# Insight & Beyond

## Class 5, Part 1: October 7th 2009

## Systematic and Non-Systematic Processes

### Summary of Material

### on Chapter 2 §3

Review of the meaning of heuristic and the four heuristic structures:

Heuristic as a kind of spontaneous, intelligent kind of anticipation.

From ‘eureka’; relates to searching and finding.

Heuristic: desire for possession *versus* desire leading to self-transcendence.

Heuristic Notions and Heuristic Structures.

Lonergan’s heuristic approach to science and its deep implications.

Offers model of modern science as intelligently heuristic, not deductively logical.

Foregrounds the creative, innovative, rule-changing aspects of insight.

§ 2. Review of Classical Heuristic Structure.

The unspecified correlation yet to be specified.

The scissors metaphor and sets of heuristic notions at all stages.

Student question: Are heuristic notions restricted solely to the natural sciences?

Classical heuristic models do show up in other domains (e.g., structural linguistics, comparative law), though a somewhat different methodology is followed.

Student question: How active or passive is a human being with respect to a sudden insight?

The activity of insight is receptivity, yet the subject does act.

But the intelligently inquiring subject actively prepares itself to receive insight.

Student question: Does the work of self-appropriation contribute to likelihood of insight?

The work helps you to recognize and own the process, to refine it and relinquish whatever does not contribute to it.

§ 3. Concrete inferences from Classical Laws [‘Correlations’].

Three presuppositions: the laws, the situation, and insight.

Modern science does not necessarily entail determinism.

Crucial to Laplacian determinism, to the idea that science yields prediction and control, is Laplace’s assumption that the events of the universe can be brought under “a single formula.”

Given the multitude of correlations/laws, insightful selection and combination is needed for any concrete inference, but it is not necessary that all such combinations yield a single formula.

Correlations: Selected and Combined.

Particularizing insights needed to select and apply general laws to specific cases. Illustrated with Galileo's combination of two of his laws in his studies of projectile paths.

Another illustration of concrete inferences from classical correlations by concrete insights that select, combine and apply: Newton's application of his "laws" to planetary motion.

Classical laws highly conditioned by context; example of falling bodies.

How Newtonian laws gave rise to the Enlightenment belief in modern science.

But these same laws are merely indeterminate in themselves.

Because the same Newtonian "laws" can be combined to yield elliptical as well as other planetary orbits.

Two Kinds of Overlooked Insights

(1) Practical, reactive insights; determined by the situation.

(2) Theoretical, constructive insights, a free exploration of the potentiality of laws.

Surprise that Newton's laws, applied to the three-body problem, encounters a mechanical system so complex it has no general, "single formula" as its solution.

How by assuming certain symmetrical, imaginative models can bring a simplicity to complex problems, rendering them solvable.

Overlooking the insights made by imaginative models.

Definition of Process and Systematic Process.

A process in general is a series of events.

Systematic Process: Every moment determined by how original imaginative model was set up.

A single intelligible unity to the unfolding of all events.

Inherent "abstractness" of classical laws open to either systematic or non-systematic processes.

Common assumption that all events in the universe can be deduced from one, single "Unified Theory" overlooks the inherent "abstractness" of classical laws, and the need for additional concrete insights.

Classical correlations yield systematic processes *only* "other things being equal"; but classical laws themselves do not determine whether or not "other things" are or remain equal.

Examples of systematic processes: Planetary orbits, moons orbiting Jupiter, plate tectonics, pendular motion, the seasons, a beating heart, etc.

The real meaning of closure.

False meaning of "closure": no self-contained systems exist, contrary to Laplace.

Lack of simplicity or systematicity hinders our ability to make predictions based on classical laws.

More adequate meaning of closure.

Influenced by Newton's physics, even Kant saw both nature and society as a *system* of laws.

Discussion of non-systematic processes.

By violating the assumptions of imaginative model, a nonsystematic model can be constructed.

Modern science's oversight of its own insights.

Failure to see that the universe might not be systematic.

Student Questions:

Question about whether Lonergan's discussion of a non-systematic process implies that a *particular* process (e.g., moons orbiting Jupiter) we once thought was systematic might someday turn out to not be systematic?

No, Lonergan's point is not about this or that process, but about the entire universe – that the classical laws do not imply that the universe as a whole is systematic and deterministic, even if some of its constituent processes are systematic.

Additional question about my knowledge and physical laws independent of my knowledge.

Discussion of the grounds for judgment follows later in the course.

Discussion of the universe as a creative non-system, with regions of systematic processes.

Student Question: Is it possible that we use ‘nonsystematic’ to mean ‘we just don’t know yet”?

A nonsystematic process may be deducible in each of its events, yet still the whole collection of events can be randomly patterned.

Examples of non-systematic processes: raindrops hitting windshield, sprouting of dandelions, etc.

No single intelligible unity, and no single formula to express why that specific *set* of dandelions sprouted there in that pattern.

Lonergan argues that there can be no proof that the universe is systematic, based upon the “laws” of science alone; yet he believes that the universe actually is non-systematic, although he offers no proof for this.

# Insight & Beyond:

## Lecture 5, Part 1:

## "*Insight*, Chapter 2, §3
## "Systematic and Non-Systematic Processes"
## 7th October 2009

Review of the meaning of heuristic and the four heuristic structures:

Heuristic as a kind of spontaneous, intelligent kind of anticipation.

From 'eureka'; relates to searching and finding.

Heuristic: desire for possession *versus* desire leading to self-transcendence.

Class #5, October 7, 2009

So we left off kind of in the middle of chapter two. And we're going to resume. But before we resume, I thought it would helpful to recapitulate a little bit.

*So Lonergan in the course of* Insight *is gradually going to give an articulation of four heuristic methods*. And we've talked about that a little bit before. And eventually he is going to give an argument as to why those are the four that there are! And we'll see what we make of that when we get there.

## Four Basic Kinds of Scientific Heuristic Methods

I thought it would be helpful to review again what he means by 'heuristic.' And the passages below — one is a passage that you saw but we didn't dwell on it. And the other is a passage that we haven't gotten to yet, but I thought it would be helpful to put it before us as a sort of an overview worth having with us in looking at this.

## Heuristic Structures

> The structure "**is named heuristic because it anticipates insights of that type, and while prescinding from their as yet unknown contents, works out their general properties to give methodical guidance to investigations."** (*CWL* 3, p. 69).
>
> "**A heuristic notion, then, is the notion of an unknown content, and it is determined by anticipating the type of act through which the unknown would become known. A heuristic structure is an ordered set of heuristic notions.**" (*CWL* 3, p. 417).

*So the key to Lonergan's use of the word 'heuristic' is **anticipation***. And it's the spontaneous 'intelligent-ness' in anticipation! There are all kinds of anticipations of course. There's the anticipation that somebody is going to ask you out on a date! There's the anticipation of getting a job, or getting into graduate school, or a postgraduate program! There's the anticipation when Friday comes. There's the anticipation of going on vacation. So not all anticipations are what Lonergan regards as what he calls *the spontaneous anticipations of intelligence*. *That isn't to say that in all those anticipations that I've just mentioned, intelligence isn't playing some role. To a greater or lesser extent, intelligence or insights are playing a role in all anticipations*.

But prior to what you might call the idea and emotional informed anticipations, there are what he refers to as *the pure spontaneous anticipation of intellectual wonder*. And the word 'heuristic,' as I mentioned last week, comes from one of Lonergan's favourite words, "Eureka!" — the joy of discovery, the excitement of discovery. So heuristic has to do with searching and finding. Finding is the result of the searching. *So heuristic takes its bearings from that intellectual anticipation. When you have a question, there's that tension of inquiry, there is an anticipation in that tension of inquiry. It's a desiring for something.*

As we will see, there's two ways of thinking about desiring. There's desire in the sense of being — having something brought into me. That's a limited way of thinking about desiring. Desiring in the sense of I desire something to be brought into me. I desire to make something my possession, whether — and sometimes I desire to make a person my possession. *The sense of desire that Lonergan is talking about is the obverse of that point. It's the desire to become! It's the desire to become different than myself. It's the desire to become better than myself. Fuller than myself! And this small increment that we're talking about at this part of the book, it's the desire to become better by understanding more*! *So every time I have an insight I transcend my old self that did not have that insight into a self that now understands what it did not understand before.*

## Heuristic Notions and Heuristic Structures

Lonergan's heuristic approach to science and its deep implications.

Offers model of modern science as intelligently heuristic, not deductively logical.

Foregrounds the creative, innovative, rule-changing aspects of insight.

So drawing upon that anticipation, that intellectual anticipation, that desire to be transformed into a more fully intelligent, more actually intelligent human being by understanding what it is I desire to understand, '**heuristic**' means that there is an anticipation of insights *of a certain type*. And so far what we've seen is the type of insight that's characteristic of classical heuristic structure, what Lonergan calls classical heuristic structure. *So there's an anticipation of a certain kind of insight. And it's the anticipation that comes from wondering what is the correlation, what is the classical correlation.*

And even while not yet knowing the precise content of the insight that one does not yet have but only anticipates, even though one does not know that content, *one can talk about where one is headed in a general sense because one knows what it is to wonder about — to* *inquire toward that! So by the very fact of the intellectual inquisitive desire, it is possible to say some things about where you're headed! And that is at the heart of any of the heuristic methods. And what Lonergan is doing in these discussions of the methods of science is saying what sorts of things are involved in that anticipation that help guide us towards the insights that we desire.*

From a little later in the book, Lonergan makes explicit the relationship between two terms, **heuristic notion** and **heuristic structure**. He doesn't actually draw that distinction very clearly in chapter two. This comes several chapters later; it comes actually in chapter fourteen:

> **A heuristic notion, then, is the notion of an unknown content, and it is determined by anticipating the type of act through which the unknown would become known.** (*CWL* 3, p. 417).

And the type of act that we have talked about so far is the type of act that is associated with classical investigations that begin — Lonergan is retrieving that innovation in Galileo, but once you see it, you discover, well, the Pythagoreans had that kind of anticipation! Apollonius had that kind of anticipation! *It wasn't unique to Galileo*. But to make it — to figure out how to do it in the context of empirical science — that was Galileo's contribution. *So a heuristic notion is an anticipation of a certain kind of content*, whereas

> **a heuristic structure is an ordered set of heuristic notions.** (*CWL* 3, p. 417).

And in a sense that's already true in the classical heuristic method, as I'll try to point out in a second. *So a heuristic structure is not just one heuristic notion, but* is rather *a bunch of them combined in such a way as to bring about the desire — as to move one towards the desired insight*.

Any questions about that? …

[No question is raised]

*Now, I wanted to emphasize here that in looking at science as heuristic, Lonergan is doing something that I think is very, very radically innovative, and very, very risky*! There is a way in which — as we saw in looking at some of those remarks from people like Bacon and Descartes and Weber last time —there's a sense that *one of the companions — one of the* *doppelgangers — of the methods of modern science are these notions of security and control and domination. That with modern science, we finally have mastery over the unpredictabilities and the insecurities and the contingencies of nature*!

As we'll see a little bit later on today, I hope, *Lonergan is going to say that that is not what modern science is about. And in place of what we might call the model of modern science as deductively logical, Lonergan is going to offer the alternative model of modern science as **intelligently heuristic**.*

## Intelligently Heuristic, not Deductively Logical

## Increase likelihood, not automatically or mechanically guarantee

Now, what's the difference? In the *methods of logic*, once you have the premises given to you, you follow the rules of deductive logic strictly and formally, and you keep going! Every step along the way has exactly the same amount of certitude as where you began. And so a logical method moves you ahead with certainty and precision and necessity.

*Heuristic methods are always at best hopeful! What they can do is increase the likelihood that you will grow in understanding! But what is crucial about a heuristic method is it's always seeking the unknown*. Now there's a sense in which in a lot of method, you're seeking the unknown. If you've ever taken a course in Logic, especially one in Symbolic Logic, *you know that if you're asked to do a proof, it does take a fair amount of intelligence to figure out how to construct the proof*! Nevertheless, the rules are set down — the rules of inference, the rules of substitution — they're all laid out, and there's — and *while there's an intelligence involved in figuring out how to find a valid path from premises to conclusion, nevertheless it's not about discovering a conclusion that takes you outside the rules*.

Insights are by definition creative, innovative, and *in some cases they change the rules! That's what a higher viewpoint does. A higher viewpoint combination of insights is actually changing the rules of the game*! You stop playing by the rules of arithmetic when you subtract five from four and say you get a number. You stop playing by the rules of rational numbers when you take the square root of two and say you get a number.

And *yet heuristic, intelligently anticipatory methods, do that all the time*. So there is something very exciting and very risky about modern science conceived in this way! As I said, *Lonergan is calling into question some of the most deeply held extra-scientific assumptions as to the correct interpretations of what modern science is all about*!

Modern science for Lonergan is all about *eureka*! It's all about self-transcendence! The methods don't give you security; what they do is they give you guides. But ultimately, they don't substitute for the creative sparks and the imaginative innovations that are required to get insights! Okay!

## § 2. Review of Classical Heuristic Structure

## The unspecified correlation yet to be specified.

## The scissors metaphor and sets of heuristic notions at all stages.

**§2 Classical Heuristic Structure**

And we saw last week the scissors metaphor to kind of illustrate, as Lonergan says, that *the kind of insight that the classical heuristic method is anticipating is an insight into* "**the unspecified correlation to be specified, the undetermined function to be determined**." (*CWL* 3, p. 62).

> **The objective is not merely the 'nature of …' but more precisely the unspecified correlation to be specified, the undetermined function to be determined**. (*CWL* 3, p. 62).

And we talked last week about —

$$f(x, y, z, t) = 0$$

We saw that in Lonergan's text, when he has the 'f' and then in parenthesis 'x, y, z, t,' the unknown there is the 'f.' There are any number of different possible correlations that could be what the classical scientist is looking for to make sense of the data. And hopefully today we'll see a little bit more how that works. And this — And by playing out diagrammatically the scissors metaphor that he uses, I wanted to give you a sense of what he means by a structured "**ordered set of heuristic notions**." There is not just one operation, but a bunch of them. There are insights involved in describing and classifying! There are insights involved in doing measuring! There are insights involved in constructing tables and graphs. There are other insights involved in discovering what he means by invariance principles, and the theories of equations and functions, and so on!

