Episode Book

EPISODE #5595

Roman Roads Still Running Under Modern Cities

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SYNOPSIS

What does it take for infrastructure to survive two thousand years of continuous use? This episode examines ancient Roman systems that never became archaeological sites — the Aqua Virgo, still feeding the Trevi Fountain; the Cloaca Maxima, still draining central Rome after twenty-six centuries; the Aqueduct of Segovia, which delivered water until 1973. Using Vitruvius's three standards — firmitas, utilitas, venustas — we look at why these systems survived: not passive preservation, but repeated retrofitting by each generation, often for reasons that had nothing to do with reverence for the past.

TRANSCRIPT



Corn

Here's the thing about Roman roads that keeps bothering me. We treat them as archaeology. But the A-66 in Spain is a Roman road with a new name.



Herman

Iter ab Emerita Asturicam. The Via de la Plata. You can drive from Seville to Gijón on essentially the same alignment the legions used, and most people doing it have no idea.



Corn

Which is where Daniel's question comes in. He wrote in this week, and he's pulling together two threads we've touched before. The Roman road network, and the sewer episodes where we got into how you can't replace the core of these systems, so municipal engineers build new sections inside old ones. His point is that the shell and the core can be from entirely different historical eras.



Herman

Right, and he's pushing past the obvious version of the question. Everyone knows the aqueducts are impressive. His interest is in the infrastructure that didn't become a site you buy a ticket for. The stuff that's still doing its job.



Corn

His words. He says he's always found it fascinating that someone in a different historical epoch could put down foundations that are still running in a different historical era, retrofitted and periodically maintained. And then the actual ask. Do we have salient examples from around the world of infrastructure created in the ancient world that hasn't just survived intact as an archaeological site, but actually formed the bedrock of the infrastructure servicing the modern world.



Herman

That's the distinction that makes this a real question. Surviving is easy if you're a pyramid. Nobody's asking a pyramid to do anything.



Corn

A pyramid has no customers.



Herman

An aqueduct has customers. A sewer has customers. The moment a structure has to keep performing, the clock starts, and the question becomes who's maintaining it and how.



Corn

So let's take his framing seriously and go find the closest examples we have to building that has survived the test of time. Not ruins. Working systems.



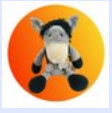
Herman

And there's a clean way to organize it. Vitruvius gives us three qualities a structure should have. Firmitas, utilitas, venustas. Durability, usefulness, beauty. The Romans wrote that down as the standard, and then a handful of their projects actually met it for two thousand years, which is a much harder bar than it sounds.



Corn

Most of what we're going to talk about fails on at least one of those. Plenty of beautiful ruins. Plenty of durable walls. Very few things that are still useful.



Herman

And the ones that are still useful share a pattern. They weren't preserved. They were maintained, repeatedly, by people who had no romantic attachment to them at all. They were kept alive because keeping them alive was cheaper or easier than replacing them.



Corn

That's the thesis, and it's worth stating once. These systems survived because every generation retrofitted them. The survival isn't passive. It's an active decision made over and over for two thousand years.



Herman

Start with Rome, because that's where the documentation is thickest and the examples are most absurd.



Corn

The Aqua Virgo.



Herman

Built nineteen BC by Marcus Agrippa under Augustus, mainly to feed the Baths of Agrippa. It's one of eleven aqueducts that supplied the city. And it is still running today, as the Acqua Vergine. Nearly all of its twenty point five kilometers run underground. Only about eighteen hundred meters ever ran on arches.



Corn

And where does it terminate?



Herman

The Trevi Fountain. That's the terminus. The same water main that Agrippa put down is what's coming out of the Trevi Fountain, and the Fontana della Barcaccia at the Spanish Steps, and the fountains in Piazza Navona, Piazza del Popolo, and the one by the Pantheon.



Corn

So the water in the Trevi is, in the most literal sense, the same water supply. Not a replica. The actual line.



