ESSAY · A SYMPOSIUM, ST BONAVENTURE PRESIDING

Soap, by Its Causes

A session of a congress, held in the old lecture theatre of the Jardin des Plantes in Paris, with St Bonaventure in the chair and the dead at the lectern. The object is a bar of soap on a saucer. The question is what it is, told not by its parts but by its causes, and whether those causes add up.

Richard Verver · October 2026

> *For he is like a refiner's fire, and like fullers' soap.*
> — Malachi 3:2

> *Laudato si', mi' Signore, per sor'aqua, la quale è multo utile et humile et pretiosa et casta.*
> — Francis of Assisi, *The Canticle of the Creatures*

A pastiche of the proceedings of a scientific congress. A chair introduces each speaker and keeps the time; the speakers give their papers; the floor asks questions; the chair sums up. Words quoted as any speaker's are his or her own, from the works named in the note at the end. Everything else they say is invented. The chemistry is the present science's, and is sourced in the same note; the verdicts are the speakers'. A word on scope. The four causes are taken here as Aristotle named them and Thomas Aquinas used them, on my reading of both, which is a Catholic and broadly Thomist one and not the only one. Whether a compound such as soap is a substance in the strict sense is a question the schools still dispute, and it is left to them.

I. Opening

The old lecture theatre in the Jardin des Plantes, Paris, on the eve of All Saints. Rain on the glass roof; through the wall, faintly, the menagerie, where something large is being fed. A banner over the stage reads THINGS BY THEIR CAUSES · SESSION 4B. *The tiers are full, and nobody in them is alive. Each wears a lanyard with a name and an affiliation, and most of the affiliations closed some centuries ago:* LYCEUM, ACADEMY, GOBELINS (DYES). *One badge says only* ASSISI, *and under it, in a different hand,* no fixed address. *On the speakers' table are a jug of water, a stack of glasses, a projector that has already made up its mind about the morning, a small brass balance, and a white saucer with a bar of soap on it, unwrapped, pale as a candle.*

The printed programme had been left on every seat. Somebody had corrected the coffee break in pencil from twenty minutes to thirty, and initialled it.

	SPEAKER	PAPER
09:00	St Bonaventure of Bagnoregio, chair	Opening
09:10	Francis of Assisi	Keynote: “Per sor’aqua”
09:40	Francis Bacon, Lord Verulam	“On the Form of Cleanness, as a Law”
10:05	Michel-Eugène Chevreul	“Recherches chimiques sur les corps gras” (1823)
10:30	The gallery	Coffee and posters
11:00	Aristotle of Stagira	“Four Answers to Why”
11:25	Plato of Athens	“The Form of the Clean”
11:50	William of Ockham	Short communication: “Not Without Necessity”
12:00	Thomas Aquinas	“Between Two Intellects”
12:25	The floor	Questions from the floor
12:50	St Bonaventure	Chair’s summary
13:00	The refectory	Lunch

The chair came in on time, which the hall took as a warning. He was a slight man in a grey habit worn to the colour of weather, with the face of someone who has read a great many bad manuscripts kindly.

Bonaventure. Good morning. I am asked to chair, which in my order means to serve at table, so I will be short and you will get your dinner. *(He holds up three cards, one after another.)* These are my instruments. At five minutes I show you this one. At one minute, this one. And at nothing, this one, which is blank, and which I find speakers understand better than the other two. Master Thomas has asked for a larger card. *(Laughter.)* He and I were received as masters in this city in the same August, and I have known him a long time, and I have never once known him to finish.

Our object is on the saucer. Monsieur Chevreul has weighed it: ninety-seven grams and a little. A child, shown it, would ask what it is for. The papers will ask what it is, which is the longer road to the same house. The congress has sent us its thesis in one sentence, and I will read it as it was sent, because I was told to: *that science explains a whole, a substance, by the sum of its causes, and that among them is its end, the one God gives.* We are to divide this bar, then, not into its parts but into its causes. At the end I will try to say whether they add up. I will tell you now that I have my doubts about the arithmetic.

The rules are the usual ones. The speakers keep to time. The floor keeps to questions. Nobody begins, “This is more of a comment than a question,” because it always is, and we know. *(He turns to the front*

row, where a small man is sitting on the floor rather than the bench, with a wooden bowl in his lap.)
Brother Francis. The keynote is yours, and the projector is yours too, if you want it.

Francis. What does it do?

Bonaventure. It shows people things they could have looked at.

Francis. Then no, thank you.

II. Keynote: Per sor'aqua

Francis came to the lectern barefoot, with no notes and the wooden bowl, which he filled from the jug, slowly, as if the jug might mind. The projector hummed at him. He looked at it kindly, and it went dark, and stayed dark for the rest of the morning whenever he was in the room.

Francis. Brothers and sisters. I was asked for a keynote, and I do not know what a keynote is, and I asked Brother Bonaventure and he said it is a long speech by someone who is not expected to be contradicted. So I will be short, and you may contradict me. I will tell you what soap is for. That is where a child begins, and where a learned man ends, if he is lucky and gets there. *(He wets his hands in the bowl, takes the bar from the saucer and turns it over in them. It begins, very slightly, to foam.)* It is for washing. You wet it, and rub it, and the dirt goes into the water, and the water goes into the ground, and you are clean. Everything else this morning will be about that, and most of it will be true.

But I learned what washing is for from the lepers. When I was in my sins it seemed very bitter to me to see them, and I would ride the long way round. Then the Lord himself led me among them, and I showed them mercy; and when I left them, "that which had seemed to me bitter was changed for me into sweetness of body and soul." I washed them. Their sores, and their feet, which is where you start if you do not know where to start. So soap is for cleaning, yes. And behind that it is for healing, because the sore you wash may close. And behind that it is for honouring, because you wash what you love, as our Lord washed the feet of his friends and said, "If I then, your Lord and Master, have washed your feet; ye also ought to wash one another's feet." And behind that it is for welcoming, because the first thing you set before a guest is water, before bread, before anything. Four ends, one behind another, like brothers in a line at a door, each holding it for the next.

I made a song once, near the end, when my eyes were gone and I could hear better. When I came to Water I called her Sister, and I said four things of her: that she is very useful, and humble, and precious, and chaste. Useful, because she washes. Humble, because she goes down, always down, to the lowest place she can find, and stays there, and does not mind. Precious, because there is never enough of her where she is wanted. Chaste, because she keeps nothing for herself. She takes your dirt and lets you go.

And I sang *Laudato si', mi' Signore, per sor'aqua.* The learned have argued ever since about that *per*. Does it mean *praised be you for Sister Water*, because of her, as you thank a man for a gift? Or *by* her, as if she praised you herself, in her own voice? Or *through* her, as if her praise went up through someone, the way light goes through a window and lands on the floor? *(He shrugs.)* I am asked, every hundred years or so, which I meant. I meant the song.

Here is what I know. Water cannot thank anyone. Nor can the soap. The fat it was made from was a sheep's, and the sheep has gone to God and does not miss it, and the ash was a beech tree's, and the tree does not know it has become anything at all. But I know. And when I wash I can thank God for all of them, the sheep, the tree, the woman who stirred the pot, and then they are thanked. So whatever *per* means, it goes through someone. If you divide the soap this morning, divide it so that it can still be thanked for.

One more thing, because the brothers who wrote down my life will say it if I don't, and they will say it longer. When I washed my hands, I chose a place where the water would not be trodden on afterwards. People laughed. I did not want to walk on what had made me clean. *(He holds up his wet hands, and the foam runs down to his wrists.)* I have not called the soap a brother. It is new. Give it a few hundred years. That is all. It is for washing. Go and wash something.

There was a silence of the kind congresses do not plan for and cannot bill. Somebody in the back row was crying, quietly, in Greek. The chair did not call for questions.

Bonaventure. There is no answer to that, so there will be no questions. *(He sets down the cards without having used one.)* Lord Verulam.

III. On the form of cleanness, as a law

Bonaventure. Our next speaker was Lord Chancellor of England, and is called the father of the experimental method, though some in my order maintain that the father was one of ours. *(In the third row a friar in a grey habit raised his hand with great energy. The chair did not see it. It was generally felt that the chair did not see it on purpose.)* He will speak on the form of cleanness, as a law.

Bacon was in black velvet with a ruff like a dish of cream, and spoke without notes, in sentences that seemed to have been finished, pressed and folded before he began them. The projector lit for him at once, and showed a grid.

Bacon. I thank the Brother for his paper, and I agree with every word of it: as a man, and not as a natural philosopher. The two agree more often than is supposed, but they do not sit in the same chair. Of ends I wrote that the inquisition of final causes is barren, and "like a virgin consecrated to God produces nothing." I have been quoted on it for four hundred years by people who read as far as *virgin*. Mark the word *consecrated*. I did not say she was nothing. I said she was God's, and not to be married

off to physic for the sake of the dowry. The end of soap is the soap-maker's, and the soap-maker is one of us; in the works of men I grant ends freely, and I said that final causes have relation to the nature of man rather than to the nature of the universe. God's ends I left to metaphysic and to divinity, reverently, and with the door shut. What I deny is that the fat wished to become soap, or that the ash meant anything by it.

What I want of this bar is not its end but its form. And by *form* I do not mean what the schools meant. "When I speak of Forms, I mean nothing more than those laws and determinations of absolute actuality, which govern and constitute any simple nature." The form of heat is a law. I found it, at my first vintage, to be a motion: expansive, restrained, and working in the smaller particles of bodies. I was pleased with that, and I remain pleased with it, which my physician says is unusual at my age. The form of cleanness will be a law too, and here is how I would find it. *(The grid on the screen acquires three headings.)*

Three tables. A Table of Presence: everything that cleans. Lye from ash. Natron from the lakes of Egypt. The soapwort, whose leaves foam when they are bruised in water, and which my gardener will not have in the borders. Fuller's earth. Ox-gall, with which painters clean their colours. Stale urine, which the fullers used, and of which I will say no more before lunch. Sand. Soap.

A Table of Absence: things near to these in which cleanness is wanting. Water alone, on grease: it runs off, and the grease sits there looking at you. Oil alone: it makes the stain larger and more confident. Ash wetted but not boiled. Lye poured on clean stone, which cleans nothing, because there is nothing there for it to take.

A Table of Degrees: soft soap and hard; soap in hot water and in cold; in rain water, and in the hard water of chalk country, where it curdles and sulks and will not lather.

Then, by exclusion. Cleanness is not heat, for soap cleans in cold water. It is not sharpness, for natron is sharper than soap and cleans less. It is not wetness, for water is wet and fails. *(He turns an invisible page.)* So I would say, for a first vintage, that cleanness is a nature which has one part apt to water and another apt to grease, so that it makes friends of things that will not mix, and the water carries off what it could not hold alone. *(He looks down the table.)* Monsieur Chevreul will tell me whether I am right. From his face I gather that I am nearly right, which in my experience is the most a Lord Chancellor is ever told, and more than he is usually paid for.

