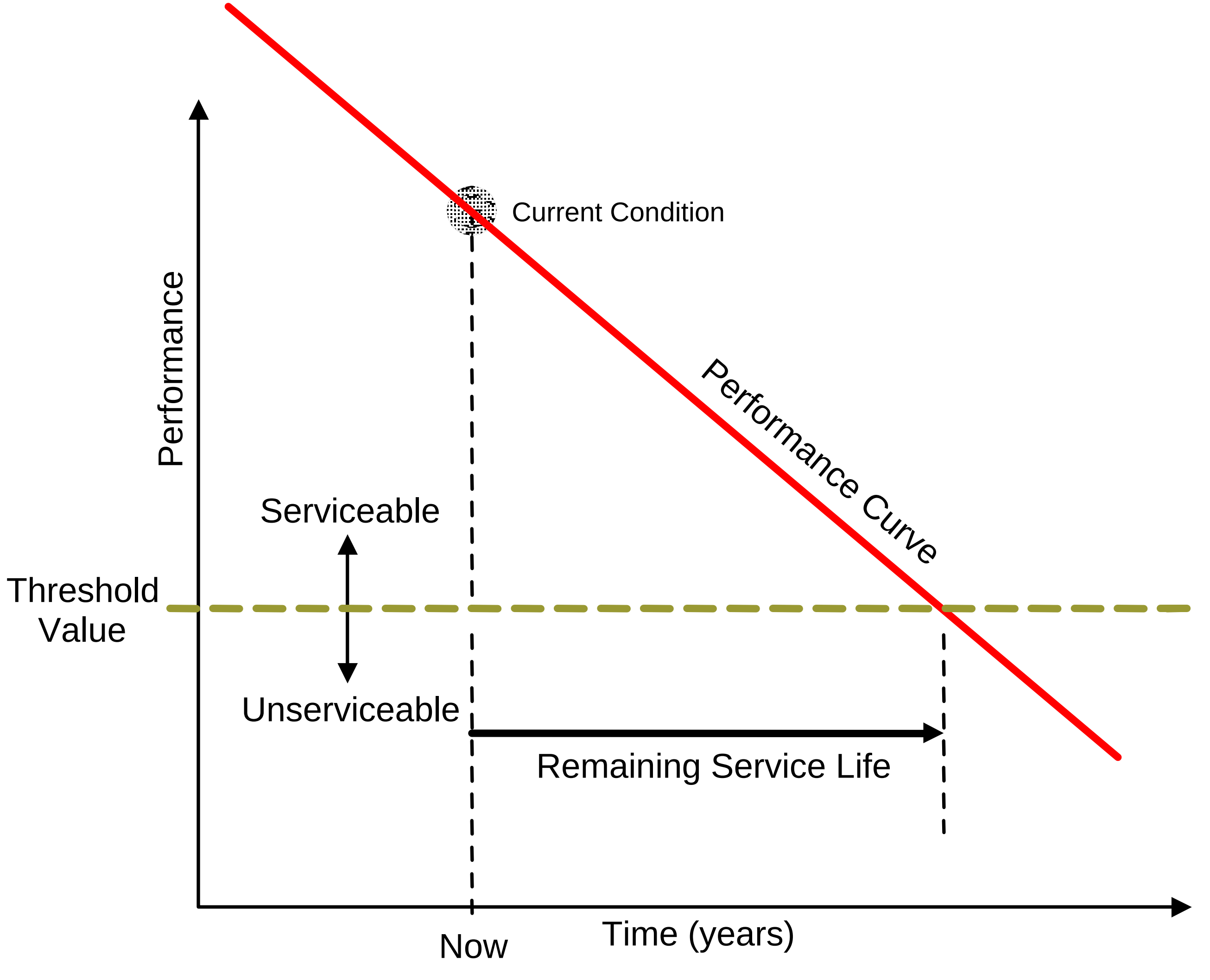
1. What is the condition of my assets?
   - What is the *importance* of *remaining useful life*?
   - How might we *determine* remaining useful life?

