

Cantower XXIX

Physics and Other Sciences

August 1st 200429.1 Whatas, Whereas, Whenas¹

How does one teach this chapter? What chapter? Either chapter: Feynman's chapter with the above title; Lonergan's chapter titled 'The Canons of Empirical Method'. From what we have been brooding over, the answer is that the teaching of either chapter must merge with the teaching of the other: that is the direction, the pointing, of GEMb. They are to merge and take the road, lead the Way, to some lift towards more integral consciousness and character of both teacher and student. We are back with the question of context raised at the beginning of *Cantower XXVIII*, but a month older, perhaps a month wiser. For some, the word *Whatas* names now a post-Heideggerian self, a Kontext poised in a where and when that can be, even in the everyday, a poise in all, even in the unreached field.² For more one might claim that at least there is a flicker of an anticipation of how "so it comes about,"³ how I come about about about.⁴

¹A first footnote seems appropriate, advising anyone who might be discouraged by the heavy first two sections to skip - on a first reading - to the third section, which is the elementary lead into the third chapter of *Insight*.

²See note 24 below.

³*Insight*, 514[537]. This is a key text of *Insight* which I recall now regularly.

⁴It seems best just to repeat, as I did in note 57 of the previous essay, the essential of the comment on this that I wrote in note 20 of *Cantower XXVII*. "This is a triplet that I have used more frequently in recent essays. Roughly, we are curious about things. But we can be curious about that about. And history bears witness to a series of such curiosities, about which we may be curious. So, if you think it out, you find that there are studies of method; but there is also the study of that study, which is the refined meaning of **methodology**."

But let us move back from the riddles and the references of this first paragraph and its references to real and humble contexts. How does one lead, how is one led, into the methods of sciences, the canons of inquiry? On the analogy of chemistry texts, which regularly print the periodic table within the front cover, you might place W3 up-front: a nominal identification of the metaperiodic or cyclic table. But certainly you benefit by having up-front the integral diagram I have named W4: the two diagrams located on pages 322-3 of *Phenomenology and Logic*. How might you have them up-front, seen-as? Obviously, at a level of realistic student attainment. My own perspective on that realistic attainment is contained in the two chapters of *Wealth of Self and Wealth of Nations* where the two diagrams originally occurred, one in chapter 2 and one in chapter 6, these two chapters corresponding respectively and roughly to key elements in the two chapters 9 and 18 of *Insight*.

My own realist perspective in those two chapters includes, of course, their context in that book: one persons effort, then, to lead the Way to reading *Insight* with some *whatas*. The book was not written for that, but for 18-year-old girls who would probably never do any more philosophy, trapped in other introductory courses in physics, psychology, sociology, economics, whatever. But there is a point to mentioning this: these other courses offer grist for the mill. I might almost say, steal Feynman's title for philosophy: "Philosophy and Other Sciences" and use the texts from the other classes. It is probably better to have tenure before you do this. Still, you might manage as I did: instruct the class both to maintain secrecy and to avoid using this stuff in other classes, since getting through these various courses sanely was a main agenda.

I recall now talking to Lonergan in 1974, before taking off for my 20 years at Mt.St.Vincent University, about relating to the large philosophy faculty in Dalhousie University. I mused that the stuff they were teaching was, to say the least, not very relevant to the students. Lonergan replied with vigour, " its just the sort of department that all the other departments want!". At all events, a teacher must figure out, from the fulness of their *whatas, whereas, whenas*, how to handle guidance in the

Way is such a manner that teacher and students survive.

My main point, however, is that context is necessary to venture maturely into either of the two chapters that we are considering. So, I have mentioned W4, and now I wish to reflect on its cultivation and use in lifting the meaning of the first introductory paragraph in either of the two chapters of our present interest. Lonergan remarks, in that paragraph, “There is a canon of relevance, for pure science aims immediately at reaching the immanent intelligibility of data and leaves to applied science the categories of final, material, instrumental, and efficient causality.”⁵

The eager student may lock onto the word *categories* or onto any of these *causes*. One is thus thrown into the context of the categorial, perhaps even lifted into the full yardage of *Method in Theology* pp. 281-293. It seems better, then, to have spiraled round the categorial issue in some elementary way: W3 sits there as a goal, but W4 offers preliminary climbing.⁶ On the other hand, Feynman, in the first paragraph, notes, “In this chapter we shall try to explain what the fundamental problems in the other sciences are, but of course it is impossible in so small a space really to deal with the complex, subtle, beautiful, matters in these other fields. Lack of space also prevents our discussing the relation of physics to engineering, industry, society, war....”⁷ In section 29.5 we shall see how he manages, and make suggestions about what is to be done about the challenge. But whatever is to be done about it must certainly include attention to the scientist as both theoretical and practical if it is to escape a description ‘from the outside’ of what goes on in the practice of science.

I seem to be writing here mainly to teachers, but I address all re-readers of

⁵*Insight*, 70[93]. Much later (651[674]) he will remark that “causality denotes the objective and real counterpart of questions”.

⁶Recall my remark in footnote 1 above. Section 29.3 is the helpful entry zone.

⁷I should recall that having Feynman’s text to hand is not necessary. I provide sufficient quotation, summary, description to make the discussion intelligible.

Insight. My attention, however, is on a realism of contextualization and re-contextualization. This will be illustrated by my reflections on my own classroom re-contextualization of chapter three of the book in sections 29.3 and 29.4. Section 29.2 concerns the broader recontextualization that pivots of the meaning of GEMb, illustrated by attention to a particular page of the chapter. So, the next three sections are mainly pointers regarding the third chapter of Lonergan's work. Feynman's third chapter shall occupy us briefly in section 29.5.

29.2 *Insight* and GEMb

If you are tuning into my oscillations round and about strategy in the previous section, indeed in my effort to reintroduce *Insight*, then already you may be suspicious about the strategy of *Insight* itself and the pattern of its progress as it moves, seemingly, under the dynamic of GEMa.⁸ Lonergan's introduction of generalized empirical method as a named strategy occurs at the end of the short section 3.1.1 on *The Restriction to Sensible Data*. "We have followed the common view that empirical science is concerned with sensibly verifiable laws and expectations. If it is true that essentially the same method could be applied to the data of consciousness, then respect for ordinary usage

⁸Lonergan's personal dynamics was GEMb. A footnote is not the place to elaborate on this but some oddments can be provided. In chapter 5 of *A Brief History of Tongue* I I drew attention to juggling with titles in chapter one when he perused the second edition in 1958. Further, in that edition there is what I might call a GEMb revision where he deals with the problem of convergence in probability sequences: *Insight*, 66-7[89] (I deal with that revision in chapter 8 of *Randomness, Statistics and Emergence*). Another amusing oddment: he invites the reader who may be bored with his rambles around Euclid to try out the transition from Euclidean to Riemannian geometry (*Insight*, 31[56]). And so on. Certainly, then, he was driven by GEMb. Was the focus on GEMa a strategy, or was it that he was over-optimistic about the sufficiently cultured consciousness of his prospective readers? The later explicit definition certainly was needed, indeed, is desperately needed now as a "doctrine that is embarrassing" (*Method in Theology*, 299) when Lonerganism is making its little tunneled way into the new millennium.

would require that a method which only in its essentials is the same be named generalized empirical method.”⁹

Our reflections so far have been leading to the elementary suspicion that, in re-reading *Insight* or in teaching it, it would be as well to bear, bring forth, in mind - one’s own and one’s students - that the relevant bent and intent of contemporary methodology should be GEMb. It is not necessary to claim that it was the luminous bent of Lonergan all along. It is a clear shift of context, Kontext, *Whereas*, somewhat like the shift from Newton to Einstein. And it seems now worthwhile to note another aspect of that shift, though it is a slight refining distraction from our broad venture into this third chapter of *Insight*.¹⁰

So I draw attention now to suspicions lurking in the original Appendix A of *Phenomenology and Logic*, the one I removed because of objections of a reader.¹¹ The key point was in section 3 of that original Appendix A, where I danced round Derrida’s *Of Grammatology*.¹² The point can be made in what seems a very elementary way: advance strategically from the sensible data of language.¹³ So, for instance, advance by

⁹*Insight*, 72[96].

¹⁰A further distraction would be to call attention to the relation of what we are doing here to the task pointed to in note 34 of page 88 of *Method in Theology*: the lift of linguistic feedback. It has been mentioned before and it will receive a richer contextualization through the reflections of *Cantowers XXXII* and *XXXIII*.

¹¹I presented the original Appendix A as chapter 5 of *Lack in the Beingstalk. A Giants Causeway*. I included the critics comments on the volume in section 4.4 of chapter 4.