Herman

And it's still regarded as some of the purest drinking water in Rome. People fill containers from those fountains. That's not a tourist thing, that's a municipal water source that happens to be gorgeous.



Corn

Two thousand years of continuous service. What does the maintenance record look like?



Herman

Layered. Tiberius repaired it in thirty-seven AD. Claudius in forty-five or forty-six. Constantine, then Theodoric. Pope Adrian the First did a major restoration in the eighth century. Pope Nicholas the Fifth did extensive repairs in fourteen fifty-three, and repaired the Trevi Fountain at the same time.



Corn

So emperors, a Gothic king, and a series of popes. Every era that inherited it decided to keep it.



Herman

And then the twentieth century does the thing that answers Daniel's question most directly. In the nineteen thirties they built a pressurised parallel version alongside the ancient channel. The Acqua Vergine Nuovo.



Corn

Say that again. They built a second aqueduct next to the first one.



Herman

Running separate but linked. The ancient gravity channel is still there, and a modern pressurised main runs alongside it. That's the "new sections within old ones" pattern, except the old one is still in the system.



Corn

There's a detail I love here. A sixty-meter stretch of the Aqua Virgo's arches was recently found inside the Rinascente shopping complex in central Rome.



Herman

Inside a department store. The building went up around it and nobody thought it was worth mentioning.



Corn

Two thousand years old and it's holding up a menswear floor.



Herman

Then there's the Cloaca Maxima, which is the one that should unsettle people. Built around six hundred BC under Tarquinius Priscus. That makes it one of the earliest sewage systems anyone built, roughly twenty-six hundred years old.



Corn

And it started as an open canal.



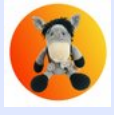
Herman

Draining the marshes that became the Roman Forum. Then it got roofed over and expanded into a system about sixteen hundred meters long. Pliny the Elder describes it as large enough to allow the passage of a wagon loaded with hay. Strabo says the same thing. It could move on the order of ten cubic meters of water per second.



Corn

And today?



Herman

It still drains rainwater and debris from the center of Rome. Under the Forum, the Velabrum, the Forum Boarium. The remaining passages have been connected to the modern urban drainage system, mainly to cope with backwash from the Tiber.



Corn

So the city's storm drainage in the middle of Rome is partly running through a channel dug by people who predate the Republic.



Herman

And the maintenance record is the part I'd underline. It kept being used after the fall of Rome. In the sixteen hundreds the Cardinal Chamberlain imposed a tax on Rome's residents specifically to pay for its upkeep.



Corn

A sewer tax. In the sixteen hundreds. For a sewer built in six hundred BC.



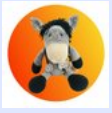
Herman

In eighteen sixty-two the city hired an engineer named Pietro Narducci to survey and restore sections. In eighteen ninety, Otto Ludwig Richter mapped it. Every generation that could have let it fill in and built something new decided the old thing was worth keeping.



Corn

Dionysius of Halicarnassus said the greatness of the Roman Empire showed itself above all in three things. The aqueducts, the paved roads, and the drains.



Herman

And Livy on the sewers, roughly, that the new splendor of his own day could scarcely produce a match for them. He was writing about infrastructure his ancestors had built and he was openly impressed.



Corn

Now, Segovia. Because this is the one that actually stopped.



Herman

The Aqueduct of Segovia. First century AD, probably completed in ninety-eight under Domitian, though the date was only pinned down in the late twentieth century. Géza Alföldy read the ghost-anchors left in the stone where bronze letters had been pried off, and reconstructed what the inscription said.



Corn

One hundred sixty-seven arches. Up to twenty-eight and a half meters tall.



Herman

Built of unmortared granite blocks. No mortar. No clamps. Held together by friction and gravity. It's a stack of rocks that has decided to be a building.



Corn

And it supplied water to Segovia until nineteen seventy-three.



Herman

Nearly nineteen hundred years of continuous service. That's the single most striking number in this whole episode. It's not a Roman aqueduct that stopped being used in antiquity. It was still delivering municipal water when people were watching the moon landing.