So there are a lot of operations that are involved, and they are put together in a structured fashion that's 'metaphored' by the scissors: a lower blade from data upwards, and an upper blade from general theoretical considerations downwards until one gets the insight. But *none of these operations substitute for the creative spark of getting the insight into what the correlation is that is the correlation among the aspects of the data*. So that's just a review!

> Student question: Are heuristic notions restricted solely to the natural sciences?
>
> Classical heuristic models do show up in other domains (e.g., structural linguistics, comparative law), though a somewhat different methodology is followed.

Questions on that before we go ahead? Byron?

Byron: As I'm reading through, the question that keeps on coming to my mind is how constrained are these varieties of heuristic notions and the structures that they comprise — How restricted are they to the natural sciences? Do they extend to the human sciences, to the — you know?

Pat: Sure. The short answer is that they are not confined to the natural sciences! So for example, if somebody is involved in comparative linguistics or comparative law, you are doing correlations.

> *There are complications that come in because you have gone from the field in which the world is meaningful, but it's not made to happen through the innovations of meanings. Human beings put their lives and their societies together by means of insights, among other things. And elementary particles and molecules and fungi don't do that!* So there is a need to add on some additional methodological issues.

But nevertheless, discovering correlations among things does that. *Structural linguistics is an example of a classical heuristic method*. The people do figure those things out — the theories of deep grammar — discovering and approximating languages — there are common grammatical structures. These are sometimes obvious — and Chomsky has argued that some are hidden. Some deep structures are hidden, some are apparent! They show up in different ways, and one has to go and look for them, and so on. That's classical heuristic method. So it shows up in the human spheres as well. … Maybe that's sufficient. Okay?

Byron: Thank you!

Pat: Yeah. So it's obvious in areas of physics, chemistry, biology, geology, astronomy, but it's also true in the human realm.

The tricky thing, and part of where — Where is Lonergan headed in these chapters? *Where Lonergan is headed is to say classical heuristic method is a wonderful thing, but don't think it's everything*! And there are difficulties! As some of you perhaps know, Structuralism had this big explosive presence in Europe before it got taken up in the United States. *And there are certainly people that thought that structuralism would explain everything! Lonergan is going to make the argument as to what the extent and what the limits are to the uses of the classical heuristic method*. And that's part of what we're going to see today! Okay? …. Tim?

Student question: How active or passive is a human being is with respect to a sudden insight?

The activity of insight is receptivity, yet the subject does act.

But the intelligently inquiring subject actively prepares itself to receive insight.

Tim: The description of insights as innovative, creative, how they change the rules — I was thinking of the description, the example that Lonergan gives about Archimedes — kind of jumps out of the bath! And he describes one of the characteristic of insights as they come "**suddenly and unexpectedly!**" So within this kind of anticipatory stance, within this notion of creativity, I'm wondering how you attribute passivity and activity to insight, in relation to the human subject.

Pat: Oh, that's a very good question!

Tim: So — which is to say — The language differs about it. At times he talks about the attainment of insight, which is like something that I do, but at other times like I get the sense that an act of insight is something that happens to me. But even to describe it as an act — I'm wondering: Well, who is *the actor*? Is that the human subject, or is the human subject in a sense kind of a witness to this act that is occurring? Yeah, so I'm just wondering, you know, the relationship of passivity and activity of the human subject in the act of an insight.

Pat: That's a very good question, so let me say a couple of things about it.

*By asking the question about the human subject and the actor, you are jumping ahead*. At the pace we are going, what I hope to be sort of the culmination of this semester but might actually be the beginning of next semester, that is, Lonergan's discussion of the human subject, of the human knower, and of the human doer. So, there's a set — How do I want to say this?

One of the things that I found most striking in my early readings of Lonergan's work is something that is not prominent in *Insight* in any place, *but it is very prominent in the work that preceded this. So if you recall, I mentioned that the work that preceded the book* Insight *was Lonergan's studies of Aquinas's Trinitarian Theology*. And in there he argued very strongly for the first time that the Trinitarian Theology after Aquinas suffered from the fact of the oversight of insight. He thought that everyone who either tried to deal with the problem of how do you do an analogical understanding of the Christian doctrine of the Trinity had not made use of the most important thing that they had to make use of, namely insight; or perhaps equally importantly, they had simply failed to discover how important that was to Aquinas, and how central it was to his theological treatment of that topic.

In the middle of that work, Lonergan quotes Aquinas at great length talking about the act *intelligere*, which is the Latin word that Lonergan is going to translate into 'insight.' And remember he uses 'insight' and 'understanding' interchangeably: there's not a distinction there, as there is perhaps in some authors. And so *intelligere* is the Latin for insight. And Lonergan says *intelligere* is a *pati*. *P-a-t-i* is the Latin spelling. It actually has a Greek derivative root to it. *And it means passion; it means to undergo; it is a receiving*. And Lonergan makes a big deal of that: that Aquinas held that; and he quotes passage after passage after passage. And so — He goes into some discussion about that, but — So *Lonergan is very clear that the activity of insight is a receptivity! But then he equally says what is it that the subject contributes*? *The subject acts*! So there's a very complicated discussion of this issue before Lonergan gets to *Insight*.

So let me see if I can translate it into somewhat simpler terms here. The first thing is that because insights always come as the response to the tension of inquiry, that means that *we have to be inquiring in order to receive*! *So we actually have to be doing something to dispose ourselves so as to receive the insights. And that is what you might call the activity*! When we had that puzzle on the first day of class, and you folks were trying to figure out the pattern of the letters below and above the line, you were actively doing something! You were actively transforming your imaginations under the guidance of the question that was a real wild question for you. *That by the way, I think, is what Aristotle means by 'agent intellect,' or 'active intellect.' It is that combination of human inquiry, the desiring driving human inquiry taking and using imagination so as to put itself in the position to have the insight. That's what I think Aristotle means by active intellect or agent intellect. So we are active and that is an intelligent activity. It is not the intelligent activity of insight. It is the intelligent activity of intelligently seeking, seeking to understand. So we are active in that way. But that activity is not the activity of having an insight*.

*Notice however Lonergan* always *speaks of insight as* an act. *It is something we do in receiving*. Now if you just stop and think about the ordinary sense of receiving! My grandson's birthday party is going to be on Saturday. He is going to receive gifts. But he actually has to receive them. For a gift to be given a gift has to be received. *You actually have to do something to receive. And insight is a receiving that the subject does*! It is an activity that you do even though it is an activity of receiving! *It's an activity — it's active — in a different way than the activity of preparing yourself in which you might say you are much more in control. You can control trying to get the insight, but you can't control getting the insight! But, nevertheless, getting the insight is something that you do. It's an activity that you do*! Okay? Does that help?

Tim: Yeah.

Student question: Does the work of self-appropriation contribute to likelihood of insight?

The work helps you to recognize and own the process, to refine it and relinquish whatever does not contribute to it.

Tim: So the work of self-appropriation, that does kind of involve a very active doing and that — would that make oneself more open to having insight? Would it increase the probability of insight occurring?

Pat: (hesitantly) Ahm, I guess I would say it makes you more open in the sense of being more aware of what it is you've been doing all along! *And the goodness of doing that*! And the ability to get out of your own mind! So self-appropriation in some very profound sense — Self-appropriation doesn't make you able to have insights! It doesn't make you able to have experiences or have inquiries, or as we'll see later on, to make judgments or to make value judgments or to make decisions. You've been doing that all along! You wouldn't be in this classroom if you hadn't done all of those things!

*What it does is helps you recognize and own that — all these operations — as your own activity. And in valuing the value of doing that, you can let go of the things that interfere with you. So it helps in the sense of the more aware you are, and the better you understand and know what you are as a knower and doer and a lover, the freer you are to do that*. Okay?

Tim: Thank you!

Pat: Okay. Sure! Good! Okay! Any other questions? … All right!

§ 3. Concrete inferences from Classical Laws
['Correlations']
Three presuppositions: the laws, the situation, and insight.
Modern science does not necessarily entail determinism.
Crucial to Laplacian determinism, to the idea that science yields prediction and control, is Laplace's assumption that the events of the universe can be brought under "a single formula."
Given the multitude of correlations/laws, insightful selection and combination is needed for any concrete inference, but it is not necessary that all such combinations yield a single formula.

## §3 Concrete Inferences from Classical Laws [Correlations]

So we made the transition from talking about classical heuristic method, we had a lot of illustrations, and we talked about the difference between explanatory and descriptive definitions, and the role that that had, and so on. And then we got to this section where Lonergan asks the question about "**Concrete Inferences from Classical Laws**" (*CWL* 3, pp. 70-76). And you will recall the following passage:

> **Hence a concrete scientific inference has not two but three conditions: (1) it supposes information on some concrete situation; (2) it supposes knowledge of laws; and (3) supposes an insight into the given situation**. (*CWL* 3, p. 70).

And I put the bracket in the heading there around ‘correlations,’ because we paused and thought about the ways in which Lonergan’s use of ‘law’ in the context of science has hidden implications that really do not fit this radical retrieval of an originary spirit of science that Lonergan is undertaking. But nevertheless, he uses the word ‘law’ all over the place. I wish he had gotten rid of it, but it is what it is. And remember he says that if you’re going to go from abstract laws to concrete inferences, which is to say predictions, applications — *take it you’re explaining concrete things that you see in the world by using the laws of science — that’s what he means by a concrete inference* — that *it has three suppositions*. *First of all you have to know the laws*; you have got to know some — *you have to have some kind of information about the concrete situation that you are going to apply the laws to*. But importantly, *you also have to have an insight into the concrete situation*. Because —

And then he says this third requirement is what has been overlooked. And we’ll see why do you leave that concrete insight out. We’ll take that up in a minute. *But you need to have that concrete insight*. And I asked, why does he say you need three not two suppositions? And I think that the background to this is the background of Laplace, and what had become, in the modern context, *the determinism that is thought to accompany modern science*.

## Pierre-Simon Marquis de Laplace

Here is the key passage from Laplace:

> “We may regard the present state of the universe as the effect of its past and the cause of its future.
>
> “An intellect which at a certain moment would know all forces that set nature in motion, and all position of all items of which nature is composed, if this intellect were also vast enough to submit these data to analysis,
>
> “it would embrace **in a single formula** the movements of the greatest bodies of the universe and those of the tiniest atom; for such an intellect nothing would be uncertain and the future just like the past would be present before its eyes.”

*So what Lonergan is doing in these chapters, with this very difficult technical material that you've been ploughing through, is making the case that determinism is not a necessary companion of modern science. It is not a necessary companion of the kinds of laws, or if you like correlations, that have been the great discoveries of modern science.* And I've highlighted this part of the quotation from Laplace's *Philosophical Essay Concerning Probabilities*: "in a single formula."

We will see a part of a quotation from Lonergan momentarily. But there are a couple of places in chapter two and then also in chapter three where Lonergan will repeat that *in a nonsystematic process, it's possible, if you have enough time and enough computer power, to completely comprehend the totality of a nonsystematic process! However, what Laplace says is "in a single formula."*

So I want to leave you with that for a moment, and try to illustrate and come back and think about why that is such an important qualification. What Lonergan is going to say is that you can have complete knowledge of a concrete situation, you can have complete knowledge of all the laws of science — which of course you know we don't have at the moment — and you still could not predict all future events "*in a single formula*." And that is crucial to determinism! It's crucial to this idea of prediction and control!

*So what is involved in having an insight into a concrete situation? You need first of all to know* **"which laws are to be selected"** (*CWL* 3, p. 70). Now stop and think about that for a minute. Think of all the things that you have heard of as laws of science. So we've got the laws of thermodynamics, the law of the conservation of energy, the law of the conservation of momentum, Newton's first law of motion, Kepler's laws of planetary motion. There's the law of types in biological theory, in comparative biology, articulated by Cuvier. So the law of types was that there are certain plans that run across not only different species, but genera and classes and orders, that are very, very general. For example, there are no six-legged vertebrates. Anything that has a spinal column has four appendages, maybe five if you include a tail, but nobody's got six! And that runs across *a huge number*! So that's an example of a classical correlation.

## § 3. Concrete Inferences from Classical Laws [Correlations]

And if you start to make the list: you have the law of gases, the law of oxidation reduction. If you start to run through all the things that are called laws in science, and print them in a book; and then you want to explain why it's gotten colder today than it was yesterday. Well, which of those laws are you going to select?

## Correlations: Selected and Combined.

### Particularizing insights needed to select and apply general laws to specific cases.

### Illustrated with Galileo's combination of two of his laws in his studies of projectile paths.

> **For it is only by the [concrete insight into the given situation] that one can know:**
>
> **(1) which laws are to be selected for the inference,**
>
> **(2) how the selected laws are to be combined to represent the spatial and dynamic configuration of the concrete situation, and**
>
> **(3) what dimensions in the situation are to be measured to supply numerical values that particularize the selected and combined laws.** (*CWL* 3, p. 70).

*Well, actually it's by having knowledge of the concrete situation that you know which laws are the ones to at least consider as potentially relevant! Some of them you are going to know are not relevant, and others you will know as potentially relevant.*

And you need to know "**how the selected laws are to be combined**" (*CWL* 3, p, 70). And you need to know "**what dimensions in the situation are to be measured to supply numerical values that particularize the selected and combined laws.**" (*CWL* 3, p. 70). That is, you need to know what dimensions of the situation you need to get further knowledge about by doing measurements, and so on. So insight into the concrete situation is needed to figure out, of all the possible correlations that might be relevant, which ones are you going to work with, how are you going to combine them, and how are you going to get determinations, more concrete determinations, from the situation to particularize them.