¹²Jacques Derrida, *Of Grammatology*, translated by Gayatri Chakravorty Spicak, John Hopkins University Press, 1976.

¹³The 49-year-old Lonergan was not unaware of the possibility. “There are many words: some are substantival because they refer to intelligible and concrete unities; some are verbal because they refer to conjugate acts; some are adjectival or adverbial because they refer to the regularity or frequency of the occurrence of acts or to

identifying question-marks.¹⁴ Or, less elementarily, I might say that strategically one does not separate data of sense and data of consciousness. This fits in with my commonsense notion of science as “doing the best you can across a wide front of varying opportunity”.

As humans, we are not too bright: use every clue. The most obvious example is the clues within any language to the elements diagramed in that Appendix A, reproduced in the short version of Appendix A that I insisted on including in *Phenomenology and Logic*, that I now name W4. And perhaps you will now notice - with a sufficient pause over my ‘little paragraph’! - that my strategy fits in with the shift from GEMa to GEMb.

Before I go on I wish to suggest that the strategy of the book *Insight* is quite legitimate as a genetic scientific presentation: but this is a topic that I must leave till I reach the sophistications of *Cantowers LXVI - LXXXI*. For the moment, it seems best to settle for the view that Lonergan, like Archimedes, is an axial man: Archimedes starts with his impossible supposition about water; Lonergan starts with his impossible supposition. What is that supposition? Is it the supposition that the troubled pilgrim of the first paragraph of chapter 14 of *Insight*, “threatened with inevitable death and before death, with disease and insanity”, will stay cool enough to climb through the book towards THE POSITION that turns up - or in - a few pages later? Or is there a parallel between Archimedes obscure Proposition 1, with its hidden focus on the centre of the earth, is a cousin to a Lonergan Proposition 1, “thoroughly understand what it is to understand”, with its hidden focus, its typing conviction about the real state of affairs?

potentialities for such regularities or frequencies” (*Insight*, 555[578]).

¹⁴The advance, of course, in its fullness is over the history and geography of languages, allowing for the fact that modern question marks are being legitimately included in reproductions of early texts.

So, one starts studying water by balancing a coathanger, by attending to a little cube of water, within the muddle truth of one's *whatas, whereas, whenas*. Where might the pilgrim start from the pool of wonder, within the water of life? "If effective freedom is to be won, it is not to be won easily".¹⁵ "As contemporary existentialism would put it, *L'homme se definit par une exigence*."¹⁶ The force is "felt in the tranquility of darkness, in the solitude of loneliness, in the shattering upheavals of personal or social disaster."¹⁷

At all events, I am placing the climb in a new pragmatic context that is paradoxically simple in that in fact it is in the context of an integral sublation of both the *Insight* of GEMa and the lift of the missing Appendix to *Phenomenology and Logic*. It is simple in that it represents a fullness of the mentality of GEMb: part of the data of inquiry in any field is the language generated in that field, so the struggle to be luminous about that language **in its self-reference** is part of the struggle to be cultivated.¹⁸ Moreover, the emphasis will be on that simplicity as we move through the following two sections. But first I wish us to muse over a single paragraph of *Insight*.¹⁹

¹⁵*Insight*, 624[647].

¹⁶*Ibid.*, 625[648].

¹⁷*Ibid.* I would wish you to attend, at some later date, to the full context of these pointers of chapter 18. They must be sublated into the new hodic morality of *Cantower XVIII.*, "The Possibility of Cultural Ethics".

¹⁸The bold print is simply a nudge of curiosity towards the reflections indicated in note 8 above. You may well pause to consider how language is always self-referent.

¹⁹The main paragraph on p.104 in the new edition. In the first edition it begins on the second last line of p. 80. What of your own brooding here? I am very aware of the multipurpose nature of these essays. I am trying to be elementary, yet open doors to the future of thinking and teaching. You may well be quite ahead of me in this matter of integral brooding, of being an integral *Whatas*. The you lift the reading into your own larger context, symbolically your own version of the brooding of the 24-year-old Brouwer, excluded from his published works but available in *Notre Dame Journal of*

The passage is a paragraph within the discussion of the canon of parsimony, the paragraph beginning optimistically “As the reader will have noted”.²⁰ Two problems lurk there: (a) where do we stand with regard to parsimony and the notion of thing? (b) where do we stand now with regard to the conclusion of the paragraph. We leave (a) to the section 29.4 . Here we pause over (b) for a bit.

The discussion in the paragraph pivots on distinguishing, e.g. A and A'. A points to the content of an act such as the seen colour, A' points to the act of seeing the colour.²¹ The paragraph goes on to talk about precisions. Prescinding from this and that is a normal human strategy, though thematic and luminous prescinding in topics and disciplines can take decades or generations.²² The question I am raising here relates to the concreteness of mature metaphysics as an integral structure of all. “All we know is somehow with us; it lurks behind the scenes and it reveals itself only in the exactitude

Formal Logic 37 (1996), 391-429: “Life, Art and Mysticism”. (It is introduced (381-390) by the translator, Walter P. Van Stigt.) A briefer linguistic symbol of the reach for integral consciousness is the title of the section of that Appendix A in which I first noted Brouwer’s struggle: *Entscheidungssproblem*. It is you and I in the concreteness of our possibilities and our decisions that are the givens of our goings-on, our leadings-on. Increasingly in these next few *Cantowers*, but more thematically in the *Cantowers* from LXVI on, we will sense the post-axial drive for integral linguistic self-luminosity.

²⁰*Insight*, 80-81[104].

²¹It is worth noting, in passing, the levels of complexity of this statement’s meaning for different readers. A serious reading of *Insight* will add the context of p. 555[578] regarding the triple correlation involved. A fuller heuristic reading, with the Kontext of W1, lifts one into the world of neurochemistry. For a sniff of this world, see Rita Carter, *Mapping the Mind*, Phoenix Paperback, 2002. Above I am introducing a point in a simple a fashion as possible.

²²In editing Lonergan’s economics I noted a very significant instance of this, where Lonergan took a turn to precise discussion of economic dynamics, prescinding from various facets of the social context. See lines 24-31 of p. xx of my Introduction to *For A New Political Economy*.

with which each minor increment to out knowing is effected".²³

Mature metaphysics is a luminosity of that lurking, never backing off from being. In its full normativity, its feltfield,²⁴ is a *whatas* (*whereas, whenas*) of all viewpoints, aspiratively universal or not, in the concrete history of their subjectivity and in their eschatological realization. Within such a metaphysics, *Metaphysik, metaphysik*, is there not a twining, in integral embrace, of all goals, "the goal of natural science or of cognitional theory"? THEN²⁵ the first and second case of the paragraph are lifted into the third case, and in that third case "one will be employing experiential conjugates", but the employer is the *whatas* of all, and the goal is singular. And that goal, as luminous goal, is a distant goal, requiring the whirl of the hodic way.

I seem to be building up layers of impossible requirements, lifting now an enriched perspective on GEMb into the fuller view mapped in W3. I leave further enrichment as an option for those learned in the philosophy and history of science. If you have been with me through the *Cantower* project you probably recall *Cantowers XV and XVI*, dealing with Gould's view of evolution theory, and Kuhn's view on the evolution of science. To this you may be able to add a more detailed view of contemporary research methodologies and the work of recent decades on actual scientific performance. But all that is quite beyond my brief collections of hints.

29.3 Some Elementary Steps

And as I turn now to some of those hints, I note already a problem that I have to deal with here, that you have to deal with either as a student or a teacher. I refer to the

²³*Insight*, 278[303].

²⁴See the index to *Phenomenology and Logic*, under *Field*. Add the context of chapter 3 of *Lack in the Beingstalk*, sections 3.4 and 3.5: "The Field and the Garden", "The Field as Foreign and Friendly".

²⁵Not for the first time I am recalling relevantly the title of *Cantower V*: "Metaphysics THEN".

problem of pushing for some light on the notion of thing. “The notion of thing involves a new type of insight”²⁶ is Lonergan’s introductory comment on the topic, and it is ambiguous, and the ambiguity lurks in his subsequent discussion. There is the operative notion of thing, so spontaneously generative of nouns in all languages. There is then the hard-won appreciation of that notion - the notion of the operative notion of the thing - that is the difficult topic of chapter 8 of *Insight*. It is not at all an easy appreciation to reach, a view that I base on my own experience of being held up, blocked, by the difficulty of chapter eight right up to the winter of 1964, twelve years after the beginning of my academic struggle with science and philosophy. How to handle that difficulty? Well, first identify it as two-layered.