Corn

Why did it stop?



Herman

Modern alternatives. But it lasted into living memory as a working system. And the retrofit history is telling. Thirty-six arches were rebuilt in the fifteenth century after the Moors destroyed a section in ten seventy-two. And the rebuilders took enormous care not to alter the original style. They were restoring, not redesigning.



Corn

Which is a choice. They could have built something contemporary and nobody would have objected.



Herman

They chose continuity. Niches and statues got added in the sixteenth century, so it's not frozen, but the structural language stays Roman. And then the modern problem. By the two thousands, differential stone decay, leakage, and pollution were cracking the granite. It went on the World Monuments Watch in two thousand six, and the World Monuments Fund pulled together Spain's Ministry of Culture, the regional government of Castilla y León, and local institutions to stabilize it.



Corn

So it's no longer delivering water, but it's still being maintained. Just for a different reason.



Herman

Which is its own kind of survival. And then the Pont du Gard, which survived for the single most cynical reason in this entire episode.



Corn

Go on.



Herman

Built around forty to sixty AD to carry water fifty kilometers to Nîmes. Forty-nine meters high, two hundred seventy-five meters long. About fifty thousand tons of limestone. Blocks up to six tons each. No mortar, no clamps. Precision cut.



Corn

And the precision is the part that doesn't sound real.



Herman

Average gradient of one in three thousand. In one section the engineers had to allow a fall of only seven millimeters per hundred meters. The bridge itself descends two and a half centimeters over four hundred fifty-six meters.



Corn

Seven millimeters per hundred meters. With hand tools. Over a fifty-kilometer run.



Herman

And it worked. The water arrived. Now here's why the bridge is still standing. The aqueduct fell out of use around the sixth century. But the bridge stayed intact because it got repurposed as a toll bridge.



Corn

A toll bridge.



Herman

Local lords and bishops maintained it in exchange for the right to levy tolls. They had a revenue stream attached to keeping it up. That is the entire secret. Nobody preserved it out of reverence. They preserved it because it was making money.



Corn

Then the damage history.



Herman

Badly damaged in the sixteen twenties when the Duke of Rohan cut away a third of the second tier's arches to move artillery through. Repaired in seventeen oh three. A new road bridge was built alongside it in the seventeen forties by the engineer Henri Pitot. Napoleon the Third funded major restoration in the eighteen fifties, replacing eroded stone, infilling piers with concrete, and separating the bridge from the aqueduct. And it survived three major floods in the last century. Nineteen fifty-eight, nineteen ninety-eight, two thousand two.



Corn

So the structure that survived two thousand years of weather needed a duke with cannon to actually hurt it.



Herman

Artillery did what the river couldn't.



Corn

Rousseau went to see it and wrote that he'd expected a monument worthy of the hands that built it, and that the object surpassed his expectation, the only time in his life. He said he felt lost like an insect in that immensity, and sighed, why was I not born a Roman.



Herman

Henry James called it unspeakably imposing, and said it had the quality of greatness. Belloc wrote that it looks as though it had been built long before all record, by beings greater than ourselves, and intended to stand long after the dissolution of our petty race.



Corn

All of them missing the actual answer, which is that a toll collector kept it alive.



Herman

Which is the least romantic and most useful fact in the episode.



Corn

So what's the engineering common denominator across all four? Because there has to be one.



Herman

Mass and redundancy. Deep foundations dug down to bedrock or the firmest ground available. Unmortared, precision-cut stone that flexes slightly under load instead of cracking, because there's no rigid mortar joint to fail. Gravity-fed systems with no moving parts. And drainage and camber designed into every layer.



Herman

A pump breaks. A gate seizes. A slope doesn't. If your system has nothing in it that can fail mechanically, then the only thing you have to do is keep the channel clear and the joints tight. That's a maintenance regime a village can run.



Corn

Which is the actual lesson. They didn't build for permanence. They built for low maintenance.