So let me give you some examples. This is an example taken again from Galileo's *Two New Sciences*. *What you might call his first law, although he doesn't called it that. It actually comes in the part of the dialogue called "The Third Day." And he calls it "Proposition One," and then just for emphasis, calls it "Theorem One."* I'm not quite sure why he does that! There's not any Proposition One, Theorem Two, or Proposition Two, Theorem One. He just repeats it, for whatever reasons. *And it's the – what you might call the law of uniform motion*.

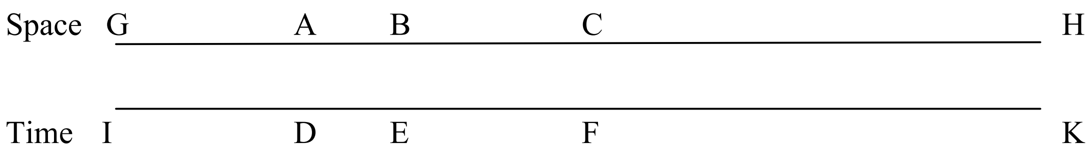
## Correlations Selected & Combined

Galileo, *Two New Sciences*, "*Third Day*" on rectilinear motion:

Proposition 1. Theorem 1: "*If a moveable equably carried with the same speed passes through two spaces, the times of the motions will be to one another as the spaces passed through*."

$$time_1 : time_2 :: distance_1 : distance_2$$

$$(d = v\,t)$$




"Space AB is to space BC as time DE is to time EF"[1]

And it says — The language is a little hard to comprehend. Sometimes for people language is a little more easy to comprehend than mathematics. And it says: "*If a moveable — or a moving body, a movable object — is equably carried with the same speed and passes through two spaces, the times of the motions will be to one another as the spaces passed through*." Or to put it as he does, in terms of the theory of proportions: if a car is driving down Beacon Street constantly at thirty miles an hour, the *amount of time* that it takes to go to *distance one* in relation to the *amount of time* it takes to go to *distance two* will form a constant ratio. Okay?

[1] From "On equable [uniform] motion: The Third Day" in Galileo Galilei, *Two New Sciences*, tr. Stillman Drake (Madison: University of Wisconsin Press, 1974), p. 149.

Or in a way that is later translated into algebraic form:

***the distance is equal to the velocity times the time*.**

Okay? *So that would be the first law.* In a later section, Galileo goes on to make the following claim:

> Proposition 2. Theorem 2: "*If a moveable descends from rest in uniformly accelerated motion, the spaces run through in any times whatever are to each other as … the squares of those times.*"[2]

$$distance_1 : distance_2 :: time_1^2 : time_2^2$$

$$(d = ½ a vt^2)$$

What may be called for our purposes his second law, Proposition Two, Theorem Two, says: "*If a moveable descends from rest in uniformly accelerated motion, the spaces run through in any of those times whatever are to each other as … the squares of those times.*" So distance one is to distance two as the square of the times.

We talked about that a little last week. I suggested that that is not a particularly easy law to discover or to test. And Galileo used ramps to slow the acceleration down, and to figure out how much he was slowing it down by using a ramp, and to give an articulation of that, and then to give an argument, a geometrical argument, as to why that was the law.

Okay. *So we've got two laws now, although Galileo didn't call either of them that. But they are two correlations.* They are correlations in the form either in the proper proportion form, or in the algebraic equation form.

*And now what Galileo does a little bit later on is he combines those two laws together. So he combines the horizontal motion being equable or uniform, which is to say constant motion, and accelerated motion down downwards* [Pat indicates the two laws as displayed].

**Correlations Selected & Combined**

[2] From "On Naturally Accelerated Motion: The Third Day" in Galileo Galilei, *Two New Sciences*, tr. Stillman Drake (Madison: University of Wisconsin Press, 1974), p. 166.

Galileo, *Two New Sciences*, “Fourth Day,” on parabolic trajectory:

> Proposition 1, Theorem 1: “When a projectile is carried in motion compounded from equable horizontal [motion] and from naturally [uniformly] accelerated downward [motions], it describes a semiparabolic line in its movement.”[3]

horizontal distance$_1^2$, : horizontal distance$_2^2$ :: downward distance$_1$ : downward distance$_2$

$$(1/2\ (a/v^2)\ x^2 = -\ y)$$

Now one of the things that’s happened in between Proposition two, Theorem two of day three, and Proposition one Theorem one of Day four, is that he has given a long argument: what he does is he gives the mathematics of uniform acceleration. And then he gives a long argument as to why, not only that uniform acceleration is natural acceleration, but in fact necessarily has to be uniform acceleration!

*At that point, Galileo stops being a modern scientist, and starts becoming a metaphysical philosopher! Because in fact it turns out it isn’t necessary that natural fall be uniform. And in fact it turns out that natural fall isn’t uniform at all*! It’s slightly off uniform! So that argument was based on extra-scientific opinions!

Be that as it may, *what he then does is to say if I take ‘natural’, which is to say uniform acceleration — which is what acceleration over relatively short heights near the surface of the earth tends to be — and I combine it with uniform horizontal motion, what I get is a parabolic path.*

*Now you see that is what Lonergan means by applying laws by combining them in concrete ways under concrete circumstances.*

And then Galileo goes on to give some arguments as to why, for example canon balls fly in a parabolic path. And the reason he says “semiparabolic” is his argument is based on rolling a ball down a ramp across the table, and then seeing what happens when it rolls off the end of the table. So it comes off the table and it starts to arc down. That’s the semiparabolic path that he’s talking about.

[3] From “On the Motion of Projectiles: The Fourth Day” in Galileo Galilei, *Two New Sciences*, tr. Stillman Drake (Madison: University of Wisconsin Press, 1974), p. 217.

Later on he talks about why if you throw a football upwards or a basket-ball upwards — we saw this last time — it's a full parabolic arc. But initially that's his argument.

So notice, among other things, that this is applied to a very specific instance, namely, the one in which the projectile rolls off the available flat surface! If it's different, then he would have to give a different kind of argument. He would have to bring these laws together in a different kind of way to give an account of something that's thrown upwards, slows, stops, and then comes back down.

So that's what Lonergan is getting at. When you do a concrete inference, you are taking these laws, which turn out to have vast ranges of applicability. You figure out how to combine them, how to particularize them, how to do the measurements that you need, so that you can give an account of why the observations that you are having are functioning in the way they function. Okay.

Let me pause there. *This is to give you a sort of illustration of what he means by the insight that is needed to apply general laws*.

He's *slowly creeping in a funny direction*, because I can guarantee you could find somebody within ten minutes of leaving this room who will say that the laws of science, the laws of modern science, explain everything. And Lonergan is saying that the laws of modern science *can be used* to explain lots of things. *But in and of themselves, they don't explain anything*! *You need these particularizing insights! And the significance of that is what is being drawn out through these chapters*. Okay?

Are there any questions about this? …

Okay!

Another illustration of concrete inferences from classical correlations by concrete insights that select, combine and apply: Newton's application of his "laws" to planetary motion.

Classical laws highly conditioned by context; example of falling bodies.

How Newtonian laws gave rise to the Enlightenment belief in modern science.

But these same laws are merely indeterminate in themselves.

Because the same Newtonian "laws" can be combined to yield elliptical as well as other planetary orbits.

Okay. So here's another example. After Galileo, Newton is the person who finds out that although natural acceleration isn't uniform because of this law right here [Pat presumably points to Newton's Law of Gravity], natural acceleration will get faster and faster the closer you get to a massive body. If you start far away, the acceleration will be less, as you get closer the amount of acceleration gets greater, and it's a function of how close you are! This $r^2$ is what tells you what kind of acceleration you are going to have. Natural acceleration is not uniform! It's only approximately uniform *under very restricted conditions*. So that's another thing that Lonergan is going to say, that *classical laws are highly conditioned*.

## Correlations Selected & Combined

**Newton's Second Law of Motion**

$$F = m\, d^2r/dt^2$$

**Newton'as Law of Gravity**

$$F = -G\, m \bullet M/r^2$$

So here's two laws: Newton's Second Law of Motion, which says that the change in the velocity of a moving body is proportionate to the force that is exerted on the moving body. And then the Law of Gravity!

And Newtonianism was the great success that gave the Enlightenment its belief in the universal salvific power of modern science! That Newtonianism, because Newton had been able to use a relatively small number of laws or correlations to explain so much! Not only Newton, but then his successors — Within thirty years of Newton's publication of the *Principia* [1687], all kinds of people discovered new techniques and methods: they discovered principles about rotating bodies, about vibrating bodies; and all sorts of things! And it was just this tremendous exponential growth in the history of thought. And that is really why the Enlightenment put such great belief in the powers of modern science. And it was basically these two laws, the Second Law of Motion — this law is the most important of the three for the purposes of giving these kinds of predictive things — and the Law of Gravity.

But as it turns out, *those laws in and of themselves are indeterminate* — something we are going to come back to again in Chapter Three! They're indeterminate because they could equally explain a movement of a planet that's elliptical, a movement of a planet that's parabolic, or a movement of a planet that's hyperbolic — all depending upon this number here, epsilon (Pat points to this symbol, E, on his overhead display). It's called the eccentricity of the solution. And the eccentricity depends on the relative masses of these — let's say, the solar body and the planetary body, the location, the velocity that they have, the different velocities. A body could come flying in from the extra-galactic space, and whizz around our Sun, and just go whizzing back out in a hyperbolic orbit, and never orbit it again. That's completely compatible with both of Newton's laws! And it's a very different concrete application, concrete inference, than what Newton really first applied it to, namely the elliptical orbits of the planets.

**Correlations Selected & Combined**

(interconnected sketches of hyperbola, parabola, ellipse and circle)

**Newton’s Second Law of Motion**

$$F = m\, d^2r/dt^2$$

**Newton’as Law of Gravity**

$$F = -G\, m \bullet M/r^2$$

Combination under

Different Conditions

$$1/r = a(1 + E \cos \theta)$$

E > 1 (hyperbola)

E = 1 (parabola)

E < 1 (ellipse)

E = 0 (circle)

Okay. So that’s another example of what happens — why you need these insights into the concrete situation to effectively and accurately apply these classical correlations to concrete situations.

Two Kinds of Overlooked Insights

(1) Practical, reactive insights; determined by the situation.

(2) Theoretical, constructive insights, a free exploration of the potentiality of laws.

Now, having made that observation, having made the observation that modern science involves, not just getting classical laws and then your work is done, but it also involves rather the hard ongoing work of applying, creatively applying, those classical laws, Lonergan goes on to make the observation that there are really two different kinds of such insights.

**Two Kinds of Overlooked Insights**

The first kind of such insights he calls **the practical** (*CWL* 3, p. 70). This is not practical in the deep and profound sense of *praxis*, *the self-making of a human being* which we'll talk about in the second semester! This is 'practical' in the ordinary American "get up and go" practical sense of dealing with things at hand. And so with regard to what he calls the practical overlooked insight, "**the situation determines the relevant insight**" (*CWL* 3, p. 70). He says that practical people look at what's going on around them, and try to figure out how to make things happen, or how to explain things. But the situation determines the relevant insight. And the insight, then, after the situation determines it, determines the selection and combination and particularization of the laws.

> **Practical**: "**The situation determines the relevant insight, and the insight determines the selection, combination, and particularization of laws**" (*CWL* 3, p. 70).

The second kind of overlooked insight, which he calls **constructive** or **theoretical** — It's a particular meaning of 'theory.' He has a richer meaning of 'theory' that we'll see later on. But here he is using the word 'theoretical' in a more limited sense. It tends to be, as he says, the "**free exploration of the potentialities of [**the**] known laws**"(*CWL* 3, p. 70). And the principal fruit of that free exploration is what he calls the ideal process that's **"dominated throughout by human intelligence**" (*CWL* 3, p. 71). But as we'll see very quickly, it's not just intelligence. "**For in such processes the basic situation is any situation that satisfies the requirements of the constructive insight, and provided that that process is closed off against all extraneous influence, every antecedent and consequent situation must assume the dimensions determined by the successive stages of the imaginative model.**" (*CWL* 3, p. 71).

> **Constructive/theoretical**: "**tends to be a free exploration of the potentialities of known laws, and its principal fruit is the formulation of <u>ideal</u> or typical processes that are <u>dominated throughout</u> by human intelligence. For in such processes the basic situation is any situation that satisfies the requirements of the constructive insight, and provided the process is <u>closed off against all extraneous</u> influence, every antecedent and consequent situation must assume the**

**dimensions determined by the successive stages of the imaginative model.**" (*CWL* 3, pp. 70-71, Pat's emphases).

So Lonergan starts off talking about his claim that the theoretical insight is going to determine the combination. But *if we ask the question what's going to determine the theoretical insight, it's not the experiences you had before you, it's imagination*!

Surprise that Newton's laws, applied to the three-body problem, encounters a mechanical system so complex it has no general, "single formula" as its solution.

How by assuming certain symmetrical, imaginative models can bring a simplicity to complex problems, rendering them solvable.

Overlooking the insights made by imaginative models.

*Now one of the things that came as a bit of a surprise and shock was, after this success that Newton had in discovering with all generality how the Law of Gravitation and the Second Law of Motion can be combined to explain the elliptical planetary orbits, he then tried to do it for three bodies*. A real simple example of three bodies is the Sun, the Earth and the Moon. And you see one of the complicating factors is that the Moon is not only attracted by the Earth, it's also attracted by the Sun. The Earth is not only attracted by the Sun, it's attracted also by the Moon. And believe it or not, not very much, the Sun is also attracted by the Moon. So figure this for a moment!

What Newton knew was that the Sun doesn't just sit there with the earth going around it. *The Sun and the Earth are doing this kind of dance! But the Sun is so heavy it only moves just a little bit around itself. So the Sun is doing this odd kind of thing that you could say it "quote unquote" is orbiting round the Earth while the Earth is orbiting round the Sun. Or you could say — maybe a better metaphor — they're dancing with each other. So there's this dance going on*! But you can neglect, to a certain amount, the motion of the Sun to a first approximation, and then you can do this amazing thing that Newton was able to do, which is to figure out *how, relative to the Sun, the Earth is moving, even though you know that the Sun* *is wobbling a little bit*. I mean that was — It was really — You can see why people were so impressed with the genius of Newton!!