There is the elementary operative notion that nudges us to unify zones of our experience and ‘noun’ them: a cloud, a train, a party (celebrative or political). I deal with that to some extent in chapter 2 of *A Brief History of Tongue*. And you may well find the discussion useful. A very brief pointing towards the core shift is in *Wealth of Self*, p. 28, where I recall my own key shift-image. But I emphasize that digesting this is a slow tough task. Of it I would make the same point that I make later, regarding the related problem of the “empirical residence”: I find it strange that Lonergan students and teachers do not give much attention or space to this topic. Then there is the more complex aspect of the topic: how it relates to aggreformism. That aspect I leave to the next section.

Where now do we stand regarding the canons of method? I am going to presume that you are a teacher of the present generation of philosophy teachers, not too well up on science. So you wish to lead yourself and your students to a slightly improved reading of this chapter. Then I would suggest that you bring the problem I have just mentioned up front for yourself and for the students. There should be no fuss about What Really are things: that would be a miss-direction in line with the old disease

²⁶*Insight*, 245[270].

of a quest for certainty rather than understanding. Focus, rather, on what I call **nouning** as a spontaneous way of ‘holding together’ relations then nudge towards what I might call psychologically unavoidable nouning. So, ‘car’ is a noun, but you can think your way to denying its unity. Taking a wheel off is not the same as taking the leg off a dog. And so on, but not too far: lots of trouble lurking here about abstract nouns, etc etc.

Next you go back to the elements, presumably already vaguely familiar: some version of W4 hovers in their imagination. W4 involves all the elements up to the judgment of value and I would claim that it is important to keep that in the ballpark here, even though the focus in science is on getting what-answers. The reading of the first page of chapter 3 demands it: don’t skip over “the categories of final, material, instrumental and efficient causality.”²⁷ Indeed, take W4, or just take a sketched bicycle wheel, and lead the group to a grip on the five Whys.²⁸ That gives a reasonable beginner’s context of the five causes as a presence in any situation. And I would suggest additions to that context, depending on class interests or your own. Even without much science you have sufficient familiarity with the notion of science being “theory verified in instances”: it is helpful to diagram the correlations:²⁹

Is?	Verification	Existence	Efficient Cause
What?	Theory	Form	Formal Cause
Given?	Instances	Matter	Material Cause

²⁷*Insight*, 70[93].

²⁸I have raised that question already, e.g. in *Cantower XIX*; there is a readable treatment of the topic in *Process: Introducing Themselves to Young (Christian) Minders*, chapter 1.

²⁹For some readers this correlating brings to mind Lonergan’s article in *Collection* on the isomorphism of scientific and Thomist thought. How much of this that can be brought in is matter of discretion depending on audience background and interest.

If you are with me alertly then you will notice that I am throwing in some tricky problems here: form and theory do not correspond; and why Efficient Cause in there? Grist for the mind.

But let us stay with the first two columns as we move more directly into the topic of canons. In the previous *Cantower*, section 28.4, we made a start on this, referring to what I consider my best introductory treatment of this. Verification / Theory / Observed Instances : this triplet is familiar to students who are in any academic science or semi-science course. So, we have an acceptable Standard Model for science. What is wrong with it? Students into naming the “seven pillars of wisdom” have no trouble in pointing out that the four elements, What? , ! , Is?, !. are missing. And finding out how these missing elements weave into scientific practice, that is what discovering the canons is all about. You are ready for a simplified version of the canons.

Might I leave it at that? A few further paragraphs may help. You might angle into the canons by talking about necessary and sufficient explanation, acceptable general terms which need talking about and when talked out they lead, respectively, to the canons of parsimony and complete explanation. So, one can get into those parts of the canons that connect with versions of the Standard Model, like Popper’s *Conjectures and Refutations*, or Theories that are Falsifiable. I am still pretty well on the first page of this chapter, and do not intend to venture much further. I would say that the chapter on the whole is not something for beginners, so a teacher has to pick and chose.

One puzzle that may occur to a reader of these canons: What does the word *complete* mean in “complete explanation”? First there is a history of the problem and it is touched on by Lonergan: extensions and durations have been slid over or muddled up over centuries: but now we are into the ‘thing’ problem again, with the focus on the thing’s properties. Secondly, this is a massive present problem that has to do with the a priori of measurement and with the meshing of the issue of real cosmic and micro-geometries with a range of muddles in contemporary physics. That will take a slow and solid hodic collaboration if we are to lift physics, its technology and education, out of

present disorientations. But, at all events, complete explanation on the elementary level can be given the simplest of meanings, or it can be fattened up to point to such topics as were raised in the previous *Cantower* regarding chemical explanation. A further, or even alternate, fattening might be done by pointing to parallels in the higher sciences: so, understanding a smile completely pushes one into physics and chemistry, and understanding personalities could be made to pivot on the dominance of one or other canon of inquiry in particular temperaments.³⁰

What of the other four canons? The canon of relevance fits in nicely in the next place, especially if the various isomorphisms have been a topic. The search in science can be identified with a search for form, and illustrated by various elementary examples, even commonsense puzzles. Might one go further? There is a range of tricky introspective experiments that relate to coming to grips with the process from form-grasping to full theoretic formulation - and a graduate class would move into all the problems of *Phenomenology and Logic*. But these are topics for another day, another generation. The canon of statistical residues, likewise, is tough for beginners. But at least there is the value of a general discussion and appreciation of the standard slogan, "other things being equal". And, if the first two chapters of *Insight* have been handled with some adequacy, the creative and additive nature of abstraction is to some extent homely.

It seems strange that I have left the first two canons till the end. They are in fact the heart of the matter, the heart of the departure from the Standard Model and regular slogan regarding "careful observation" and "cautious verification". These are canons of creativity and risk. But they also lean the scientist towards constructivity and control. The text in *Insight* is pretty clear here: what one has to do is ring the many changes on the four elements of meaning that are missing from the Standard Model. The non-

³⁰ There is a good deal of fruitful work to be done in lifting Freud, Jung, Gardiner, Meyers-Briggs, etc into the context of the simple diagrams of knowing and doing of Appendix A, *Phenomenology and Logic*.

scientist cannot aim too high here; it requires competence in some area if one is to bring students to appreciate the process by which the recurrent pattern of operating selectively, “the normative pattern of recurrent and related operations, yields cumulative and progressive results”.³¹ What is important here is to draw attention to the subjectivity of science: one is back with all the elements of W4, and more deeply with the subject as *Whatas*, *Whenas*, *Whereas*.

29.4 *Insight and Things*

So we move to the more complex aspect of the problem of things, one which we met quite early - in *Cantower VII* - when we noted it as a fundamental problem in various theories of systems. In the symbolism of the metaphysical words the problem is to come to grips with the meaning of “;”, the semi-colon that occurs in W1,W2,W3. Here I hold with the elementary perspective, and to it I add the invitation to educate the students regarding a principle of modesty in judgment, an education which helps against the cultural bent of the past seven centuries towards certainty. That invitation is contained in a sentence from Lonergan’s discussion of energy - a challenge of the next essay. “The ‘Yes’ of judgment is restricted to the formulation it affirms; and this formulation is restricted to the pattern of the data to be understood”.³² I am taking this sentence with a broader sense than the flow of the text there requires. What I am thinking of is the challenge of leading students to some grasp of the grasp of unity that can occur when one helps them by juggling with various complexifications of imaging of lower level aggregates of recurrence-schemes.

For the non-expert teacher, the pattern of data may be just a matter of a thin symbolic indication of, say, the protein foldings that are associated with the mobility of the amoeba. The student is feebly invited to do a feeble GEMb job on themselves with

³¹*Method in Theology*, 4.

³²*Insight*, 442[468].

this poor image: they need not expect, then, to reach any magnificent formulation of the nature of formulating the higher-thingness involved, nor of having any solid certainties. My own first serious effort to deal with this problem is both enlightening and entertaining, and worth repeating from an earlier *Cantower*.

I was in my fourth and last year of theology, not really focused on the theology available in Heythrop College, Oxon., but quite preoccupied with writing “Insight and the Strategy of Biology”. I was working in the meaning of *vivens* in Aquinas, using relevant bits of biology. My jottings began on page A: by the time I reached page W I had a reasonable grasp of the grasp. I abandoned my notes and wrote a sentence of the article. Now what use was that to my unfortunate audience?

Later writings may be more helpful. Here I add another piece of help, but a teacher needs to spread it out over several classes, and it is a huge task of the specialty Communications to nudge culture towards an understanding and an operative sense of the meaning of “;”, a sense that would identify our world as aggreformic, that would expose the nonsense in both reductionism and vitalism. But that is a larger topic. Meantime, let us take a helpful ramble into the physics and chemistry of hydrogen.