"Nature to be commanded must be obeyed." We do not command the grease to leave the cloth. We obey what soap is, and the grease leaves. And to resolve nature into abstractions "is less to our purpose than to dissect her into parts": better to cut this bar, and the fat it came from, into what it is made of, than to sit about a saucer discussing what it would like.

One thing more, for the Brother, who I see is listening with his hands. I wrote that "in charity there is no excess; neither can angel or man come in danger by it." I did not leave charity out of my philosophy. I left it out of physic, because it is too great for physic, and physic would have dropped it. The soap is not charitable. The surgeon who scrubs is.

Bonaventure. Thank you, my lord. You finished early, which in a lawyer is a miracle, and the congress keeps a register of them. Monsieur Chevreul.

IV. The fats

Bonaventure. Monsieur Chevreul taught chemistry here, at the Muséum, for half a century, in this room, and I am told some of the stains are his. He was born three years before the Revolution and died at a hundred and two, in the spring the tower on the Champ de Mars opened with his name cast on the side of it. On his centenary his friends called him the dean of the students of France. He has asked me to say that he was never old; he was a student who had been at it a long time.

Chevreul was small and white-haired and very upright, like a candle that had decided not to burn down. He had brought a flask, which he set beside the saucer, and a sheet of figures, which he did not look at, and he began by looking at the hall over the top of his spectacles as if it were a class that had not done the reading.

Chevreul. Messieurs, mesdames. I have been asked to be brief, which at my age is the one thing I never found time to learn. I worked twelve years on fats. Before me it was said that soap is made of fat and alkali, which is true, and that the fat is simply joined to the alkali, which is false, and that is the whole history of chemistry: a true thing with a false thing tied to it, and twelve years with a knife. A fat is not one body. I separated it, with solvents, with cold, crystallizing again and again, into what I called its immediate principles: bodies I could take out of the fat without destroying them, so that I could have put them back. That is not the same as burning a fat to see how much carbon is in it. Burning gives you its elements, and destroys the fat, and tells you what it was made of in the way that a fire tells you what a house was made of. I wanted to divide it and keep what I had divided.

What I found was this. The fat is made of fatty acids, joined to a sweet principle that Scheele had already seen, which we call glycerine, from the Greek for sweet, because it is. When you boil the fat with lye, the alkali takes the acids and lets the sweet principle go. The acids with the alkali are the soap. The glycerine stays behind in the water, and the soap-boilers for a century poured it down the drain, which I mention so that you will know that chemists also have regrets. *(He taps the flask.)* So soap is not fat with alkali added. It is a new body, made when the old ones give up what they were.

And here is what I wish to say to the Brother and to the Chancellor together, since they will not say it to each other: the soap-maker does not make the soap. She weighs, she heats, she stirs, she waits. The alkali and the acids do the rest, by what they are. She provides the conditions, and then she stands at the pot and watches, which is most of chemistry. The thing happens.

I also worked on colours, for the dyers at the Gobelins, who complained that their reds were wrong, when their reds were right and their neighbours were wrong, so I may say one thing about this bar. It looks white because of what is around it. Lay it on a red cloth and it will seem a little green. That is not the soap's doing either. And I spent some years on the divining pendulum, and showed that it swings because the hand that holds it wishes it to, and stops when the hand finds out. So I know what it looks like when a man finds the cause he came to find. I have tried not to do it. I have not always succeeded.

I am asked whether soap is for something. I did not measure that. I measured what it is made of and how it comes to be, by experiment, going from the facts to their causes and no further than the facts would carry me. Whether there is a cause above the facts I leave to those who had more time than I did. *(A pause.)* I had a hundred and two years, and I did not find the time. Perhaps it was not a question of time.

Bonaventure. Coffee is served in the gallery. There are posters. There is also, I am told, a cake, which was not in the budget and will be discussed.

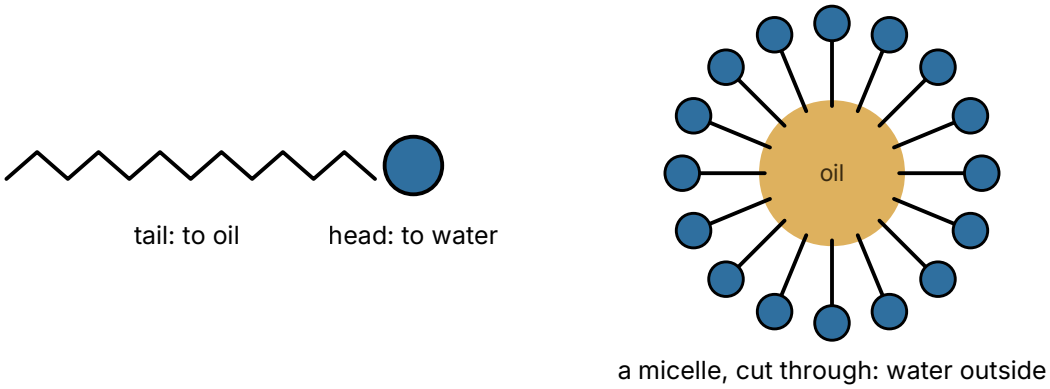
V. Coffee and posters

The poster in the gallery was unsigned, printed on the congress's own paper, and pinned slightly crooked, which several of the dead corrected and one of them uncorrected. It is reproduced here as it stood, because the papers after the break kept pointing at it.

What soap does in water.

The reaction. A fat or an oil is mostly triglycerides: three chains of fatty acid, each joined by an ester link to one small molecule of glycerol, like three ribbons tied to one small hand. Boiled with a strong alkali, sodium hydroxide for a hard soap or potassium hydroxide for a soft one, the links break. Each molecule of fat gives three molecules of soap, which are the sodium or potassium salts of the fatty acids, and one of glycerol. This is saponification, and it was Chevreul who showed what it is. Soap-makers call the moment when the oils and the lye water have emulsified and begun to thicken *trace*. The bar on the saucer is what a trace becomes.

The molecule. A soap molecule has two ends and two loyalties. One is a charged group, a carboxylate, which water holds closely. The other is a chain of twelve to eighteen carbon atoms, which water does not hold and oil does. Chemists call such a molecule amphiphilic: fond of both. It is a go-between for two things that will not mix, and like every go-between it is pulled in two directions for a living.



The poster's figure. Left, one soap molecule. Right, a micelle cut through, with grease taken into its core.

The micelle. In water, above a certain concentration, the critical micelle concentration, soap molecules gather into tiny spheres called micelles, each of many molecules, with the chains turned inward and the charged heads outward to the water, like a huddle of people in the rain who have agreed which way to face. Grease is taken into the oily core, and the micelles, with the grease inside them, are rinsed away. Below that concentration the molecules gather at surfaces instead: at the water's skin, and on the grease. That is why soapy water wets what plain water runs off.

Why they gather. Not chiefly because the chains pull on one another. They do, weakly, the way strangers on a bench do. But at room temperature the free energy of forming a micelle comes mostly from entropy, and the entropy that matters is the water's. Water next to a small oily chain is held in a more ordered network of hydrogen bonds than water elsewhere; it stands to attention. When the chains gather, that water is let go, and stands easy. Walter Kauzmann named the effect in 1959, in work on proteins, and Charles Tanford's *The Hydrophobic Effect* (1973) made it the standard account. How it changes with the size of what gathers, from one chain to a membrane, is still being worked out. What it is not is a force inside any one molecule. It belongs to the soap and the water together: a cause in the whole, and in no part of it.

The method of parts. Computational chemists can calculate how strongly two molecules hold each other, and then divide that energy into terms with names: electrostatics; the repulsion of electron clouds that the Pauli principle keeps apart; polarization; charge transfer; dispersion. The division is useful, and it is taught, and it has settled arguments. But only the total could in principle be measured. The terms are not observables, and different schemes divide the same total differently. A recent review says it plainly: "there is not a unique way to compute quantities related with such intuitive chemical concepts." The terms are the intellect's, and good ones. They are not pieces of the molecule.

The oracle. Put a few hundred soap molecules at random into a box of water in a computer, give them the forces and the laws of motion, and let the program run overnight. In the morning they have gathered into micelles, and nobody told them to. The simulation answers what the parts do together, as an oracle an-

swers yes or no. Nobody has yet asked it what they are for, partly because nobody is sure how to type the question.

Around the poster, the dead stood in small groups with their cups, and the cake went quickly. Aristotle read the fourth paragraph twice and said, to no one in particular, "The whole is prior to the part," and took a second slice. Plato said, "The water arranges them for the best." Bacon said, "The water arranges them by a law." They looked at each other and then at the cake, and agreed about the cake. William of Ockham read the fifth paragraph and smiled for the first time that morning, a small economical smile that used no more of his face than was necessary. An American in spectacles had brought his own cruet of oil and was looking for a pond. A woman in a plain dark dress was measuring the edge of the poster with a strip of tin, and had the air of someone who was going to write to a journal about it. And a small barefoot man had taken the saucer out to the gallery with him and was washing the cups.

VI. Four answers to why

Bonaventure. We resume. The saucer has come back from the gallery with the soap on it, and the soap is wet, and the cups are clean, and I think we may all guess the efficient cause. Our next speaker has been called the master of those who know. He has asked me not to say so, and I have said so, because it is true and because he asked. Aristotle.

Aristotle spoke quickly, in lists, walking, like a man reading his own lecture notes aloud to see whether they still held after two thousand years. They did. He had the air of someone who has dissected a great many things and been fond of most of them.

Aristotle. When we ask *why*, we are asking four questions, and I have said so in two books, so I will be brief, which is a thing I have also said in two books. Out of what is it? Out of fat and ash, or, the chemist tells us, fat and lye. That is the matter. What is it? A body whose least part has one end for water and one for grease, and which gathers in water into his little spheres. That is the form: the account of what it is to be soap. By what did it come to be? By the boiling, and by the woman who stoked the fire, and by the lye that did the work while she watched. That is the source of the change. For the sake of what? For washing. That is the end. Four questions, four answers, one saucer. The Chancellor would like three. I am sorry for him.

Now mark something. In nature the last three often coincide: the what and the for-the-sake-of-which are one, and the first source of motion is the same in kind as these, for a man begets a man. In soap they do not coincide. The soap is not the son of a soap-maker. *(Laughter.)* That is how you tell art from nature: in art the end is in the maker's soul before it is in the thing. Yet art imitates nature, and "partly completes what nature cannot bring to a finish." Grease and water would never come to terms by themselves. They have been at it since the flood. The soap-maker finishes what neither could.

The Chancellor's objection is an old one. Empedocles made it, and others before him, and I have been answering it since before the Chancellor's island had a name. Why should not nature work, they said, "just as the sky rains, not in order to make the corn grow, but of necessity"? If the corn is spoiled on the threshing floor, the rain did not fall for that either. So perhaps teeth come up sharp in front and broad behind by necessity, and the animals that happened to be so made survived, and the others perished, and here we all are, chewing.