But the minute you put the Moon, or Mars, or Venus, or Mercury, or Jupiter, or Saturn, into the picture, it got too complicated! It was too complicated to get a simple solution. Just three bodies!! *The three body problem does not have a general solution. The three body problem, unlike the two body problem as they're called in physics, does not have a general solution*. You find that general solution to the two body problem as expressed in that single formula that I showed you before. Let's go back.

## Correlations Selected & Combined

**Newton's Second Law of Motion**

$$F = m\, d^2r/dt^2$$

**Newton'as Law of Gravity**

$$F = -G\, m \bullet M/r^2$$

Combination under
Different Conditions

$$1/r = a(1 + E \cos \theta)$$

$E > 1$ (hyperbola)

$E = 1$ (parabola)

$E < 1$ (ellipse)

$E = 0$ (circle)

Okay! Here's a single formula, and it relates the radius from the centre of the Sun — actually from — for simplicity — from the centre of the Sun to wherever the planet is along the elliptical orbit, and the angle. So this is one value of θ, this is another value of θ, that's another [Pat uses his pointer to show the relevant points on his overhead display, which I've approximated below]. And what it's doing is relating the radius, the distance from the Sun, to where angularly, the law/line of the orbit is [last phrase is unclear]! It's a single formula!

*What did Laplace say was going to be the power of modern science? He did it all in a single formula*! This [Pat uses his pointer] is one of the single formulas that he had in mind. It varies — But with a three body problem, you can't get a formula like that!

But what you can do is find certain situations which make the solution of the problem easier. Particularly symmetries! There's all kinds of things in doing physics — Certain problems are very difficult unless you say suppose they're all equally distant from one another. Suppose one is going up and the other is going down at the same velocity. And suddenly your problems get a lot easier! That's what Lonergan means by the imaginative model! When you have imaginative models that have certain kinds of symmetries and simplicities to them, complex combinations of classical laws become easily soluble in simple formulas.

## Two Kinds of Overlooked Insights

Now this is the oversight of insight that Lonergan is saying is so desperately important! Because it's insights into imaginative models that make life simple, that provided the model for what modern science was to be, and was to be about. And that's what Laplace thought was at the heart of classical laws that we discover by the classical heuristic methods.

Definition of Process and Systematic Process.

A process in general is a series of events.

Systematic Process: Every moment determined by how original imaginative model was set up.

A single intelligible unity to the unfolding of all events.

Inherent "abstractness" of classical laws open to either systematic or non-systematic processes.

Common assumption that all events in the universe can be deduced from one, single "Unified Theory" overlooks the inherent "abstractness" of classical laws, and the need for additional concrete insights.

## Systematic Process

Okay. Now, the next step Lonergan takes is to talk about **Systematic Processes** (*CWL* 3, p. 71). And systematic processes have certain kinds of qualities. So first of all, what's a process? *So a **process** is a series of events in time.* I don't think in any place Lonergan ever gives you a straightforward definition of a process. But you can see in reading through what he is talking about that *a process is a series of events in* time. Now something that is important is that that series of events in time does not mean a single event now and a single event the next second and a single event the next second! A process can be a multiplicity of events now, followed by a multiplicity of events in the next second, followed by a multiplicity of events in the next second. Which is, after all, what a solar system is!

A solar system is not just a series of one planet's motions; a solar system is a series of — Well now it's eight planets' motions, plus a bunch of things that are asteroids, or asteroid-like, or other things. So *if you want to talk about the process of the solar system* — if it's a system — *you have to talk about a multiplicity of events at each moment in time. So the first thing we have to remember here is that when he is talking about processes, he is talking about events that are seriated in time, but not just one event and then another event and then another event sequenced in time. It can be a multiplicity, a multiplicity, a multiplicity. And that's terribly important!!*

And then he gives some characteristics of systematic processes.

### Systematic Process:

> **For in such processes the basic situation is any situation that satisfies the requirements of the constructive insight, and provided the process is closed off against all extraneous influence, every antecedent and consequent situation must assume the dimensions determined by the successive stages of the imaginative model.** (*CWL* 3, p. 71).

"**For in such processes the basic situation is any situation that satisfies the requirements of the constructive insight** —" (*CWL* 3, p. 71). Now this is a constructive insight that has already afforded a certain amount of symmetry, simplicity, ease of solution, because that's what a theoretical investigator is doing. "— **and provided the process is closed off against all extraneous influence …**" (*CWL* 3, p. 71). Now, one of the things that I did do explicitly when we were looking at those solutions to Newton's equations was to say: "Oh, by the way, no big massive object is going to come hurtling in, like in the film "Deep Impact" or something like that, and screw up this whole nice formula. But there's nothing in the classical laws that forbids that!!!

*The point that Lonergan's going to make emphatically in chapter three, and then again in chapter four, is the radical abstractness and conditionality of classical laws*; that *they tell you what will happen if certain conditions are given. But they don't tell you what conditions have to be given*. Now that's implicit in Laplace also. It's perhaps not implicit in some of the contemporary cosmologies. Einstein really thought that when he got his gravitational field equations, that they would have the capacity to explain everything. Einstein said a couple of times that his ambition was to discover how "the Old One" made it work! He wanted to discover the mind of "the Old One," which was his affectionate word for God as he conceived of God. That he thought what he was doing was discovering the unified principle, the unified field theory, that would allow him to deduce every event of every future situation. And Stephen Hawking has carried that sort of analysis another step further with his way of advancing a research programme of Einstein: the idea being that from one single law, everything gets explained.

Classical correlations yield systematic processes *only* "other things being equal"; but classical laws themselves do not determine whether or not "other things" are or remain equal.

And what Lonergan is arguing here is that *every classical law of those types always depends upon conditions which the laws themselves do not determine. That you need the additional insight into the concrete to tell you how to apply that, because it has so many potential applications*. And so as he says here, it's determined by — Every successive moment in a systematic process is determined by the way in which you've set up the originative imaginative model.

> **For in such processes the basic situation is any situation that satisfies the requirements of the constructive insight, and provided the process is closed off against all extraneous influence, every antecedent and consequent situation must assume the dimensions determined by the successive stages of the imaginative model.**" (*CWL* 3, p. 71).

And then he gives some characteristics of the "other things being equal." So "other things being equal" meaning other things don't interfere: things that don't come in from outside your imaginative model, things that don't come in from outside the solar system, things that don't come in from outside the moon, things that don't come in from outside the ecological niche. Other things being equal, a systematic process has this kind of wholeness, this whole, this intelligible unity.

## Systematic Process

> **Other things being equal,**
>
> **(1) the whole of a systematic process and its every event possess but a single intelligibility that corresponds to a single insight or single set of unified insights,**
>
> **(2) any situation can be deduced from any other without an explicit consideration of intervening situations, and**
>
> **(3) the empirical investigation of such processes is marked not only by a notable facility in ascertaining and checking abundant and significant data but also by a supreme moment when all data fall into a single perspective, sweeping deductions become possible, and subsequent exact predictions regularly are fulfilled**. (*CWL* 3, p. 72).

*And the important thing is that there's one single unity to — one single intelligible unity to the whole unfolding of all the events. If we imagine back for a moment to the orbit, the elliptical orbit of planets around the Sun, it's that one equation over and over and over* *again: it's one intelligibility! You don't need a new set of combinations of laws every time you go to the winter solstice.*

Indeed, part of a religious symbolism is the recognition of how out of our control the way the planets really are, and the great joy that, well, we're going to get out of here after all next year! Sometimes in Boston it's not always that clear but —

[Subdued laughter]

But *you don't need another way of combining the laws every time you go around the cycle. It's one intelligibility! That's what a systematic process is!*

Examples of systematic processes: Planetary orbits, moons orbiting Jupiter, plate tectonics, pendular motion, the seasons, a beating heart, etc.

**Systematic Processes:**

Planetary Orbits

http://www.ioncmaste.ca/homepage/
resources/web_resources/CSA_Astro9/files/
multimedia/unit4/planetary_orbits/
planetary_obits.html

So now, at this — Hang on, because I'm not sure that this is going to work!

[Pat opens on his overhead display the material showing planetary orbits at the above web-pages]

Okay. So here's a systematic process! The movement of the planets: to give you an illustration: watch this very process. The movement of the planets year after year, epoch after epoch, we have one single intelligible unification of laws and a certain particular intelligible pattern for each of those orbits.

[Pat teaches from Galileo's *Notebooks* displayed on right-hand side of the display, confining himself to this side down to "So there's Jupiter!" below]

**Classical Heuristic Method & Systematic Process**

Ah, and here's another example of that very same thing that we saw as *a classical heuristic process*. This is Galileo's *Notebook*. Over here on the right-hand side, these are Galileo's observations of the motion of what he called the "Medici Stars" around the planet Jupiter. This was very important in his argument in favor of the heliocentric account of the solar system. This is a series of diagrams that he made. This is his representation of Jupiter, and these are three of what we now call the moons of Jupiter. So this is one night, and this is a few nights later. This is Jupiter, and there are two moons here, and two moons over here. Now notice there's only three there! This is very important, because as I mentioned, Galileo's daughter [inaudible] for the importance of explaining to her but it is a little complex to go through for the moment.

*But what I wanted to show you here is that Galileo was doing some of that scissors from below upwards. He made observations; he made tables and charts, and those tables and charts helped him to have insights.*

And so you can see here his representation of the relative — and he's got them numbered here — relative representation of the locations of the planets night after night. …

So there's Jupiter!

**Classical Heuristic Method & Systematic Process**

Now we go from the table to a diagram, to a graph! And so, as you see, along the horizontal lines of the paper [on left-hand side], the moons moving back and forth relative to that circle of Jupiter. And now he can put it into a graph. So the systematic process: it looks like it's going according to some nice sweeping phenomenon. [Graph points arranged like a continuous uncoiled spring spiralling upwards from Jupiter on Pat's diagram].

*And although Galileo was really making the argument about the motion of things in the solar system, in the universe, around something other than the earth, which was important for his argument, it took Newton to be able to take, and combine laws, to give a concrete inference about the motion of the moons around Jupiter.*

And we saw that equation for the concrete inference a moment ago! And if you graph that equation, lo and behold: all those observations — okay, this would be one particular moment as it orbits around Jupiter — going through a nice single intelligibility that unites all those observations, all those experiential data points, okay.

**Classical Correlations**

$$F = m\, d^2r/dt^2$$

**(Newton's Second Law of Motion)**

$$F = -G\, m\bullet M/r^2$$

**(Newton's Law of Gravity)**

**Concrete Inference**

$$1/r = a\,(1 + E\cos\theta)$$

**(An ellipse when E < 1)**

**Single intelligibility; deducible without intervening situations; exact predictions**

Moving on now, here is *another example of a systematic process*. Let's stop here for a moment! *What we are looking at here is a diagrammatic and imaginative representation of the dynamics of plate tectonics*.

## Systematic Processes:

## Tectonic Plate Convections

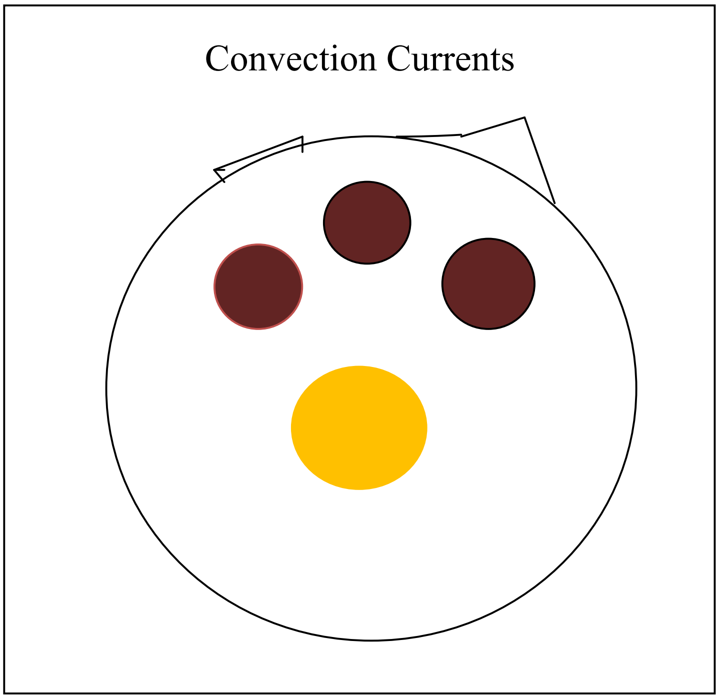
http://education.sdsc.edu/optiputer/flash/convection.htm

This is meant to be the earth [Pat uses his pointer]; these are meant to be the continental plates, these big massive rocks that carry the continents, and these are the convection zones. [Pat is pointing to aspects of his diagram, a diagram from the site specified above.]

So what's happening in the interior of the earth is: it's so hot that rock is molten, and even hot enough that it melts metals like iron. And the heat flows in circulating patterns, much as the heat flows in circulating patterns here at the surface of the earth. As you know, here on the earth gases — things evaporate, rise, cool, come right down again to earth. So something very much like that happens in the interior.

*Now, the important thing of course is no physicist or geologist ever sees this happening! This is very important! And it's one of the things that is the trap of the oversight of insight*! There is really good evidence that this is a correct, intelligible understanding of data. And among the data are things like fissures in the ocean and mountain building, which we're going to see happening in a moment.

But this is a systematic process! The molten materials in the interior of the earth just keep circulating around and around, the same thing, one single intelligible process! And they then result, as I said, in these fissures in the ocean as plates collide. You see this: you get earthquakes and you get mountain building.




So that's another example of a systematic process.

Now, remember systematic processes are always under the proviso: "Other things being equal!" External things don't interfere! But if you can imaginatively seal off undesirable — because it makes you work a lot harder — interferences, you can get systematic processes.