The length of the ramble is up to you, and indeed you may find it easier, or more effective, with yourself and/or your class to stay with the example of the unicellular plant or animal.³³ One way or another, if you are to break beyond Lonergan

³³This is the focus I held to in *Randomness, Statistics and Emergence*, and you may find helpful stuff there. Unless you have a decent background in physics, however, you won't be able to illustrate biophysics, and the same with regard to biochemistry. But at least read up about, say, the ‘popular’ amoeba, or what are known as the “amoeboid protist”. A handy survey book I have treats of these in chapter six: Michael A. Sleight, *Protozoa and Other Protists*, Routledge, Chapman and Hall, N.Y., 1989. Recall my remarks in *Cantower XXVII*, section 3, regarding reading chemistry books as opposed to reading philosophy books. You have to make a career and teaching choice. You can read up on the history of the dispute about vitalism and reductionism etc, or you can do some serious GEMb. But even without heavy reading you can get yourself and the students into this. You draw the one-cell chap, amoeba proteus, picture its movements, pushing out pseudo-pods, intussuscepting, etc etc etc. Get yourself and the students to

nominalism, you have to do, and get others to do, some prolonged serious work on the part-sentence from my key 'challenge page' of *Insight*: "There have to be invented appropriate symbolic images of the relevant physical and chemical processes; in these images there have to be grasped by insight the laws of the higher system that account for regularities beyond the range of physical and chemical explanation".³⁴ However, what I am suggesting in these next few pages is an exercise that is important if any of us is to come to grips with the contemporary mess in quantum theory. Skip it, then, on a first reading, but pass it on as a hand out to your students who have a taste for and a competence in the lower sciences.

It would be nice, of course, if we could stick with our old friend water, and see with it how we make sense of the suggestion, which I quoted in note 37, that Lonergan makes about images and higher systems etc. But our old friend water - **merely** renamed H₂O, unless you have done some decent chemistry - is too complex for us to handle here: we are going to focus on hydrogen, but keep an eye on water. First, then, recall what we were dealing with in the conclusion of section 3 of *Cantower XXVIII*. There we focused on the question of **bonding**. You recall - at least now you have to! - the equation for Tums and stomach acid: the yield included water. The character³⁵ of each

'think chemically' about the goings on, note the randomness from amoeba to amoeba, yet you think of them all the same way, etc etc. This is not at all an easy exercise, and it does push you towards finding out some chemistry, protein-folding dynamics or whatever. Eventually you get closer to a decent reading of Lonergan's claim: "a concrete plurality of lower entities may be the material cause from which a higher form is educed" (*Collection*, "Finality, Love, Marriage, 20). Then you should find the corresponding zones in the various chapters of *Insight*.

³⁴*Insight*, 464[489]. Challenge page? Readers are not, I hope, tired of my regular return to "study of the organism", self-study of the organism... . I quote only a third of the sentence; the rest of it is a killer-program!

³⁵You may find it useful to think seriously in terms of **character** as I have repeatedly invited in these : recall my regular quoting of the beginning of the *Magna Moralia* or of section 1 of chapter 14 of *Method in Theology*. The chemical elements and

component of the reaction and the reaction itself are “determined” (a tricky word!) by the bonding capacities, the “capacities for performance”³⁶ of the elements and compounds. For the moment let us keep our focus on the character of water, and on the Tums reaction-equation.

If you have brooded over the previous footnote pointings (recall the meaning of doctrinal writing) then you have a sense that a key attitude here is holding within your view the rich range of the bonding potential of water while focusing on “symbolic images of the relevant physical processes”. There are layers of these symbolic images, depended on your education.³⁷ But whatever the level of complexity - even with school chemistry - what you are trying to do is reach an “ **account for regularities beyond the**

compounds are quite peculiar characters. For instance, what an odd character is ethanol, $\text{CH}_3\text{CH}_2\text{OH}$, a standard component in intoxicating drink. Its cousin methanol, CH_3OH , can cause blindness.

³⁶By putting in this phrase I am very deliberately throwing you into a fuller context. The fullest context would throw you into the problem of the isomorphism of methodology and metaphysics, e.g. a correspondence between ‘capacity for performance’ and ‘*potentia activa*’ (See *Verbum*, index); but let us not go there for the present. But, to advance the perspective that being sought above, one does well to read that ‘famous’ page of *Insight*, page 464[489], for water - or any chemical - instead of “the organism”. Take the long sentence at the end of the paragraph starting “So physiology follows anatomy”. It may be thus rewritten for hydrogen: “To this end, there have to be invented appropriate symbolic images of the relevant physical processes; in these images there have to be grasped by insight the laws of the higher system, hydrogen, that account for regularities beyond the range of physical explanation; from these laws, there have to be constructed the flexible circle of schemes of recurrence in which hydrogen functions; finally, this flexible circle of schemes must be coincident with the related set of capacities-for-performance that previously were grasped in sensibly presented components-of-hydrogen.” The flexible circle of recurrence-schemes in which hydrogen functions - horizontally, recalling section 28.4 - are imaged by the total set of verified - or indeed verifiable - reaction equations in which hydrogen occurs.

³⁷This is a difficult topic that we return to in *Cantower XXXIII* when we first face the problem of layers of metalanguages related to progress, growth, in metaphysics. But what is said above is a good illustration of and introduction to the larger issue.

range of physical explanation.”³⁸ Water is able to do a whole lot of funny things (horizontally, is our present interest). We are looking for light on the regularities of these capacities by focusing on (but not in some exclusiveness of negative abstractness) the water molecule. What layer of symbolic imaging can you , or your class, handle?

There are the school text images, the first-year undergraduate images, quantum images in various levels of detail and mathematical back-up³⁹, detailed graduate images. You have, perhaps the texts referred to in the previous note, to be used when we pause over hydrogen, so here I wish to throw you into the deep end of advanced imaging. The experience is doubly worthwhile: you get a sense of what GEMb is all about, but also - if you happen to be a physicist or chemist of this area - you get a sense of the missing elements in a science done truncatedly: what am I doing when I am “Making Light of Reaction Dynamics”? The phrase in quotation marks occurs in the long quotation below from a contemporary advanced book. A serious reflection on it can raise the huge question of the transition from axial to third stage science, but with blunt contextualization: Wouldn't it be better to know precisely what you are doing when you are doing this work, writing about it, teaching it?

So, back we go to our Tums equation:



To tune into the text about water we are going to read shortly, think of water as AB: then you may think of the equation as very roughly equivalent to



Not to worry: we are interested in the empirical nature of the strategy of GEMb,

³⁸*Insight*, 464[489].

³⁹Two levels of quantum imaging, which is the focus of our attention in our reflections on hydrogen, are available in the two texts that I have made “standard” for these *Cantowers*: Feynman III, chapter 19, “The Hydrogen Atom and the Periodic Table”; W.Greiner, *Quantum Mechanics: An Introduction*, section 9.2, “The Hydrogen Atom”.

including the empirical nature of the establishment of aggreformism. This is a massively important point, and here certainly we are reaching out beyond the introductory level, but I cannot avoid it, since there is no literature on the topic and little sign of it emerging from the present generation of Lonergan disciples, and it is unlikely that I shall get back to the topic as it is raised in either chapter 8 or chapter 15 of *Insight*.⁴⁰

So, recall here the strategy that I used in *Cantowers XV - XXI* : I sometimes just focused on a short passage as an introduction to studying the whole chapter. So, here I take two short passages, one from each of chapters 8 and 15 of *Insight*. My comments on the passages may well be taken as indicative of the task, in the next generations, of reading the book with adequate seriousness. Let me first present the two passages. I present these two passages, then, before the modern text on water. They are the context for its proper reading, and in saying that I am inviting you to further your perspective on the meaning of context both in relation to GEMb and in relation to the problem of interpretation as it is to be tackled in later *Cantowers*. But, let us get on with presenting our three texts in a block.

“Consider, then, a genus of things T_i , with explanatory conjugates, C_i , and a consequent list of possible schemes of recurrence, S_i . Suppose there occurs an aggregate of events, E_{ij} , that is merely coincidental when considered in the light of the laws of the things, T_i , and of all their possible schemes of recurrence, S_i . Then, if the aggregate of event, E_{ij} , occurs regularly, it is necessary to advance to the higher viewpoint of some genus of things, T_j , with conjugates C_i and C_j , and with schemes of recurrence, S_j . The lower viewpoint is insufficient for it has to regard as merely coincidental what in fact is regular. The higher viewpoint is justified, for the conjugates, C_j , and the schemes, S_j , constitute a higher system that makes regular what otherwise would be merely

⁴⁰It may be treated more fully in the *Cantowers* of 2008, but don't hold your breath or your curiosity: I would be (have been!) 76 that year.

coincidental".⁴¹

The second passage is a recasting of this within a luminous metaphysical context ... if you have done the climbing. If you haven't, if you 'just read' the book, then it really is only the same vague problem as in the first quotation. So here we go with some self-taste of chapter 15.