Herman

Roman roads make that explicit. The roadbed is layered. Tamped rubble at the bottom, the statumen. Then rudus, coarse concrete. Then nucleus, fine concrete. Then the summa crusta, the paving stones. Crowned for drainage so water runs off instead of pooling and freezing. And they excavated down to firm ground every time.



Corn

And Roman law treated it as an ideological objective. Building roads that would not need frequent repair.



Herman

The Twelve Tables gave wayfarers the right to cross private land where a public road was in disrepair. Think about the incentive that creates. If your road falls apart, strangers can walk across your field. You build it properly because the alternative is a legal nuisance you can't stop.



Corn

So that's the Roman core. Now take it global, because Daniel asked for examples from around the world and Rome is only one civilization's answer.



Herman

The qanat. Also called karez, also called foggaras, also called khettaras, depending on where you are. A gently sloping underground tunnel that taps an aquifer, with vertical access shafts every so often, delivering water by gravity. No pumping. No power. Nothing to fuel.



Corn

How old?



Herman

Originated in ancient Iran, roughly three thousand years ago, early first millennium BCE. Spread west to Egypt, North Africa, and Spain, and east along the Silk Road into China. It's one idea that traveled the length of Eurasia.



Corn

And the headline example.



Herman

The qanats of Gonabad, in Iran. Built between seven hundred and five hundred BCE. After twenty-seven hundred years, still providing drinking and agricultural water to nearly forty thousand people. Main well depth over three hundred sixty meters. Length forty-five kilometers. Four hundred twenty-seven water wells. UNESCO World Heritage Site in twenty sixteen.



Corn

Three hundred sixty meters down. That's deeper than most modern boreholes people drill for domestic water.



Herman

And they dug it by hand, from the bottom, with the shaft above them. The technique is difficult. You can't just dig a tunnel and hope it hits water. You survey the slope, you sink the shafts, you work from the far end back toward the source so the water doesn't flood your workface before you're done.



Corn

Iran had how many of these?



Herman

Around fifty thousand in the mid-twentieth century. About thirty-seven thousand still in use as of twenty fifteen.



Corn

Still in use. In use.



Herman

Oman has roughly three thousand aflaj still running, dating back to around five hundred CE. The city of Nizwa was built around a falaj that's still in use. UNESCO listed them in two thousand six. Afghanistan's oldest functional kariz is over three hundred years old, eight kilometers long, still supplying about three thousand people. Azerbaijan has around eight hundred kahrizes still functioning, and the International Organization for Migration has rehabilitated more than a hundred sixty since nineteen ninety-nine.



Corn

And China.



Herman

Turpan. Around a thousand karez systems, total canal length on the order of five thousand kilometers, dating to the Han dynasty. And then Peru, which is the one that breaks the pattern. The puquios of Nazca. Possibly indigenous, around five hundred CE, and still in use in the twenty-first century.



Corn

So the same solution shows up in Persia, Oman, Afghanistan, Azerbaijan, China, and Peru, independently or by transmission, across three continents.



Herman

It's what you build when you have an aquifer, a slope, and no fuel. Which describes most of the arid world for most of history.



Corn

And the sustainability profile is almost unfair. Gravity powered. Resistant to floods, earthquakes, and wartime destruction. Almost insensitive to rainfall variation, because you're drawing from stored groundwater, not from this year's rain.



Herman

They also control soil salinity and slow desertification, because they deliver a steady flow rather than dumping water on the surface.



Corn

Now the decline story, because this is where it stops being a feel-good episode.



Herman

Iraq went from three hundred eighty active karez in two thousand four to a hundred sixteen in two thousand nine. Over a hundred thousand people left their homes because of water shortages. Morocco lost half its khettaras, partly because of the Hassan Adahkil Dam in nineteen seventy-one.



Corn

So the ancient systems are dying. What kills them?



Herman

Two things. Groundwater depletion, because we drill deeper and pump faster than the aquifer recharges, and the qanat can only reach as deep as it was dug. And cheap pumped wells, which undercut the labor cost of maintaining a tunnel that needs desilting every few years.