The real meaning of closure.

False meaning of "closure": no self-contained systems exist, contrary to Laplace.

Lack of simplicity or systematicity hinders our ability to make predictions based on classical laws.

More adequate meaning of closure.

## Systematic Process

*We've talked about some of the examples*! We talked about the planet systems. We talked about plate tectonics. A pendulum swinging back and forth is a systematic process. You only need one equation. It'll just keep swinging back and forth. If you ever get the chance to go to the Museum of Science in Boston, there is this huge Foucault pendulum that swings back and forth. It's not the Foucault of the twentieth century!

[Subdued laughter]

This was Léon Foucault, who lived in the nineteenth century.[4] And the pendulum just swings back and forth — single equation, single formula covering it. One could include the seasons of weather — I don't mean the particularities of the weather. I mean the seasons! Every year we have summer — well, this year we didn't, but … !?!

[Hearty laughter]

Every year we have winter. And so on. And other things like the beating of the heart, respiration, and so on! Blossoming of vegetation, the falling of the leaves. Those are sort of illustrations of systematic processes, just to give you some further things to think about what they are!

[4] **Léon Foucault** (1819 – 1868) was a French physicist best known for the invention of the Foucault pendulum, a device demonstrating the effect of the Earth's rotation. He also made an early measurement of the speed of light, discovered eddy currents, and although he didn't invent it, is credited with naming the gyroscope.

And as Lonergan says, systematic process "**throws light on the precise meaning of closure.**"(*CWL* 3, p 76). Now, the interesting thing is what Lonergan actually does say about that, because he is actually speaking against a false idea of closure. *The false idea of closure is the ideal of the closed system, meaning totally self-contained. And in a sense that is what Laplace is saying: that modern sciences give us a totally self-enclosing system.*

What Lonergan says is something very different, and interestingly different. So this is on page seventy-six:

> **The distinction between systematic and nonsystematic processes throws light on the precise meaning of closure. For there is an external closure that excludes outside interference.** (*CWL* 3, p 76).

So you just think of things like mountain ranges that pose barriers between species on one side of the mountain range and species on the other side of the mountain range. And so on.

> **When it is applied to a systematic process, the whole course of events is mastered by intelligence with relative ease.** (*CWL* 3, p 76).

So in other words, if you've got an imaginative way of closing things off — and it's your imagination, so you're free to do whatever you want — if you want to include [exclude?] external influences, it makes the whole of whatever you are thinking about and its unfolding very easy to handle.

> **But when it is applied to a nonsystematic process, then it merely leaves internal factors all the freer to interfere with one another.** (*CWL* 3, p 76).

Which is — For example, this business of a three-body problem. The moon, the sun and the earth are dancing with each other in ways that interrupt the dance. So the moon's dance with the sun interrupts the earth's dance with the sun, and vice versa; and so on all through the various permutations of that. *So that's why the three-body problem is not in general soluble! Because if you don't have a nice symmetric easy initial situation, it just leaves the moon all the freer to interfere with the sun and the earth, the sun all the freer to interfere with the moon and the earth, and so on.*

Now the fact of the matter that the moon does have a fairly regular period around the earth means that it happens to have had one of these nice accidental symmetries, that was constitutive in its generation. *But the laws weren't responsible for that! It was just a matter of circumstances that we had that symmetry that allows for regular movement of the moon around the earth and of the earth around the sun*.

Influenced by Newton's physics, even Kant saw both nature and society as a *system* of laws.

I thought I'd throw in something, because Kant was extremely concerned with the implications of Newton's physics. He initially was a Leibnizian, because he thought that Leibniz had a way of resolving what's called the action at a distance problem of gravitation. He later on, for a variety of reasons, became dissatisfied with Leibnizian or Wolffian metaphysics, and sought other ways of dealing with some of these issues, partly because he became convinced that Leibniz seemed to have excluded real human freedom.

**Systematic Process**

**Immanuel Kant: Nature as a System of Laws**

The determinism that he saw built into the Leibnizian system seemed to him to exclude human freedom, which was really crucial for Kant's whole way of thinking about the moral issue. So I've just thrown in a couple of these quotes. This is from the *Grounding of a Metaphysics of Morals*, where Kant talks about *nature*.

> "In the previous imperatives, namely, that based on the conception of the conformity of actions to general laws, as in a physical system of nature …"
> "By a kingdom I understand the union of different rational beings in a system by common laws." (*Grounding of a Metaphysics of Morals*).

And *he uses that word 'system:' that nature is a system of laws*. And when he goes to give an argument about the ideal human society, that it would be a kingdom just as we speak of the animal kingdom and the plant kingdom and the mineral kingdom; *that the ideal human kingdom would also be governed by a system of laws*.

And it would take us too far afield here to make the argument, but I think that in some ways, Kant is here either assuming or quantifying [word unclear] this notion that *modern science has delivered to us nature as a system*.

So the implications of this oversight of insight are pretty profound!!

Discussion of non-systematic processes.
By violating the assumptions of imaginative model, a nonsystematic model can be constructed.
Modern science's oversight of its own insights.
Failure to see that the universe might not be systematic.

## Non-Systematic Process

> **It is always possible to construct a different group or series by the simple expedient of violating the determinate principles. But the group of systematic processes is constructed on determinate principles. Therefore, by violating the principles one can construct other processes that are nonsystematic.** (*CWL* 3, p. 72).

But then Lonergan says: if we'd really paid attention, *what we discover is you can create another kind — you can construct another kind of model simply by violating the assumptions of the imaginative model*. And so it's possible to not only construct a systematic process using the classical laws of physics and chemistry and biology and geology and so on, but *you can also construct a non-systematic model. And Lonergan is blaming the oversight of the possibility that modern — that the natural world is a non-systematic phenomenon he's blamed on the oversight of insight. That because they didn't recognize how much they can put into the combining of laws to get these great predictions, modern science overlooked the fact that its achievements are equally open to the possibility that the universe is non-systematic*.

And Lonergan is going to — He's not going to give us an argument that the universe is non-systematic. *What he's going to do is to give us an argument that there's no necessity of it being systematic, that the universe is equally open to being non-systematic and being systematic*!

So that's really what the — Both this and that long section of "**The Canon of Statistical Residues**" (*CWL* 3, pp. 109-125) in chapter three — that's what it's all about.

## Student Questions

Question about whether Lonergan's discussion of a non-systematic process implies that a *particular* process (e.g., moons orbiting Jupiter) we once thought was systematic might someday turn out to not be systematic?

No, Lonergan's point is not about this or that process, but about the entire universe – that the classical laws do not imply that the universe as a whole is systematic and deterministic, even if some of its constituent processes are systematic.

Additional question about my knowledge and physical laws independent of my knowledge.

Discussion of the grounds for judgment follows later in the course.

Ah, Mick?

Mick: Yes, I have — I was a little confused about this section when I was reading it. And just by way of example: would we say, in this sort of non-systematic process, is it the case that the revolving of the moons around Saturn, and they did all that work and then charted it, and then said: "See, the moons revolved around Saturn?" Is this basically just saying, like, someone else could come by and say, no they don't?

Pat: Ahm … no, no! So two things! First of all, Galileo didn't figure out that they were systematic. He knew they were regular and periodic!

Mick: Okay.

Pat: But he was able to figure out which one was which, and he figured out the periods for each of them. So in effect, what the "year" or "month," if you like, of a moon on Jupiter was.

Mick: Okay!

Pat: He didn't yet know it as a systematic process. Newton gave the mathematics that was going to be — Newton gave the laws and the mathematics and the methods that were going to enable people to figure out the systematic intelligibility, the unified intelligibility, that combination of intelligible laws that made that one nice systematic intelligible process.

Lonergan is not saying: somebody is going to come along and say "No, no, what you thought was systematic is not systematic!" He's going to be pretty convinced that the planets around the sun are relatively systematic, and that the moons around Jupiter and the other planets are relatively systematic. *What he's saying is that systematicity is not the whole story of the universe. And there is no necessity that, having discovered the laws of physics, that that means that the universe is systematic*!

Mick: Do you mean: in the Laplace sense that we can predict everything?

Pat: That's right! That's right!

Mick: Okay! And then … is there a distinction then between … I'm still unclear about the distinction between my understanding of the universe and the laws of the universe, you know, correlated independent of whether I know them or not! I don't understand what … Is there a connection between those two possibilities and the systematic and non-systematic process?

Pat: Ahm, well, sort of! Part of the difficulty is Lonergan is going to take this later on! If you remember the first lecture, I very briefly spelled out what he calls his cognitional structure.

Mick: Sure!

Pat: *The first eight chapters of Insight are all focused intently on just that second level of the questions and the acts of insight. When he gets to chapter nine, he is going to take up the question of judgment, and chapter ten the way in which we know we have grounds for making good judgments.*

Mick: Okay!

Pat: So at this point, all he is talking about are the possibilities that are available in view of the insights that are part of modern physics, the classical insights that are part of modern physics. Knowing whether or not the laws are true, whether the classical correlations are true, and knowing whether or not you tru — correctly apply them to situations, that is a matter of judgment! And that he is going to have some things to say about when we get to that point.

> *So the difference between what I think is true of the universe, and what is true of the universe is the difference between my insights about what might be possible about the universe, and my judgments about which of those possible understandings is in fact correct. Okay? There isn't any difference between correct understandings of insights and the way things really are in the universe. And that's going to be his position with regard to the problem of objectivity.* So that's going to — That's a bit down the road for us. Okay?

So it's quite possible that our understanding of the orbits of the moons around the planet Jupiter are imperfect and need to have further self-correcting insights to make them more adequate to understanding how the moons really do orbit. But that's a process of the self-correction of insight headed towards judgment. Okay? Does that help?

Mick: Yes!

## Discussion of the universe as a creative non-system, with regions of systematic processes.

What Lonergan is doing in systematic is to say: Sure, there's a lot of systematic processes in the universe! But that, so to speak, is a kind of an accident, a happy accident —

because things don't have to be systematic.  And now, with our Lonergan eyes open, we can discover, my God, the universe is full of lots of non-systematic phenomena!  And they have important significances!  Does that help?

Mick: Uh, uh!

Pat: *So this is really an argument, not about what the universe is, but what possibilities are opened and closed by classical methods.  And it's against the overwhelming tide of the extra-scientific opinions that the universe is a system.  Lonergan basically is going to say that the universe is a very creative non-system!  And its creativity is to bubble up systematic processes in its midst, but as a whole, it's out of control* [last few words spoken dramatically]!!  *And that's despite the fact that there can be laws of science, the laws of nature!  That that doesn't exclude the possibility that, on the whole, the universe is non-systematic*.

So those of you who've studied some of these figures from Nietzsche to Heidegger to Derrida to Levinas, Lonergan is a post-modern in that sense!!  He doesn't share other post-modern things.  But in the sense that the world, reality, is shot through with contingency and unpredictability and creativity — that's the universe!  But Lonergan is making this claim, not against science, but in the name of science.  And it's modern science itself that opens up these possibilities!  Okay?  That's really what's going on in — especially the end of chapter two and section six of chapter three, "**The Canon of Statistical Residues**" (*CWL* 3, pp. 109-125). …

How are we doing for time? [Pat checks his timepiece!].  Okay.

Student Question:  Is it possible that we use
'nonsystematic' to mean 'we just don't know yet"?
A nonsystematic process may be deducible in
each of its events, yet still the whole collection
of events can be randomly patterned.
Examples of non-systematic processes: raindrops
hitting windshield, sprouting of dandelions, etc.

No single intelligible unity, and no single formula to express why that specific ***set*** of dandelions sprouted there in that pattern.

Okay. Mike?

Mike: I guess I'm still having trouble about seeing why non-systematic means "We just don't yet know!" And saying like, 'systematic' is what we've figured out, and non-systematic is what we have yet to discover! And so it's just really kind of putting, saying, well, we can never know everything. And so, it just seems like an assumption.

Pat: Okay. Part of the answer — and I'm not sure if it fully answers what you are asking! But part of the answer is something that Lonergan says. He actually says it in several different ways over the course of these sections of these chapters. But one of the places is on pages seventy-two through seventy-three, where he begins to give some of the characteristics of the non-systematic process. …

## Non-Systematic Process

Let me get my bearings! … Among the points that Lonergan makes on pages 72 and 73 regarding the meaning of non-systematic process are the following: There is

(1) no single insight, or single set of unified insights, that masters at once the whole process and all its events, and

(2) no single combination of selected laws that holds for the whole process.

(3) The process may be deducible in all its events, and it

(4) exhibits coincidental aggregates.

So right at the top of page seventy-three, he says: "**Thirdly, such nonsystematic process may be deducible in all its events.**" (*CWL* 3, p. 73). So in other words …

What are examples of non-systematic processes? Yeah … Well, so here's an example: Pattern of raindrops falling on a windshield! So at any given moment, several raindrops are hitting the windshield, each section of it. Or the series of clicks in a Geiger counter that are used to measure radiation. Or the series of genetic mutations in the history of a species. Or the sprouting of dandelions in a lawn.

**Non-Systematic Processes**

Pattern of raindrops falling on a windshield

Series of clicks in a Geiger counter

Series of genetic mutations in history of a species

Sprouting of dandelions on a lawn in a season

Pattern of temperatures in course of a year

Within the next twenty-four hours if it's not raining, I invite you to do a couple of things. Find a piece of grass, a plot of grass, that's say no more than a yard square, and just look at it! And you will not see nice rows. You won't see any nice grid. The grass grows there in ways that have no simple pattern. Now I can't prove to you that that's the case, but very likely it's a non-systematic aggregate of grass! And there is no particular rhyme or reason for why dandelions grow where they grow. Every single dandelion is completely explainable if you grant that that little "parachuty" thing [puff-ball?] goes down, gets into the ground, wriggles itself down, gets enough moisture and has enough of the right nutrients, starts to sprout its roots, and boy, once dandelions sprout their roots, they grow like crazy! And then it will grow up!

