

AccessionIndex: TCD-SCSS-X.20121208.007

Accession Date: 8-Dec-2012

Accession By: Prof.J.G.Byrne

Object name: Richardson's Fantastic Forecast Factory

Vintage: c.1922

Synopsis: Painting of imaginary prediction factory, based on Ch.11 of Richardson's 'Weather Prediction by Numerical Process', ink and water colour, commissioned and owned by Prof.J.G.Byrne, painted by and Copyright of Stephen Conlin, 1986, see also Literature category of this catalog.

### **Description:**

This painting was commissioned and owned by Prof.J.G.Byrne, painted by and Copyright of Stephen Conlin, 1986. For an engaging short introduction to the painting, see the MPEG4 video [7] in the related folder in this catalog. Dr.Dan McCarthy's account in [10] reproduces manuscript evidence of Prof.Byrne's contribution to the design of the painting.

The description below is by Prof.Peter Lynch, School of Mathematics & Statistics, University College Dublin, also see: <http://www.emetsoc.org/resources/rff/>.

For zoom browsing of the painting, see: <http://www.emetsoc.org/resources/rff/rff/>

### ***Richardson's Fantastic Forecast Factory***

In 1922 Lewis Fry Richardson published a remarkable book, *Weather Prediction by Numerical Process*, describing his attempt to forecast changes in the weather by numerical means.

#### ***Weather Prediction by Numerical Process***

Richardson devised a method of solving the mathematical equations that describe atmospheric flow by dividing the globe into cells and specifying the dynamical variables at the centre of each cell. In Chapter 11 of his book, he presents what he calls a 'fantasy', describing in detail his remarkable vision of an enormous building, a fantastic forecast factory.

Several artists have created images of the forecast factory. One particular image, which has recently come to light, is described here. The painting, see Figure 1, in ink and water colours, was made by the Irish artist Stephen Conlin in 1986, on the commission of Prof. John Byrne, then Head of the Department of Computer Science in Trinity College, Dublin, who provided both Richardson's text and suggestions regarding the inclusion of important figures from the history of mathematics and computation.

#### ***Richardson's Fantasy***

Richardson showed remarkable foresight when he penned his famous fantasy; his description is in *Weather Prediction by Numerical Process*, page 219. Conlin's image depicts a huge building, some twenty storeys high, with a vast central chamber, spherical in form. On the wall of this chamber is a map with roughly half the globe visible, divided into red and white chequers. The numbers in the red cells represent pressure at the model levels (Richardson's model had five layers) and those in the white cells are momenta or winds.

Richardson describes how “A myriad computers are at work upon the weather of the part of the map where each sits ... . The work of each region is coordinated by an official of higher rank.” The image divides the globe into about twenty zones.

The upper floor, with the desks of four senior clerks, is shown below the central column. A banner on each desk identifies a major figure in the history of computing. The Director of Operations stands on a dais atop the central tower, “like the conductor of an orchestra in which the instruments are slide-rules and calculating machines”. He coordinates the computations, signalling with a red spotlight to those who are racing ahead, and with a blue light to those who are behindhand.

There are striking similarities between Richardson’s forecast factory and a modern massively parallel processor (MPP). Richardson envisaged a large number of processors – his estimate was 64,000 – working in synchronous fashion on different sub-tasks. The forecasting job was sub-divided, or parallelized, using domain decomposition, a technique often used in MPPs today.

### ***Historical Characters in the Image***

Several scholars and savants are depicted in the painting of the forecast factory. The artist, Stephen Conlin, provided an alphabetic key to the most important of these. It is reproduced in Figure 2.

A list of the individuals corresponding to each letter in the key is given in Table 1.

### ***Communications & Computing***

Blue pneumatic tubes can be seen throughout the building. These were used to transport documents to and from a centralized Tube Room, shown at the bottom right corner of the image. An electrical switch-board nearby controlled the distribution of forecasts by radio transmission. A radio antenna is seen near the top right side of the main picture.

In the building on the right side of the image (above the Tube Room) there is a large room containing computing equipment. This is where senior operatives are developing strategies for improving the forecasting operations. At the lower left corner, we see “an enthusiast ... observing eddies in the liquid lining of a huge spinning bowl ... ”.

Richardson, with his Quaker background, was no slave-driver. He anticipated the need for what we now call a good work-life balance: “Outside are playing fields, houses, mountains and lakes, for it was thought that those who compute the weather should breathe of it freely.” This quotation is indicative of Richardson’s humanitarian spirit. At centre-left, we see parkland where people are playing sports or relaxing.