# AM plan 10-step process

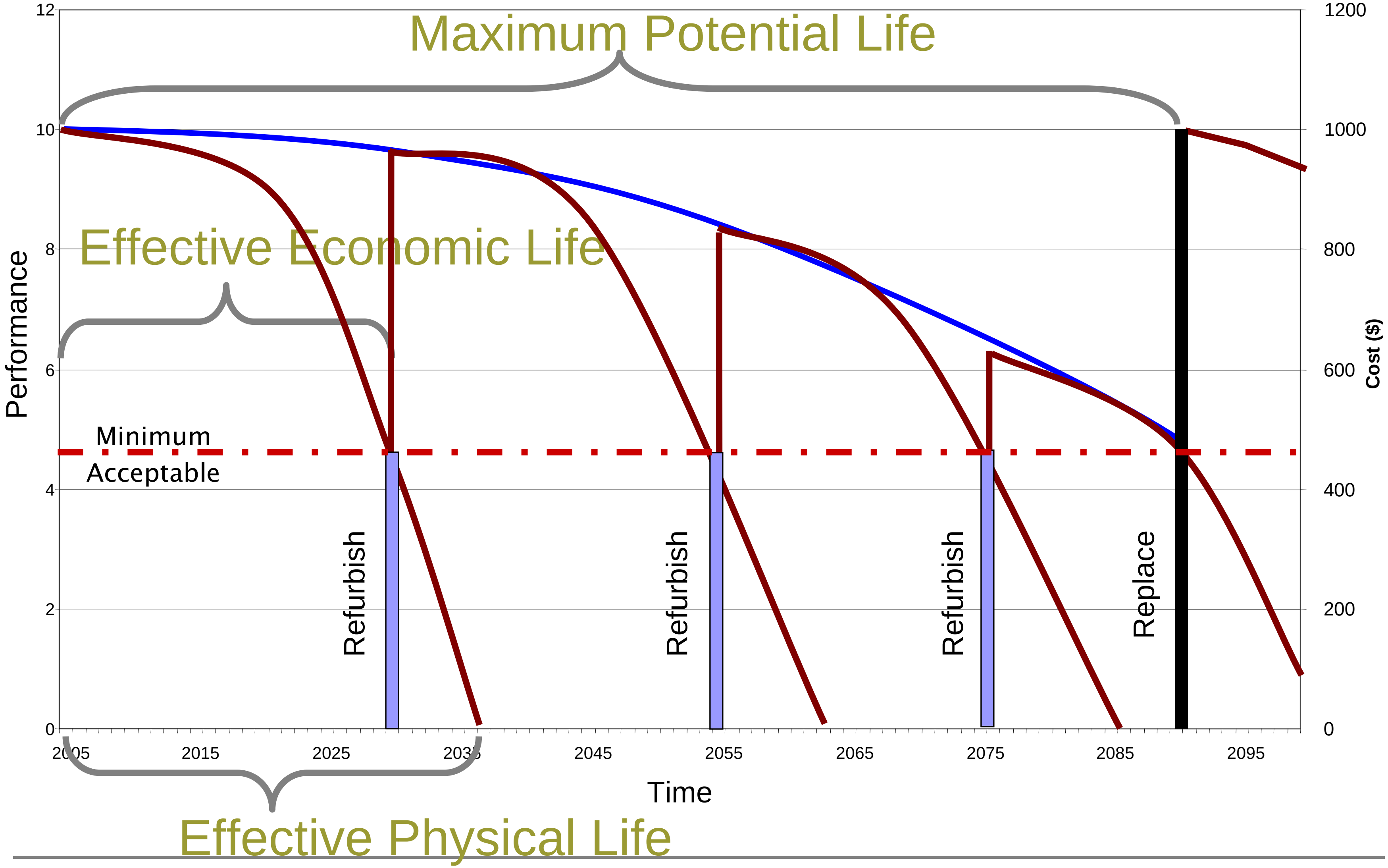
1. What is the current state of my assets?