*You see every single dandelion can be completely explained, so to speak, as a systematic process. But a lawn of dandelions can't!* So his point here is that if you take a *process* to be *a bunch of events*, each event in that bunch can be very nicely 'cause and effect' traced. *But it doesn't have any intelligible unity of the whole of those. The whole lawn of dandelions doesn't have any intelligible unity. You can't give me a Laplacian single formula that expresses the intelligibility for why all those dandelions are there! You can give me a lot of intelligibility as to why each dandelion is there, but not why the bunch of them is there.* And that's pivotal! [This short utterance is unclear and uncertain.] There isn't any intrinsic connection among the dandelions, and where they grow, and when they started and germinated, and so on. And that's what he's getting at there! It's this Laplacian ambition of a single intelligibility! Does that make some sense?

Mike: Yes.

And we can be just as ignorant about how non-systematic it is, as we can be ignorant about how systematic it is!

*His argument isn't about how accurate our knowledge is. His argument is about the fact that the laws of classical heuristic structure don't mean that the universe has to be completely and fully determined. That's all he's doing! He's taking that off the table as an implication of modern science!*

Lonergan argues that there can be no proof that the universe is systematic, based upon the 'laws' of science alone; yet he believes that the universe actually is non-systematic, although he offers no proof for this.

Now with a bit of a sleight of a hand, he throws in one line "*and they probably are*!" *There probably are non-systematic processes. And then it is clear that his* **belief** *we might say, or his opinion, is that the universe is non-systematic. There's no argument for that in the book*! The argument is against the idea that the laws of science give us a closed system universe. He is arguing that the laws of science are open to both the possibility that the universe is systematic, or that it is non-systematic. And it is, you might say, his judgment or his opinion, that the universe is a non-systematic process. Okay? *About that he could be wrong*!

But as he says, I would be wrong on empirical grounds, and not as a consequence of the laws of science, which is what is being presumed in the extra-scientific opinions! Okay!

All right! Jonathan and Matt and Byron and anybody else who may have questions, hang on to your questions. Let's take a break and when we come back, I'll start with those questions. Okay?

## Insight & Beyond: Lecture 5, Part 2:

## Chapter 2, §§ 3-4: Non-Systematic Processes and "Statistical Heuristic Structures"

Various Student Questions:

Question about how the systematic intersects with the non-systematic.

If the universe were a systematic process, a non-systematic process could *not* emerge.

But, on the other hand, systematic processes can emerge out of non-systematic processes.

Discussion of the gradual emergence of systematic processes from an initially non-systematic universe. (Movement from grand chaos to patches of systematic orderliness.)

Question about restoring a systematic process that has gone awry.

Question as to whether integers and irrational numbers can be considered systematic and non-systematic, respectively.

Question: When we talk about the anticipatory nature of the heuristic, does this mean that we are anticipating those conditions under which the object of observation must be put so that it becomes intelligible to us?

The various different heuristics anticipate different kinds of intelligibilities. Discussion.

Question about whether a process can be non-systematic with respect to some system A and systematic with respect to some system B?

Yes, actually. The question of higher level viewpoints and explanatory genera arises later in Chapter 8.

Model of a Non-systematic process.

Characterized by sporadic appearances; no intelligible order.

Whether or not a process is systematic or non-systematic must ultimately be determined by using empirical methods, working out implications of the alternatives, and gathering supporting conditions.

Where is Lonergan headed?

Western culture absorbed statistics only with difficulty.

Statistics seen as a cloak for ignorance, or an instrumental tool for managing large populations.

*versus* statistics as revealing something important about reality that cannot be known in some other manner.

The Canon of Statistical Residues and why statistical inquiry is needed.

§ 4. Statistical Heuristic Structures.

The difference between the classical mentality and the statistical mentality.

What is Statistics?

Statistical heuristic seeks the intelligibility of *probability* – the *ideal* frequencies – of events in particular times & places.

Classical heuristic seeks correlations that hold for all times and all places.

Lonergan pays attention to the "deeds" – the actual practices of statistical investigators, in order to determine the meaning and intelligibility of these practices.

Statistical investigations as the method of determining *states of populations*.

The "state" of a population consists of a list ("schedule") of probabilities for characteristic categories of events.

Populations are concrete – in this place during that time period.

Examples of statistical populations. Emphasis on the frequency of events, not things.

Lonergan uses the term "co-incidental aggregates" to refer to populations.

Unity of spatial juxtaposition or temporal succession, or both.

No single law or set of laws relating them to each other.

Implications of viewing the universe as a statistical population.

Statistics and Counting.

Questions answered by statistical method: How many, how often, how frequently?

The conditions for being able to do the counting.

Problems encountered in attempting to count.

Limited scientific value of counting.

Statistical method: Sampling instead of counting everything.

Counting is not the ultimate objective of statistical method.

Counting determines the actual frequencies, for the sake of then determining ideal frequencies, from which actual frequencies vary non-systematically.

Statistical method as *going beyond* Actual Relative Frequencies to Ideal Relative Frequencies.

Ideal Relative Frequencies are called probabilities.

Illustration from botany: Mendel's plant genetics.

Supplied insights that met problems that arose within Darwinian Evolutionary theory.

Mendel's insight leaps from actual to ideal relative frequencies.

Statistical method aims at the ideal frequencies of non-systematic processes in populations that are not completely systematic.

Various Student Questions:

Question about how the systematic intersects with the non-systematic.

If the universe were a systematic process, a non-systematic process could *not* emerge.

But, on the other hand, systematic processes can emerge out of non-systematic processes.

Discussion of the gradual emergence of systematic processes from an initially non-systematic universe. (Movement from grand chaos to patches of systematic orderliness.)

| **Non-Systematic Processes** |
|---|
| Pattern of raindrops falling on a windshield |
| Series of clicks in a Geiger counter |
| Series of genetic mutations in history of a species |
| Sprouting of dandelions on a lawn in a season |
| Pattern of temperatures in course of a year |

[Happy even joyful atmosphere at start of session]

Okay. I'm going to ask Byron to start, because at the break Byron got an insight; and I want us to self-appropriate the occurrence of that insight. It may very well have been a judgment as well.

Byron: Ah, that might very well have been the case!

Pat: So Byron, could you tell us what the question was that you had, and what you discovered by thumbing through the pages of *Insight*?

Byron: Yes, yes. Ah, well, so I was very interested in how the systematic breaks into non-systematic, and how conditions can influence that. So if you look at something like, let's say, you know, your plot of grass, right? And you have the turf [grass and the surface layer of earth held together by its roots]. There is a systematic process that you talked about, of growth and all that, but there can be — you know, once you take out, once you take "all things being equal," then everything, you know, you kind of throw the baby out with the bathwater in a sense. And you have to go into a nonsystematic. So if one of the conditions changes, you know, your turf is too compacted or whatever, there's — you have to — you can look at those conditions and manipulate those conditions in order to return it back. *So a systematic process serves as a base line* [Byron holds out his hand in a purely horizontal gesture in front of him] *in a lot of cases*. Am I right in —

Pat: No!

Byron: Darn!!

[Loud loving class laughter]

Pat: You know, it didn't — Okay. So let's think about that for a moment! Suppose *the universe* were a systematic process, which is not really what Byron was saying! *Suppose the universe were a systematic process*! And remember what Lonergan says about *closure*. *Suppose the universe were a closed system. Can the universe go from being a closed system to being a non-systematic process? ... No*!

Given the account that Lonergan has given of what a systematic process is, and that notion of closure, there isn't anything that's going to disrupt the intelligible unity governing all events as they unfold through time. So in fact what Lonergan has is *exactly the opposite* of what Byron was saying.

[Loud Class laughter while Pat has a broad smile;
lovely atmosphere in the class]

Sometimes you know, well, *it's a self-correcting process*!! *We're going to make mistakes*! Byron happens to be on the spot now. I'll be on the spot some other time! You know, Jonathan just asked me a question and I initially said something that gave him an answer and it wasn't right, and he corrected me, so — And next week it will be one of you! But today it's Byron.

> *Lonergan's account is this: that the universe in its earliest times was overwhelmingly non-systematic. And gradually systematic processes emerge out of non-systematic*! That's — And when we get to chapter four, *he's going to use the phrase "**scheme of recurrence**." Now, a scheme of recurrence is not exactly identical with a systematic process*. For example, *a hyperbolic orbit is systematic because it has that one single intelligibility that governs all the events in that motion*. *It's a systematic process, but it's not recurrent*. So there's — But there is a way in which *all recurrent schemes are systematic processes, but not all systematic processes are recurrent schemes*. But what he's going to present for us is: *how, out of non-systematic coincidental aggregates* — we're going to talk about that weird phrase in a moment — *how out of them, systematic processes can emerge where, as he says, they continue to function so long as "other things being equal.*" *So as long as the non-systematic processes continue to, in some statistical fashion, supply the conditions for those systematic processes, and as long as, in statistical fashion, they don't disrupt the functioning of those systematic processes*! Now, we'll go into that in detail next time.

But the universe for Lonergan, and again — What the argument really is — *If you want to say what argument, what valid conclusion, has he really drawn in section four of chapter two* (**Statistical Heuristic Structures** (*CWL* 3, pp. 76-91))*, and particularly in section six of chapter three* (**The Canon of Statistical Residues** (*CWL* 3, pp. 109-125))*, the valid argument that he's given is: there is no necessity that the universe has to be a systematic process just because there is modern science.* What he is going to hold, and argue for, in a more quasi-inductive probabilistic fashion, is that the universe is moving from a grand chaos towards gradual systematic orderliness; but not in a way that is ever going to mean that everything becomes one system. As he says, it is out of the womb of non-systematic — it's the womb of novelty! Things novel, systematic, intelligible emerge out of the non-systematic!

## Question about restoring a systematic process that has gone awry.

Byron: How would you explain something like — Let's look at cardiology! So you have the systematic process of the beating heart, the functioning, beating heart. The conditions of that beating, right, the conditions change or something! You know, I've got a leaky valve or something like that.

Pat: You're saying that the conditions are not equal anymore! Other things are no longer equal!

Byron: Correct! Right! Okay! So they're not equal any more. But the goal is to get back into that systematic process. That was my — That's what I was trying to —

Pat: Okay. So what I did was I changed your question into talking about the whole universe rather than a particular thing. So what your example in effect amounts to is figuring out how to change the non-systematic conditions, the environment of the heart, so as to put it back into a systematic process!

Disease, particularly of things like cardiology, are complicated. How the conditioning factors for a regular functioning of the heart-beat get out of kilter, at some level involve a non-systematic interference: other things stop being equal. But they can do so in such a way as you get a kind of systematic interference with the heart. Things that shouldn't be there during the cycle of the heart-beat, are there [actual words inaudible], and it will change the sodium [unclear word], you've got to change the electrolytic balance, and things like that. So you do that by figuring out what part of the conditions supporting the regularity of the systematic beating of the heart, how have they gone wrong, and then try to make them [previous four words guessed at] equal. Okay? That's probably what you meant to say, that I didn't listen to [with a warm smile].

Byron: Uh uh.

## Question as to whether integers and irrational numbers can be considered systematic and non-systematic, respectively.

Pat: Okay. Matt?

Matt: Yeah! I just wanted to go back — it was like two pages ago, I think, on the PowerPoint, you talked about shifting from systematic to non-systematic by "**violating the determinate principles**" (*CWL* 3, p. 72).

Pat: Right! Uh, uh!

Matt: I just wanted to make sure I've got this correct. Would an example be, if you're given in mathematics, the number system of just — I don't know the proper vocabulary — but whole numbers, one, two, three, four … And then you were to do the square-root of two or [the square-root of] four minus five and you get an irrational number, is that what he's talking about by going — Is that —

Pat: — *That actually would be an example*! He has this remark about: *A situation is random if it violates a determinate intelligible principle*. So if you have a determinate intelligible principle, what you can do with numbers, and you do something against it, that would be a random act in the mathematics.

### Non-Systematic Process

> **It is always possible to construct a different group or series by the simple expedient of violating the determinate principles. But the group of systematic processes is constructed on determinate principles. Therefore, by violating the principles one can construct other processes that are nonsystematic.** (*CWL* 3, p. 72).

Matt: Because I like — Before you said that it was completely wrong, I liked Byron's idea that the systematic was the baseline! Can it be kind of an abstracted baseline, if we all know that it's not — that there *are* these numbers that we don't *see*, but they do exist; that the square-root of two does exist, but it's not a pretty number. But if the number system of just whole numbers does act kind of like a baseline, and then when we deviate from that and we go into unreal numbers, that's when we're getting into what is really true, but it's very difficult to work with:  not working with whole numbers.  That's what I understood by the base line of systematic.

Pat: Ah …. Okay, I'm not sure I quite follow that. … If we're in the arithmetic, in the mathematics of whole numbers, and then suddenly there's an entity that doesn't fit in the orderly pattern of the whole numbers, how they add and subtract and multiply and divide, then that would be a non-systematic irruption into the whole numbers! The difficulty is that the whole numbers sort of don't function like the universe.  They're overwhelmingly a product of human invention.  They're overwhelmingly a product of this imaginative model.  You know, you put some marbles out on the table, and you start to count them with your finger, and you get a certain kind of ordering that comes about from that. That is different than the way in which things like dandelions and cosmic radiation fall upon us, so to speak.

Matt: Because aren't whole numbers a primary example of us saying, in a whole, you know, world-wide community, suppose, let's just suppose?

Pat: That's right!  That's exactly right!  *That's what he means by the constructive theoretical insight*.  Let's suppose the world were ordered this way!

Matt: Right!

Pat: But his point is that sometimes the imaginative model comes first, and the supposing is kind of implicit already in the imaginative model.  But what has happened in western thought for several centuries is thinking that that's all the result of just the classical laws, and not the imaginative model!  So there's a lot of supposing involved in it!!

Matt: For Lonergan ideally we should have started at irrational numbers, at the non-systematic, and then went from that ground to saying:  "Okay now, since this is nitty-gritty and it doesn't really work well in the common day-to-day practice, because no-one wants to deal with the square-root of two, let's all suppose that the number system is more systematic than it really is."