### ***Summary***

Conlin’s painting, which has gone unnoticed for many years, is a remarkable work, rich in detail and replete with hidden gems. The above extracts are just a small sample of what the original image contains. Examination of the high-resolution image with a computer visualisation program is a rewarding experience and will reveal a wealth of other interesting details.

### ***Acknowledgements***

My thanks first to Prof. John Byrne for allowing a copy of his painting to be made and used, and for consultation regarding the background to it, and to Dr. Dan McCarthy,

Trinity College Dublin, who brought the painting to my attention, and arranged the high-resolution scan of it. Thanks also to Hendrik Hoffmann of UCD for re-sampling and compressing the images. Finally, special thanks to the artist, Stephen Conlin, for generously permitting reproduction of the image and for information about it.

Peter Lynch  
UCD Dublin  
October 2015.

The principal characters in the history of computing up to the date of publication of Richardson's book in 1922 are represented. Remarkably, in the *Arithmetic Research Room*, Lord Kelvin and his brother James Thomson are being offered a tray of refreshments by Percy Ludgate, who is standing right beside Ada Lovelace, who is gesticulating to George Boole. So the painting shows the authors (Lovelace and Ludgate) of the first papers on the first two designs (by Babbage and Ludgate) for analytical engines standing beside each other. And Prof.J.G.Byrne collected original copies of both those papers, see elsewhere in this collection. Babbage is shown too.

Interestingly, Richardson's first works in 1908 proposed a graphical method to solve the Laplacian equations for free flow of water in saturated soil in relation to draining peat (from 1906–1907 he worked as a chemist at the National Peat Industry Ltd). His second paper [8] was published in the Scientific Proceedings of the Royal Dublin Society in 1908 on that subject, the year before Ludgate published his first paper in the same journal. Richardson's paper was referred to Prof.Arthur Conway for report in the minutes of the RDS Publications Committee on Tuesday 10-Dec-1907, then Ludgate's paper was referred to Prof.Conway for report on Tuesday 8-Dec-1908.

In 1913 Richardson joined the Meteorological Office, and is likely to have known Francis Whipple, whose paper in the 1914 Napier tercentenary handbook preceded Ludgate's paper. Meteorology and computing have been inextricably linked since Richardson's work was published. After World War II the notable mathematician John von Neumann was largely responsible for scheduling American work on the new machines. His first priority was design calculations for nuclear weapons, but next was Richardson's numerical methods for weather forecasting [9].

Many thanks to Prof.Peter Lynch for permission to republish the description above, and to meteorologist M.J. McDermott for permission to preserve a copy of the video [7] in the related folder in this catalog.

The homepage for this catalog is at: <https://www.scss.tcd.ie/SCSSTreasuresCatalog/>  
Click 'Accession Index' (1st column listed) for related folder, or 'About' for further guidance. Some of the items below may be more properly part of other categories of this catalog, but are listed here for convenience.

| Accession Index                         | Object and Identification                                                                                                                                                                                                                                                                                                          |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <a href="#">TCD-SCSS-X.20121208.007</a> | Richardson's Fantastic Forecast Factory, Painting of imaginary prediction factory, based on Ch.11 of Richardson's 'Weather Prediction by Numerical Process', ink and water colour, commissioned and owned by Prof.J.G.Byrne, painted by and Copyright of Stephen Conlin, 1986, see also Literature category of this catalog, 1922. |
| <a href="#">TCD-SCSS-V.20121208.048</a> | Weather Prediction by Numerical Process, Richardson, L.F., Dover, N.Y., 1965.                                                                                                                                                                                                                                                      |
| <a href="#">TCD-SCSS-V.20121208.832</a> | An approximately full scale preliminary draft in ink on semi-transparent paper of Conlin's Richardson painting, Conlin, S., inscribed 'Stephen Conlin, 53 York Road, Dun Laoghaire, Tel. 802 882', c19xx.                                                                                                                          |
| <a href="#">TCD-SCSS-V.20121208.869</a> | Richardson's Fantastic Forecast Factory, Painting of imaginary prediction factory, based on Ch.11 of Richardson's 'Weather Prediction by Numerical Process', ink and water colour, commissioned and owned by Prof.J.G.Byrne, painted by and Copyright of Stephen Conlin, 1986, see also Hardware category of this catalog, 1922.   |
| <a href="#">TCD-SCSS-V.20170310.001</a> | M.J. McDermott, <i>TV interview about Richardson's Fantastic Forecast Factory</i> , Q13 News This Morning, Q13 NEWS, Q13FOX TV, Seattle, Washington State, USA, 7:54am 13-Sep-2016, MPEG4 video, see related folder in this catalog, 2016.                                                                                         |
| <a href="#">TCD-SCSS-X.20121208.001</a> | Charles Babbage's Engines, Irish interactions with Charles Babbage regarding his Difference Engines and Analytical Engine, c.1843.                                                                                                                                                                                                 |
| <a href="#">TCD-SCSS-X.20121208.002</a> | Percy E. Ludgate Prize in Computer Science, Prize in memory of Percy Ludgate's novel 1909 design for an Analytical Engine, the next after Babbage's, c.1909.                                                                                                                                                                       |
| <a href="#">TCD-SCSS-V.20121208.870</a> | Ada Lovelace's famous translation with an 'Addition', Prof.J.G.Byrne's offprint of Ada Lovelace's translation of L.Menabrea's 'Sketch' of the Analytical Engine, incorporating an offprint of Charles Babbage's 'Addition', 1843.                                                                                                  |
| <a href="#">TCD-SCSS-V.20121208.873</a> | Percy E.Ludgate, 'On a Proposed Analytical Machine', offprint of article in Scientific Proceedings of the Royal Dublin Society, Vol.12, No.9, pp.77-91, 28-Apr-1909.                                                                                                                                                               |
| <a href="#">TCD-SCSS-V.20171231.001</a> | Ed: Chris Horn, Professor John Byrne: <i>Reminiscences: Father of Computing in Ireland</i> , 2017. ISBN-10: 1520696841, ISBN-13: 978 1520696843.                                                                                                                                                                                   |

