

Midnight Engineering

Paper 4 of 4 — what a change costs when nobody wrote down why

1 • Background

A field engineer stands in a turnover meeting while the operations team describes something that is not working.

A pump running back against itself at low flow. A tank level nobody can hold without a man standing at a valve. Barrel pumps failing because their lubrication depends on somebody remembering.

None of it arrives as a project. It arrives as a sentence from an operator.

What follows is always the same sequence. Go and look at it — tape, notebook, eyes on the actual pipe, because what is there and what the record says are two different things. Draw the system as it exists. Draw what comes out: the demolition drawing, this spool, this valve, this support. Tag the tie-in, so the join between new work and existing plant has a name. Draw what goes in, including that tie-in. Then update the record drawings.

Sometimes the whole loop, construction included, closes within a week.

It is called midnight engineering.

It is not a compliment. The phrase carries everything the industry thinks about urgent plant changes: done in the small hours by whoever was available, undocumented, and often needing to be redone properly later by someone else.

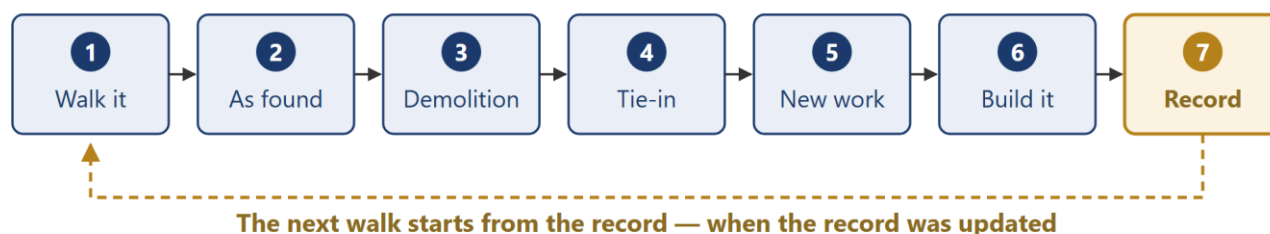
That reputation is earned. Not by every job — but by enough of them, often enough, that the name sticks.

And the difference between the two kinds is never skill, and never urgency. Both are fast. **The difference is whether the loop closes** — whether the record catches up before everybody moves on to the next thing.

The seven steps above are what closing it looks like. Miss the last one and the work is indistinguishable, a decade later, from a hack.

The loop, and the step that closes it

Nobody designed this. It is what changing a running plant has always required.



The difference between good work and a hack is never skill, and never urgency. Both are fast. It is whether step 7 happens — and step 7 is the step nobody owns. Miss it and the sheets join the stack instead of updating anything. The record becomes a history, not a statement.

The loop, and the step that closes it

The drawings survive. Some of them are sketches. They are real, and they go into the record.

And they carry more than they appear to.

The demolition is usually its own sheet: a sepia of the original drawing, cross-hatched where things come out, with the tie-ins and end preps annotated and dimensioned. **The removal is authored on a copy of the record itself** — a change written directly against the thing being changed.

The new work carries the rest. Existing conditions ghosted back, so what stays can be told from what goes. Tie-ins tagged, so the joins have names. A dimension to a known survey point, so the work can be found again. New supports, new piping, new conduit. References out to the schematics that govern it. And a piping isometric as a detail in the corner, for whoever has to fabricate it.

Two or three sheets. One person. Every discipline the change touched, and enough information to build it.

The content of a change set was solved a long time ago, and so was the idea of authoring it against the record. What paper could not do was **merge it back** — so the sheets joined the stack instead of updating anything.

The meeting does not survive at all.

The construction drawing shows a bypass around a pump. It does not say the bypass is there because the pump was running back on itself at low flow. It does not say what the minimum flow is, who decided it, what else was considered, or which turnover meeting raised it.

That part was spoken. It lives in the people who were in the room, and it stays accurate for exactly as long as they do.

And it is not the exception

Here is the part that matters, and it is the reason the name is worth reclaiming.

Over the life of an operating plant, this is most of the work.

Capital projects get the process. They get the document control, the review gates, the handover, the deliverables register — and they are a small fraction of what happens to a facility across its life. The rest is thousands of small changes raised at turnover meetings, executed between shifts, and recorded with whatever is left over.