# Determining Residual Life



# Asset Lives



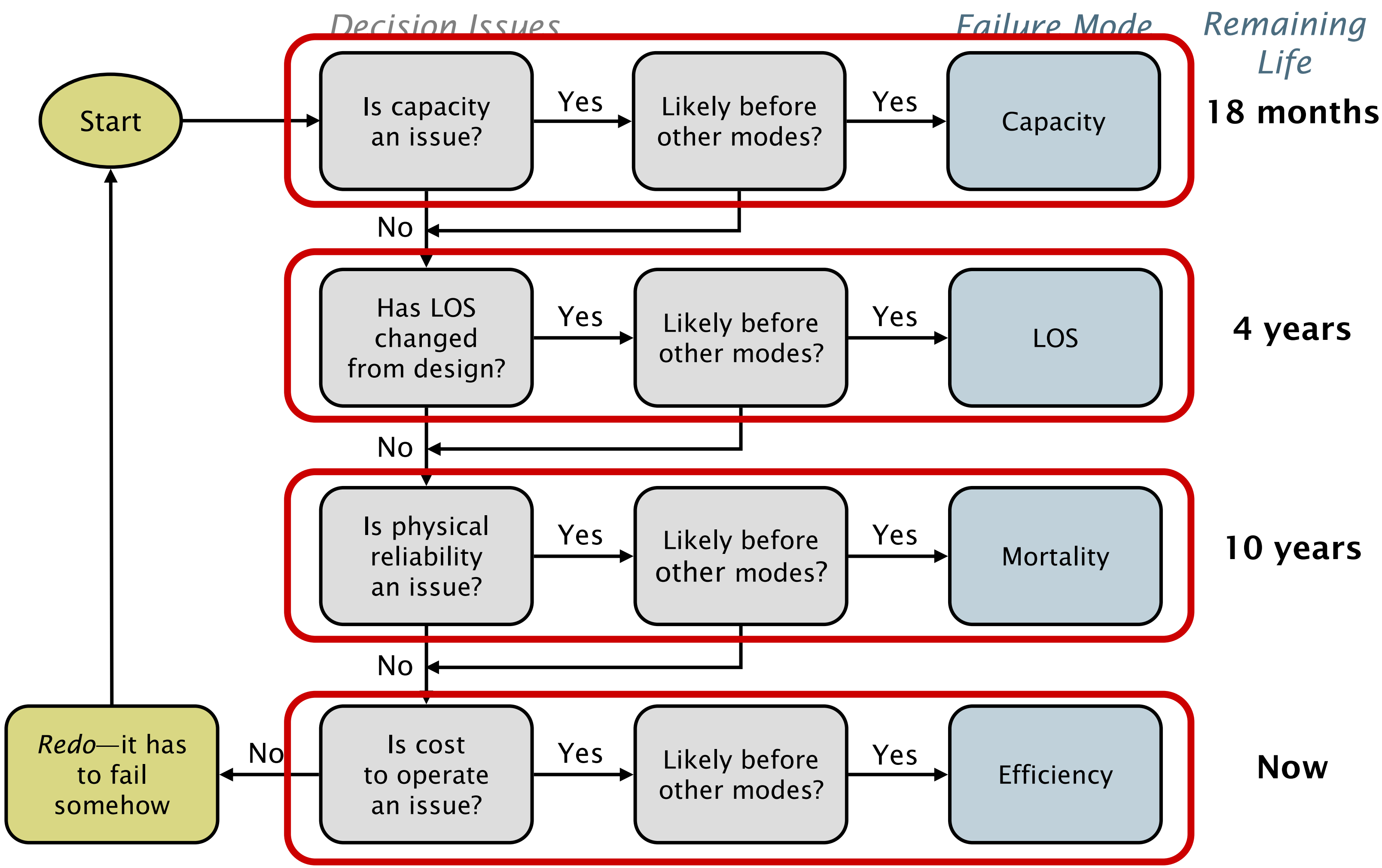
Maximum Potential Life
Effective Economic Life
Effective Physical Life
Minimum Acceptable
Refurbish
Refurbish
Refurbish
Replace
Performance
Cost ($)
Time
0
2
4
6
8
10
12
0
200
400
600
800
1000
1200
2005
2015
2025
2035
2045
2055
2065
2075
2085
2095

# “Physical life” vs. “economic life”

## Effective Economic life is

- The period from the acquisition of the asset to the time when the asset, while physically able to provide a service, *ceases to be the lowest cost alternative to satisfy a particular service requirement*.
- At a maximum, equal to the physical life, but obsolescence often will ensure that *the economic life is less than the physical life*.

# The role of failure modes in determining residual life



# Determining residual life

- *Approach 1* Effective life table
- *Approach 2* Effective life table, plus modification factors
- *Approach 3* Direct observation table
- *Approach 4* Condition and decay curve table

# Approach 1, effective life table

| Class | Asset Type | Effective Life | Class | Asset Type | Effective Life |
|---|---|---|---|---|---|
| 1 | Civil | 75 | 6 | Motors | 35 |
| 2 | Pressure pipework | 60 | 7 | Electrical | 30 |
| 3 | Sewers | 100 | 8 | Controls | 25 |
| 4 | Pumps | 40 | 9 | Building assets | 30 |
| 5 | Valves | 30 | 10 | Land | NA |

Sources: manufacturers, industrial associations, GASB, colleagues, consulting engineers, research (professional associations, universities), international community

# Tying age to effective life

| *% of Effective Life Consumed* | *PoF Rating* |
|---|---|
| 0 | 1 |
| 10 | 2 |
| 20 | 3 |
| 30 | 4 |
| 40 | 5 |
| 50 | 6 |
| 60 | 7 |
| 70 | 8 |
| 80 | 9 |
| 90 | 10 |

PoF is probability of failure

# Example: determination of “% Residual life”

1. Calculate effective life consumed

$$\text{\% Effective life consumed} = \frac{\text{Life to date}}{\text{Estimated useful life}}$$

