The Invisible City

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What does the philosopher see when he looks at the city? As a philosopher, I turn a little away, for I wish to see both the city and what it is that people see, when they look at her. Whose vision defines the city? Perhaps none can by itself, there are many ways in which this city lives in many eyes; together do they show what it is? Let us examine the claims to veracity of each vision, possible and actual. Where is truth, what lies veiled, what blinds us to the real city?

An extraterrestrial comes hurtling down from outer space, her craft out of control. From the moment she enters high in our atmosphere, till her death in a crater in the center of our city, she has a breath-taking sequence of views. She is the most privileged viewer our city shall ever have, as it expands in her visual field, in ever more intimate close-up – from a dot in a plain ringed by mountains and sea, to a city planners' nightmare of incongruously assorted streets and squares, to a matrix of buildings about to engulf her.

Yet, despite her visual privilege, there was much she could not see. Low in the mountains, overlooking us, lives an immortal. Her view is diachronic: as eons pass she sees the waters gather, the earth fold, the first gathering, the growing hovels, the explosion into a village feast, a center of stone gods doused with wine. The center radiates outward, and slowly upward. The man-made hillock grows before her eyes, wanes, appears to die, is reborn, refortified, recovered. Even the level of trade fluctuates visibly before her, the years pass like the wind, the city bursts out of its own walls, it raises itself upwards in skyscrapers, and spreads outward into suburbs.

Yet, despite her diachronic vision that includes our entire evolution into a metropolis, and her clear prevision of our future, there is a city that we live in, and she does not see.

Unlike these fantastic beings, and also unlike the citizen immersed in our city in the here and now, science stares at the city with unseeing eyes. The city it sees is an invisible and abstract structure, partly depicted sometimes in charts, diagrams, maps, tables – for the sake of human communication – at first sight utterly different from the city-dweller's life world. Is this abstract structure the city's essence? Science makes the claim that only through its isolation of fundamentals can we hope to understand the whole. It silences dissent through its success. This success of science lies of course in prediction, manipulation, and control, but also – and this I wish to emphasize – through its demonstration of absolute limits to prediction and control. In the latter lies, perhaps, the most radical break of science with magic.

"A screaming comes across the sky. It has happened before, but there is nothing to compare it to now. It is too late. The Evacuation still proceeds..."

This is the beginning of Thomas Pynchon's *Gravity's Rainbow*, the description of a city at war. 1944: London is under attack by V-weapons. A grey stone house just off Grosvenor Square is ACHTUNG: Allied Clearing House, Technical Units, Northern Germany, one of a number of technical intelligence units engaged in evaluation and research. All are trying to find some guidance for deployment of the overwhelmed fire brigades, emergency crews, ambulances.

Each morning someone in Civil Defense publishes a list of yesterday's hits. Only one person appears to have any success, a statistician, Roger Mexico. "His little bureau is dominated now by a glimmering map [...] an ink ghost of London, ruled off into 576 squares" – a grid of 24×24 squares each representing a quarter square kilometer. Beside the map hang various diagrams: his curves and projections, based on the Poisson equation.

To the statistician Mexico "belongs the domain *between* zero and one – the probabilities. A chance of 0.37 that, by the time he stops his count, a given square on his map will have suffered only one hit, 0.17 that it will suffer two...". From these numbers we can deduce (by means of Poisson's equation) that his current predictions are for a count of approximately 540 missiles (see diagram 1).

Every day he plots the new data. Every day, a better fit. "The rockets *are* distributing about London just as Poisson's equation predicts. As the data keep coming in, Roger looks more and more like a prophet. Psi Section people stare after him in the hallways...".

But the hopes this raises are vain. The statistical equation graphs the angels' view – who see the invisible city depicted so accurately in this grid, these numbers, these curves. "Why is your equation only for angels", asks Jessica Swanlake, "Why can't we do something [...] Couldn't there be an equation for us too, to help us find a safer place?". But no, the very assumption on which Mexico's projection is based, is that there is no systematic clustering, no predictable pattern, only a constant mean density, no place better for hiding than any other. This is the paradox of the success that lies in the recognition of limits – when reason replaces the hopes of magic and precognition. This is the predictable shape of chaos.