"First, then, if there is any explanatory science, then there is a set of conjugate forms, say, C_i , defined implicitly by their empirically established and explanatory relations. Different combinations of forms from the set C_i serve to define explanatorily the unities or things T_i , which differ specifically from one another but pertain to the same explanatory genus. Again, different combinations of the verified correlations yield a range of schemes of recurrence S_i , and in the measure such schemes are realized, they make systematic the occurrence of the conjugate acts A_i .

Secondly, either all acts of the type A occur systematically, or some occur systematically in virtue of the schemes S , while others occur at random. If there are such random occurrences, then there are instances of the merely empirical residue on the level of conjugate acts. For a manifold of random occurrences offers a much larger range of merely coincidental conjunctions and successions, and such conjunctions and successions pertain to the empirical residue.

Thirdly, there is a further possibility. Besides occurring systematically in virtue of the schemes S_i and occurring at random, conjugate acts of the type A_i may occur quite regularly yet in a manner that cannot be accounted for by any of the schemes S_i . In that case there is the evidence that is necessary and sufficient to affirm the existence of another set of conjugates C_j , defining another genus of things T_j , and yielding another

⁴¹*Insight*, 256[281]. I do not intend to return to the canons soon in any elaborate fashion, but I invite you here to consider the notion of 'higher things' in this context. So, scan the canons with the two words 'insufficient' and 'justified' in this text.

range of schemes S_j that make systematic another type of conjugate act A_j .”⁴²

The third text is from a contemporary advanced survey. I print it as it is in the book, but I take the liberty to add footnotes - there are none in the original. These notes can be omitted on a first reading: they are meant to add further problems regarding the adequate context for serious and luminous advanced physics and chemistry, problems then of GEMb. In the previous footnote I wrote of hearing the 45 year old genius reaching beyond his times. Here, and in the added footnotes, I am inviting you to reflect on the standard culture of doing, thinking and writing advanced chemistry. Indeed, I invite you, if you are serious about developing a consciousness sufficiently cultured to teach *Insight* properly in this century, to tackle the entire book quoted from, *The New Chemistry*, in this fashion. But we shall return to that question after we have dealt with the key problem of the two *Insight* texts. First, let us have the piece from *The New Chemistry*.

“Making Light of Reaction Dynamics

The study of photodissociation - using light⁴³ to break molecules apart - has been a

⁴²*Insight*, 437-8[463]. How did you find these texts as readings? Suggestive but pretty incomprehensible? You are hearing, and inviting students to hear, a genius of age 45 typing beyond the context of his times. I began my struggle with these texts, of course, in the late 1950s, but began seriously on them in 1963-4, when I wrote “*Insight and the Strategy of Biology*”. I move forward on them in doctorate work that involved me in biophysics and biochemistry, and the related expressions (in *Randomness, Statistics and Emergence* and in “*Image and Emergence: Towards an Adequate Weltanschauung*”) were only slightly more adequate than the previous compact work, even if I had made solid progress. I am making solid progress now towards the mind of this genius. Why do I ramble thus here in a footnote? Because there is need for an aside, an honest pause, a breath of sadness. It is quite clear to me that not too many of the Lonergan “followers” have followed the climb of Lonergan in this very essential search for an up-to-date heuristic of *quidditas rei materialis*. Yet without this climb, what is all their talk of human form and feeling and imaging worth? Perhaps it has value as a type of uncomprehending popularization, but it is not science, it is not GEMb.

⁴³What do you, and the author, think that light is? A Flow of things? A conjugating of distant things? In the fullness of our exercise it is evident that almost

source of tremendous insight into the deliciously complex world of chemical reaction dynamics. In a general bimolecular reaction of the type $A + BC \rightarrow AB + C$, the atom or molecule A collides with the molecule BC and they combine to produce a transition⁴⁴ state, usually denoted by $[ABC]^+$, which then breaks apart to form⁴⁵ the products. In their search for answers to the fundamental questions of chemical reaction dynamics, chemists have settled for a half-way house.⁴⁶ If they can somehow create the transition state $[ABC]^+$, then observing how this goes on to produce $AB + C$ at least gives them half the story. This is done in practice by exciting a stable ABC molecule, photodissociating the AB-C bond and monitoring the quantum states of the product AB.

The simplest [yet amongst the most revealing] type of information⁴⁷ that can be gained from this kind of experiment is the basic distribution⁴⁸ of product AB molecules over all the quantum states of AB that can be potentially populated, including electronic, vibrational and rotational states. For example, photodissociation of water (H_2O) molecules in the gas phase using ultraviolet radiation with a wavelength of

every word of the text needs footnoting), but there is no harm in having an initial reflective whirl at these few selected footnote questions. We are struggling towards a sense of GEMb, a sense of a massive committed yet inessential opaqueness within axial culture. Deeply, we do not know WHAT we're ABOUT. About about is what we should be about: a conundrum we have already met.

⁴⁴One may puzzle over the noun *transition* in a manner that parallels the puzzling over the noun *light*.

⁴⁵**Form?** What types of causality are involved?

⁴⁶Recall the half-way house realism of *Insight* xxviii[25]. How remote is this larger problem from the community of chemists, of philosophers of chemistry?

⁴⁷Add the context of Feynman's use and abuse of the word *information*: see below, at note 81.

⁴⁸Has distribution a precise statistical sense here, within a full context of sampling-problems?

around 157 nm⁴⁹ produces OH fragments that are found to be rotationally 'cold', meaning that the population of rotational quantum states of OH is heavily biased towards the lowest states. However, when H₂O is dissociated using higher energy 121.6 nm radiation, the resulting OH fragments are both electronically excited and rotationally 'hot', despite the fact that the amount of energy 'left over' to go into rotation is considerably smaller in the second case than it is in the first. It is impossible to understand these results without reference to the detailed contortions of the excited H₂O molecules in the process of breaking apart.

In the first case, excitation at 157 nm promotes the H₂O molecule from its ground state to its first electronically excited state. This state is said to be dissociative or repulsive: the H-OH bond breaks 'instantly' and the two fragments move away from each other without imparting any kind of 'kick' to the OH fragment that would be necessary in order to set it spinning end over end. The OH-radical products are therefore formed with little or no rotational excitation. In contrast, excitation at 121.6 nm generates the second electronically excited state of H₂O, which has distinctly different properties. This excited state prefers to be linear, unlike the ground state, which prefers a bent structure with an equilibrium HOH angle of 104°. ⁵⁰ As soon as it is excited, the H₂O molecule opens up and a strong torque is exerted. When the H-OH bond breaks, that torque is translated into significant rotational motion of the OH

⁴⁹A nano-meter, however small (a thousand millionth of a meter), still raises the question of measurement that we are to tackle in *Cantower XXXI*. We raised it previously in *Cantower XII*, and must return to it in a fuller 'micro-context' in *Cantower XLII*. It is a central problem in physics, with its focus on geometrical and topological conjugation, but obscurity about it clouds chemistry. See the next note.

⁵⁰A Euclidean geometry is an accepted context of present chemistry. The underlying problem is an assumption of a naive objectivity of the imagings of that geometry in chemical treatises. So: don't we all know that DNA etc is just a small case of spiral staring?

fragment.⁵¹

Although these explanations may appear somewhat simplistic, they are backed up by detailed theoretical calculations of the structures of the first and second excited states of H₂O. The results demonstrate the utility of measuring products' quantum-state distributions and the explanation shows how such measurements provide insights into the dynamics of the dissociation process.

Other kinds of information are available from photodissociation experiments by virtue of the simple fact that laser⁵² light is usually linearly polarized - the light waves oscillate in one spatial dimension only. The probability⁵³ of a molecule absorbing light is greatest when the amplitude of the light wave is at its peak, so the directionality provided by the laser beam's polarization can be used to impose a reference direction on the subsequent dissociation. This means that certain vector quantities associated with the fragments (such as 'recoil' velocities and rotational angular momenta) are correlated to each other and to the other vector quantities associated with the absorption of light.⁵⁴ These correlations can be measured in the laboratory using lasers and their interpretation adds further to our understanding of the detailed dynamics of

⁵¹I omit here a helping diagram added in the text. But if you are seriously following the text already, then you have been pushing for that diagram. How are you doing? The diagram is not an extraordinary achievement.

⁵²There is a convenient introductory scientific account of lasers and masers in the text WE are using: Feynman III, chapter 9: "The Ammonia Maser".

⁵³As with **distribution** (note 48), there is a problem here of luminous context. Is the meaning of **probability** here clearly statistical in the author's mind, in yours? This is a recurrent problem throughout Feynman III.