My answer was this, and it still is. Teeth and all other natural things come about in a given way either always or for the most part, and nothing that comes about by chance does that. Rain in the dog days is chance; rain in winter is not. Now: the chemist's molecules, put into water, gather into his spheres with their tails turned in, and they do it not once but every time, in every basin, in every water above his concentration, in Paris and in Stagira and in a box inside a machine. Always, or for the most part. That is not chance. Then there is something in them for the sake of which.

"The soap does not intend," says my lord. No. Nor does the swallow deliberate over its nest, nor the plant its roots, nor, I am told, the Lord Chancellor over his sentences. *(Bacon inclined his head, which was the nearest he came all morning to a bow.)* "It is absurd to suppose that purpose is not present because we do not observe the agent deliberating. Art does not deliberate. If the ship-building art were in the wood, it would produce the same results by nature." In soap, as it happens, the art very nearly is in the wood. The chemist has just told us that the soap-maker provides the conditions and the fat and the lye do the rest.

Then the parts. A finger cut off is a finger only in name, and so is a hand of stone; and of the things thought to be substances, most are only potencies, like the parts of animals, which when separated exist merely as matter. So with soap. Divide the bar: you have smaller bars, soap all the way down, until you come to the least that is still soap. There is a least flesh, and there is a least soap: one of the chemist's molecules. Divide that, take its head from its tail, and you have no soap, but two other things, and neither of them cleans, and one of them smells. The division into parts goes below the form and loses it. The division into causes keeps it, because the form is one of the four.

And the poster says that the gathering belongs to the soap and the water together, and to no part. I could have told it so, and did, in a book the poster did not cite. The whole is prior to the part, even in a basin. *(He sat down, in time, and looked at the chair as if expecting a prize.)*

VII. The form of the clean

Bonaventure. Our next speaker asked to give his paper as a dialogue, and was told that the congress allows one voice to a paper. He has agreed to speak in one voice, provided it is understood that it is not his own. Plato.

Plato was tall, with the shoulders of a wrestler and the manner of a man who has never been in a hurry in his life and does not intend to start for a soap. He addressed the hall as if it were a single friend who had said something slightly foolish.

Plato. My teacher sat in prison waiting to die, and a clever man would have told him that he sat there because his bones and muscles were bent in a sitting position, and the clever man would have been quite right, and useless. My teacher said that the real cause was that the Athenians had thought it better to condemn him, and he had thought it better to stay. Bones and muscles were not nothing. Without them he could not have sat anywhere. But he said that to call them the cause was "a very careless and idle mode of speaking," and he wondered that people "cannot distinguish the cause from the condition." Monsieur Chevreul's fats and lyes are conditions, and very fine ones; without them there is no soap. In the *Timaeus* I called such things the second and co-operative causes, which God uses as his ministers in carrying out the idea of the best, as far as it can be carried out. Would you not say so, Chair?

Bonaventure. One voice, Plato.

Plato. It was one voice. It was mine, asking. *(He went on.)* The Chancellor wants to dissect nature. So do I. But divide it as a good carver does, "according to the natural formation, where the joint is, not breaking any part as a bad carver might." The bad carver cuts the soap through the middle and holds up the halves and calls them its parts, and is proud of the halves. The good carver looks for the joints. A thing's joints are where its causes meet.

I have divided the cleansing arts myself, which is more than most of you have done. In the *Sophist* my Stranger divides purification into that of living bodies, inward, as by medicine and gymnastic, and outward, as by the bath-man; and that of lifeless bodies, as by the fuller; and then, last and best, the cleansing of the soul. And he says that the method never considers whether the benefit is greater from the purge or from the sponge, and does not think the general's art "at all more decorous" than the vermin-destroyer's. I was pleased with that. The generals were not. I think the Brother would have been.

Then the soul. In the *Phaedo* I said that purification is the separation of the soul from the body, as far as that can be. Here I part company with the Brother, who would not have separated anything from anything, and washed lepers to prove it. *(He bowed toward the front row, where Francis was drying a cup on his sleeve.)* Perhaps he was right. I will not argue with a man holding a bowl of water. I have seen what my teacher did with one.

Last, the ladder. Diotima taught me to go up from one beautiful body to all of them, and from bodies to souls, to laws, to knowledge, and at last to beauty itself, using the others as steps. So with the clean: from a clean hand to a clean cloth, to a clean house, to clean laws, to a clean heart, and at last to the Clean itself, which is never cleaned and never needed to be. The soap on the saucer is a rung. It is a good rung. Do not stand on the saucer.

Aristotle *(from his seat, not quite under his breath).* And where is this Clean itself? In what place?

Plato. In no place.

Aristotle. Then nowhere. To say the Forms are patterns, and that other things share in them, is "to use empty words and poetical metaphors."

Plato. You have been saying that since you were seventeen. Then ask the Brother where his Sister Water's praise goes. It goes somewhere, and not to a place.

Bonaventure. Gentlemen. You have been having this argument for twenty-three centuries, you have both been dead for most of them, and the coffee is cold. Brother William has five minutes, and I expect him to use three.

VIII. Not without necessity

Bonaventure. Brother William is of my order. He left Avignon in some haste, with the pope's seal in one pocket and the pope's displeasure in the other, and he has been in a hurry ever since.

Ockham came to the lectern with nothing, looked at the projector, decided against it on principle, and spoke standing on one foot, as if the other were already on the road.

Ockham. Four minutes, then. Plurality is not to be posited without necessity. This morning I have heard of four causes, a form, a Form, a law, an end, immediate principles, co-operative causes, a ladder, and a cake. I need fewer. What is there? This bar, and every single thing in it: the molecules, if the chemist says so, each one singular and minding its own business. The rest are signs. A universal is a concept in the mind, a natural sign that stands for many singular things. It is not in the bar. Look in the bar; you will not find it; I have looked. The four causes are four ways the mind answers *why*: four terms. The things answer to them as singulars do.

Look at the poster, the fifth paragraph, the only paragraph on it that I would have written. The chemists of the last century divide an energy into electrostatics, Pauli repulsion, polarization and the rest. Is the Pauli term in the molecule? No. It is in the scheme. Change the scheme and the term changes, and the total stays, like a bill divided among friends. Those are names. Useful names; I have no quarrel with names, I spent my life on them and they were good company. But do not count them as things, and do not send them to the choir.

So I say what the congress's thesis says, only more plainly, because it is shorter. The causes are distinct from the substance because they exist in the intellect. Only there. The bar is one thing. The causes are what we say of it.

Now the end, which everyone wants, and which I am accused of having stolen. The soap-maker's end is real: she knows it, and an end moves only where someone knows it. "If things without souls are not

directed or moved by anything that cognizes an end, then there is no final cause in them." By reason alone, I said, a man "would say that there is no question to ask, 'Fire is generated for the sake of what?'" By faith I hold that all of nature acts for an end, because God, who knows, directs it. I am a friar; I hold a great deal by faith; it is lighter to carry. So keep your end for soap, Master Thomas. But it is in God's knowing, and in hers, and not in the soap.

One thing more, for the Thomists, who will want to put the forms in God as ideas, because they want to put everything somewhere. God's ideas are not a second set of things in God; God is simple, and does not keep a cupboard. The idea of a creature is the creature itself, as God knows it. So begin from the creature; it is what we know first, and it is standing right there on the saucer. And God can do whatever does not contradict itself. He could clean without soap. *(He sat down. He had, in fact, one foot on the road.)*

Bonaventure. Three minutes and forty seconds. *(He wrote it down, and underlined it.)* Master Thomas. *(He held up the large card, which was the size of a tea tray.)*

IX. Between two intellects

Thomas was a big man, and slow to the lectern, and spoke quietly, so that the back rows leaned forward and stayed leaning, which is the only known method of making a hall of the dead sit still. He had one slide, and put it up at once, and the projector, which had sulked at Francis and shown off for Bacon, showed it without comment, as a cat will sit on the one person who has not asked it to.

	THE BAR	THE SOAP
For what	A guest's basin, a scrub, a gift	To clean: to take grease into water
What it is	Shape, colour, scent: forms by art, accidental	Salts of fatty acids: a new kind of stuff, by nature
Out of what	Soap, a dye, an oil of lavender	Fat or oil, and lye
By what	The soap-maker, the mould, the knife	The reaction, by its own powers, under her direction

Thomas. I will answer as I usually do, by agreeing with everyone and then making a distinction. *(Laughter, and from the chair a sound that might have been a sigh.)* There will be seven. I have counted them, and so has the chair.

First, with the Brother: begin with the end. The end is the cause of causes, because it is the cause of the causality in all the other causes. The soap-maker does not light the fire and then stand back to see what will come of it, like a man who has struck a match in a cellar. She lights it for soap, and makes the soap for washing. The matter is chosen for the form, and the form for the end, and the end moves the mover, before anything has moved. So I would change one word in the congress's thesis, if the chair

permits. The causes are not a sum. They do not add, as weights add in a pan. They are of four kinds, and they are ordered, and the end is first, as the host is first at the door.

Second, with Monsieur Chevreul: the soap-maker does not make the soap. I said as much of bread, some time ago, in another connection. Art by itself produces only accidental forms, but it can produce a substantial form by the power of natural agents, as bread is produced by fire. So there are three things on that saucer, and my slide shows them, which is why I brought it. There is the bar: its shape, its colour, its scent, put there by art, accidental forms all of them, the kind that a knife can give and a knife can take away. There is the soap: a new kind of stuff, brought about by nature's own powers under art's direction, as bread is, and which no knife made. And there is the end, to clean, which the maker intends, and which rests on what the soap itself is inclined to by its form: to hold to water by one end and to grease by the other, and not to let go of either.

Third, with Brother William, and with the congress: the causes exist in the intellect. Yes: as divided. Form and matter are not things in the soap, as the molecules are. Forms do not have being; composites have being through them. A form is not *that which* is, but *that by which* a thing is what it is. Not a *quod* but a *quo*. You will never find one in Monsieur Chevreul's flask, and he has looked, for twelve years, with a very good flask. So when we divide the soap into its causes, the division is the intellect's. It considers apart what is not apart, and it does not lie in doing so, because it does not say that they are apart. Aristotle said as much of the mathematician: no falsity results from separating. But the causes it divides are in the thing. The soap really was made from that fat. It really does hold water by one end. She really did stir it. It really is for washing. Brother William puts the soap's end in God's knowing and in the soap-maker's, and not in the soap. I put it in all three: in God, as the archer's aim; in her, as her purpose; and in the soap, as the arrow's flight. The arrow does not aim itself, but its flight is toward the mark. Take the *toward* out of the flight and you have a stick in the air, and a very surprised archer. If the end were only in a mind, even God's, the soap would not be for washing; it would merely be used, as a stone is used to hold a door. The intellect divides. It does not invent what it divides.