2. Determine % residual (remaining) life

$$\text{\% Residual life} = 1.0 - \text{\% Effect. life consumed}$$

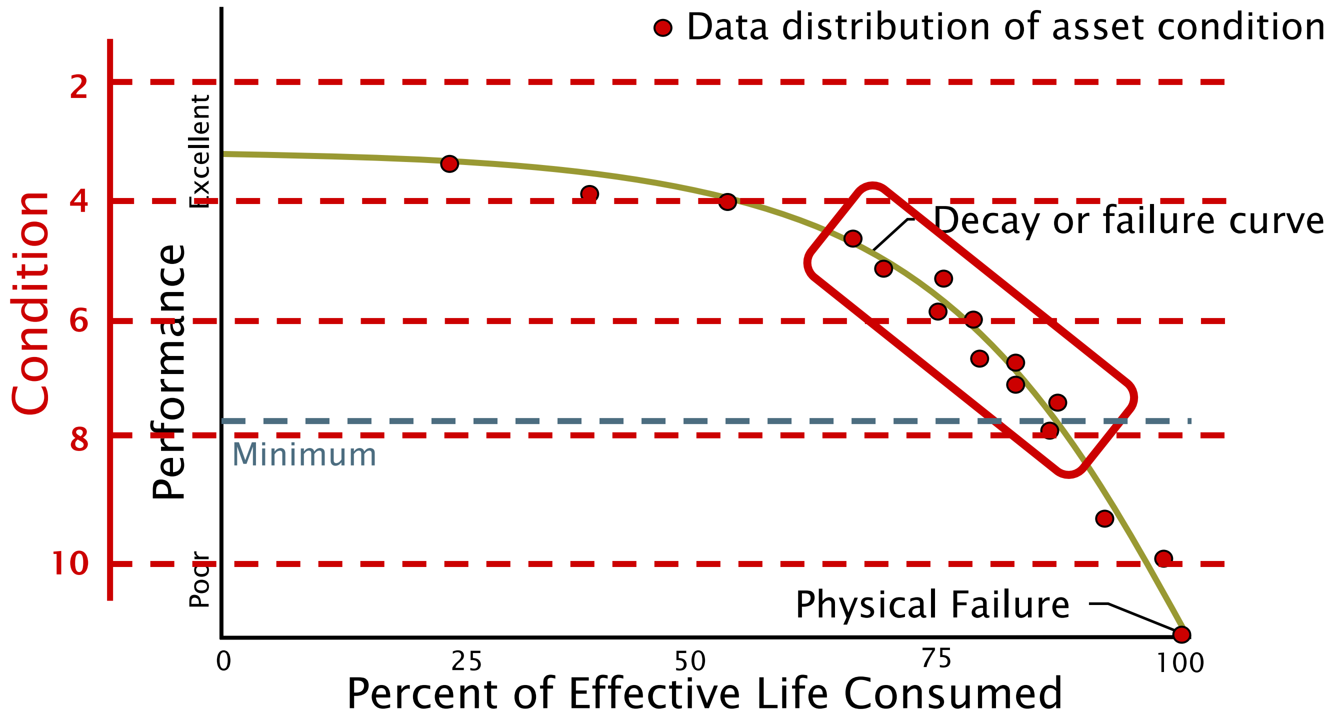
3. Example calculation

*Asset acquired 1997; current year 2007; useful life 25 years*

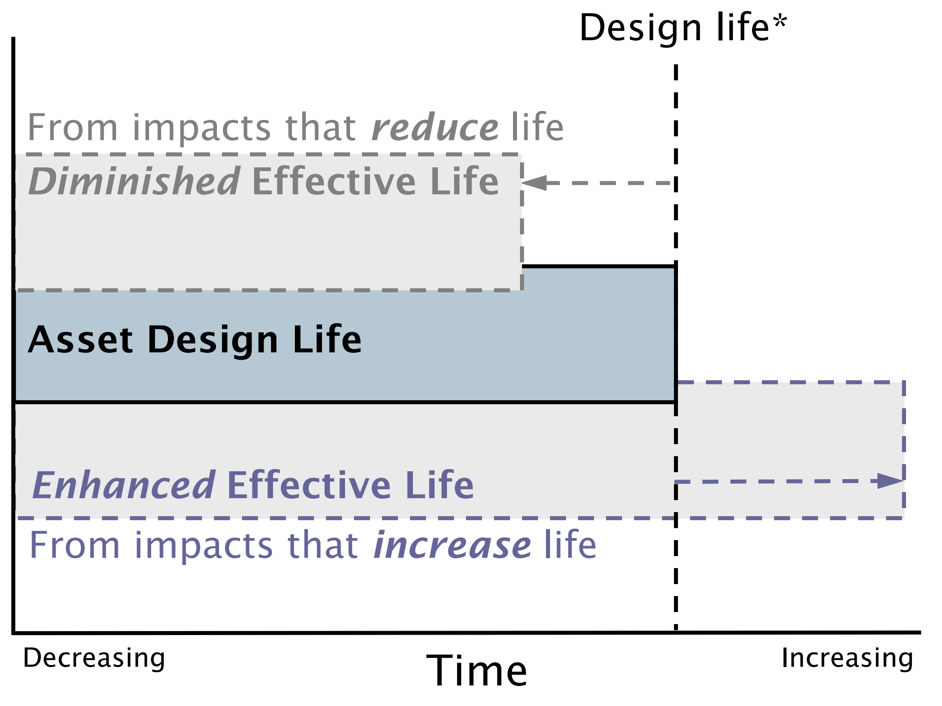
$$\text{40\% Residual life} = 1.0 - (\text{10 yr. LTD / 25 yr. EUL})$$