⁵⁴Recall the question above (note) about light. The question here is the thing-character of absorption. The reflections on energy on the next *Cantower* puts that question in a much deeper context.

the transition state $[ABC]^+$.⁵⁵

The footnote comment on the two texts from *Insight* give you scope for brooding: you have more than likely 'seen' these texts before, they are in that sense part of your context, a part that I claim to be a neglected heart of the matter of understanding material things. But what are you to make of the third text? It deals with water, with experiments on water, but most likely it is quite opaque. Again, the footnotes help to get you brooding, but the brooding requires months and indeed, as was noted, points towards a massive change of culture.

But let us start with the two *Insight* texts, placed usefully together, pointing to the neglected heart of matter. We are evidently focused here on the heart of chemical matter, and I hope to push you towards the exercises that might lift you to that heart beat. Return, please to the footnote to the second text, add eventually the mood that is the tone of the conclusion of this *Cantower*: "you just have to admire Aristotle", you just have to admire Lonergan. But did he have to be so brutally, suavely, doctrinal? Recall the quotation at note 36 above, from that "challenge page" of *Insight*: there have to be invented appropriate symbolic images. Lonergan skips the pedagogical challenge: the book is already too long. But I have been heading towards such images throughout these last *Cantowers*, including the making present images of pace and patience. Here I home in on the key image given by Lonergan is these two quotations: the image " E_{ij} " .

Recall our struggle with the imaging related to the principle of displacement⁵⁶; we have a similar struggle ahead when we deal with measurement.⁵⁷ What did you make, have you made, of that image, " E_{ij} " - which I am now going to call by its more official name " ; " - in previous readings? And now, of course, the previous readings

⁵⁵*The New Chemistry*, edited by Nina Hall, Cambridge University Press, 2000, quoted from Jim Baggott, "Chemistry in a New Light", 43-54: 46-7.

⁵⁶*Cantower XXVII*, section 1.

⁵⁷*Cantower XXXI*, section 1.

include occurrences of ; in the different words of metaphysics.

I am moving towards exercising you in complexifying images, an exercise that you have already been submitted to in my meshing of the images W0, W1, W2, W3, W4. If I am right in my suspicion, this particular essential piece of the exercises of metaphysics has just not been done by you, nor has it been done by the Lonergan community. I was lucky enough to find it at the center of my doctorate work, but it had occupied me before then. Not too many have had such luck. It involves months of work which transforms one's perspective, one's **asing**, one's reading of Aristotle and Lonergan and of the world. One is no longer a vague dualist or a vague reductionist or - worst perhaps - a vague middle-ground advocate of hylemorphism. One is in the poise of the extreme realism of aggreformism.

But how is one to get there, how am I going to coax you to do the work, perhaps with your students?

Reading E_{ij} , reading ;. Let me start by associating the dot and comma of ; respectively with the **I** and the **j** of the E_{ij} . Think now of the first word of metaphysics with its recurrent use of the symbol “;”. Let us focus on the tree as $f(p_c; c_c; b_c)$, where I am changing the subscripts both to avoid to avoid confusion (I and j occurring twice with different meanings) and to help us on. The subscript C is to remind you of conjugates on the level of, in the genus of, physics or chemistry or botany: the C_i or C_j of the two Lonergan texts.

Now, I want you to recall the exercise I suggested in the previous *Cantower*: think of the tree as one big molecule. Or the cat, or the dog: these are better in being, so to speak, more mobile molecules, with four legs instead of the tree's one leg, though we are interested here in the chemistry of botany. But cats and dogs in your image, or your sight, may help. We need a sort of new-born eye: you look out at the chemical world, the dusty street of mobilities, and spy the molecule eventually called 'cat'. A lone molecule, say, among other large molecules sticks and stones and blowing

newspapers, cars and bikes and dogs and mice. We are heading for a distinction between a dot-aggregate and a comma-aggregate. Cat, dog and mouse are strange aggregates, commaggregates: an activity at one end can occur regularly with a wagging at the other end. And so on and on: this is a lengthy weeks-long intussusceptive eye-ing and aye-ing of these commaggregates, **comags**, aggregates that somehow act like a community as opposed to doddered or doddering aggregates, dotaggregates, **dotags**, that are feeble, lacking unity, shaky.⁵⁸

We are reading E_{ij} or ; here in relation to chemistry and botany. It is an easier entry point, because of various problems of physics that are beyond us at the moment.⁵⁹

So, let us stay with cats and dogs and trees and now, with our growing overlapping layered imaging of comags and dotags let us return to the first text of Lonergan's, from chapter 8. We have a problem of liberation here, the liberation of becoming aggreformists, where my reference to chapter 18, section 3, brings up the need for humour (18.3.3). Lonergan was certainly not thinking of Tom, Dick and Mary when he simply threw in " E_{ij} " in that paragraph. He could have helped us along by starting with the I aggregates, then noted a sub-group of ij or j aggregates. So, there are molecular aggregates like cars and molecular aggregates like cats.⁶⁰ The latter are a

⁵⁸A ramble through a dictionary could help here, or at least entertain: dot, (dots lacking joining), dot-age, dotard, dodder in its Indo-European root-base of dheudh, to whirl in confusion.

⁵⁹We need more preparation to get into the proper and full genus of physics: indeed, that is the topic of *Cantower LX*, "Quantum Chromodynamics in the Field Context". Quantum Mechanics, as we may see through the *Cantowers* from 42 on, is a curious mixed - and mixed up - zone of physics and chemistry. Quantum Electrodynamics, a highly successful particular zone, is a concern of *Cantowers LII* and following. Shortly here, I shall introduce a first taste of quantum mechanics when we tackle the commaggregate that is hydrogen.

⁶⁰There is no way that, in my compact presentation of a long pedagogical task, I can avoid simplifications, dodgings, doctrinal writing. So, questions occur to you that are skimmed over e.g. regarding the flexibility of organic molecules: something we only

subgroup of the former: so the former might be labeled simply as E_i ⁶¹, and can be understood through use of the conjugates C_i .

But you must envisage such understanding: the effects of various bondings of a car: a collision, a falling tree, a falling electric cable, water - especially winter-salted - sunlight. Now, think of the population of the Comags: their bonding is 'distinctly' different - mating, fun and flight, masticating, urinating, mating.⁶² Be new-eyed here; these are just names for large chemical activities that are, however, peculiar when viewed as merely that. There is, then, a type of 'bulk bonding' that is 'far-out' in regularity on a broad statistics of occurrence and recurrence. You may lift your image-making a notch by shifting now to images coined from section 5 of chapter 8, which deals with the topic of emergence. So, stretch your imagination to the "non-systematic

touch on briefly below in mentioning organic chemistry. But there are flexibilities, so to speak, in all directions: the underlying aggregates from one amoeba to another, from tree to tree, from sapling to tree, from minute to minute.

⁶¹Again, some massive skimming, skimming: what are events? What are 'acts'? In physics, in chemistry, in higher genera? Note that on the level of physics one gets, so to speak, on the right track, by thinking in terms of tracks, four dimensional tracks that are not cross-sectioned as points. It is helpful to recall Lonergan's suggestion that "mass-velocity will be a conjugate act" (concluding paragraph of *Insight*, 15.2). Certainly, one has to get beyond thinking in terms of point-events, like collisions in a Euclidean spacetime. That it just thinking in terms of an elementary "subjective" metric, a huge difficulty on contemporary physics. We make a beginning on that problem in *Cantowers XXXI, XLII*.

⁶²Again, you notice simplifications? What are involved above are not just conjugates but recurrence-schemes (think, for instance, of tooth-motions during eating). Are we beginning to read "list of possible schemes of recurrence"? Consider the sureness with which Lonergan is writing this packed paragraph. In 1957 he was asked - and gave an answer - about the possibility of axiomatization in metaphysics (*Phenomenology and Logic*, index under *Axiomatization*), but here the tone is quite axiomatic. We shall turn shortly to an evolutionary perspective, closer to the empirical approach which would be content with the presence of some 'odd' recurrence-schemes to lead one to suspect 'higher things'.

occurrence of the aggregates of events, E_{ij} ⁶³, where E_{ij} is the cat in the cat-world. In the cat-world? Don't let your imagination isolated the skin-in cat as a sufficient aggregate: the cat breaths in, pees out, runs to mice, runs from dogs, and to and from other such comags and various dotags.

But I must let you read down through that third paragraph of *Insight*, 15.5 on your own, At this new pace, with this new poise. I have already gone on too long. Someone, please, write the Big Book on E_{ij} ! My final warning, which hangs over this entire exercise: if you are not genuinely into this **as** subject, within GEMb, you are not heading for aggreformism but for a more complex conformism to a school, a dualist or a reductionist in cheap clothing.