Fourth, on measure. A natural thing stands between two intellects. A thing made by art is measured by the mind of its maker: the bar is a good bar if it is as she meant it, and if she meant it lopsided it is a good lopsided bar. But a natural thing measures our intellect and is measured by God's. The soap, the stuff, not the bar, is true to the divine intellect, and our chemistry is true when it is true to the soap. Monsieur Chevreul's twelve years were twelve years of being measured by it, and he has the grace to say so.

Fifth, on the Chancellor's virgin, whom I would not have brought up, but she has been brought. Final causes in physics are not barren, I would say, but they are not bred by experiment either, and the Chancellor is right that if you put them to the plough they will not pull. They are known by asking what a nature does always or for the most part, as Aristotle said, and the experiment is how we learn

what it does. I once made an argument of it: that things which lack knowledge act for an end, as is evident from their acting always or nearly always in the same way, and that what lacks knowledge does not tend to an end unless it is directed by one who knows, "as the arrow is shot to its mark by the archer." I will not make that argument again this morning. It needs a session of its own, and I am told it is to have one, and a hall with better heating.

Sixth, on God, and here I must correct all of us a little, myself first, since I have been talking longest. God is not one more cause on the list. He is not the fifth cause of soap, standing beside the lye with a longer name. Nor is the effect from God in part and from nature in part, as if they shared the work and signed the bottom of the page. It is wholly from both, in different orders, as the whole of the writing is from the pen and the whole of it from the writer. Nor is he the form of the soap, or its matter. And he is the cause of its being, where the soap-maker is the cause only of its becoming. When she leaves the kitchen, the soap goes on being soap. If God left, nothing would, not even the saucer.

Last, Plato and Aristotle, who have been passing notes. The form of the clean is not in a place apart. Aristotle was right. But Plato was right that there is an exemplar before the thing. It is in the mind of God: not as a second thing beside God, Brother William, and not in a cupboard, but as God himself, knowing the ways in which his own essence can be imitated, of which soap is one, and not the least. So the form of soap is in three ways. In the Word, before the thing, as its idea. In the soap, as its form. In our minds, after the thing, as its concept. The soap stands between the first and the last. And the word we say for it stands between the soap and our arguments, so that an argument about soap is about soap, and not about our words, which is more than can be said for most arguments. *(He looked at the chair, who was holding up the blank card.)* I have four minutes left.

Bonaventure. Two miracles in one morning. I will have to write to Rome. The microphone will go round. Please give your name and your affiliation, and please let go of the microphone when you have finished with it.

X. Questions from the floor

A friar *(the one in the third row, who had been holding the microphone since the coffee break).* Roger Bacon, Friars Minor, Oxford. No relation. *(Laughter.)* A question for the Chancellor. Three hundred and fifty years before you, I wrote that without experience nothing can be sufficiently known. I wrote it for a pope, in secret, because my order would not let us publish without leave.

Bonaventure. It still won't.

Roger Bacon. I had noticed. My question is this. Your Table of Presence was a table of everything that cleans. How did you know what to put in it, before you had found the form of cleanness?

Bacon. By the effect. Whatever takes the grease away.

Roger Bacon. Then you sorted the world by what it does when it does what we want. The effect you were looking for has a name in the schools. It is called an end.

Bacon *(after a moment, and with the air of a man conceding a pawn).* The experimenter has ends. I never denied it. The fat has none.

Roger Bacon. And yet the fat always gets the grease out for you. *(He sat, and kept the microphone a moment longer than was strictly necessary.)*

A stout man in a toga, at the aisle. Pliny, the elder one. Rome, the fleet. I only wish to put on the record that the Gauls invented it, to redden their hair, out of tallow and ash; that the Germans took it up, the men more than the women; and that nobody in that hall has mentioned the hair.

Bonaventure. It is in the minutes. Next.

An American in spectacles. Benjamin Franklin, Philadelphia, a printer. On a windy day at Clapham Common I put a teaspoon of oil on a pond, to see what it would do, which is my reason for most things. It "produced an instant calm over a space several yards square, which spread amazingly," until it had made "perhaps half an acre, as smooth as a looking-glass." I never understood why it spread so far and no farther. Does Monsieur Chevreul know?

Chevreul. No.

Franklin. Thank you. It is restful to meet a chemist who says so.

A voice at the back. Charles Tanford, Duke University. I do, or near enough. It spread until it was one molecule thick, and then it could spread no more, because there was nothing thinner for it to be. From your teaspoon and your half acre one can work out the size of a molecule. You measured a molecule with a teaspoon, Dr Franklin, a century before anyone knew there was one to measure.

Franklin. I should have written that down. I wrote down everything else.

A woman in a plain dark dress *(the one with the strip of tin, which she had not put away).* Agnes Pockels, Brunswick. No affiliation; I was not allowed one. I did my work at home, with a tin trough, a strip of tin across it, and a balance, between the cooking and the nursing, and I learned what I learned partly by watching the water in the washing-up, which is the one laboratory they let me have. When Lord Rayleigh sent my letter to *Nature*, he wrote that I had arrived at valuable results with very homely appliances. The appliances were the kitchen. My question is for the chair. All morning you have spoken of the soap-maker who arranges and the chemist who divides and the philosopher who orders. Who, in your opinion, did the washing?

Bonaventure. Women, mostly. And the brothers, when it was their week in the kitchen, and they complained.

Pockels. Then put it in your summary.

Bonaventure. I will. I had been going to.

Pockels. Now you will.

A thin man in a frock coat *(standing, though nobody had passed him the microphone).* Ignaz Semmelweis, the First Obstetrical Clinic, Vienna. In 1847 I made the students wash their hands before they examined the women, and the deaths on my ward fell to a fraction of what they had been. Not with soap: with chlorine water, and then chlorinated lime, because it was cheaper, and because soap did not take the smell of the dead-house off their hands, and I thought that whatever carried the smell carried the death. I knew that the washing saved them before I knew why. I could not say why, and so I was not believed, and I was not believed for a long time.

Thomas *(gently).* You knew that it was so before you knew why. That is the order of our knowing. The order of things is the other way round.

Semmelweis. They let women die while they waited for the why.

Nobody answered that, because there is no answer to it, and the hall knew it. Francis, in the front row, put down the cup he was drying. After a while Tanford spoke again, more quietly.

Tanford. One question for Brother William. I wrote "driving force" a great many times, for what makes the chains gather. I was never comfortable with it. Was I naming a thing?

Ockham. You were naming the water.

Thomas. You were naming an end, seen from behind. A force is what an end looks like to someone who is standing at the beginning.

Ockham. Or what a name looks like to someone who has decided to find a thing.

Bonaventure. We are out of time, and I have run out of cards. I am told there is a session later this term on whether nature acts for an end; take that quarrel there, both of you, and take the cake. I will sum up.

XI. The chair sums up

He did not go to the lectern. He stood where he was, by the table, with one hand resting on the balance.

Bonaventure. I said this morning that I would tell you whether the causes add up. They do not. I have had the balance here all morning, and I will come back to it.

I read you the congress's thesis: that science explains a whole by the sum of its causes, and that among them is its end, the one God gives. I take back one word, and it is the only one I would change, and I

would change it in ink. Not *sum*: *order*. Four causes, of four kinds, ordered by the first of them, which is the end. Master Thomas said it: the end is the cause of causes. The Brother began with it because he is a saint, and a child begins with it because he is a child, and these are the same reason; a chemist ends with it, if he is honest, after twelve years of finding out what the soap-maker knew when she lit the fire. The Chancellor will not have it in the house, but he keeps it in the garden, consecrated, and visits.

Second, the intellect. Brother William and Master Thomas both told you the causes are in the intellect, and they were both right, and they did not mean the same thing, which is the usual state of my order and his. One meant *only there*. The other meant *there as divided, and in the thing as one*. And both of them, you will have noticed, said that an end needs someone who knows it; they differ only on whether the soap carries it. Monsieur Chevreul divided fats without destroying them, so that he could have put them back. The intellect divides a thing into its causes the same way: without destroying it, and gives it back whole, and a little better understood. And the poster showed us that one of soap's causes is in no part at all, but in the soap and the water together. A division into parts would have lost that on the floor. A division into causes keeps it.

Third, Plato and Aristotle. I once said that among the philosophers the word of wisdom was given to Plato, and the word of knowledge to Aristotle, and both to Augustine, who is not here, and sends his apologies, and is sitting in the garden. This morning they agreed more than they let us see, as old friends do who have had the same quarrel so long they would miss it. The exemplar is before the thing, in the Word. The form is in the thing. Our concept comes after it. Brother William may have his signs, so long as they are signs *of* something; a sign of nothing is a signpost in a field.

Fourth, *per*. The Brother would not tell you what his *per* means. I will tell you, since I wrote his life and he has never once corrected it, which worries me. He saw in beautiful things the most Beautiful, and through the traces imprinted on things he followed the Beloved everywhere, making of all things a ladder for himself. A ladder is something you go up *through*. The fat does not know it is soap; the electron does not know it is in a choir; the water cannot thank anyone. But the praise of things goes up through the one who knows them. The Council said it of man: that through his body the elements of the material world reach their crown through him, and through him raise their voice in free praise of the Creator. Through him: *per ipsum*. And through him in whom all things hold together; in my last lectures in this city I told the brothers that we must begin from the centre, which is Christ, and some of them wrote it down.

So science is a kind of listening. To divide a thing into its causes is to hear what part it has in the song: what it is made of, what it is, who brought it about, what it is for. Division into parts silences a thing; you hear the pieces fall. Division into causes lets it be heard in the order it is in, the way a choirmaster hears a chord and knows the alto is flat. That is communion, of a kind: not that the soap becomes us, but that its part in the choir is heard, and handed on, by someone who can speak. Sister Water has sung all morning. We are the ones with the words.

Last, making. In a little treatise of mine that they still give to students, and that the students still do not read, I said that every mechanical art shows the Word. The maker has an idea in her mind, and brings it out into matter as like as she can, and means it to be beautiful and useful and lasting. The soap-maker gives a shape to stuff that was already there. She does not make the stuff. That is not a poverty. It is the condition of a new song. The psalm says, "O sing unto the LORD a new song." It does not say, make new notes. The notes are given. The order is new. Every bar of soap is a small new song made of old fat and old ash, and it sings by washing, and it sings best when it is nearly gone.

Which brings me to the balance. *(He lifts the bar from the saucer, wet, and sets it in the pan.)* Ninety-one grams. Six are missing. They are in the cups in the gallery, and on the Brother's hands, and down the drain, and in the ground. Nobody divided them off. They went where soap goes, and that is where the end is. Madame Pockels asked me to put the washing in my summary, and here it is, and here it was going to be. The end of this bar is not reached on the saucer, or in the chemist's flask, or in this hall, or in any of our papers, including mine. It is reached in a basin, in someone's hands, most of them, through most of history, a woman's. That is where soap is what it is for. The rest of us were describing the arrow. *(He gathers his cards. The blank one is on top.)* Lunch is served in the refectory. Wash your hands.