# Percent of effective life consumed concept

Relating asset condition to percent of effective life consumed



# Approach 2, amending standard effective lives




*Asset *design life* is from average effective life tables

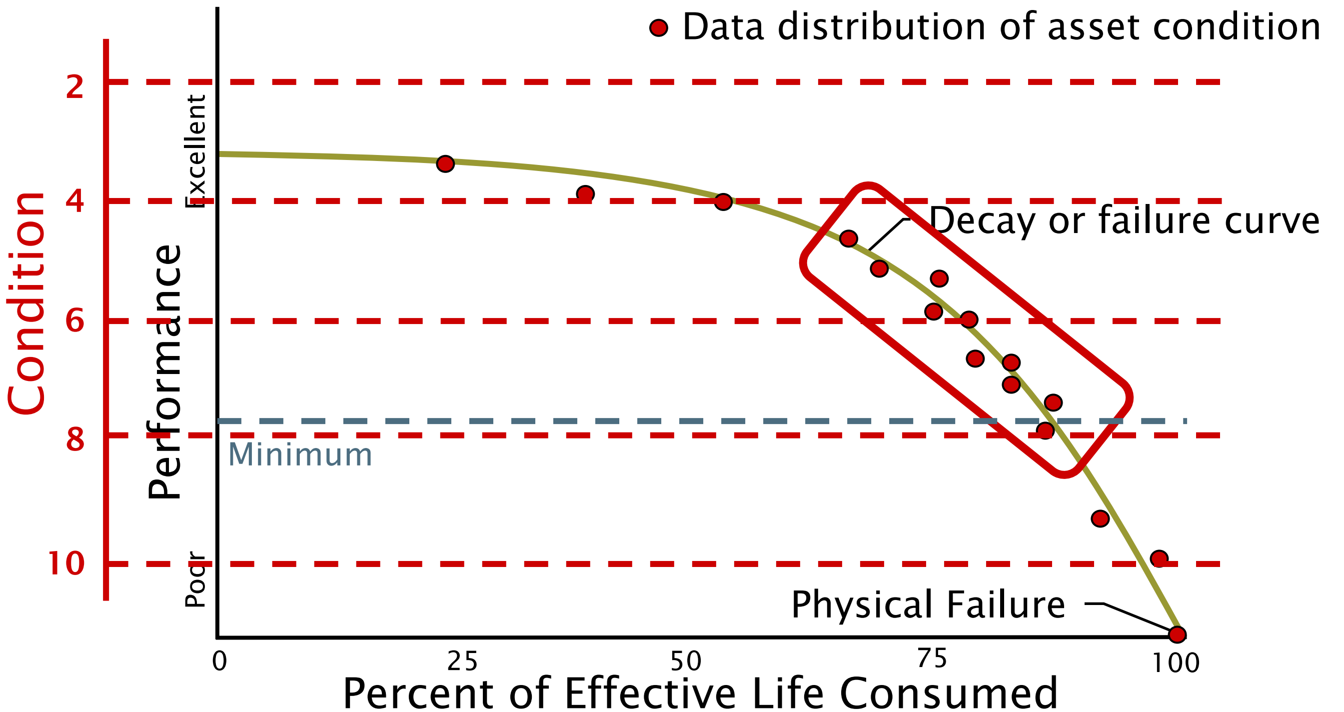
# Modification factors for effective life tables

| | Impact Rating Factor | | | | |
|---|---|---|---|---|---|
| ***Condition Variables*** | ***1*** | ***2*** | ***3*** | ***4*** | ***5*** |
| Design standards | +10% | +5% | 0 | -5% | +10% |
| Construction quality | +10% | +5% | 0 | -5% | +10% |
| Material quality | +10% | +5% | 0 | -5% | +10% |
| Operational history | +10% | +5% | 0 | -5% | +10% |
| Operating environment | +10% | +5% | 0 | -5% | +10% |
| External stresses | +10% | +5% | 0 | -5% | +10% |

# Approach 3: Direct observation table

| ***Assessment (Likelihood of Occurrence within One Year*** | ***Description*** |
|---|---|
| Almost certain | Expected to occur within 1 year |
| Very high | Likely to occur within 1 year |
| High | Estimated 50% chance of occurring within any year |
| Quite likely | Expected to occur within 5 years; estimated 20% chance of occurring in any year |
| Moderate | Expected to occur within 10 years; estimated 10% chance of occurring in any year |
| Low | Expected to occur within 50 years |
| Very low | Expected to occur within 100 years |