The grid, the ink ghost of London on the wall, the graphs – in this icon the invisible city finds at once a feeble manifestation and a powerful demonstration of reality. The abstract model constructed by science fits the real world, more and more closely, rather obscure while the deliverances of the senses shatter bit by bit. This abstraction is the reality of a city in the grip of war.

Of course I chose the example to have not only the graph and the equation, but a novelist telling the story. The same story happens daily

in every modern metropolis. The workers who keep its traffic flowing, its energy arteries unblocked, its streets and squares lit and clean, are guided by directives stemming from such a statistical model. Where the model follows Poisson's equation, no time is wasted on useless schemes to latch onto apparent trends. When data deviate from that curve, new equations are tailored to them, and only then is differential action advised.

Having found, in this success, such strong evidence of truth and reality in the scientists' abstraction, we are still faced with a far from superficial question. What is abstraction? Is it certain to lead us to truth, when carried out correctly, or can it be false?

We have come here to a deep division in philosophy, the rupture that began in the seventeenth century between Descartes and Pascal. From Descartes came analytic geometry, the powerful new method that reveals the intimate connection of equations and graphs. To Descartes the certainty of truth lies exactly and solely in what abstract modelling reveals. But from Pascal came to us at once the mathematics of probability – the foundation of statistics – and the insistence that abstraction is a flight away from what is real, a deception all the more destructive for its elements of veracity. Since we have looked especially at a model which simultaneously exploits both analytic geometry and mathematical statistics, we should listen to both.

There is a very simple argument that abstraction can only lead to truth, if carried out correctly. To abstract is merely to discard details and irrelevant aspects – what is left certainly belonged to the original, and therefore no falsehood can have been introduced. Every modern account of abstraction appears to lead to this conclusion. To abstract, that is to grasp the problem addressed in its full generality, to retain only the relevant skeleton of the subject of our inquiry. To grasp in full generality, that is to delimit exactly which situations are equivalent to the original in all relevant respects. But that is to isolate the essence, for it defines which transformations leave invariant all and only what is essential and relevant. In this way the method of abstraction advocated by Descartes evolved, through Felix Klein's program for geometry as a study of transformation groups, into the mathematical physics of Minkowski, Weyl, and Wigner. At every step it only seems clearer that through abstraction, truth can be uncovered but no falsehood added.

But what happens when we turn to the domain *between* zero and one, the domain of probabilities? If the heritage of Descartes in geometry bears out his philosophical stance, what of Pascal's heritage in statistics? An urgent question, especially now that the two have become one, in our new science.

Abstraction can lie. An illustration as simple as Pynchon's London will show it. In our city there are both men and women working in the offices in the city center. There is a good deal of job mobility, "horizontally" across companies and "vertically" within. Both men and women insist that they are affected by conditions of light and space in the work place. When they are transferred to spacious, well-lit, open-plan buldings they do well – the symptoms of stress disappear, attendance and productivity are high.

The statistician in City Planning, let us call him Richard Peru, constructs a statistical model, initially based on a large random sample. He abstracts from the difference between men and women, and sets simple criteria of demarcation: well-lit versus not well-lit; highly productive versus not highly productive. His model reveals zero correlation between the two categories. A further test of the model against a new random sample shows an excellent fit. He has only abstracted, he has only ignored details. Surely he can have introduced no element of falsity? The city planners who consult him conclude that the whole issue can be dropped from consideration.

But yet another statistician appears, and reanalyzes Peru's data – she takes no new samples, but ceases to ignore the difference between men and women. She graphs the statistical proportions, and the following pattern emerges (see diagram 2): in the population as a whole, the ratio of productive to non-productive workers is 2:1, both in the well-lit category and in the not well-lit. But for men there is a higher proportion of the productive workers in the well-lit category (1/2 as against 1/3), and among the women too (3/4 as against 2/3). So in the population as a whole there is no correlation, but once we take men and women as separate categories, we see that *in each*, there is a strong positive correlation between high productivity and well-lit conditions. The conclusion must be reversed!