The industry has a name for that majority, and the name is an insult.

So the disparaged category is the dominant category. A plant is not mostly what its projects built. It is mostly what midnight engineering does to it afterwards — and that is precisely the portion with the thinnest record.

And the loop does not change with the size of the job. A capital revamp and a shutdown retrofit walk the same seven steps as a change raised at a Tuesday turnover meeting — what changes is how many hands they pass through, and how long after demobilisation the last step falls due. The work gets more organised as it gets bigger, and the closing step gets less likely, because by then there is nobody whose job it is.

2 · The problem this leaves

Two things follow from that loop, and the second is the one that costs money.

The loop is fast when one person owns all of it. Walk the line, draw the change, stand in the meeting, update the record. Seven days including construction — not because the tools are good, but because nothing crossed a boundary and nothing had to be handed to anybody.

It is slow when it crosses systems and owners. Survey in one place, design in another, documents in a third, the change process in a fourth, handover to a fifth. That is nobody's fault and each of those does its job. But the change has stopped being one person's work, and nothing has taken responsibility for the whole of it.

This is not a story about better tools then and worse tools now. The tools are enormously better. **What fragmented is ownership of the loop** — and the last step, the one that closes it, is the step nobody owns.

The other thing that changed is the medium, and it changed less than it looks. The records used to be paper. Now they are digital, which mostly means **electric paper**. A scanned mark-up. A PDF of a P&ID. A folder of drawings in a document system, correctly named and correctly filed. Still documents, still stacked, still requiring somebody to read through the pile to work out what is actually there.

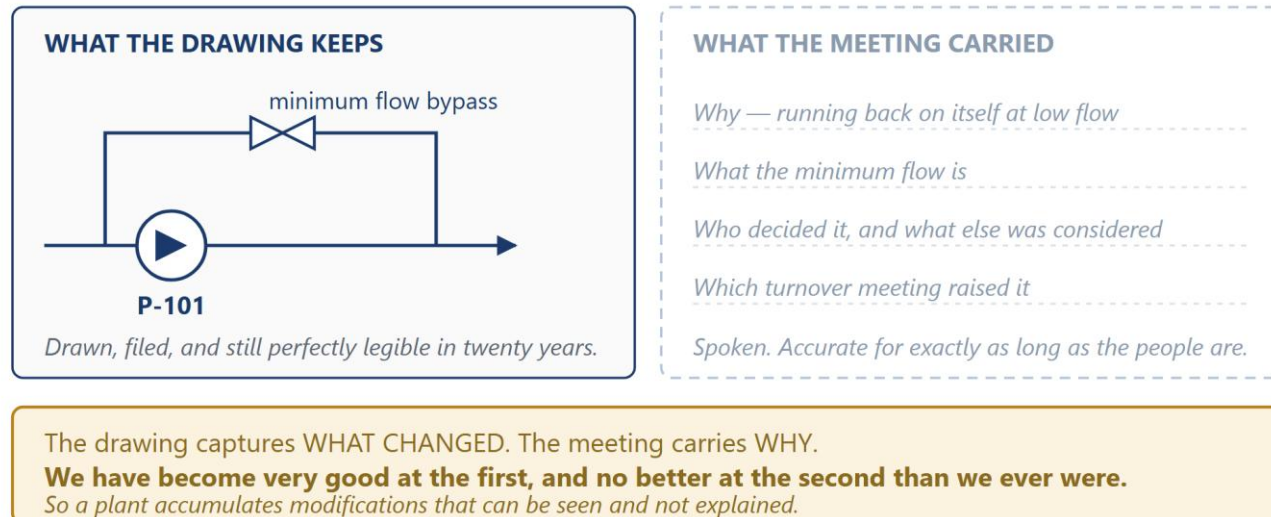
The record is half-missing, and always has been. The drawing captures *what changed*. The meeting carries *why*. We have become very good at the first and no better at the second than we ever were.

So a plant accumulates modifications that can be seen and not explained. Twenty years on, somebody finds a bypass on a pump and has to work out from first principles whether it can be removed. Usually they leave it, because removing something you do not understand is how incidents happen.

That is the real cost of an unrecorded change, and it does not appear for a decade.

The record is half-missing, and always has been

A minimum flow bypass, added at two in the morning. Twenty years later, both halves are asked for.