## References:

1. Lynch, Peter, *Richardson's Fantastic Forecast Factory*, on website of the European Meteorological Society, see: <http://www.emetsoc.org/resources/rff/>  
Last viewed 26-Nov-2015.
2. Ashford, Oliver, M., *Prophet – or Professor? The Life and Work of Lewis Fry Richardson*, Adam Hilger, Bristol & Boston, 304pp, 1985.
3. Conlin, Stephen, Artist: For a range of work by the artist, see: <http://www.pictu.co.uk/>  
Last viewed 26-Nov-2015.
4. Lynch, Peter, *The Emergence of Numerical Weather Prediction: Richardson's Dream*, Cambridge University Press, 279pp, ISBN-13: 978-0-521-857291, 2006.
5. Lynch, Peter, *An Artist's Impression of Richardson's Fantastic Forecast Factory*, to appear in *Weather*, PDF preprint, 2016.
6. Richardson, Lewis Fry, *Numerical Prediction by Numerical Process*, Cambridge Univ.Press, Second Edition (corrected version of the 1922 original with a new Foreward by Peter Lynch), Cambridge University Press, ISBN: 978-0-521-68044-8, 2007.
7. M.J. McDermott, *TV interview about Richardson's Fantastic Forecast Factory*, Q13 News This Morning, Q13 NEWS, Q13FOX TV, Seattle, Washington State, USA, 7:54am 13-Sep-2016, MPEG4 video, see related folder in this catalog.
8. Richardson, Lewis Fry, *The lines of flow of water in saturated soils: explaining a simple method for determining the relation between the distance apart of ditches and the height to which the saturating water will rise with a given rainfall, special reference being made to the draining of peat-mosses*, Scientific Proceedings of the Royal Dublin Society, Vol.11, 295–316, 1908 (also in *Collected Papers of Lewis Fry Richardson*, Vol.1, *Meteorology and Numerical Analysis*, Ed P.G.Drazin, 95–118.5.
9. George Dyson, *Turing's Cathedral: The Origins of the Digital Universe*, Pantheon, ISBN: 0-375-42277-3, 2012.
10. Ed: Chris Horn, *Professor John Byrne: Reminiscences: Father of Computing in Ireland*, ISBN-10: 1520696841, ISBN-13: 978-1520696843, 2017, see elsewhere in this catalog. In relation to Stephen Conlin's painting, Dr.Dan McCarthy's account on pp.136-140 reproduces manuscript evidence of Prof.J.G.Byrne's contribution to the design of the painting.