# Recall tying condition score to asset failure



# Approach 4, condition and decay curve table

| Asset Type | Effective Life, Years | Condition Rating & Residual Life | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| Civil | 75 | 75 | 60 | 45 | 30 | 15 |
| Pressure pipework | 60 | 60 | 48 | 36 | 24 | 12 |
| Sewers | 100 | 100 | 80 | 60 | 40 | 20 |
| Pumps | 40 | 40 | 32 | 24 | 16 | 8 |
| Motors | 35 | 35 | 28 | 21 | 14 | 7 |
| Electrical | 30 | 30 | 24 | 18 | 12 | 6 |
| Controls | 25 | 25 | 20 | 15 | 10 | 5 |
| Building assets | 60 | 60 | 48 | 36 | 24 | 12 |

# Condition rating and residual life factors

| | Condition Rating & Residual Life Factor | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Asset Type*** | ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** | ***8*** | ***9*** | ***10*** |
| Motor bearing | 0.9 | 0.8 | 0.7 | 0.6 | 0.5 | 0.4 | 0.3 | 0.2 | 0.1 | 0 |
| Bearing temp sensor | 0.9 | 0.8 | 0.7 | 0.6 | 0.5 | 0.4 | 0.3 | 0.2 | 0.1 | 0 |
| Cooling motor | 0.9 | 0.8 | 0.7 | 0.6 | 0.5 | 0.4 | 0.3 | 0.2 | 0.1 | 0 |
| Electric motor | 0.9 | 0.8 | 0.7 | 0.6 | 0.5 | 0.4 | 0.3 | 0.2 | 0.1 | 0 |
| Coupling | 0.9 | 0.8 | 0.7 | 0.6 | 0.5 | 0.4 | 0.3 | 0.2 | 0.1 | 0 |
| Blower bearing | 0.9 | 0.8 | 0.7 | 0.6 | 0.5 | 0.4 | 0.3 | 0.2 | 0.1 | 0 |
| Centrifugal blower | 0.9 | 0.8 | 0.7 | 0.6 | 0.5 | 0.4 | 0.3 | 0.2 | 0.1 | 0 |
| Front blower bearing | 0.9 | 0.8 | 0.7 | 0.6 | 0.5 | 0.4 | 0.3 | 0.2 | 0.1 | 0 |
| Discharge check valve | 0.9 | 0.8 | 0.7 | 0.6 | 0.5 | 0.4 | 0.3 | 0.2 | 0.1 | 0 |
| Input butterfly valve | 0.9 | 0.8 | 0.7 | 0.6 | 0.5 | 0.4 | 0.3 | 0.2 | 0.1 | 0 |
| Silencer | 0.9 | 0.8 | 0.7 | 0.6 | 0.5 | 0.4 | 0.3 | 0.2 | 0.1 | 0 |

# Condition rating and residual life

0.5 Residual Life Factor

Times

Yields

| Asset Type | Effective Life, Years | Condition Rating & Residual Life | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Motor bearing | 25 | 22.5 | 20 | 17.5 | 15 | 12.5 | 10 | 7.5 | 5 | 2.5 | 0 |
| Bearing temp sensor | 20 | 18 | 16 | 14 | 12 | 10 | 8 | 6 | 4 | 2 | 0 |
| Cooling motor | 40 | 36 | 32 | 28 | 24 | 20 | 16 | 12 | 8 | 4 | 0 |
| Electric motor | 75 | 67.5 | 60 | 52.5 | 45 | 37.5 | 30 | 22.5 | 15 | 7.5 | 0 |
| Coupling | 15 | 13.5 | 12 | 10.5 | 9 | 7.5 | 6 | 4.5 | 3 | 1.5 | 0 |
| Blower bearing | 25 | 22.5 | 20 | 17.5 | 15 | 12.5 | 10 | 7.5 | 5 | 2.5 | 0 |
| Centrifugal blower | 75 | 67.5 | 60 | 52.5 | 45 | 37.5 | 30 | 22.5 | 15 | 7.5 | 0 |
| Front blower bearing | 25 | 22.5 | 20 | 17.5 | 15 | 12.5 | 10 | 7.5 | 5 | 2.5 | 0 |
| Discharge check valve | 25 | 22.5 | 20 | 17.5 | 15 | 12.5 | 10 | 7.5 | 5 | 2.5 | 0 |
| Input butterfly valve | 25 | 22.5 | 20 | 17.5 | 15 | 12.5 | 10 | 7.5 | 5 | 2.5 | 0 |
| Silencer | 75 | 67.5 | 60 | 52.5 | 45 | 37.5 | 30 | 22.5 | 15 | 7.5 | 0 |