Pat: Well you — Yeah, sure you could say it that way, except we wouldn't learn — we don't learn in that way. *We learn by making great abstractions, and then adding further insights that complexify things*! Okay? …

I'm feeling bad because I didn't really listen to what Byron was suggesting [remark unclear].

[Huge class laughter]

This will haunt me for the rest of the week!!!

Student: No, no!!

Question: When we talk about the anticipatory nature of the heuristic, does this mean that we are anticipating those conditions under which the object of observation must be put so that it becomes intelligible to us?

The various different heuristics anticipate different kinds of intelligibilities. Discussion.

Pat: Let's see? Greg?

Greg: I guess my question is: when we talk about the anticipatory nature of human intelligence, the heuristic nature of it, are we anticipating precisely those conditions under which we're going to put an observation so that it becomes intelligible to us, or something different?

Pat: Ahm, sure! *There are a lot of different kinds of anticipations. So, when I gave that sort of overview of heuristic notions and heuristic structures, it just had to do with the general way in which human inquiry intelligently anticipates. And by talking about classical heuristic structures, we're talking about the particular kind of intelligibility that's being anticipated*. People do anticipate other things, namely, what kind of situations there are, to which these classical correlations can now be applied. That would be a second kind of anticipation. When we get to the chapters on common sense, we will discover that people of common sense anticipate in all kinds of complicated ways.

The next thing that we're going to do, hopefully today, is to talk about the way in which statistical investigators anticipate a different kind of intelligibility, different in kind from the classical correlation. The genetic method, the dialectic method, they also anticipate still further dramatically different kinds of intelligibilities. So, yeah, we have anticipations also about what kinds of situations there are to which these laws might be applied. And we can be either more or less closed-minded in anticipation. Does that help? Okay!

> Question about whether a process can be non-systematic with respect to some system A and systematic with respect to some system B?
>
> > Yes, actually. The question of higher level viewpoints and explanatory genera arises later in Chapter 8.

Ahm, was there somebody there? … Ivan?

Ivan: If the systematicity or non-systematicity of an ideal process is relative to the system, is it possible to consider the same processes at the same time non-systematic with respect to system A, and systematic with respect to system B?

Pat: Ah, yes! That's right! So it's systematic relative to the classical laws that have been combined in a relatively simple and unified fashion. And if you don't have in mind, say the laws of biology, there are going to be regular things that appear kind of strange. You can say the laws of physics explain everything, but you really don't know the intelligible reasons for their intelligible unity, unless you get to level B or system B, as you call it. So yeah, that's right! And we'll talk about that. Ah, I think this first comes up in chapter eight, where he talks about explanatory genera. He's going to make an argument that there are higher viewpoints among the sciences: where things that are regarded as non-systematic on one level will be regarded as systematic on the other level, because there are intelligibilities that weren't thought of on the lower levels. So that's right! Okay?

Okay! So let's move ahead here!

Model of a Non-systematic process.

Characterized by sporadic appearances; no intelligible order.

Whether or not a process is systematic or non-systematic must ultimately be determined by using empirical methods, working out implications of the alternatives, and gathering supporting conditions.

Ah, I just wanted — like, I gave you just some examples of non-systematic processes [Pat says 'systematic'] without giving any illustrations.

**Non-Systematic Processes**

Pattern of raindrops falling on a windshield

Series of clicks in a Geiger counter

Series of genetic mutations in history of a species

Sprouting of dandelions on a lawn in a season

Pattern of temperatures in course of a year

And this [the "Non-Systematic Process" slide after p. 59] is a kind of abstract illustration of a non-systematic process [Pat again says 'systematic], but if you compare this with the nice periodic systematic way in which the x's appeared when I was giving you the comparison of the moons of Jupiter [the "Classical Heuristic Method & Systematic Process" slide prior to p. 38], this is sort of an example of one of the non-systematic processes.

These things, these events are happening *in places* — the location axis there — and *at times*, and they just appear to have no simple intelligible unity. *They have a unity, as he says, in space and in time, but there's no intelligible order to them. And how do we know that? We don't!* At one point Lonergan says: ultimately what you have to do is to work out the implications of something being systematic, work out the implications of its being non-systematic, and see what the evidence is on either side of the equation!

*So again, as I've been saying, what he's really doing here is trying to reverse a very powerful, over-riding, extra-scientific opinion about what is implied by natural science*! This extra-scientific opinion appears in such a way, as I tried to point out last week, as to make the universe an alien universe in which human being and human creativity have no place; its effect tends to be such that we have to retreat into our interiority because the universe is against us! That type of thing! So that's what he's doing here.

So that's an example — If you compare that to the swings back and forth of the graph points that were meant to represent the motion of one of the moons of Jupiter around Jupiter, that [pointing to the non-systematic process diagram] would be relatively non-systematic! I tried to make this diagram as kind of random as I possibly could! Random and non-systematic are not identical by the way.

Where is Lonergan headed?

Western culture absorbed statistics only with difficulty.

Statistics seen as a cloak for ignorance, or an

instrumental tool for managing large populations,

*versus* statistics as revealing something important about

reality that cannot be known in some other manner.

The Canon of Statistical Residues and why statistical

inquiry is needed.

So where is Lonergan headed with all this? So remember, we've only — we're still — we're just getting out of section three of chapter two here! And it's been a big — he's made a big deal — *an awful lot depends on his claim that there has been an oversight of insight that has to do with how people go from the discovery of classical laws to what they think it actually explains in the universe*. And, where is he headed?

**Where is Lonergan Headed?**

**Even if world process proves to be systematic, still that will be true only on empirical grounds and a posteriori; it follows that it cannot be true a priori that statistical science**

> **cannot be the science of what exists. On the present showing, then, there can be no valid theoretical arguments that establish that statistical science in every possible meaning of the term must be a mere cloak for ignorance**."
> (*CWL* 3, p. 76).

So "**even if world process proves to be systematic,"** — and he doesn't think it will — **"still that will be true only on *empirical* grounds and *a posteriori,"*** — *so based on experience* — ***"it follows that it cannot be true a priori that statistical science cannot be the science of what exists."*** (*CWL* 3, p. 76, emphases added by Pat).

Now, there was a remark earlier on with regard to extra-scientific opinions. And I'll give you a short version to put in. If you go back and look at that quote where Lonergan talks about extra-scientific opinions, one of the things he mentions explicitly there is the difficulty that western culture had in absorbing the implications of statistical science. And one of the ways it absorbed it was to say it's a cloak for ignorance. And that's actually what Laplace does! *Laplace is one of the great innovators in the mathematics of probability, and he basically disowns his child! Because he says, it only has an instrumental value; that* really *you can predict everything! But* practically*, probabilities are good things to have because it's so much work*! But then, you know, he didn't have Pentium chips to grind the numbers for him!

> **On the present showing, then, there can be no valid theoretical arguments that establish that statistical science in every possible meaning of the term must be a mere cloak for ignorance**." (*CWL* 3, p. 76).

*Lonergan is saying that statistics and probability theory are not cloaks for ignorance*. That's what's meant by saying that statistics is a cloak for ignorance, that is, that *it really gives you only a proximate version of the real world. It doesn't tell you anything really real. It just is a convenient calculation device that you can use to manage populations*. And so every bureaucratic society has statistics bureaus, because you get a lot of statistics! And God help us, the University is becoming ever more data-driven! What kind of data? Statistical data!

*So the idea that statistics is about nothing more than a convenient device for managing things comes right out of Laplace, with the idea that you don't really need statistics except as a labour-saving, time-saving device.*

> *Now Lonergan is saying: No, it's not just a cloak for ignorance; it actually is about reality. Or it could be! This is going to be determined only by empirical investigation*, not by saying what the laws of science are supposed to tell us about how everything runs!

> **The Canon of Statistical Residues**: "**existence of residues that call for statistical inquiry**." (*CWL* 3, p. 109).

And then in that section six of chapter three, he's going to have a section entitled — the section is entitled "**The Canon of Statistical Residues**" (*CWL* 3, pp. 109-125). And he points out there that *there is an existence of residues that call for statistical inquiry*! So let's remember now that phrase that he had of "**empirical residues**" (*CWL* 3, pp. 50-56). *The empirical residue had to do with whatever it is in the data that is left over once your insights have explained some part of the data*. And the thesis of that section of chapter one about empirical residues is that there is some aspect to our experience which will always be left over from any finite understanding that human beings in their intellectual endeavour [last four words unclear] will achieve. There will always be something which will escape what he calls the immanent intelligibility that is part and parcel of human knowing.

> Here he is not talking about the empirical residue. He's talking about **a statistical residue**: that there's always going to be some aspect of the data left over after you've done as much as you can with the classical investigation. There's going to be a need for — There's going to be the possibility of, and the desire for, another kind of intelligibility that's different from the classical intelligibility.

That's where he's headed, and I talked a little bit earlier about what he sees as some of the implications of that for the character of the universe, the meaningfulness of the universe, the place of human beings in the natural universe, that's what this is all about!

## § 4. Statistical Heuristic Structures.

The difference between the classical mentality and the statistical mentality.

What is Statistics?

Statistical heuristic seeks the intelligibility of *probability* – the *ideal* frequencies – of events in particular times & places.

Classical heuristic seeks correlations that hold for all times and all places.

Lonergan pays attention to the "deeds" – the actual practices of statistical investigators, in order to determine the meaning and intelligibility of these practices.

**§ 4. Statistical Heuristic Structures.**

So now finally, we're into section four of chapter two (**Statistical Heuristic Structures** (*CWL* 3, pp. 76-91)). And he says that between classical investigators and statistical investigators there is a profound difference in their mentality.

**A profound difference in mentality** (*CWL* 3, p. 77).

**Their deeds seem a sufficient witness to their thought** (*CWL* 3, p. 78).

**The statistical scientist seems content to define events and areas, to count the instances of each defined class within the defined area, and to offer some general but rather vague view of things as a whole.** (*CWL* 3, p. 77).

And he says that the deeds that statistical investigators perform witness to something different! *They witness to the fact that they are seeking a different kind of intelligibility. And the intelligibility that they're seeking is what he's going to call "***ideal frequencies**," which *is* *another word for* **probability** (*CWL* 3, p. 77). *So probability and ideal frequency are two words for the same intelligibility*. And his argument is that statistical investigators are looking for the intelligibility of probability, and that that's different from the intelligibility of classical correlations.

And in talking about the deeds that statistical investigators perform —

*So what are the operations that are structured into a heuristic structure for statistical investigators*?

So statistical scientists seem to be content not to seek or to find a formula, a single formula, that explains all the things, but in fact content

> **to define events and areas, to count the instances of each defined class within the defined area, and to offer some general but rather vague view of things as a whole** (*CWL* 3, p. 77).

So there's a certain contentment with a different kind of pursuit! Now what Lonergan is doing here is looking for the meaning of and the intelligibility behind that kind of pursuit.

Statistical investigations as the method of determining *states of populations.*

The "state" of a population consists of a list ("schedule") of probabilities for characteristic categories of events.

Populations are concrete – in this place during that time period.

## What is Statistics?

So let's revert to the language that's a little more familiar to people who work in statistics, because Lonergan has invented some terminology here that you won't find in your "*Introduction to Statistics*." *And his method of identifying the deeds of statisticians is coming out of really what he sees as the significance of the innovation of statistical sciences*. And so it's kind of — That trajectory that he's on has covered over to some extent things that we are a little bit more familiar with. But nevertheless, if you read carefully, you'll say: "Oh yeah, that's right! Those *are* the deeds of statistical investigators!" It's just that he's flying kind of fast and furious through this. So let's slow down a little bit, and look at: What do statisticians do?

So statistics — *Think of statistics as the method of determining states*. So he says, just as classical investigators want to know the *nature of something*, statisticians want to know the *state of something*. And knowing the state of something, that means knowing of several different categories which exhaust the categories, so like: How many people in age-bracket zero to ten, ten to twenty, twenty to thirty, thirty to forty … eighty to ninety, ninety to a hundred, a hundred to a hundred-and-ten, have heart disease? That's the *state* of cardiac health! But in order to do statistics, you have to say: in the United States, in the decade between two thousand and two thousand and ten!

## § 4. Statistical Heuristic Structures.

> **The statistical scientist seems content to define events and areas, to count the instances of each defined class within the defined area, and to offer some general but rather vague view of things as a whole.** (*CWL* 3, p. 77).

Statistical scientists "**define events,"** heart disease, **"and areas … count the instances … and … offer some general but rather vague view of things as a whole."** (*CWL* 3, p. 77). So you have to define an area, you have to define a period of time, and you have to determine what category you're talking about, in order to do the statistical science.

## What is Statistics?

That's why he says that *statisticians have to say statistics for what time and what place and what kind of event*. Classical investigators want to know the correlations that hold for all time and in all places; and when they find that it doesn't hold for a time, they want to correct it and make it more general. That's not what a statistician does! So a statistician seeks to talk about the state of a population! Statisticians deal with populations. And a population, by definition, out of a Merriam-Webster dictionary, is "all the people living in a region." But by extension, a population is a collection of events or things, a "total set of items from which a sample is taken." This is another dictionary definition!

*So I want to emphasize here the word '**events**.'* Lonergan's emphasis is going to be on statistics as events! We tend to think of populations as people or animals or plants, or maybe even diamonds in an area with a mine, i.e. as things! *The emphasis here is on events, because statisticians are not really even talking about the things or the number of moose organisms in Massachusetts. They're talking about the number of sightings of moose organisms at a particular time*. So even the most obvious examples where statistics seems to deal with things, a little bit of reflection reveals that they are most probably talking about events.

*Now Lonergan is really interested in the statistical study of events, because he is interested in implications that statistics has for processes. And processes are series of events*! So he's going to put the emphases on events. It isn't that statistics is *only* about events*, but it is overwhelmingly a study of events*! The *occurrences* of heart-disease in people, as opposed to *people* with bad hearts!