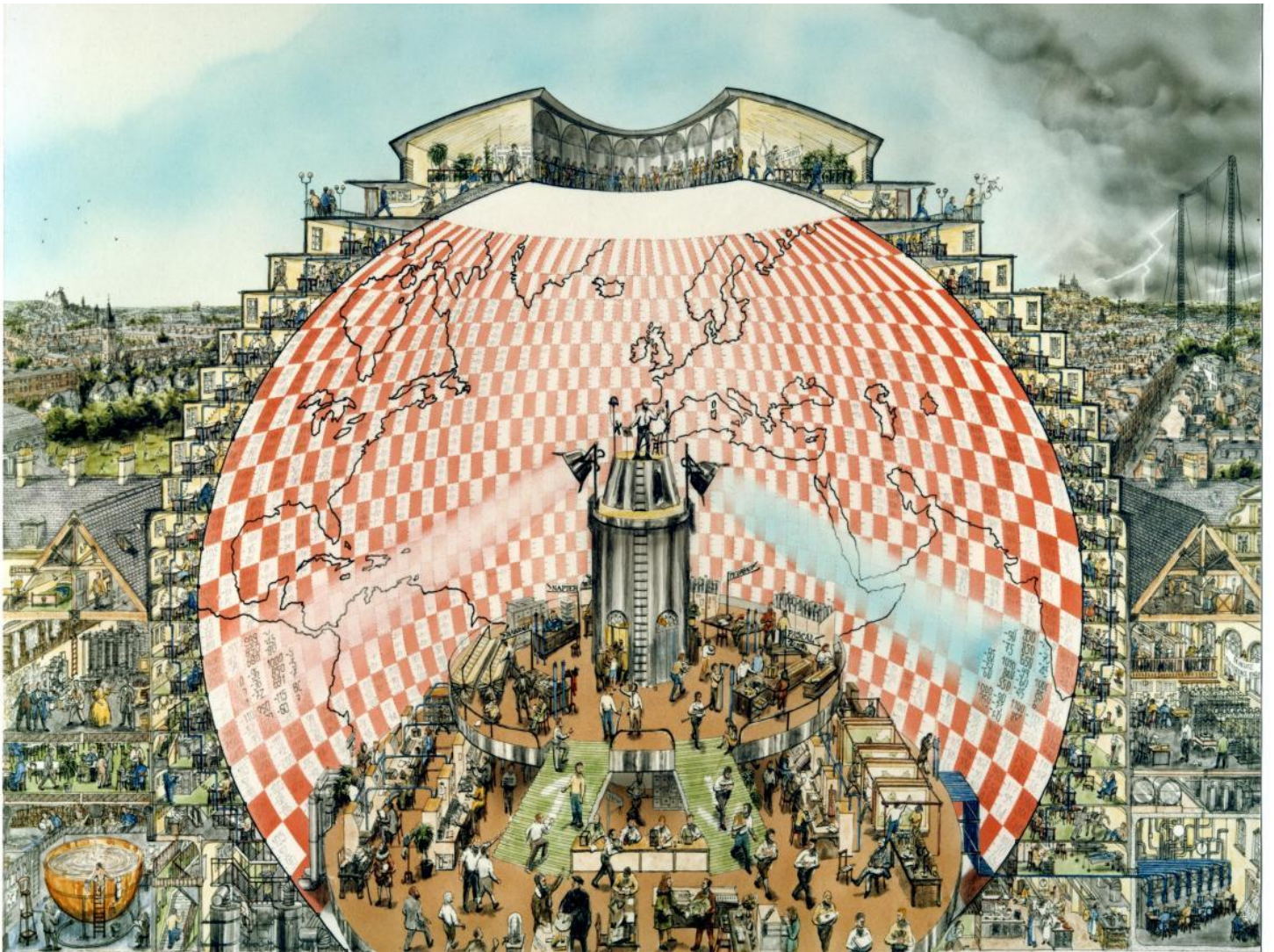


Figure 1: Richardson's Fantastic Forecast Factory