This phenomenon, of reversal at a less shallow level of statistical analysis is called Simpson's paradox. It appears in this case because the women are more productive, but have also the largest proportion of workers in poorly lit areas. (The above proportions are taken from Simpson's original example, published in 1951, but it is easy to generate many such examples, even mechanically on a computer.) Statistics, the discipline, itself shows that statistical abstraction can hide, veil, or distort the truth.
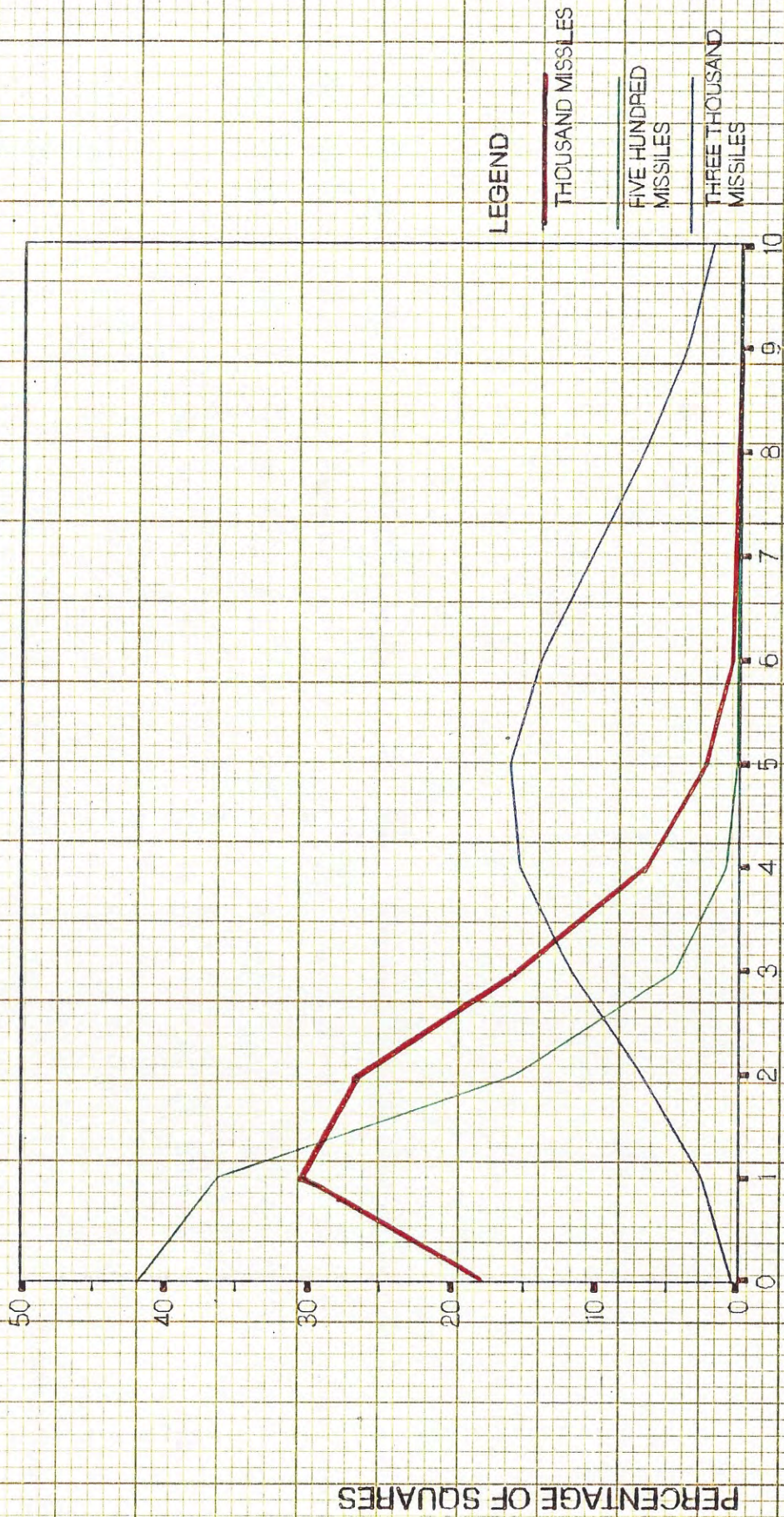
The shape of chaos, so neatly tracked by precise statistical equations, is ambiguous. Every new analysis, that ignores still one less factor, may reverse the judgement concerning correlations of its predecessor. Indeed, this raises an intriguing conceptual problem: can we coherently conceive of a chaos that is pure chaos "all the way down", at ever deeper levels of analysis? But let us stay with our present concern: even at a very practical level, abstraction is *not* simply the truth unadorned by irrelevant detail. The invisible city is not transparent to the mind – even for this abstract entity there is a problem of appearance and reality.