Corn

The qanat didn't fail. We outcompeted it.



Herman

And that's the honest version of Daniel's question. These systems survive when someone is responsible for them and the resource they depend on holds up. Take away either one and two thousand years of continuity ends in a decade.



Corn

Which brings us to roads, because that's the other half of what he asked about, and the reuse there is the most visible.



Herman

At its peak, Rome had twenty-nine great military highways radiating from the city and three hundred seventy-two great roads connecting a hundred thirteen provinces. Over four hundred thousand kilometers of road total, of which more than eighty thousand were stone paved.



Corn

And the courses of many of them survived for millennia, and some are overlaid by modern roads.



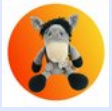
Herman

The Via de la Plata in Spain, the Iter ab Emerita Asturicam, is now the A-66 freeway. The Via Augusta is still traced through Valencia, Tarragona, Barcelona. The Via Egnatia, built in a hundred forty-six BC, is still the corridor through Albania, Greece, and Turkey. The Via Appia is still a road, now a regional park.



Corn

Why does the route survive even when the pavement doesn't?



Herman

Because the route is the hard part. Finding a line that gets you from A to B with acceptable grades, crossing rivers where they can be crossed, avoiding ground that won't hold a roadbed. That survey work is expensive and it doesn't expire. Once somebody has found the good line, every generation after them uses it.



Corn

The Romans did the expensive part once and everyone since has been free-riding on it.



Herman

And the maintenance bureaucracy is the part I'd put on a wall. Rome had curatores viarum, road commissioners. Quattuorviri and duoviri responsible for roads inside and outside the walls. Redemptores, contractors. Magistri pagorum for local roads. Augustus professionalized the whole system.



Corn

So there's a job title whose entire function is keeping the road alive.



Herman

That's the pattern across everything we've talked about. The Aqua Virgo had emperors and popes. The Cloaca Maxima had a tax. The Pont du Gard had toll collectors. The qanats have mirab, the water masters, whose job is to allocate and maintain. The infrastructure that lasted had an institution attached to it.



Corn

Institutions outlast materials.



Herman

A road with a commissioner lasts longer than a road without one, even if the road is worse.



Corn

Let's answer his other question, because it's the practical one. When modern engineers have to work inside or alongside these old systems, what do they actually do?



Herman

Four moves. First, build parallel. That's the Acqua Vergine Nuovo. Leave the ancient channel in service and run a new pressurised main alongside it, linked but separate.



Corn

Second?



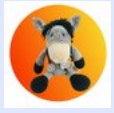
Herman

Reuse the route. Lay the modern highway on the Roman roadbed. It's cheaper and the alignment is already proven.



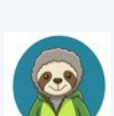
Corn

Third.



Herman

Reconnect. The Cloaca Maxima's remaining passages were tied into the modern drainage network, mainly to handle Tiber backwash. The old channel becomes a component in a system it predates by two thousand years.



Corn

And fourth.



Herman

Rehabilitate in place. The IOM's kahriz restoration in Azerbaijan. The Bidar karez desilting in India, where clearing the tunnel uncovered twenty-seven vertical shafts and recharged the local wells. You don't replace it. You clean it out and put it back to work.



Corn

All four of those are variations on the same idea. The old thing is an asset, not an obstacle.



Herman

The cut-and-cover technique is why it's possible. Roman aqueducts were built in accessible trenches that were then covered, so you can get back in. Qanats have vertical shafts every few dozen meters for exactly that reason. The design assumes somebody will need to get inside it later.



Corn

Which is the thing modern infrastructure often gets wrong.



Herman

It's the thing modern infrastructure is designed not to do. A buried pipe with no access points is cheaper to install and impossible to service. You replace it.



Corn

We've got the pattern. Now let's get the ground-level version, because there's a difference between reading about maintenance and doing it.



Hilbert

It wasn't Roman.



Corn

Sorry?



Hilbert

The aqueduct I worked on. You keep saying Roman. This one was nineteenth century. Stone lined, and the stone lining was the problem.