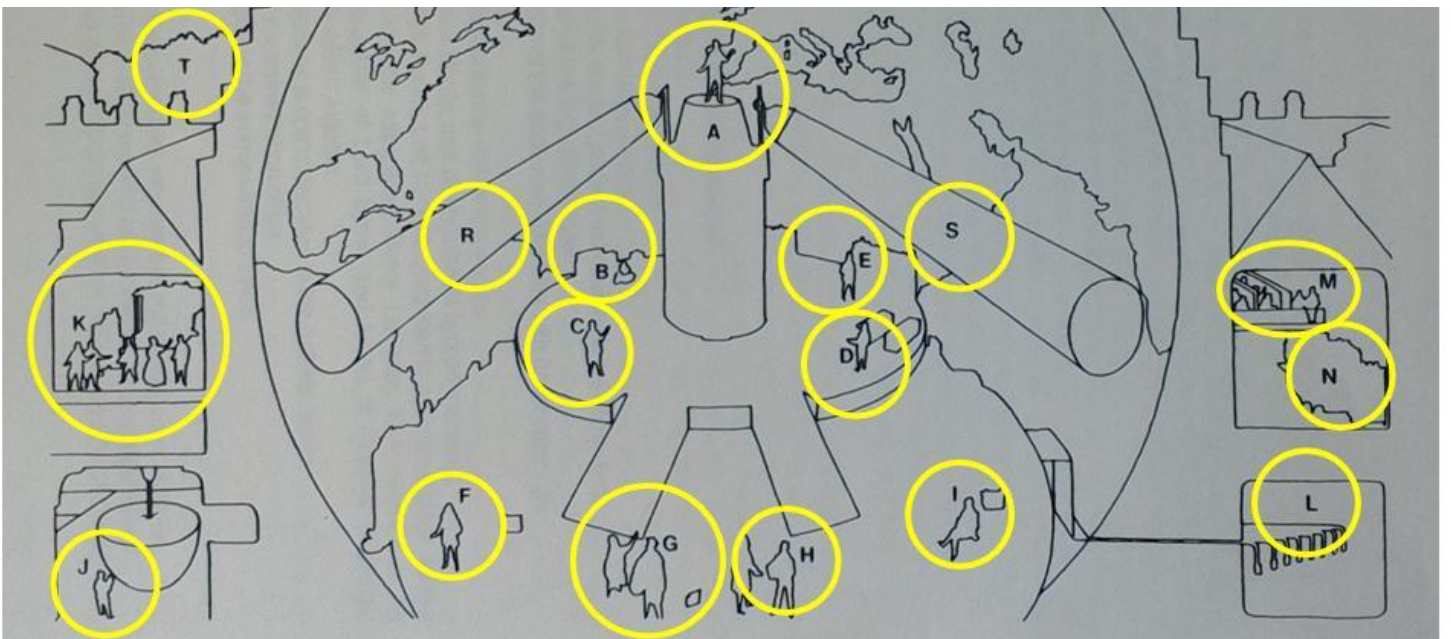
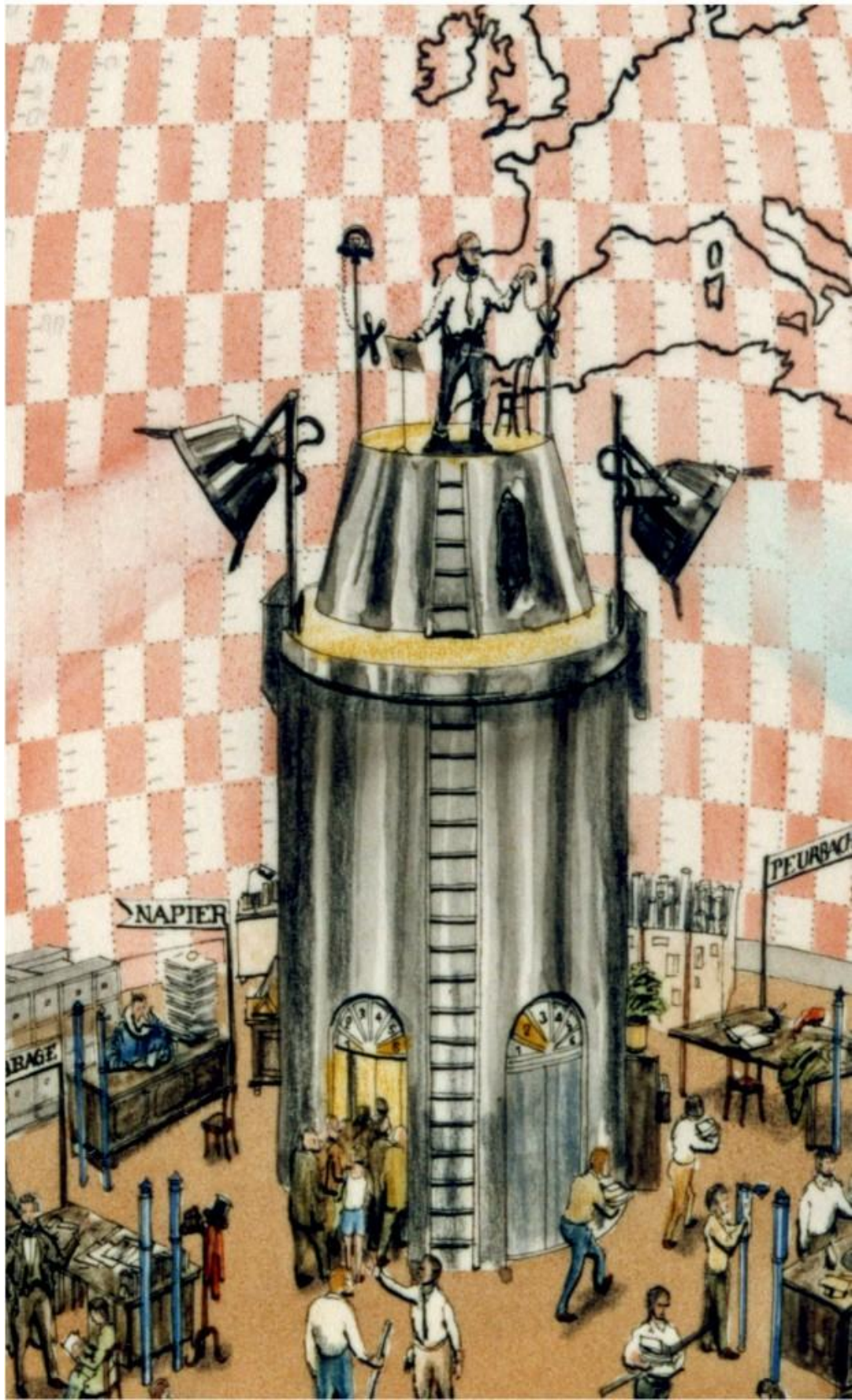