What survives and what does not

Caption: Both halves are asked for twenty years later. Only one of them was ever written down.

The record that is a history and not a statement

There is a shape this settles into, and anyone who has worked on an older facility will recognise it.

The plant record becomes a chronological accumulation. Every project that was ever done, layered in the order it happened, each one a set of changes against whatever was there before. To establish what actually exists on the plant floor, you would have to work through the whole accumulation.

So people don't. They walk the equipment in the field, measure what is there, produce a document sufficient to demolish, tie in and construct — and when the job is done, that document joins the accumulation.

Which makes it deeper, and the next field walk more necessary.

The record is not wrong. It can be a complete and accurate history of every change, in order, and still be unusable — because it has never been merged into a statement of what the plant currently is. Decades of correct information, and the fastest way to find out what is in front of you is still to go and look at it.

3 · Change against a known asset

An engineer is asked to add a minimum flow bypass to P-101.

Before anything is drawn, they already know what P-101 is — its identity, its properties, the documents behind it, and how complete and consistent that information is. Somebody had to establish all of that before this change was raised. **Change against a known asset is a different operation from change against a drawing.**

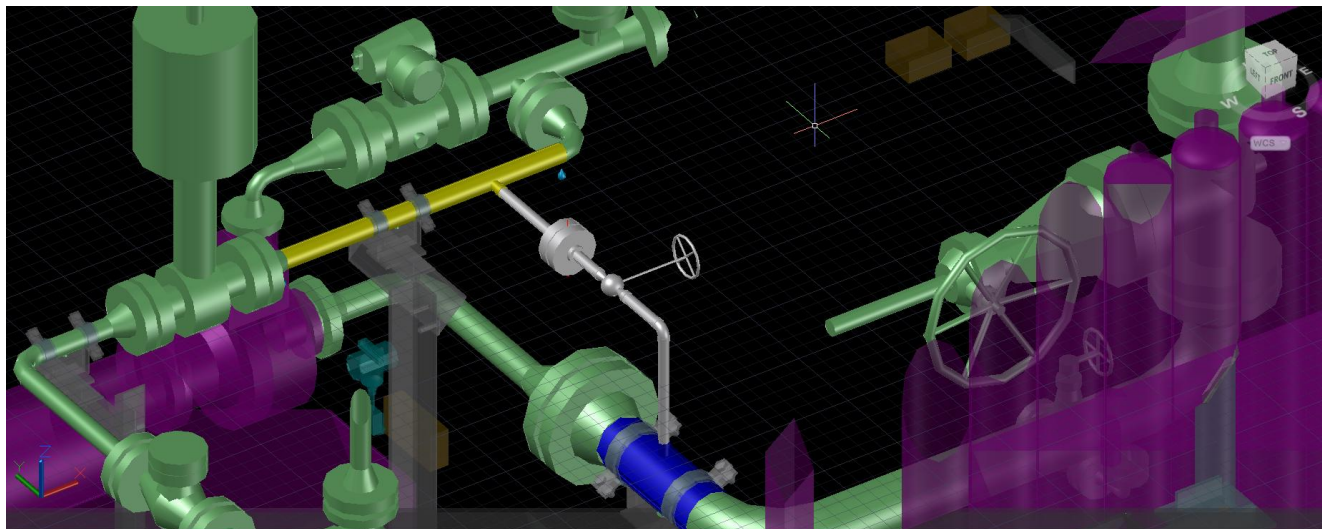
The change itself has a vocabulary, and it is the field vocabulary rather than a software one.

Demolish — remove an existing component while preserving the knowledge that it existed, and the context around its removal.

Tie-in — create a deliberate, identified connection between new work and an existing condition.

Add new — introduce components, and establish their identity and their relationship to what is already there.

These are not drawing operations. They are changes to a facility that is running.



A bypass authored against existing plant

Caption: A minimum flow bypass authored against existing plant, in a live session.

The engineer keeps working in their own authoring tool. The contractor on the next job may use a different one. The proposition is not that everybody adopts one application — it is that **the record should survive the application**, which is the argument of the whole series applied to the moment a plant actually changes.

Up to this point the workflow traces an ordinary field project. Survey, schematic, demolition, tie-in, new configuration. Nothing about that is novel, and it should not be — it is what the work has always been.

The difference is what happens at the end.