At the door the porter had set out a basin, a jug and a towel, and the six grams would have been glad of the company. The dead filed past it. Most washed and dried their hands and went in to lunch. Aristotle and Plato went in arguing, and sat together. A Roman in a governor's toga washed his with great care, did not dry them, and went out into the garden instead; nobody needed to ask his name, because it is in the Creed. Semmelweis washed his twice, and then stood by the basin, and made sure.

Francis was last. He picked up his wooden bowl from the lectern, carried it out through the rain into the Jardin des Plantes, past the menagerie, where the large thing had finished eating and was watching him, and poured the water out at the foot of a plane tree, where nobody would walk on it. Then he went in to lunch, and sat with the porter.

Edges

The essays here make a graph, and this one draws on two before it and on a unit of the curriculum. From Brother Electron it takes Francis and his *per*; the rule that matter is known by division, and has law in it only by similitude; and Thomas's bread, the offertory's "fruit of the earth and work of human hands," which becomes here art working through nature. From Whether the Cloud Makes Many Worlds it takes Bacon's branch: the search for ends called barren, and the rule that to learn a thing by cutting it is to learn its parts. Here the cutting is answered by another kind of division. From Making, the fourth unit of the Benedict Year, it takes the child's rule, "When you make something, you give a shape to stuff that was already there. You do not make the stuff," which Chevreul says in the hall in a chemist's words.

It also points ahead. *Trace*, the soap-maker's word for the moment the oils and the lye come together, is lent once to an essay still to come on modernity as a partial trace, which keeps a thing's matter and its mover in the description and leaves out its form and its end. The session Thomas declines to hold, on whether nature acts for an end, is a disputation still to be written. And the end as the cause of causes waits for an essay on law as light, where Christ is called the end, the *telos*, of the law (Romans 10:4).

Coda: the music

The symposium has a twin you can play: a dub techno track at 120 beats a minute for Strudel, a free live-coding environment that makes music in a web browser. A dub mix takes a song apart. It strips out the singer, keeps the drums and the bass, and lets the other parts in and out through echo and reverb, which the engineers call washes. It is the method of parts done to music, and a lovely one. This track is divided another way, into its causes, and its code says so. It is written in their order. First comes the final cause, what the track is for, declared before any sound: `TO CLEAN`. Then the material cause, the sounds it is made of, which do not know what they will become; then the formal cause, the mode and the tunes, which are what it is; and last the efficient cause, the sections and the arrangement, which are the player's to change while it plays. Every part names the parts it is made from and what it is for, and every *for* leads back to the end.

The tracks inherit, as the essays do. This essay draws on Whether the Cloud Makes Many Worlds and Brother Electron, so Thomas's section sings the first one's hook, the Ascension introit *Viri Galilaei*, in fauxbourdon, first above the groove and then above and below it at once: the thing between two intellects. And Francis sings the second one's canticle again, now for Sister Water: first plainly, then on the water itself, then through the echo, which is one way to hear what *per* might mean. Each line quoted from a parent carries a short hash of the original, so anyone can check that it came down unchanged. The family moves up by fifths: the cloud in G, its children in D and A, the double fugue on E, and this one in B. The whole family sings together in A New Song. Made by Claude + Richard.

1. **I. Opening** (0:00): water from a jug, bubbles, and the chair's bell.
2. **II. Keynote** (0:16): Francis's canticle three ways: plainly on the recorder, for Sister Water; sung by the water itself, in bubbles; and at 0:32 through the echo, where a sound goes on after the one who made it. "Useful and humble and precious and chaste"; "It is for washing."
3. **III. The tables** (0:48): Bacon's presence, absence and degrees as one rhythm, its rests, and its loudness. "Nature to be commanded must be obeyed."
4. **IV. Trace** (1:04): two lines, fat and lye, one climbing and one falling, until they meet on the same note and come together; the sweet principle let go on a celesta. "A new body."
5. **V. The micelle** (1:20): the drop. The chords spread over two octaves while the drums come in, then gathered, tails in and heads out. "A cause in the whole"; "The whole is prior to the part."

6. **VI. Four** (1:52): the four causes enter two bars apart, in their order: the end, the form, the matter, the maker.
7. **VII. The joints** (2:08): a bad carver chops through the beats; a good one cuts at the bar; then the ladder, the canticle's first phrase climbing a step every half bar.
8. **VIII. The razor** (2:24): one note and its echo. "Not without necessity."
9. **IX. Between two intellects** (2:32): *Viri Galilaei* in three voices above the groove; at 2:48 above and below it at once. "The end is the cause of causes."
10. **X. The floor** (3:04): a drop on a pond, its echo spreading until it can spread no more; a tin trough; two washings. "Who did the washing?"
11. **XI. The order** (3:20): everything in its order. At 3:36 the chant and the bell, "O sing unto the LORD a new song"; at 3:52 the last chord.
12. **XII. Lunch** (4:00): "Wash your hands." The canticle alone; the end tapped in Morse on the rim, TO CLEAN; then the water poured out, the filter falling as the bowl empties.

For the floor: the club form

The dub mix has a club form beside it, for a basement at two in the morning: the same skeleton with more flesh on it, as the essay was given its flesh after its bones. Nothing in the skeleton is touched. The end is still declared before any sound, the code is still written in the order of the causes, every section keeps its name, its length and its place, the two parents are quoted as written with their hashes, and `TO CLEAN` is still tapped on the rim at the last, now over the last kicks. What changes is the room. The clock is a 909 four to the floor at 126 beats a minute, clipped a little, with claps on two and four and an open hat on the offbeat; a hand-made sidechain ducks everything that is not the clock four times a bar, so the water makes room for the beat; the sub is retriggered in eighths with a growl on the offbeats; the chords are a supersaw stab, still on the offbeats, still through the echo, with an acid line under them; and the chant in Thomas's section is sung by the choir and a supersaw together. The drops fall where the dub mix had its weight: the micelle, the thing between two intellects, and the order. The razor is the breakdown, one note and no clock; the drop of oil on the pond is the second. The spoken lines are off by default, since the floor does not need them; set `WORDS = 1` and they come back, filtered and ducked, in exactly the places the dub mix has them. Open the club form in Strudel, or download its source.

Watch, listen, or take it with you

The video is of the club form, and everything in it is drawn from the music. None of its colours were chosen: they are the colours a real soap film reflects, computed from the physics of light in a thin layer of soapy water, so that as a film drains on screen it runs through pastel, magenta and green, blue and gold, silver, and the black film just before it bursts, which is how the video ends. A film forms on a wire loop

while the jug pours; Francis's canticle rises as bubbles, for her, by her and through the echo; Bacon's tables are tiles of film, named; fat and lye meet at trace over the kettle; at the drop the molecules, loose in the water with its cold cages round their tails, gather into a micelle, heads out and tails in, and the water is let go; Aristotle's four panels enter with the end first; Plato's carvers cut the picture badly and well, and the ladder is lettered; Ockham has one note; Thomas's film lies between a sun above and a mirror below, with the chant as rays; Franklin's teaspoon of oil stills the pond and spreads to one molecule thick; Pockels's trough tips its balance; the four causes go into one bubble; and at lunch the water is poured out at the foot of a plane tree. Made by Claude + Richard. On YouTube: the video. Download it as an MP4 (720p, 41 MB).

A recording of the dub mix, 4 minutes 24 seconds, to download and keep: MP3 (320 kbps, 10.6 MB), Ogg Vorbis (4.8 MB), or lossless FLAC (16.3 MB). It was exported from Strudel itself, from the same code, note for note. The spoken lines come from a text-to-speech service that was not answering when it was recorded, so the recording has none; the words are in the code, and a voice of our own is coming for them.

And the club form, 4 minutes 11 seconds: MP3 (320 kbps, 10 MB), Ogg Vorbis (4.9 MB), or lossless FLAC (19.7 MB), exported the same way; its spoken lines are off by design. Like everything on this page, both are in the public domain: play them, sample them, remix them, upload them.

How to play it yourself

1. Open the track in Strudel. The link carries the whole score; nothing is uploaded anywhere.
2. Press **play** at the top of the editor, or click in the code and press **Ctrl+Enter** (Alt+Enter also works). **Ctrl+.** stops it.
3. The instruments, drums and spoken lines are samples that load the first time they sound, so the first run can stutter or miss a line. If it does, stop and play again. The spoken lines come from a free text-to-speech service; if it is down, the track still plays without them.
4. To play it live, change it while it runs. Edit a line and press Ctrl+Enter, and Strudel takes up the new version without stopping. Give it another end in `const END = 'TO CLEAN'` (it is tapped in Morse in the last section; add any letter it lacks to `CODE`), another figure for Bacon's tables in `PRESENCE` (sixteen steps, `x` where the nature is present and `~` where it is not), another tempo in `setcpm(120/4)`; mute a layer by putting `//` in front of its line, or move the sections around in the `arrange(…)` at the bottom.
5. If the link ever stops working, download the source (or copy it from below), paste it into the editor at strudel.cc, and press play. The PDF of this page prints the whole source on paper.

The chant is the cloud track's, *Viri Galilaei*, and Francis's tune is *Brother Electron*'s. The spoken words are the essay's, with Psalm 98:1 in the King James Version. The instruments are Strudel's General MIDI soundfonts, its synthesizers and its built-in TR-909 samples. Strudel is free software by its own authors. The track itself, the code below, is dedicated to the public domain with this essay. Please do not register it with Content ID or any service that claims copies on your behalf.