Figure 2: Guide to important features in Richardson's Fantastic Forecast Factory

| Index | Historical Character                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A     | <b>Lewis F. Richardson</b> (1881-1953) in the pulpit, directing operations.                                                                                                                                                                                                                                                                                                                                              |
| B     | <b>John Napier</b> (1550–1617) inventor of logarithms, which had a profound influence on the course of astronomy, and of science in general.                                                                                                                                                                                                                                                                             |
| C     | <b>Charles Babbage</b> (1791-1871), mathematician, inventor and mechanical engineer, originated the concept of a programmable computer and designed highly advanced mechanical calculating machinery.                                                                                                                                                                                                                    |
| D     | <b>Blaise Pascal</b> (1623–1662) French mathematician, inventor, writer and philosopher. When only 18 years old, he constructed a mechanical calculator capable of addition and subtraction, called the <i>Pascaline</i> .                                                                                                                                                                                               |
| E     | <b>Georg von Peurbach</b> (1423–1461), Austrian astronomer and instrument maker who arranged for the first printed set of sines to be computed. He also computed a set of eclipse tables, the <i>Tabulae Eclipsium</i> , which remained highly influential for many years.                                                                                                                                               |
| F     | <b>Edmund Gunter</b> (1581-1626), English clergyman and mathematician, inventor of the logarithmic ruler.                                                                                                                                                                                                                                                                                                                |
| G     | <b>William Oughtred</b> (1574-1660), English mathematician and Anglican minister, inventor of the slide rule.<br><b>Walter Lilly</b> (c. 1900), Lecturer in Mechanical Engineering, Trinity College Dublin, with his circular rule.                                                                                                                                                                                      |
| H     | <b>Gottfried Wilhelm von Leibniz</b> (1646-1716), mathematician and philosopher, who invented the first mass-produced mechanical calculator. His ‘ <i>Stepped Reckoner</i> ’, which performed addition, subtraction, multiplication and division, is illustrated on the table behind him, between Leibniz and <b>George Fuller</b> (one-time Professor of Engineering at Queen’s College, Belfast) with his spiral rule. |
| I     | <b>Per Georg Scheutz</b> (1785-1873), Swedish lawyer, translator, inventor and builder of the first practical difference engine. Scheutz’s calculator was used for generating tables of logarithms.                                                                                                                                                                                                                      |
| J     | <b>Sir G.I. Taylor</b> (1886-1975), distinguished hydrodynamicist, grandson of George Boole.                                                                                                                                                                                                                                                                                                                             |
| K     | The Arithmetic Research Room. Left to right:<br><b>Lord Kelvin</b> (1824-1907) and his brother <b>James Thomson</b> (with a ball and disk integrator);<br><b>Percy Ludgate</b> (1883-1922), Irish inventor of an Analytical Engine;<br><b>Ada Lovelace</b> (1815-1852), daughter of Lord Byron and friend of Babbage;<br><b>George Boole</b> (1815-1864), inventor of Boolean algebra.                                   |
| L     | Tube Room, or “ <i>quiet room</i> ”, in which weather information is communicated within the forecast factory by pneumatic tube and to and from the outside world by wireless telegraphy.                                                                                                                                                                                                                                |
| M     | Hollerith machines in the research department.                                                                                                                                                                                                                                                                                                                                                                           |
| N     | Scheutz Difference Engine in the research department.                                                                                                                                                                                                                                                                                                                                                                    |
| P     | Radio masts for reception of observations and transmission of forecasts.                                                                                                                                                                                                                                                                                                                                                 |
| Q     | Public viewing gallery at top of building.                                                                                                                                                                                                                                                                                                                                                                               |
| R     | A rosy light – shone on computers who are forward in their computations.                                                                                                                                                                                                                                                                                                                                                 |
| S     | A blue light – shone on computers who are behind in their computations.                                                                                                                                                                                                                                                                                                                                                  |
| T     | Recreation area, since “ <i>those who compute the weather should breathe of it freely</i> ”.                                                                                                                                                                                                                                                                                                                             |