And are you up to struggling with chemical genera and species, with elements and compounds, with E_{ijx} and E_{ijy} ?⁶⁴ The terminology needs improving, and we'll get to that after *Cantower LXVI*, but a week or a month should see you adequately through this section. And, in the present *Cantower*, on to the piece from *The New Chemistry*: for methinks we have given enough pointers to freshen the challenge of the two pieces from *Insight*.

Now THEN,⁶⁵ we may pass on to some reflection on the third quotation, from *The New Chemistry*. May we? Are you noticing the distinctions between doctrinal writing and foundational pedagogy? You are reading NOW not THEN: unless you have magnificent self-control, and took a few months off here! The key existential decision has to be about where you stand with regard to THEN. So: my doctrinal writing here merges with what can be identified as foundational fantasy, which meshes with motivational writing, See - and assent to, ascend to - how things might be! I do not

⁶³*Insight*, 259[285].

⁶⁴*Insight*, ch. 15, section 6.

⁶⁵By now a familiar reference to the orientation of *Cantower V*'s "Metaphysics THEN".

wish to annoy by odd punnings, but see also a meaning of the **as** - in relation to section 29.1 - in **assent**, **assend**.

Even if you do not take months to push on from the pointings regarding the previous two texts, you have brood a little over the difference it would make to the reading, the **interpretation**.

Already I have footnoted the text from this perspective, but now you notice the larger context. Any serious pausing over the comments on the previous two texts enlarges that perspective. Can you imagine - fantasy again - what a full ethos-shift of horizon might do for the critical reading?⁶⁶ Such an opaque text, of course, should not be a part of later luminous culture. I am not going to comment on the page of text in that light - it would require twenty pages, and would be quite obscure. Rather, I leave those comments to you, aided by the footnotes hints given. What I wish to do is to broaden our reflections to the entire book, an excellent survey of contemporary front-line chemistry. Excellent: but it brings to my mind the old Irish joke about the couple walking home from the Church after a sermon on sex by the Reverend Celibate, sharing the conversational comment, "just grand: but I wish I knew as little about sex as he does!"

Is this not a bold statement, claim, on my part? It is my stand: contemporary culture is not luminous about aggreformism and is deeply distant from the language that would be faithful to it, foster it. In this matter I can suggest to you a simple initial exercise: go through the book, in deed any book of science, popular or serious, with an eye on the word **information**. You will - but oh so slowly self-discovered! - find, discover, yourself in a world of massive illusion. *The New Chemistry* is packed with, has been written by, the culture and expression of that illusion.⁶⁷

⁶⁶In technical terms, think of the "use of the general categories" in dialectic as it will occur in the third stage of meaning.

⁶⁷See also notes 47 and 81.

But I must move on, or this *Cantower* will turn into a book. The perspective that is to be gained from intussuscepting the pointings of Lonergan would bring the culture into a luminosity about the task of chemistry in its horizontal and its doubly-vertical relations, finalities.⁶⁸ Chemical realities have an orientation towards the lower and the higher realities, and you can find representative samples of these orientations in *The New Chemistry*, or in the broader literature of chemistry. What is going on in the text quoted and the work to which it refers? A huge complex question, but I would say that you have a very helpful clue in a phrase that I steal from another context. The interest is in the lower acts and their recurrence-schemes, ranges of population-tolerance, act-tolerance, statistic-tolerance, etc etc that are compatible with or conducive to the identity of the components in the chemical bonding: the interest may be broadly described as a seeking to better determine “the flexible circle of ranges of schemes of recurrence”⁶⁹ of the lower acts.⁷⁰ A help here for the beginner is to ‘think up’, in terms say of prescription-medicine or drug habits, or plant-cultivation in relation to water-table. And such ‘thinking up’ helps us along here. For, recurrence-scheme flexibility is not only a feature of chemical progress in its face towards physics, but it is a driving element in the other two orientations: intra-chemical and life-oriented.

Are you making a beginning on assessing the opaqueness of present chemistry? That in a very precise sense, chemists **do not know what they are doing**? And wouldn't it be nice if they did? In the previous *Cantower* we reflected on poor texts for

⁶⁸No harm in drawing attention to the neglected article where Lonergan handled these issues compactly, “Finality, Love Marriage” originally published, 1943, in *Theological Studies*. I return to that article and that journal in *Cantower XXXV*.

⁶⁹*Insight*, 465[490].

⁷⁰Notice that I write *lower acts* not *lower entities*: here you have the tricky question of, say, the electronic properties of various types of molecules: e.g. the thing-status of such properties in relation to covalent or looser bondings such as described in Feynman II, chapter 30: “The Internal Geometry of Crystals”. So, you may ponder such questions as “Is the Buckyball - C₆₀ - a thing?”

school chemistry: the situation does not improve as one move up through undergraduate texts, graduate studies, learned articles. I have to hand various university texts on organic and inorganic chemistry and had initially - quite foolishly - thought of detailed comments on their disorientations and on the disorientating of students - the serial killing - that goes with them. But perhaps what I already wrote in section 4 of *Cantower XXVIII*, regarding a school text, gives sufficient leads. And, further, I would note the value of lifting your reflections on that section and this up into the context of the canons and causes that we considered in the first section of the present *Cantower*.

So, we come to the final topic of this section, our first step into quantum mechanics. Bring with you whatever you can of the context of these last few *Cantowers*. But without a decent background in physics my few points here cannot but be obscure. Still, a general impression seems worthwhile and besides, there may be a few physicists tuning in who could take over the task of recasting quantum physics. The topic is hydrogen and what Schroedinger's famous equation gives us. From what I have written, then, you know that we are dealing with chemistry in its relation 'downward'. However, it is mightily important to have a horizontal perspective, to at least descriptively advert to the actual context essential to a relevant and serious illumination of problems associated with this particular application of Schroedinger's equation.

There are many ways to approach this problem: for instance, one can begin pedagogically with the Balmer spectral series,⁷¹ a 'downward' business, and follow the struggle to make sense of it. Or one can launch into solving the Schroedinger equation for proton-electron relating under a set of approximations. This task is, of courses, quite beyond our present context. Even if our launch-pad were the standard confused situation of chemistry and quantum mechanics, it would be quite beyond anything short of book-length treatment. That should be evident from our text-resources, already

⁷¹See Greiner, *Quantum Mechanics*, 227, for the relations of the various series.

mentioned. The standard treatment that I would have you work with is the slightly-eccentric presentation in Feynman's Lectures, backed up and enlarged by the textbook of your choice: mine happens to be one of the series of Greiner's books.⁷² So, we are on p. 217ff of Greiner, in chapter 19 of Feynman III. Feynman's 3-volume lectures symbolizes the problem well. That third volume is his rather risky attempt to present quantum theory in an introductory course. It is a fine attempt, well worth struggling with, but getting to chapter 19 of this third volume is no mean achievement.

What to do? Well, at least you notice that I am raising the bar, and the context of that raising is chapter 4 of *Lack in the Beingstalk*, where I draw a parallel between advances in the calculus of variation in physics and the projected advances in the calculus of variation that is hodics. How is one to sort out the mess of present quantum mechanics? The full physics has to be done in the new context.

Might you make a beginning? Feynman's 18 pages is a magnificent effort to make this "first great success of the Schroedinger theory"⁷³ palatable to undergraduates. A sufficiently cultured undergraduate class, who knew their way round spherical harmonics, Kummer's differential equation, whatever, could home in nicely on just how, where, why, eigenvalued results emerge. But of course there is the bafflement of the beginning: where from does this equation of Schroedinger come, and to what do the *forms* of the solutions - as distinct from the eigenvalues - pertain? I shall have something to say about all this in *Cantowers XLII - XLV*.

But there may be the odd reader up to reading, say, Greiner's text with the beginnings of a critical stance such as I suggested in relation to the selected text from *The New Chemistry*. One illustration of such a reading possibility is better than paragraphs of compact doctrinal writing. Moreover, the illustration serves to introduce us to the key topic of the next *Cantower* : energy. His context is the characterization of

⁷²See note 59 above.