The source code

```
// ============================================================
// SOAP, BY ITS CAUSES — the dub mix
// A symposium, Bonaventure presiding · B mixolydian x dub techno
// 120 BPM · 132 bars · ~4:24, then it loops
// For Strudel (https://strudel.cc): paste, press play (Ctrl+Enter).
// Dedicated to the public domain (CC0 1.0).
//
// A dub mix takes a song apart. It strips out the singer, keeps the
// drums and the bass, and lets the other parts in and out through
// echo and reverb, which the engineers call washes. It is the method
// of parts, done to music, and it is a lovely one. This track is
// divided another way, into its causes, and the code says so: it is
// written in their order, the end first.
//   I.   THE FINAL CAUSE: what the track is for. It is declared
//        before any sound, and every part below names it as what
//        that part is FOR.
//   II.  THE MATERIAL CAUSE: what it is made of. The sounds, which
//        do not know what they will become.
//   III. THE FORMAL CAUSE: what it is. The mode and the tunes.
//   IV.  THE EFFICIENT CAUSE: what brings it about. The sections and
//        the arrangement, which are the player's: change them while
//        it plays.
// "The end is the cause of causes" (Thomas Aquinas, De principiis
// naturae 4). Each part also names its PARENTS, the parts it is made
// from, which always stand above it, except the end, which stands
// above everything and is made from nothing in the track.
//
// PARENTS. The tracks, like the essays, form a DAG, and a track
// carries its parents in its own material. This essay draws on
// "Whether the Cloud Makes Many Worlds" and "Brother Electron", so
// Thomas sings the first one's hook, the Ascension introit "Viri
// Galilaei", in fauxbourdon, between two choirs; and Francis sings
// the second one's canticle again, now for Sister Water. Each quoted
// line keeps a short hash of the parent's original (sha256 of the
// quoted text, first 12 hex):
//   whether-the-cloud.strudel.js   VIRI       fd123dbc28e8
//   brother-electron.strudel.js    CANTICLE   2b82b56f32b5
// The family moves up by fifths: the cloud in G, its children in D
// and A, the double fugue on E, and this one in B. From the parents
// it also takes the household's Morse, which taps the end at the end.
```

```
//
// TIMELINE (bar / time):
//   OPENING    1  0:00  water from a jug; the chair's bell
//   KEYNOTE    9  0:16  Francis's canticle three ways: for Sister
//                       Water, by her, and through the echo
//   TABLES    25  0:48  presence, absence and degrees: one figure,
//                       its rests, its loudness
//   TRACE     33  1:04  fat and lye, until they come together; the
//                       sweet principle let go
//   MICELLE   41  1:20  the drop: the chords gather, tails in and
//                       heads out; "the whole is prior to the part"
//   FOUR      57  1:52  the four causes enter in their order, the
//                       end first
//   JOINTS    65  2:08  a bad carver, a good one, and the ladder
//   RAZOR     73  2:24  not without necessity: one note
//   BETWEEN   77  2:32  Viri Galilaei in fauxbourdon, above; then
//                       above and below, the groove between
//   FLOOR     93  3:04  a teaspoon of oil on a pond; a tin trough;
//                       two washings
//   ORDER    101  3:20  everything, in its order: a new song
//   LUNCH    121  4:00  wash your hands; the end tapped out; the
//                       water poured where no one will walk on it
//   tail     129  4:16  the reverb, and nothing
//
// The spoken lines come from Shabda's text-to-speech and load the
// first time they play. If they are slow, stop and play again.
// ============================================================

setcpm(120/4) // one cycle = one bar = two seconds

// ---- the spoken lines: the reader, the speakers, and the floor
samples('shabda/speech/en-GB/
f:praised_be_you_my_lord_through_sister_water,useful_and_humble_and_precious_and
_chaste,a_cause_in_the_whole,who_did_the_washing,o_sing_unto_the_lord_a_new_song
')
samples('shabda/speech/en-GB/
m:it_is_for_washing,nature_to_be_commanded_must_be_obeyed,a_new_body,the_whole_i
s_prior_to_the_part,for_the_sake_of_what,where_the_joint_is,not_without_necessit
y,between_two_intellects,the_end_is_the_cause_of_causes,as_smooth_as_a_looking_g
lass,not_a_sum_an_order,wash_your_hands')

// ============================================================
// ORBITS: 1 drums · 2 bass and synths · 3 spoken word ·
//         4 bells and organ · 5 water · 6 choir · 7 recorder ·
//         8 the chords and their echo
// Strudel plays soundfonts at 0.3 of their gain, so the
// instruments are lifted (gain x 3) to sit with the drums.
// ============================================================

// ============================================================
```

```
// I. THE FINAL CAUSE: what the track is for
// ============================================================

// END. To clean: the first thing a child asks of soap, and the last
// thing this track says, tapped in Morse on the rim in LUNCH. Behind
// it, as Francis gives them, stand three more, each the end of the
// one before: to heal, to honour, to welcome. Every FOR below leads
// here.
// parents: none (it is intended; nothing in the track makes it)
const END = 'TO CLEAN'
const BEHIND = ['TO HEAL', 'TO HONOUR', 'TO WELCOME']

// ============================================================
// II. THE MATERIAL CAUSE: what it is made of
// ============================================================

// THE WATER: pink noise through a filter that opens and closes like
// a stream; and bubbles, short sines that rise and burst.
// parents: none (it is given)
// for: KEYNOTE, FLOOR, LUNCH, and so END
const water = (g = .05) => s('pink').hpf(220)
  .lpf(sine.slow(3).range(600, 1900)).gain(perlin.slow(2).range(g * .5, g))
  .pan(sine.slow(5).range(.3, .7)).room(.3).orbit(5)
const bubbles = (g = .07) => n(irand(8).segment(16)).scale('B5:mixolydian')
  .s('sine').attack(.001).decay(.05).sustain(0).degradeBy(.55)
  .gain(g).pan(rand).room(.4).orbit(5)

// THE BELL: the chair's, on the first beat of a bar.
// parents: none (it is struck)
// for: OPENING, ORDER
const bell = (g = .22) => note('b4').s('gm_tubular_bells')
  .gain(g * 3).room(.7).roomsize(6).orbit(4)

// THE DRUMS: a dub techno kit. The kick on every beat, soft at the
// top; the rimshot on two and four, thrown into the echo; the hats
// on the offbeats.
// parents: none (they only measure)
// for: MICELLE, and every section after it that moves
const kick = s("bd*4").bank('RolandTR909').lpf(1800).gain(.8).orbit(1)
const rim = s("~ rim ~ rim").bank('RolandTR909').gain(.32)
  .delay(.45).delaytime(.375).delayfeedback(.55).room(.3).orbit(1)
const hats = s("[~ hh]*4").bank('RolandTR909').hpf(6000)
  .gain(".2 .16 .2 .14").orbit(1)
const drums = stack(kick, rim, hats)

// THE ECHO: the dub engineer's wash, a dotted eighth (three
// sixteenths), fed back on itself. The place where a thing goes
// through.
// parents: none (it is a room, not a sound)
// for: KEYNOTE ("through"), FLOOR, and the chords
```

```
const echo = (pat, fb = .55, wet = .5) => pat.delay(wet).delaytime(.375)
  .delayfeedback(fb).room(.5).roomsize(5)

// THE MORSE: the household's telegraph, as in the parents: a dot a
// sixteenth, a dash three; one between signs, three between
// letters, seven between words.
// parents: none (it is the household's)
// for: LUNCH, where it taps END
const CODE = { A: '.-', C: '-.-.', E: '.', L: '.-..', N: '-.', O: '---', T:
'-' }
const morse = (text) => text.split(' ').map((word) =>
  word.split('').map((ch) =>
    CODE[ch].split('').map((sign) => (sign === '.' ? 'x' : 'x@3')).join(' ~ ')
  ).join(' ~@3 ')
).join(' ~@7 ') + ' ~@7'
const units = (talea) => talea.split(' ').reduce((k, t) => k +
(t.includes('@') ? +t.split('@')[1] : 1), 0)
const telegraph = (text, sound) => {
  const talea = morse(text)
  return s(sound).struct(mini(talea)).slow(units(talea) /
16).bank('RolandTR909')
}

// THE VOICES
// parents: none (they are lent)
const vox = (p, g = 1.4) => s(p).hpf(150).lpf(8000).gain(g)
  .delay(.25).delaytime(.375).delayfeedback(.35).room(.25).orbit(3)

// ============================================================
// III. THE FORMAL CAUSE: what it is
// ============================================================

// THE MODE: B mixolydian, I bVII IV I: B A E B. The household's mode,
// the chant's own (mode VII), a fifth above Brother Electron.
// parents: none (it is given)
// for: everything that sounds a pitch
const SCALE = 'B3:mixolydian'
const ROOTS = "<b1 a1 e2 b1>"
const CLOSE = "<[b3,d#4,f#4,a4] [a3,c#4,e4,g#4] [e3,g#3,b3,d#4]
[b3,d#4,f#4,a4]>"
const OPEN = "<[b2,f#4,d#5] [a2,e4,c#5] [e2,b3,g#4] [b2,f#4,d#5]>"

// THE CANTICLE
// from brother-electron.strudel.js: Francis's canticle, four bars,
// quoted as written in A (sha256 2b82b56f32b5). It is sung here a
// tone higher, in B, and now for Sister Water: "Laudato si', mi'
// Signore, per sor'aqua."
// parents: PARENTS, THE MODE
// for: KEYNOTE, FOUR (where the end enters first), ORDER, LUNCH
const CANTICLE = 'a4 a4 b4 c#5@2 b4 a4@2 g4 a4 b4@2 a4@4 e5 d5 c#5 b4 c#5@2 b4
```

```
a4 g4@2 e4@2 a4@4'
const canticle = () => note(mini(CANTICLE)).slow(4).transpose(2)
const recorder = (pat, g = .3) => pat.s('gm_recorder').release(.3)
  .gain(g * 3).room(.4).pan(.45).orbit(7)

// VIRI: the Ascension introit, from the eldest
// from whether-the-cloud.strudel.js: "Viri Galilaei", two bars,
// quoted as written in G (sha256 fd123dbc28e8)
const VIRI = 'g3@2 g3@2 g3 c4 b3 c4@2 d4 c4 e4 d4 d4@3'
// the chant read as steps of its mode, so that it can be sung in B,
// and in three voices
const STEP = { g3: 0, a3: 1, b3: 2, c4: 3, d4: 4, e4: 5, f4: 6, g4: 7 }
const inMode = (phrase) => phrase.split(' ').map((t) => {
  const [p, d] = t.split('@'); return STEP[p] + (d ? '@' + d : '')
}).join(' ')
// FAUXBOURDON: the chant on top, a fourth and a sixth below it, as
// in Brother Electron's chariot.
// parents: PARENTS, THE MODE