Table 1: List of important features in Richardson’s *Fantastic Forecast Factory*  
Note that Richardson’s vision was 15-20 years before Turing and Shannon’s discoveries



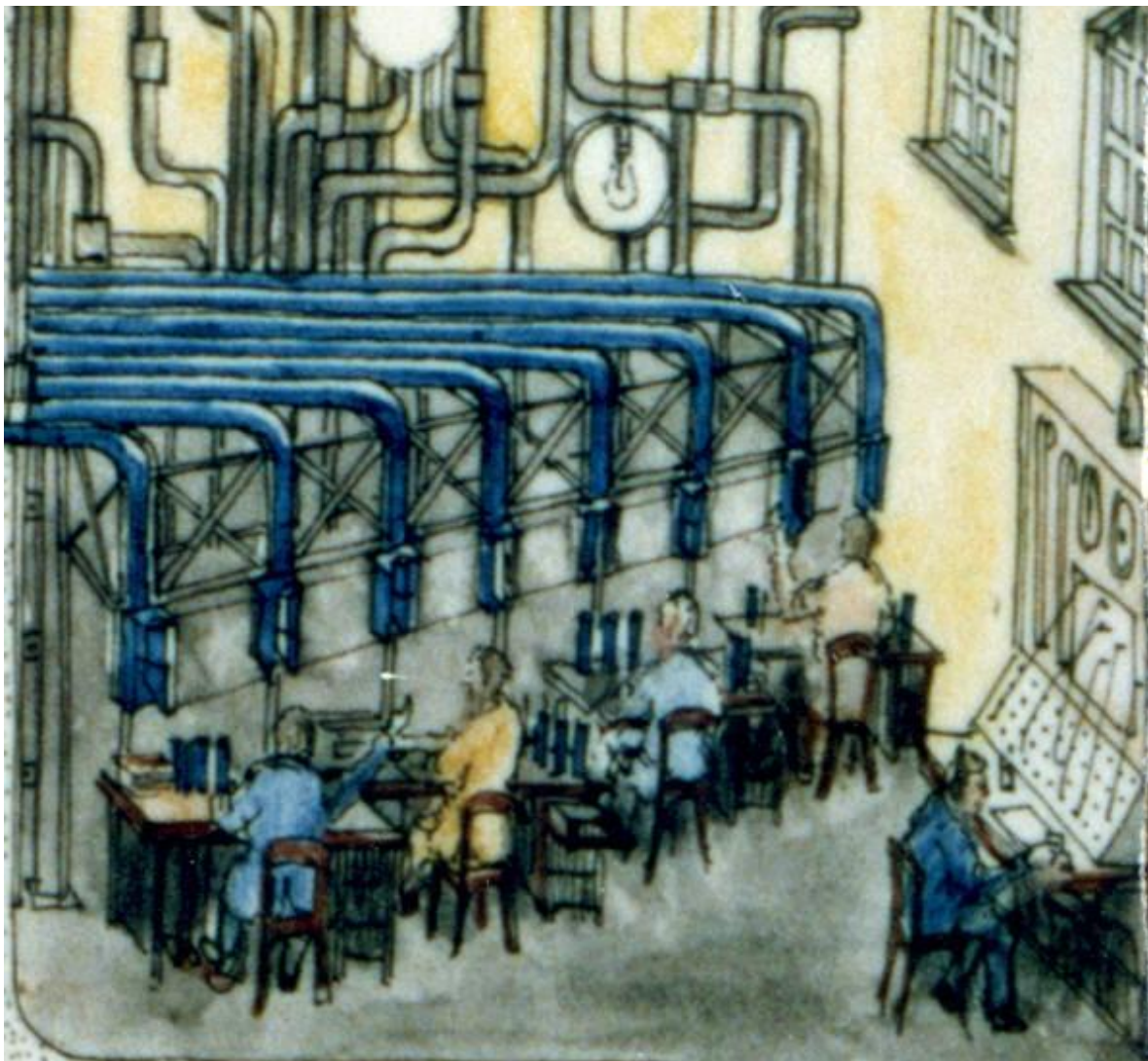
*Figure 3: Richardson's Fantastic Forecast Factory closeup  
Richardson shown as Director of Operations*