⁷³Feynman III, 19.5.

the energy levels of the hydrogen atom. "During the transition of an electron from the level E_n to another level $E_{n'}$, the atom emits a photon of energy".⁷⁴ Reading this within the context of our words of metaphysics is an enormous challenge. Or, to keep it in Lonergan's own terms, we are in the ball park here of "*The Significance of Metaphysical Equivalence*."⁷⁵ Do you read there an earlier version of GEMb? You might brood on the compact statement, in the previous section, of the principles of such searching and go on to ask about Greiner's sentence, word by word. Tough work: metaphysics as science, pushing hoddically towards a new control of meaning that should, in later culture, be the poise of academic nerves. **Transition?; level ?; another?; the?**

But more elementarily you might focus on the 'thing-nouns', **electron, atom, photon**. Can we accept these as referring to (hypothetical) things? Is it perhaps not more acceptable to claim that the thing hydrogen has electronic conjugates, relations with secondary determinations, and that photonic emission is a determination-change? But then what is the metaphysical equivalent of the last word of Greiner's sentence, **energy**? And what might be meant by "the *binding energy of the hydrogen atom* in the ground state, $E_0 = -1/2[e^2/a_0] = -13.6 \text{ eV}$?"⁷⁶ Has binding - let us think of horse-control, the animal on the hoof of even horse power on wheels - anything to do with harnessing? Does the atom somehow harness energy in various ways, an energy that "on its own" would be "quite scatty"⁷⁷, quite dispersive? And would not that lift us to a

⁷⁴Greiner, *Quantum Mechanics*, 226.

⁷⁵*Insight*, 507[530].

⁷⁶Greiner, 220. Italics his. The energy 13.6 eV is called a Ryberg. $a_0 = .53$ angstroms is called the Bohr radius.

⁷⁷You would perhaps find it interesting to follow up all the various roots of scat and scato ,even muse on scatology as being redeemed eschatologically by the cloaking of scattiness in forms of finality. This might well head you towards the two sections in *Insight* titled "potency and limitation" and "potency and finality", sections 4 and 5 of chapter 15.

new heuristic conception of “;” in an identification of its lowest occurrence, a filling in of a basic gap in our first word of metaphysics, a presupposition of “p_i”?

At all events, have we not made a beginning here on Feynman’s chapter “Physics and Other Sciences” even if we had to shift to the less-tricky zone of chemistry? Indeed, might we not conclude this section as Feynman concludes his chapter 19 of Feynman III, making a beginning of the metaphysical equivalence problem by asking about the words “Schroedinger” and “physics”. Is Schroedinger’s equation really just a triumph of physics? Does it not include chemistry? Does it not include Schroedinger, who “has a central form (formal cause), is a man (primary formal effect), capable of understanding (necessary, secondary, intrinsic formal effect), occasionally understands (conditioned, secondary, intrinsic, formal effect)”⁷⁸, indeed triumphantly. And what do you think, now, of Feynman’s muddled phrase “the machinery of atomic structure”? So, I may leave you to a tentative reading of Feynman’s conclusion and to a self-reading that may turn your molecules towards foundational fantasy of the future of chemical reading and writing.

“The Schroedinger equation has been one of the great triumphs of physics. By providing the key to the underlying machinery of atomic structure it has given an explanation for atomic spectra, for chemistry, and for the nature of matter.”⁷⁹

29.5 Some Ramblings About About About Feynman’s chapter 3

The triple *About* is just a check - have you been trying to tune in to this subtle full meaning of **as**?⁸⁰ Ramblings? You might say that the whole of *Insight* is about about about this chapter of Feynman, so here I shall only touch on a few points that can be

⁷⁸*Insight*, 506-7[530]. The sentence prior to “*The Significance of Metaphysical Equivalence*”.

⁷⁹Feynman III, 19-18.

⁸⁰See note 4, above.

followed up personally or made in class, supplementing hints already given. And again, you don't need Feynman's text to pick up on the few points.

Feynman's introductory paragraph is worth prolonged brooding. Two points. The first line begins "Physics is the most fundamental and all-inclusive of the sciences". Give this a twist by reading 'all-included'. Every entity has a geometry, complexifying as one moves "up" through the sciences: put differently, every entity has conjugates of that fundamental level. Fundamental?: our reflections on energy in the next and later *Cantowers* should help towards a richer view of the that.

The second point regards Feynman's wonder and dedication, which comes out here in his attitude of wonder expressed here in his talk of beauty and later in a wonderfilled footnote on p. 3-6. "How I'm rushing through this! How much each sentence in this brief story contains. "The stars are made of the same atoms as the earth". I usually pick one small topic like this to give a lecture on. Poets say science takes away from the beauty of the stars - mere globs of gas atoms. Nothing is 'mere'. There is a profound problem lurking here, one that we tackled head-on in *Cantower XXI*, "Epilodge", that relates to the restoration in the third stage of meaning of the mood of mystery, a surround about all our abouts. Perhaps here I might point to the task by a turn-about about the end of this introductory paragraph. Feynman says the "love is not science". Now love, indeed, is science, but only if we rescue the word science, lacing it with wonder and sensibility and Bud Ah! Love is science, but science is also love.

I wont comment on Feynman's next short section, on Chemistry: we have given hints about the field already in this and the previous two *Cantowers*. But I would draw attention to his next excellent 5 pages on biology, worth a deal of classwork digestion. The digestion, in the present context, would be a lifting of his reflections into the context of the canons of inquiry but always with an eye to larger issues. I make mention only of one of these, one that is a dominant mood of the writing. Feynman writes of

“information” being conveyed in the organism,⁸¹ of “messages” received,⁸² of instructions, of codes. The point I would make is that breaking out of and forward from that perspective is heavy self-transforming work. The odd, eccentric, individual may do it, but it will take hodic method’s cycling to eventually rescue the global culture.

This is a topic that I dealt with before, but now I would emphasize the need for rambling illustrations, analogies with nature and technologies. What of this ‘genetic code’ stuff? In what senses is a building coded in the structures of its bricks and other components? Personal answers can be forthcoming only by going about about about the question in a way that gets you into a luminousness about the distinction between disposition or suitability and “form”. We are back, of course, with Aristotle, and, as I type, my molecules lead me to recall Lonergan writing of admiring Aristotle in one of his Latin works. I checked a previous recalling of the passage, in the curious Appendix B to *Phenomenology and Logic: “The Experience of Science”*. The appendix reproduces notes of Lonergan where he collects his drive and gathers some key texts. It seems a fitting end to the present piece of our adventure, a context for Feynman’s puzzling over the relation of physics to other sciences. I recommend that you bring the two together, use Appendix B as a handout in class (don’t tell U of T!).

“The Experience of Science”? Well, I take the stand that science is love, a reach within love for an informing love. The reach can focus on anything: the sunflower, a dewdrop, a glass of wine. So, I link up on Feynman’s concluding paragraph: “A poet once said, ‘The whole universe is in a glass of wine.’ We will probably never know in what sense he meant that, for poets do not write to be understood. But it is true that if we look at a glass of wine closely enough we can see the entire universe”.⁸³ Look?

⁸¹Feynman I, 3-2, line 36; 3-5, lines 35, 40. Add to your reflections the context of notes 47 and 67.

⁸²Feynman I, 3-2, 2nd last line; 3-6, line 27.

⁸³Feynman I, 3-10.

Closely enough? The wine is about us, in the universe about us, and we can cherish the seeing that is not a seeing, in the glass, darkly, a darkness deepened and illuminated by science.

Loneragan's jottings begin with the question, "What is meant by 'science'? His first paragraph reads:

"Questions arise from problem of integration.

Not any answer will do: the answer must

- a) account for the Ar[istotelian] concept of science
- b) account for its transformation into a modern concept of science
- c) provide a norm that will make possible a critique both of the ancient and the modern concepts
- d) provide a key to the problem of integration"⁸⁴

One can miss-read *norm*, like one can misread molecules as information-carriers. The norms that are to be provided are the people spun-off-of the cycling of hodic method, lifted by such contexts as those lectures on logic and existentialism, tuned lovingly to the field and its flowers, its photons, its flights of birds.

So I come to the note, in this short Appendix B, where I recall Lonergan's admiration for the lonely achievement of the oddball Greek. And, in conclusion, I leave you with the note as I wrote it, wishing it to wind round your existential decision problem about your turn-about about about: "It seems useful to give here a loose continuous translation of the five Latin passages from Aquinas in the text: 'You and I surely notice the experience of image dependence in ourselves?' 'It is an experience of our way of knowing, of course, that fits right in with Aristotle's talk of it.' 'For we gather creatively and collect from images, by our minding, our actual understandings: and how otherwise might we come to appreciate these activities if they were not part of our experience?' 'What reveals perfectly our creative energy and our nature is that

⁸⁴*Phenomenology and Logic*, 324.

natural activity of understanding *through the understanding of which* we get that perfect revelation.' 'And that's what the Philosopher did: he scrutinized the nature of the capacity to understand by attending to his understandings and their natural reach.'

So: '*Admiramini enim subtilitatem Aristotelis*' (Lonergan, *De Deo Trino. Pars Systematica* [Rome:Gregorian University Press,1964] 283: the entire appendix 2 there is relevant), 'You just have to admire Aristotle's subtlety.' The decision problem is to reach for a Bell-curve translation of that admired subtlety into industry, commerce, class-rooms, governments, religions, homes."