Conventionally a brownfield project produces its own models, drawings and documents, and hands them over as a package. Somebody at the plant then reconciles that package against the plant record. Or does not, which is more common, because reconciliation is slow, unglamorous, and belongs to nobody in particular once the project has closed out.

Here the project's output returns to the plant record as a **merged change set**. Not a replacement for the record, and not a parallel deliverable sitting beside it waiting to be interpreted. A set of identified changes — these components demolished, this tie-in established at this tag, these things added — applied to a record that keeps what was there before.

And that is the whole of it. A record set that receives change is a living description of the plant. An as-original that can only be added to was obsolete the day it was issued, and every change since has made it more so.

Which is why demolish, tie-in and add new are the vocabulary rather than some other set of verbs. They are the operations a change set is made of.

And because the changes are identified rather than implied, the record follows the work. A change can carry who made it, when, which values moved, what caused it, and which version of which document it came from — with the asset's identity holding even when its tag is renamed. That is enough to answer, later, *what happened here, and when*.

This is the engineering-record side of management of change. It is not the hazard review, the approval routing or the pre-startup safety review; those belong to the operator's own procedure and this does not replace them. What it does is keep the engineering record honest while that procedure runs.

And it is worth being exact about what a change set is written against. The work is done on the content already in the drawing — either native Plant 3D parts, or content brought across from another system that carries its engineering data and its connection points with it. That second kind matters more than it sounds: the geometry may not be natively editable, but it is data-rich and it still offers somewhere real for a tie-in to land. A change merges back into that same content, in kind.

What it does not do is reach back into the system that authored the original. The source project stays untouched and stays authoritative, exactly as in the three papers before this one.

4 · Where this stands

We would rather be plain about this than have someone discover it later.

The workflow is proven, and it is not ours. It predates computers. Nobody designed it — it is what changing a running plant has always required, and the seven steps have not moved because the physical problem has not moved.

What is new is the technology, and it does not make the work faster. A loop that closed in a week does not need speeding up.

It changes two other things. **Visibility** — the change can be seen by everyone it affects while it is happening, rather than only by the people who happened to be in the room. And **retention** — what is decided can survive, merged into the record rather than added to the stack, instead of depending on paper and memory.

Same loop. Same seven steps. Wider while it runs, and durable after it ends.

That is the ambition. Here is where it actually stands.

The tools are built. Demolish, tie-in and add new are written and can be demonstrated today, against real content, working the way the vocabulary above describes. They are part of AssetLink rather than a separate thing to adopt — which is the point, because AssetLink is already what holds the engineering data on the objects a change touches. The change works on a record that is there before the change is raised.

The record behind them is partly there. A change is captured with who made it, when, which values moved, what caused it, and which version of which document it came from — and the asset's identity survives a rename, which is harder than it sounds.

Two gaps remain, and they are the two this paper is about.

The record expires. It is kept for months, at most a couple of years. That is a useful operational audit window. The question this paper describes arrives in year twenty.

And it records the transaction, not the intent. It can tell you a bypass was added, by whom, from which drawing version. It cannot tell you the pump was running back on itself at low flow.

Which is the same gap as 1984, better instrumented. We have become much better at writing down what changed. We still have not written down why.

If you have run a turnaround, you already know whether this is real. We would like to hear from you either way.

One more, because it is still there

A field engineer hears how a shutdown is run and works out that a reactor cooldown loop is venting liquid nitrogen. He designs an exchanger to recover it. Sixty thousand dollars saved on the first shutdown, in 1987 money, and the installation goes in with field changes under two per cent of contract value — because somebody walked the line and drew what was actually there.

That was thirty-nine years ago. The shutdown runs on an eighteen-month cycle, so call it twenty-five shutdowns since, each one paying the exchanger back again. It is still in service. You can see it on satellite imagery, sitting where it was put.

Everything needed to understand why it is there still exists — just about. The drawings were kept deliberately, by someone who valued them. Fifteen house moves later, a few sheets survive and the rest are gone. Not through carelessness. Through ordinary life.

The engineer who designed it still remembers the tag. **E-680.**

That is where the identity of that asset has been living for thirty-nine years: in somebody's memory, and in a box.

None of it was ever attached to the exchanger.

The project ends. The asset continues.

The question is whether anyone will still know why.