# Key points from this session

### *What is its remaining life?*

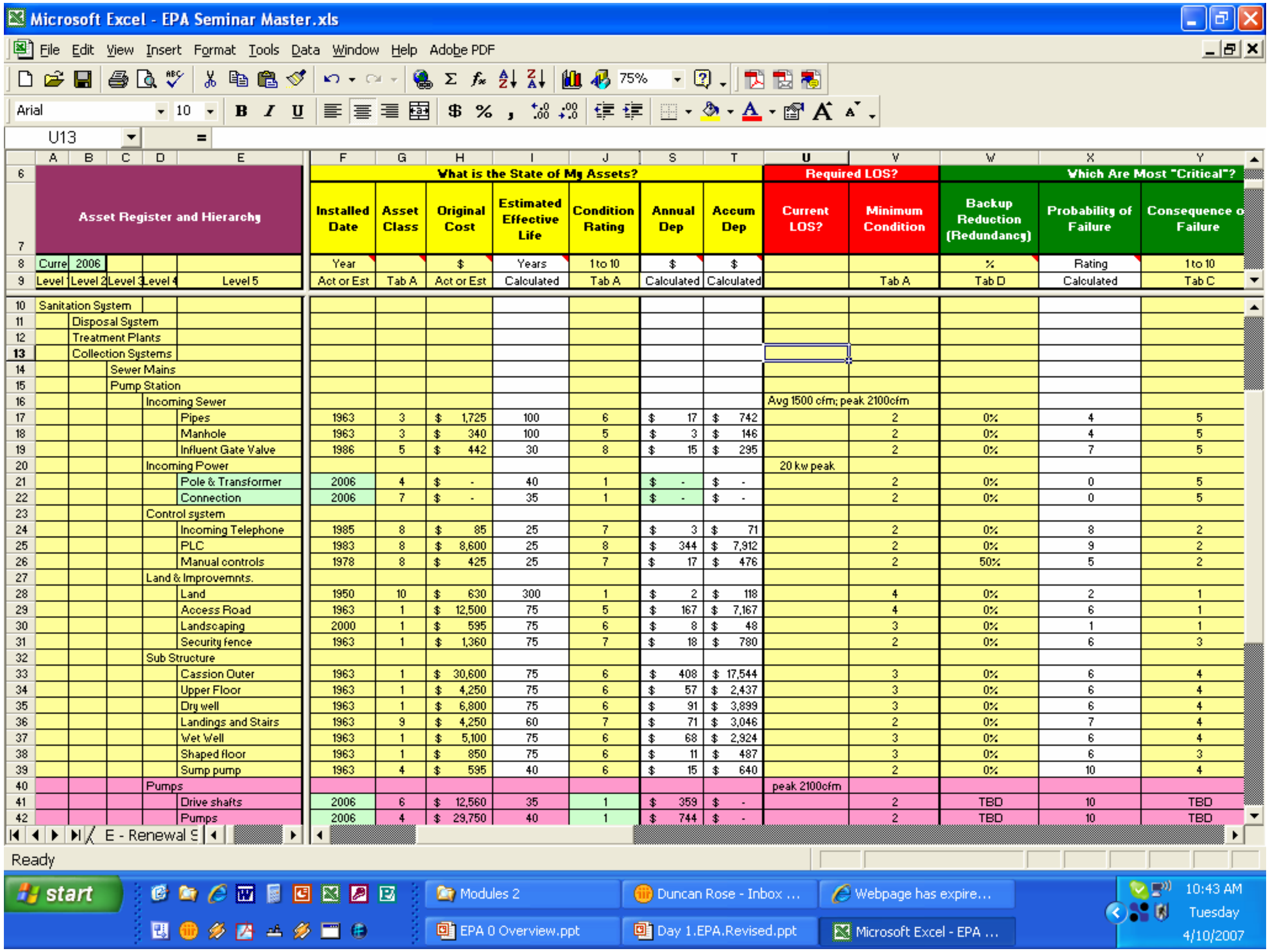
Key Points:

- Determining remaining useful life is as much art at this point as science
- Although good information is better, asset “decay curves” need not be highly detailed to be useful.
- Good CMMS data is key to building agency specific failure curves
- Good condition information is vital to assigning remaining useful life
- Incorporating good failure codes into the work order is important to building good failure curves

Associated Techniques:

- Remaining useful life assessment·
- Decay curves, useful-life tables
- Survivor curves
- Major failure modes