Herman

Go on.



Hilbert

Summer job, municipal water department. My job was crawling through sections during inspections. You'd go in at an access point with a flashlight and a clipboard and you'd note the joints. Tree roots get into the joints. They find the mortar, they follow the water, and they come in. So you patch it. Modern grout, trowel, by hand. Two of us, most of a day, for maybe a meter and a half of joint.



Corn

The water still got to your apartment.



Hilbert

It got to everybody's apartment. That's the part that stays with you. You're inside something built by people who had no idea what a microchip was, and it's delivering water to your building that same afternoon. Nobody thinks about it. You turn the tap and it's there.



Herman

The stone lining was a liability.



Hilbert

It was a liability we could fix with a trowel. That's the trade. My cousin works for a water utility in another city, and he's got the opposite problem. Their pipes are so specialized that when something goes, they can't patch it. They need a proprietary part from a specific manufacturer, and if that part isn't in the warehouse, the section comes out and



Hilbert (continued)

goes in the ground new. He's got a crew that replaces pipe. I had a crew that fixed pipe.



Corn

Different job entirely.



Hilbert

Different job. And I'd say the lesson isn't that the old engineers were geniuses. Some of what they did was just heavy. The lesson is that they built things a man with simple tools could repair. That's not durability. Durability is the stone. Repairability is the trowel.



Herman

Access and simplicity.



Hilbert

If you can't get to it and you can't fix it with what's on the truck, then it doesn't matter how long the material lasts. And I've still got the inspection manual from that job. The aqueduct's gone, they replaced the whole run in the two thousands. I kept the manual.



Corn

Why?



Hilbert

Because it's got the joint spacing written in it. Somebody worked that out by hand and it's still correct. Anyway, your levels are drifting on the second mic. I'll fix it in the edit.



Herman

The thing we've been circling all episode is that repairability is a design decision, not a material property. The Romans got it right, and so did whoever built the aqueduct Hilbert was crawling through, and so did the qanat builders, because all of them assumed somebody would need to get inside and work.



Corn

The modern default assumes the opposite. Design for replacement, seal it, bury it, and let the asset management software handle it.



Herman

Which works, right up until the institution that's supposed to replace it loses the funding, or the manufacturer discontinues the part, or the groundwater drops below where the intake can reach.



Corn

The misconception here, and it's the one I'd want to kill, is that ancient infrastructure survived because it was too big to destroy or frozen in amber. The pyramids are frozen in amber. Nobody's asking them to do anything.



Herman

The reality is that everything we talked about survived because it kept being used. The Pont du Gard is standing because it was a toll bridge. The Aqua Virgo is running because emperors, popes, and twentieth-century engineers each decided to repair it rather than replace it. The qanats are dying not because they were badly built, but because we drilled cheaper wells and drained the aquifer underneath them.



Corn

The building was never the thing that lasted. The arrangement around the building is what lasted.



Herman

That's the uncomfortable question for us. If the systems that survived two thousand years did it because they were repairable with simple tools and backed by an institution whose job was keeping them alive, what does that say about infrastructure designed for replacement, maintained by nobody in particular, and dependent on a supply chain that has to still exist when the part fails?



Corn

The qanats are the warning. Perfect engineering, three thousand years of service, and they're going out because we found a cheaper way to pull water and didn't think about what happens to the aquifer.



Herman

The Romans would have recognized the problem. They had curatores viarum. They had a tax for the sewer. They understood that the structure and the institution are the same project.



Corn

That's the forward-looking thought, then. The next time somebody proposes a piece of infrastructure, the question isn't just whether it'll last. It's whether anyone will still know how to fix it in eighty years, and whether the thing it depends on will still be there.



Herman

Thanks to Hilbert Flumingtop, our producer, for the levels and the manual.



Corn

This has been My Weird Prompts. If you enjoyed this episode, please leave a review on your podcast platform of choice. It helps other listeners find the show.



Herman

We'll be back soon.



Corn

See you tomorrow.