// for: BETWEEN, ORDER
const viri = (lift = 0, g = .3) => stack(...[0, -3, -5].map((under) =>
  n(mini(inMode(VIRI)).add(under + lift)).scale(SCALE)))
  .slow(2).s('gm_choir_aahs').attack(.05).release(.6)
  .room(.6).roomsize(5).gain(g * 3).orbit(6)

// THE SUB AND THE SKANK: the bass on the roots, and the chords on the
// offbeats, through a filter that opens over sixteen bars and into
// the echo. OPEN spreads a chord over two octaves; CLOSE gathers it
// into one, the outer voices turned toward the middle: tails in,
// heads out, as soap molecules gather in water.
// parents: THE MODE, THE ECHO
// for: MICELLE, and every section after it that moves
const sub = (roots = ROOTS) => note(roots).struct("x ~ ~ x ~ ~ x ~")
  .s('sine').attack(.01).decay(.4).sustain(.5).release(.2).gain(.42).orbit(2)
const skank = (chords = CLOSE, g = .11) => echo(note(chords).struct("[~ x]*2")
  .s('sawtooth').attack(.003).decay(.18).sustain(0)
  .lpf(sine.slow(16).range(500, 2600)).lpq(6).gain(g), .6, .55).orbit(8)

// THE TABLES: Bacon's three, as one figure. PRESENCE is where the
// nature is found, ABSENCE where it is wanting (the same steps,
// turned inside out), DEGREES the presence growing louder.
// parents: THE DRUMS
// for: TABLES, and so (Roger Bacon says) END
const PRESENCE = 'x ~ ~ x ~ x ~ ~ x ~ x ~ ~ x ~ ~'
const ABSENCE = PRESENCE.split(' ').map((t) => (t === 'x' ? '~' : 'x')).join('
')
const table = (fig, sound = 'hh') => s(sound).struct(mini(fig))
  .bank('RolandTR909').hpf(3000).gain(.3).orbit(1)

// FAT AND LYE: two lines a long way apart, one climbing and one
// falling, until they meet on the same B and emulsify: trace.
```

```
// parents: THE MODE
// for: TRACE
const fat = note(saw.slow(6).range(35, 59).segment(48)).s('sawtooth')
  .lpf(800).attack(.01).release(.08).gain(.08).orbit(2)
const lye = note(isaw.slow(6).range(83, 59).segment(48)).s('square')
  .lpf(2600).attack(.01).release(.08).gain(.05).orbit(2)
const emulsion = stack(note("[b3,f#4]").s('sawtooth'), note('b3').s('square'))
  .lpf(1200).attack(.4).release(1).gain(.06).room(.4).orbit(2)
// THE SWEET PRINCIPLE: glycerine, let go when the alkali takes the
// acids. Celesta, rising.
// parents: THE MODE
const sweet = note("b5 d#6 f#6 b6 d#7 ~ ~ ~").s('gm_celesta')
  .release(.6).gain(.2 * 3).room(.6).orbit(4)

// ============================================================
// IV. THE EFFICIENT CAUSE: what brings it about
// ============================================================

// I. OPENING. The jug, the glasses, the bell.
// parents: THE WATER, THE BELL
// for: KEYNOTE
const secOPENING = arrange(
  [4, stack(water(.04), bubbles(.05).mask("<0 1 1 0>"))],
  [4, stack(water(.05), bell().struct("<x ~ ~ ~>"),
    note("<b1 ~ ~ ~>").s('sine').attack(.5).release(2).gain(.2).orbit(2))],
)

// II. KEYNOTE. "Per sor'aqua": praised for her, by her, through
// her. The canticle plain on the recorder; then sung by the water
// itself, as bubbles; then through the echo, where a sound goes on
// after the one who made it.
// parents: THE CANTICLE, THE WATER, THE ECHO
// for: END (it is for washing)
const secKEYNOTE = arrange(
  [4, stack(water(.035), recorder(canticle(), .28),
    vox("<praised_be_you_my_lord_through_sister_water ~ ~ ~>"))],
  [4, stack(water(.03),
    canticle().s('sine').attack(.002).decay(.12).sustain(.2).release(.1)
      .gain(.12).room(.5).pan(sine.fast(2).range(.3, .7)).orbit(5),
    bubbles(.04))],
  [8, stack(water(.03),
    echo(recorder(canticle(), .26), .62, .55),
    note("<b1 a1 e2 b1>").s('sine').attack(.3).release(1).gain(.22).orbit(2),
    kick.gain(.5).mask("<0 0 0 0 1 1 1 1>"),
    vox("<useful_and_humble_and_precious_and_chaste ~ ~ ~ ~ ~ it_is_for_washing
~>"))],
)

// III. TABLES. Presence, absence, degrees, and the three at once;
// "Nature to be commanded must be obeyed."
```

```
// parents: THE TABLES, THE DRUMS
// for: END (they were sorted by it before they began)
const secTABLES = arrange(
  [2, stack(table(PRESENCE), kick.gain(.55),
    vox("<nature_to_be_commanded_must_be_obeyed ~>"))],
  [2, stack(table(ABSENCE, 'rim'), kick.gain(.55))],
  [2, stack(table(PRESENCE).gain(saw.segment(16).range(.05, .45)), kick.gain(.
6))],
  [2, stack(table(PRESENCE), table(ABSENCE, 'rim').gain(.2), kick.gain(.65),
sub().gain(.3))],
)

// IV. TRACE. Fat and lye come together and become a new body; the
// sweet principle goes free.
// parents: FAT AND LYE, THE SWEET PRINCIPLE, THE MODE
// for: MICELLE (it makes the soap that gathers)
const secTRACE = arrange(
  [6, stack(fat, lye, hats.gain(.12), vox("<~ ~ ~ ~ a_new_body ~>"))],
  [2, stack(emulsion, sweet, hats.gain(.14))],
)

// V. MICELLE. The drop. First the chords wide open, over two
// octaves, while the drums come in; then gathered, the outer voices
// turned inward. "A cause in the whole, and in no part of it."
// parents: THE SUB AND THE SKANK, THE DRUMS
// for: END (the micelle is what takes the grease into the water)
const secMICELLE = arrange(
  [8, stack(drums, sub(), skank(OPEN, .1),
    vox("<~ ~ ~ ~ a_cause_in_the_whole ~ ~ ~>"))],
  [8, stack(drums, sub(), skank(CLOSE),
    bubbles(.03),
    vox("<the_whole_is_prior_to_the_part ~ ~ ~ ~ ~ ~ ~>"))],
)

// VI. FOUR. The four causes enter in their order, two bars apart:
// the end (the canticle), the form (the chords), the matter (the
// sub), and the maker (the drums), which comes last because it is
// moved by the rest.
// parents: THE CANTICLE, THE SUB AND THE SKANK, THE DRUMS
// for: END
const secFOUR = stack(
  recorder(canticle(), .26),
  skank(CLOSE).mask("<0 0 1 1 1 1 1 1>"),
  sub().mask("<0 0 0 0 1 1 1 1>"),
  drums.mask("<0 0 0 0 0 0 1 1>"),
  vox("<for_the_sake_of_what ~ ~ ~ ~ ~ ~ ~>"),
)

// VII. JOINTS. A bad carver cuts through the middle of the beats; a
// good one at the joints, a bar at a time; then the canticle's first
```

```
// phrase climbs, a step every half bar: the ladder.
// parents: THE DRUMS, THE SUB AND THE SKANK, THE CANTICLE
// for: END
const groove = () => stack(drums, sub(), skank(CLOSE))
const secJOINTS = arrange(
  [2, groove().mask("1 1 1 [1 0] 0 [0 1] 1 [1 0]")],
  [2, stack(groove().mask("<1 0>"), vox("<where_the_joint_is ~>"))],
  [4, stack(drums, sub(),
    recorder(note(mini('b4 b4 c#5 d#5@2 c#5 b4@2')).transpose("<[0 2] [4 5] [7
9] [10 12]>"), .26))],
)

// VIII. RAZOR. "Plurality is not to be posited without necessity."
// One note, struck once a bar, and its echo.
// parents: THE ECHO, THE MODE
// for: BETWEEN (what is left is enough to start again)
const secRAZOR = stack(
  echo(note('b3').struct("x ~ ~ ~").s('sine').attack(.002).decay(.6).sustain(0)
    .gain(.3), .5, .5).orbit(2),
  vox("<not_without_necessity ~ ~ ~>"),
)

// IX. BETWEEN. "A natural thing stands between two intellects." The
// parent's chant above, then above and below at once, an octave and
// more apart, and the groove between them.
// parents: FAUXBOURDON, THE SUB AND THE SKANK, THE DRUMS
// for: ORDER
const secBETWEEN = arrange(
  [8, stack(groove(), viri(7, .26),
    vox("<between_two_intellects ~ ~ ~ ~ ~ ~ ~>"))],
  [8, stack(groove(), viri(7, .24), viri(-7, .22),
    vox("<the_end_is_the_cause_of_causes ~ ~ ~ ~ ~ ~ ~>"))],
)

// X. FLOOR. A teaspoon of oil on a pond: one drop, and its echo
// spreading wider and longer until it can spread no more, one
// molecule thick. Then a tin trough, measured on a balance; and a
// man who washed his hands twice.
// parents: THE WATER, THE ECHO, THE DRUMS
// for: ORDER
const secFLOOR = arrange(
  [4, stack(water(.03), kick.gain(.4),
    note('b6').struct("<x ~ ~ ~>").s('sine').attack(.001).decay(.
2).sustain(0).gain(.2)
      .delay(.7).delaytime(.25).delayfeedback(saw.slow(4).range(.35, .82))
      .pan(sine.fast(4).range(.1, .9)).room(.6).orbit(5),
    vox("<~ ~ ~ as_smooth_as_a_looking_glass>"))],
  [4, stack(sub(), kick.gain(.6), hats,
    s("rim*8").bank('RolandTR909').hpf(4000).gain(".18 .1 .14 .1").pan(.
65).orbit(1),
```

```
    s('white').struct("<~ ~ ~ [x ~ x ~]>").attack(.05).decay(.35).sustain(0)
      .lpf(3000).gain(.12).orbit(5),
    vox("<who_did_the_washing ~ ~ ~>"))],
)

// XI. ORDER. The chair sums up: not a sum but an order. Everything,
// in its order: the end above, the form, the matter, the maker; then
// the parent's chant and the bell, a new song made of old notes.
// parents: everything above but the tables and the trace
// for: LUNCH
const secORDER = arrange(
  [8, stack(groove(), recorder(canticle(), .24),
    vox("<not_a_sum_an_order ~ ~ ~ ~ ~ ~ ~>"))],
  [8, stack(groove(), echo(recorder(canticle(), .22), .5, .4), viri(7, .24),
    bell(.16).struct("<x ~ x ~>"),
    vox("<~ ~ ~ ~ o_sing_unto_the_lord_a_new_song ~ ~ ~>"))],
  [4, stack(kick.mask("<1 1 1 0>"), sub().mask("<1 1 1 0>"),
    viri(7, .26), skank(CLOSE, .12).mask("<1 1 1 0>"),
    note("<~ ~ ~ [b2,f#3,b3,d#4,f#4,b4]>").s('gm_church_organ')
      .attack(.05).release(3).gain(.1 * 3).room(.7).roomsize(6).orbit(4),
    bell(.2).struct("<~ ~ ~ x>"))],
)

// XII. LUNCH. "Wash your hands." The water again, the canticle alone,
// and END tapped on the rim, a little under five bars of it; then the bowl
carried out and poured at
// the foot of a tree, the filter falling as it empties.
// parents: THE WATER, THE CANTICLE, THE MORSE, END
// for: END (here it is reached: in a basin, in someone's hands)
const secLUNCH = stack(arrange(
  [4, stack(water(.05), recorder(canticle(), .22),
    vox("<wash_your_hands ~ ~ ~>"))],
  [4, stack(
    s('pink').hpf(150).lpf(saw.slow(4).range(2600,
200)).gain(isaw.slow(4).range(.08, 0))
      .room(.4).orbit(5),
    note("<b1 ~ ~ ~>").s('sine').attack(.2).release(3).gain(.2).orbit(2))],
), telegraph(END, 'rim').gain(.38).room(.3).pan(.6).orbit(1).mask("<1 1 1 1 [1
0] 0 0 0>"))

// ============================================================
// THE ARRANGEMENT: the player's
// ============================================================
arrange(
  [8,  secOPENING],
  [16, secKEYNOTE],
  [8,  secTABLES],
  [8,  secTRACE],
  [16, secMICELLE],
  [8,  secFOUR],
```

```
  [8,  secJOINTS],
  [4,  secRAZOR],
  [16, secBETWEEN],
  [8,  secFLOOR],
  [20, secORDER],
  [8,  secLUNCH],
  [4,  silence],
)
```