# Tom’s spreadsheet




| | A | B | C | D | E | F | G | H | I | J | S | T | U | V | W | X | Y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | Asset Register and Hierarchy | | | | | What is the State of My Assets? | | | | | | | Required LOS? | | Which Are Most "Critical"? | | |
| 7 | | | | | | Installed Date | Asset Class | Original Cost | Estimated Effective Life | Condition Rating | Annual Dep | Accum Dep | Current LOS? | Minimum Condition | Backup Reduction (Redundancy) | Probability of Failure | Consequence o Failure |
| 8 | Curre | 2006 | | | | Year | | $ | Years | 1 to 10 | $ | $ | | | % | Rating | 1 to 10 |
| 9 | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Act or Est | Tab A | Act or Est | Calculated | Tab A | Calculated | Calculated | | Tab A | Tab D | Calculated | Tab C |
| 10 | Sanitation System | | | | | | | | | | | | | | | | |
| 11 | | Disposal System | | | | | | | | | | | | | | | |
| 12 | | Treatment Plants | | | | | | | | | | | | | | | |
| 13 | | Collection Systems | | | | | | | | | | | | | | | |
| 14 | | | Sewer Mains | | | | | | | | | | | | | | |
| 15 | | | Pump Station | | | | | | | | | | | | | | |
| 16 | | | | Incoming Sewer | | | | | | | | | Avg 1500 cfm; peak 2100cfm | | | | |
| 17 | | | | | Pipes | 1963 | 3 | $ 1,725 | 100 | 6 | $ 17 | $ 742 | | 2 | 0% | 4 | 5 |
| 18 | | | | | Manhole | 1963 | 3 | $ 340 | 100 | 5 | $ 3 | $ 146 | | 2 | 0% | 4 | 5 |
| 19 | | | | | Influent Gate Valve | 1986 | 5 | $ 442 | 30 | 8 | $ 15 | $ 295 | | 2 | 0% | 7 | 5 |
| 20 | | | | Incoming Power | | | | | | | | | 20 kw peak | | | | |
| 21 | | | | | Pole & Transformer | 2006 | 4 | $ - | 40 | 1 | $ - | $ - | | 2 | 0% | 0 | 5 |
| 22 | | | | | Connection | 2006 | 7 | $ - | 35 | 1 | $ - | $ - | | 2 | 0% | 0 | 5 |
| 23 | | | | Control system | | | | | | | | | | | | | |
| 24 | | | | | Incoming Telephone | 1985 | 8 | $ 85 | 25 | 7 | $ 3 | $ 71 | | 2 | 0% | 8 | 2 |
| 25 | | | | | PLC | 1983 | 8 | $ 8,600 | 25 | 8 | $ 344 | $ 7,912 | | 2 | 0% | 9 | 2 |
| 26 | | | | | Manual controls | 1978 | 8 | $ 425 | 25 | 7 | $ 17 | $ 476 | | 2 | 50% | 5 | 2 |
| 27 | | | | Land & Improvemnts. | | | | | | | | | | | | | |
| 28 | | | | | Land | 1950 | 10 | $ 630 | 300 | 1 | $ 2 | $ 118 | | 4 | 0% | 2 | 1 |
| 29 | | | | | Access Road | 1963 | 1 | $ 12,500 | 75 | 5 | $ 167 | $ 7,167 | | 4 | 0% | 6 | 1 |
| 30 | | | | | Landscaping | 2000 | 1 | $ 595 | 75 | 6 | $ 8 | $ 48 | | 3 | 0% | 1 | 1 |
| 31 | | | | | Security fence | 1963 | 1 | $ 1,360 | 75 | 7 | $ 18 | $ 780 | | 2 | 0% | 6 | 3 |
| 32 | | | | Sub Structure | | | | | | | | | | | | | |
| 33 | | | | | Cassion Outer | 1963 | 1 | $ 30,600 | 75 | 6 | $ 408 | $ 17,544 | | 3 | 0% | 6 | 4 |
| 34 | | | | | Upper Floor | 1963 | 1 | $ 4,250 | 75 | 6 | $ 57 | $ 2,437 | | 3 | 0% | 6 | 4 |
| 35 | | | | | Dry well | 1963 | 1 | $ 6,800 | 75 | 6 | $ 91 | $ 3,899 | | 3 | 0% | 6 | 4 |
| 36 | | | | | Landings and Stairs | 1963 | 9 | $ 4,250 | 60 | 7 | $ 71 | $ 3,046 | | 2 | 0% | 7 | 4 |
| 37 | | | | | Wet Well | 1963 | 1 | $ 5,100 | 75 | 6 | $ 68 | $ 2,924 | | 3 | 0% | 6 | 4 |
| 38 | | | | | Shaped floor | 1963 | 1 | $ 850 | 75 | 6 | $ 11 | $ 487 | | 3 | 0% | 6 | 3 |
| 39 | | | | | Sump pump | 1963 | 4 | $ 595 | 40 | 6 | $ 15 | $ 640 | | 2 | 0% | 10 | 4 |
| 40 | | | | Pumps | | | | | | | | | peak 2100cfm | | | | |
| 41 | | | | | Drive shafts | 2006 | 6 | $ 12,560 | 35 | 1 | $ 359 | $ - | | 2 | TBD | 10 | TBD |
| 42 | | | | | Pumps | 2006 | 4 | $ 29,750 | 40 | 1 | $ 744 | $ - | | 2 | TBD | 10 | TBD |