But what if we must admit that the city in the end falsifies every vision of her that we can attain? What if the visible city we live in eventually refutes every invisible city we can construct, even in science?

She only shows us our endless vulnerability. Looking at her, we see what we are.

POISSON DISTRIBUTION CURVES

GRID 24X24 TOTAL OF 576 SQUARES

LEGEND

THOUSAND MISSLES

FIVE HUNDRED MISSILES

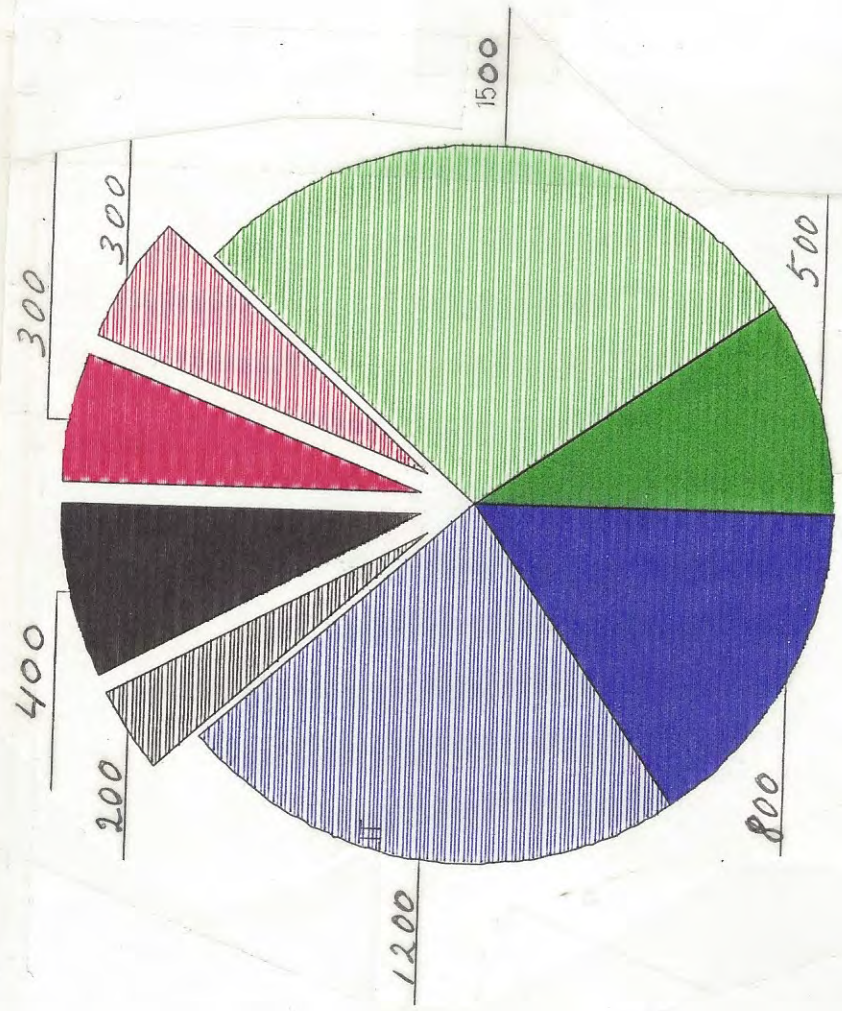THREE THOUSAND MISSILES

PERCENTAGE OF SQUARES

NUMBER OF HITS IN SQUARE

SIMPSON'S PARADOX
Classification of workers: Male/Female, Productive/Unproductive

Classification of work areas. Well lit/Poorly lit

LEGEND

- UNPROD MALE POOR LIGHT
- UNPROD FEMALE POOR LIGHT
- PROD FEMALE POOR LIGHT
- PROD MALE POOR LIGHT
- PROD MALE WELL-LIT
- PROD FEMALE WELL-LIT
- UNPROD FEMALE WELL-LIT
- UNPROD MALE WELL-LIT