## Populations in Regions and Times

So for example, "Populations in Regions and Times." "*All the people or things in a region*:" the number of people, chairs, computers in this room right now" is an example of that. "The number of human-beings twenty-one years or older in the U.S. right now." So notice that we've got *a geographical confined period of time*, and then we're talking about *the number*. The number of people infected with the H1N1 flu in the world right now! The number of moose in Massachusetts right now! *So all the events in a period*! The number of tornados in the U.S. during 2004! The number of inches of rain (rain-drop events) received at BC during June 2009! There was a lot! The number of deaths due to pneumonia in France in the nineteenth century! The formations of ozone in the stratosphere per second! What I mean by that is the conversion of $0_2$ into $0_3$. Ozone is $0_3$, and it is very important to shield the earth from excessive ultra-violet radiation.

Just giving you an example: *what is statistics about? It wants to find the state of — What's the state of the moose population in Massachusetts in a year? It wants to find the state of the influenza, and so on! So that's what's being studied in statistics*.

# Co-incidental Aggregates

Now Lonergan doesn't use the word 'population.' He uses the word '**coincidental aggregate**' (*CWL* 3, p. 73), a very puzzling word. But it is the same as 'population.' So he defines a coincidental aggregate as: "**(1) the members of the aggregate,**" the collection**,** "**that have some unity based on spatial juxtaposition or temporal succession or both.**"

> **For an aggregate is coincidental if**
>
> **(1) the members of the aggregate have some unity based on spatial juxtaposition or temporal succession or both, and**
>
> **(2) there is no corresponding unity on the level of insight and intelligible relation**. (*CWL* 3, p. 73).

So notice what I did here just in saying the sort of thing that statisticians study. They identify a spatial area, a spatial confine or a group of spatial confines, and a period or periods of duration that is their object of study. So that gives the "**spatial juxtaposition or temporal succession or both**!" So events that are confined or reside within some geographical and temporally defined region. But "**(2) there is no corresponding unity on the level of insight and intelligible relation**" (*CWL* 3, p. 73). *There's lots of events going on in this location during this period of time, but there's not one law, not one single law, not one unified set of laws that explains all the events going on in that place and in that time. So it has a spatio-temporal unity to it, but not a corresponding intelligible unity*. There's not one single formula that explains all those events in that period of time. *There's a lot of different intelligibilities that explain each of those events, but those paths of intelligibility don't have any necessary connection with one another*!

That's why I used that example of dandelions on a lawn. The fact that a dandelion is here and a dandelion is there doesn't necessarily have anything to do with one another. It doesn't even have to do with the fact that they have the same parent that sends down these little parachutes. One parachute could have come from one and one from another. There's no intrinsic intelligible connection! And yet they're all here together!

*Now behind this is the idea that the universe is a big spatial, temporal container, so to speak*! *And the idea behind Laplace and the deterministic, closed, calculable notion of the universe is that it has an intelligible unity in virtue of the classical laws of science, when in* *fact it just has a spatio-temporal unity, in which there is a lot of disconnectedness*! *This is a disconnectedness which has potentiality for new intelligibility, but not an intelligible unity that squeezes out innovative new intelligibilities.*

Statistics and Counting.

Questions answered by statistical method: How many, how often, how frequently?

The conditions for being able to do the counting.

Problems encountered in attempting to count.

Limited scientific value of counting.

*As Lonergan says, what statisticians do is they ask the questions: How many? How often? How frequently*? Now the simplest answer to that is by counting. So we can just count everybody in this room, and we will get the statistics on this room.

**Statistics and Counting**

Statistics answers the questions,

"**How many, how often, how frequently?**" (*CWL* 3, p. 77)

The simplest answer is obtained by counting.

As Lonergan says, that doesn't do two things. First of all, it doesn't give you anything that has any validity as soon as this period is over! This room will have different occupants. They will come into this room for as many different reasons as the class that is taught after us drew them in there. There's no one over-arching intelligible reason that put them all in the room. And it had nothing to do with us! *So whatever counting we do here is of limited value, and of limited scientific importance*.

**Conditions for counting:**

Definition and Classification

Containment in space and time.

And there are conditions for being able to do the counting, namely: you have some way of differentiating some events from others, and of getting a specific time and place.

**Problems with Counting**

**Problems faced by counting populations**

Size

Populations change and shift through space and time

Population size at a particular place and time is of very limited scientific value (*CWL* 3, p. 80).

But there are problems with counting! First of all, the size! It would be very difficult to count all the oxygen atoms in this room like that! That is a huge number, and they keep moving around, a little like the Count's bats! They move a lot faster!

[Class laughter]

*So counting is often very difficult*! So statisticians, when they want to find the state of something in a geographical temporal boundary, are faced by the fact that *quite often they are talking about populations that are very big*. Even the human beings in the United States are difficult to count because there are over three hundred million of us! *And to make matters worse, populations shift and change*! So as soon as you start to count the people in the United States, somebody gets on a plane and flies someplace else. By the time you get done counting the population has changed, and somebody else has followed them there.

Statistical method: Sampling instead of counting everything.
Counting is not the ultimate objective of statistical method.
Counting determines the actual frequencies, for the sake of then determining ideal frequencies, from which actual frequencies vary non-systematically.
Statistical method as *going beyond* Actual Relative Frequencies to Ideal Relative Frequencies.
Ideal Relative Frequencies are called Probabilities.

And, as I mentioned before, *Lonergan says that getting the exact numbers in statistical studies doesn't have very much scientific importance*. It's not generalizable, and that should be done [phrase uncertain]! You've got no way of knowing that the numbers you came up with in that place have any relevance to any other successive situation.

But we have statisticians who use statistics to draw certain kinds of generalizations: some of them rash, but others not; others well-grounded.

## Statistical Methods

So what are we doing in statistical method? *So one of the things that statisticians do is they don't count everything; they sample*! And if you take methods research courses, what they are teaching you how to do, at their best, is teaching you how to do good sampling as a way of assessing a whole population. So pollsters, when they want to find out how votes are going to go, they don't count everybody. They do a selective sample!

*So statistical methods are actually after something else*! That's the point to all this! It is that statisticians really are not solely interested in an accurate count of the numbers of things in a population. They're after something else. That's what Lonergan says. *Look at their deeds*! They don't rest with just the accurate numbers. They do something else. They do what we humorously call: massage the data! *And what are they doing when they're massaging the data*? *What they're doing is the same kind of thing that we saw in classical* *investigators: they're taking the data and putting it in successively combined and complexified imaginative form for the sake of getting some insights.*

What insights are they seeking? It's not classical correlation! *What they are really after is* ***ideal relative frequencies*** *— which in other words is called* ***probabilities****, from which the actual relative frequency diverge only non-systematically.*

| Actual Relative Frequencies vs. Ideal Relative Frequencies |
|---|

So to begin your investigation, the first thing you have to do is come up with *a set of kinds of events* that we're going to determine. And you have to *define a place and time*. And then you're going to look for *a schedule* — Lonergan uses the word 'schedule' [with a k] — we usually pronounce it schedule [with an sh]! *It's a list*!

*So to study a population, you don't want to know just about one kind of thing; you want to know about the possible ranges in that category*. You don't want to just find out about who's got heart disease. You want to find out who's got healthy hearts. You don't want to just find out about one kind of disease, but all the different kinds of diseases. *You want to find out about the state of health of a population*! You want to find the frequency of the various kinds of diseases that they have. You want to find out about the genetic composition of the population. You don't want to find out just how many of one gene there are, but of all the genes that could be displayed on that genetic location of the chromosome. And how frequently they occur in the population. That's what he means by a schedule!

**Actual Relative Frequencies**

**vs.**

**Ideal Relative Frequencies**

**(1)** ***A set of classes of events, P, Q, R, …*** **in a place and time.**

**(2)** ***Series ("schedule") of actual relative frequencies,***

$$p_1 / n_1,\ q_1 / n_1,\ r_1 / n_1\ \ldots$$

$$p_2 / n_2,\ q_2 / n_2,\ r_2 / n_2\ \ldots$$

$$\ldots$$

$$p_i / n_i,\ q_i / n_i,\ r_i / n_i\ \ldots$$

**(3)** ***The series ("schedule") of ideal relative frequencies,***

$$p / n,\ q / n,\ r / n\ \ldots$$

***is the series or list ("schedule") of probabilities of the events in the population, if the differences***

$$p / n - p_1 / n_1,\ q / n - p_1 / n_1,\ r / n - p_1 / n_1 \ldots$$

***are always random or non-systematic.***

There is this kind of gene, that kind of gene, the other kind of gene, and a fourth kind of gene [Pat gestures at different levels with a horizontal hand] and they appear with these following relative frequencies, these following relative *ideal* frequencies.

$$p_1 / n_1,\ q_1 / n_1,\ r_1 / n_1\ \ldots$$

Now what these numbers here [above] refer to is the number of occurrences of type ***p***, or let's say gene ***p***, in the population that has n subscript one ($n_1$) numbers to it. And then the number that have the gene ***q***, and the number that have the gene ***r***, and so on.

And then you count again on another population:

$$p_2 / n_2,\ q_2 / n_2,\ r_2 / n_2\ \ldots$$

And then you count again on other populations, until you've got a large collection of counts relative to populations. And that gives you the *actual* relative frequencies, how frequently these things occur in this population — in this place in this population at that time, and so on.

$$p_i / n_i, \; q_i / n_i, \; r_i / n_i \; \ldots$$

*But what we're really after is the ideal frequencies.*

**(3)** ***The series ("schedule") of ideal relative frequencies,***

$$p / n, \; q / n, \; r / n \; \ldots$$

And notice there are no little numbers at the bottom of the ***p***s and the ***n***s and the ***q***s and the ***r***s there! That's because we're driving at fractions, percentages, that are not tied to the specific population that we studied in a particular place and in a particular time, fractions or percentages but have some generality that is extendable beyond the limits of those populations. That's the kind of intelligibility that statisticians are looking for.

**(3)** ***The series ("schedule") of ideal relative frequencies,***

$$p / n, \; q / n, \; r / n \; \ldots$$

***is the series or list ("schedule") of probabilities of the events in the population, if the differences***

$$p / n - p_1 / n_1, \; q / n - p_1 / n_1, \; r / n - p_1 / n_1 \ldots$$

***are always random or non-systematic.***

That is what Lonergan says is the probabilities of the events in the population if the differences — So, in other words, if these subtractions here [Pat points at the symbolic elements just above] were the ideal frequency, the probability ***p*** divided by ***n*** minus any of the actual counts you actually did up here [Pat presumably points to the earlier actual counting stages] always form what he calls a "non-systematic aggregate." *So the difference between the actual counts in this trial, in this trial, in this sample, in that sample, if those differences form no systematic pattern whatsoever, then the ideal frequency, the probability that you subtracted them from is an ideal frequency*. It has the quality of being a certain kind of number.

Illustration from botany: Mendel's plant genetics.
Supplied insights that met problems that arose within Darwinian Evolutionary theory.
Mendel's insight leaps from actual to ideal relative frequencies.
Statistical method aims at the ideal frequencies of non-systematic processes in populations that are not completely systematic.

**Statistics of Peas**

**Gregor Mendel, "Experiments in Plant Hybridization," 1865**

If you needed a concrete illustration, one of the most important early applications of probability is from Gregor Mendel's *Experiments in Plant Hybridization*. This is the famous paper which would have solved a very serious problem that Darwin ran into soon after he published — not the religious controversies which he occasioned — but strictly scientific ones! Darwin held to a theory called "blending inheritance." And with blending inheritance, it was hard to see how an adaptive mutation would get stabilized in a population. Mendel had made discoveries about dominant and recessive genes that would have been a big breakthrough for this. But Mendel's work wasn't known by the people who were actively involved in Darwinian Evolutionary theory until about nineteen hundred.

When this was rediscovered, it began a fifty-year period of the development of what's now called Modern Synthesis, or the Neo-Darwinian Synthesis. But it was absolutely essential to move Darwinianism out of the serious scientific limitations that it had into a much better and more adequate theory of evolution. So Mendel's experiments and his use of probabilities were absolutely essential to this.

## Statistics of Peas

**Gregor Mendel, "Experiments in Plant Hybridization," 1865**

| Experiment | Relative Actual Frequencies |
|---|---|
| 3 | 3.15 to 1 |
| 4 | 2.95 to 1 |
| 5 | 2.82 to 1 |
| 6 | 3.14 to 1 |
| 7 | 2.84 to 1 |

"If now the results of the whole of the experiments be brought together, there is found … an average ratio of 2.98 to 1, or 3 to 1."

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And here is — This is just something right out of that paper! So Mendel did these experiments on — He was counting peas with different characters. This one, if I remember correctly, was smooth and wrinkled! He opened pea-pods up to find some peas inside that had nice smooth covers and some were sort of crinkled. They all tasted as good, but I think the Green Giant doesn't like the wrinkly peas, because people are going to think that they don't taste as good — they taste the same, but anyway!!

They show up — And Mendel didn't use the same kind of ratios that Lonergan was using. So he doesn't use "three to one." But this [what is displayed] would be something like: just a little bit over seventy-five percent to twenty-five percent, and so on. So these are his numbers! He did one set of peas that they harvested. They got this ratio of wrinkled to smooth. Another one he got this kind of ratio. [Pat is using his pointer to identify some of the displayed results]. Now notice that those aren't the same number every time. Why? Well, those are the actual frequencies!

And then right in the middle of the article, right after this table, he says: "If now the results of the whole of the experiments be brought together," so if you add these things all together and average them out, "there is found … an average ratio of 2.98 to 1, *or 3 to 1*."

Where did he get three to one? … He never measured that!! And no matter how many times he performed this experiment, he would never get it to come out to be three to one! *That's the insight! That's the insight that grasps an ideal frequency*! And the methods of statistics are shooting to grasp the ideal frequencies of non-systematic processes and populations that are not completely systematic in the organization of the events in those populations.

Okay! We'll have to stop there for today!