A note on what is claimed

Every factual claim below was checked against the source named; documents and measurements settle a question, and reports leave it open. The verdicts (that the causes are an order and not a sum, that the division is the intellect's and the causes the thing's, that a force is an end seen from behind) are the speakers' judgments, not findings. The congress's thesis, read at the opening, is the seed this essay grew from, in its first wording; the chair's one correction to it is the essay's argument.

- Soap is a mixture of the sodium or potassium salts of long-chain fatty acids, made by saponifying fat with alkali; each molecule of fat gives three of soap and one of glycerol; the carboxylate end is hydrophilic and the hydrocarbon chain hydrophobic; the chains cluster inside micelles, grease is taken in and rinsed away; in hard water the soap becomes insoluble calcium and magnesium salts — *Documented; OpenStax, Organic Chemistry 27.2*
- Micelles form above a critical micelle concentration — *Documented; Wikipedia*
- Chevreul (1786–1889) showed that fats are compounds of fatty acids and glycerol, named stearic and oleic acid, and published his *Recherches chimiques sur les corps gras d'origine animale* in 1823 — *Documented; Wikipedia, Britannica*
- Chevreul was professor of organic chemistry at the Muséum national d'Histoire naturelle from 1830, its director until 1879, and director of dyeing at the Gobelins from 1824; his law of the simultaneous contrast of colours dates from 1839 — *Documented; Wikipedia*
- Chevreul's name is one of the 72 on the Eiffel Tower, which opened in the spring of 1889; he died on 9 April 1889, aged 102; a bibliography for his centenary called him the "doyen des étudiants de France" — *Documented; Wikipedia*
- At room temperature the formation of micelles is driven mainly by the entropy of water; the effect was named by Kauzmann (1959) and given its standard account by Tanford (1973); its dependence on the size of what assembles is still studied — *Documented; Chandler, Nature 437 (2005)*
- The terms of an energy decomposition are not observables, and different schemes divide the same interaction energy differently — *Documented; Andrés et al., J. Comput. Chem. 40 (2019)*
- Soap-like molecules placed at random in simulated water gather into micelles — *Documented; Marrink, Tieleman and Mark, J. Phys. Chem. B 104 (2000)*
- A film of oil spread from Franklin's figures is about a molecule thick; Rayleigh measured such films in 1890 — *Documented; Asimov Press, "How to Measure Molecules"*
- Roger Bacon sent the *Opus maius* to Clement IV in 1267, under a rule of his order against publishing without leave, and at the pope's request kept the commission secret — *Documented; Catholic Encyclopedia (1912)*

- The Paris masters accepted Bonaventure and Thomas Aquinas as masters of theology on 12 August 1257; Bonaventure gave the *Collationes in Hexaëmeron* in Paris in the spring of 1273 — *Documented; Stanford Encyclopedia of Philosophy, "Bonaventure"*
- Darwin quoted Aristotle's passage on the rain and the teeth (*Physics* II.8) in a note to the *Origin* and wrote, "We here see the principle of natural selection shadowed forth" — *Documented; On the Origin of Species, the historical sketch*
- Ockham held that a natural agent's acting for an end cannot be proved by reason, though he held by faith that nature acts for an end (*Quodlibet* IV q. 1; *Summula* II.6) — *Documented; Pasnau, on final causes in the later Middle Ages*

What the checker says. The load-bearing claims were run through the Theological Type Checker, a deterministic checker of theological claims that types a claim before it weighs it. It does not say whether a claim is true; it shows when one is badly formed. Three results. First, "soap is nothing but its molecules," resting on a finding reached by division, is refused on every horizon the checker knows, Bacon's and Ockham's included, and on the bare checker with no school loaded at all: a method of division can say what the parts are, never that there is nothing else. The claim about the parts stands. Second, the three arguments that soap is for washing, from its maker's end, from its own nature and from God's intention for natural things, stand or fall by horizon. Of the forty-one schools the checker models, all forty-one allow the maker's end, twenty-six allow God's, and fifteen allow nature's. Bacon's horizon allows the maker's and God's and not nature's, which is where he puts himself in the hall. Fourteen, among them Descartes's, Hobbes's, Spinoza's, Kant's, Marx's and Ockham's, allow the maker's end alone. The question itself stays open, because an essay settles nothing. Third, what the checker cannot yet say. It types causes on arguments, not on things, so it can say which horizons may argue from an end, but not that the soap has one. A revision that would let it say that a cause is in the thing, with the word standing between the thing and the argument as Thomas has it here, has had its predictions committed and is not yet built.

Words quoted as the speakers' own. Francis of Assisi, *Testament* and *The Canticle of the Creatures*, trans. Paschal Robinson (1905); the Canticle's Umbrian from the Assisi manuscript (cod. 338), which writes *sor aqua*, lower case and without a *c*, and the dispute over *per* from F. C. Burkitt, *Journal of Theological Studies* 28 (1926); the washing of the lepers is Bonaventure, *Legenda maior* II.6, paraphrased; the hand-washing is *Speculum perfectionis* 118, where Steele's English (1902) has him choose "such a place that the water which fell on the ground should not be trodden underfoot." Bacon, *De augmentis scientiarum* III.5 (the virgin: *tanquam virgo Deo consecrata, nihil parit*; Spedding's *Works* I, p. 565), *Novum Organum* I.3, I.48, I.51 and II.11–20 (the tables and the first vintage), trans. Spedding, Ellis and Heath; *Essays* (1625), "Of Goodness, and Goodness of Nature", spelling modernised. Chevreul, *Recherches chimiques sur les corps gras d'origine animale* (1823) and his immediate principles, as Armand Gautier quoted him in 1893, paraphrased. Aristotle, *Physics* II.2, II.3 and II.8, trans. Hardie and Gaye (whose "invariably or normally" is given here as "always or for the most part", the more literal rendering); *Metaphysics* I.9 and VII.10 and 16, trans. Ross; *Politics* I.2 (the hand of stone), paraphrased. Plato, *Phaedo* 67c and 98c–99b, *Timaeus* 46c–d, *Sophist* 226e–227b, *Phaedrus* 265e and *Symposium* 211b–d, trans. Jowett. Ockham, *Ordinatio* I d. 27 q. 2 (plurality without necessity), *Summula philosophiae naturalis* II.6 and *Quodlibet* IV q. 1, the

last two in Robert Pasnau's translation. Thomas Aquinas, *Summa theologiae* I q. 2 a. 3 (the archer), q. 15 a. 1 and 2, q. 45 a. 4, q. 65 a. 4, q. 85 a. 1, q. 104 a. 1 and q. 105 a. 5; III q. 75 a. 6 ad 1 (the bread); *De veritate* q. 1 a. 2; *De principiis naturae* 1 and 4; *Summa contra gentiles* III.70 (the pen and the writer), all paraphrased except the archer. Bonaventure, *Christus unus omnium magister* 18–19, *Legenda maior* IX.1 (*contuebatur in pulchris pulcherrimum ... de omnibus sibi scalam faciens*; Quaracchi *Opera omnia* VIII, p. 530), *Collationes in Hexaëmeron* I.10 and *De reductione artium ad theologiam* 2 and 11–14, paraphrased. Roger Bacon, *Opus maius* VI.1, trans. Burke. Pliny, *Natural History* 28.191, paraphrased. Franklin to William Brownrigg, 7 November 1773, as printed in *Philosophical Transactions* 64 (1774). Rayleigh's note introducing Agnes Pockels, *Nature* 43 (12 March 1891). Semmelweis's dates and agents from Sinclair, *Semmelweis: His Life and His Doctrine* (1909). The Second Vatican Council, *Gaudium et spes* 14 (*ita ut, per ipsum, illa fastigium suum attingant et ad liberam Creatoris laudem vocem attollant*; AAS 58, 1966, p. 1035), paraphrased. Pockels's trough, "a rectangular tin trough, 70 cm. long," with a strip of tin across it and "a small balance," is from her letter in Lady Rayleigh's translation. Scripture is the King James Version: Malachi 3:2; John 13:14; Psalm 98:1.

Still to check against print: the commas of the 1625 *Essays* against a facsimile; the page in Chevreul's *Considérations générales sur l'analyse organique* (1824) where he defines immediate principles, here taken from Armand Gautier's summary of him; and the Latin of Roger Bacon's "without experience nothing can be sufficiently known," given here in Burke's English.

What the other side argues. Aristotle's answer to the rain has a famous reply: the creatures with useful teeth survived and the others perished, as his opponents said, and Darwin, who quoted the passage in a note to the *Origin*, read it as a glimpse of natural selection. On that reading, "always or for the most part" shows that a thing is lawful, not that it is for anything, and a micelle forms because it is the arrangement of least free energy, which says nothing of ends. Bacon's heirs add that final causes have never yet predicted a measurement. Thomists answer that a law of least free energy is itself a tendency toward a terminus, and the quarrel is the subject of the session Thomas declined. Ockham's defenders would add that his view is not a denial of ends but a more honest account of what reason can show: that a natural agent acts for an end, he held, is known by faith and not demonstrated, and his paper here gives that as fairly as five minutes allow. Chemists who use energy decomposition answer that its terms, though not observables, track real differences between molecules and predict them well, and that "signs, not things" is a philosopher's gloss on a tool that works. The textbook account of the hydrophobic effect as chiefly entropic holds for small molecules at room temperature; for larger assemblies the balance shifts, and the physics is still argued. And the story of Semmelweis has been told so often, and so often simplified, that historians now take care to separate what he showed from what was later said he showed.

SOURCES OpenStax, *Organic Chemistry* 27.2, "Soap", Chandler, "Interfaces and the driving force of hydrophobic assembly" (2005), Andrés et al., "Nine questions on energy decomposition analysis" (2019), Marrink, Tieleman and Mark, "Molecular dynamics simulation of the kinetics of spontaneous micelle formation" (2000), Asimov Press, "How to Measure Molecules", "Michel Eugène Chevreul" (Wikipedia), "Roger

Bacon," *Catholic Encyclopedia* (1912), "Bonaventure," *Stanford Encyclopedia of Philosophy*, Darwin, *On the Origin of Species*, endnotes (Standard Ebooks), Pasnau, on final causes (PDF), Burkitt, "Note on the Text of the Canticum Solis," *JTS* 28 (1926), Franklin to Brownrigg, 7 November 1773 (Founders Online), Pockels, "Surface Tension," *Nature* 43 (1891), Sinclair, *Semmelweis: His Life and His Doctrine* (1909), Robinson, *The Writings of St Francis* (1905): the Testament

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