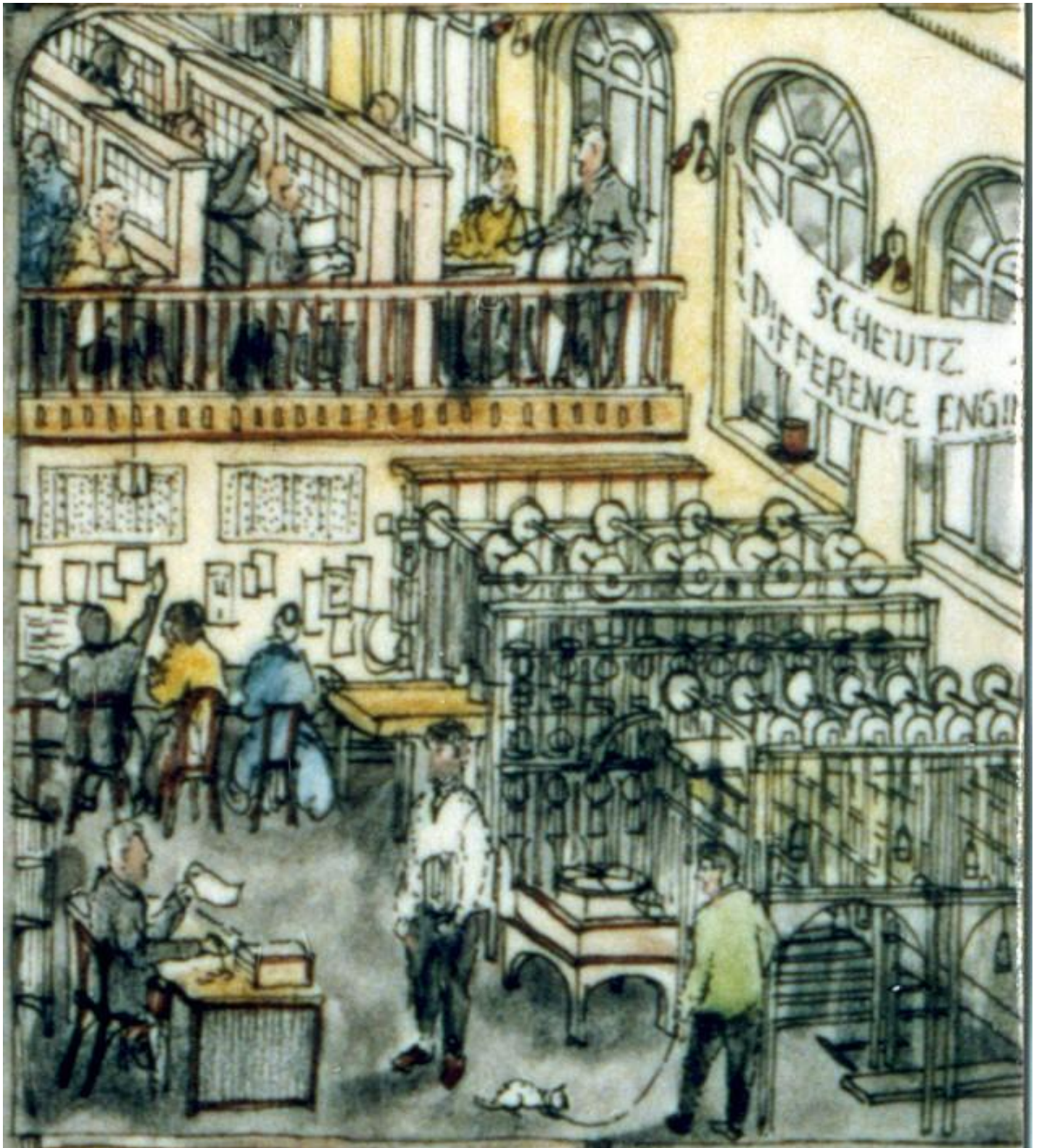


Figure 4: Richardson's *Fantastic Forecast Factory* closeup of senior clerks



Figure 5: Richardson's *Fantastic Forecast Factory* closeup of "computers"





*Figure 8: Richardson's Fantastic Forecast Factory closeup of Research Department  
Scheutz Difference Engine at right  
Hollerith machines at top left*



*Figure 9: Richardson's Fantastic Forecast Factory closeup of Arithmetic Research Room  
Lord Kelvin, James Thomson, Percy Ludgate, Ada Lovelace, George Boole*

*The machine behind Ludgate, Lovelace & Boole is Babbage's analytical engine  
The machine with cylinders and dials on the wall is Kelvin's tide predictor*



Figure 10: Richardson's *Fantastic Forecast Factory* closeup of Sir G.I.Taylor conducting eddy experiments

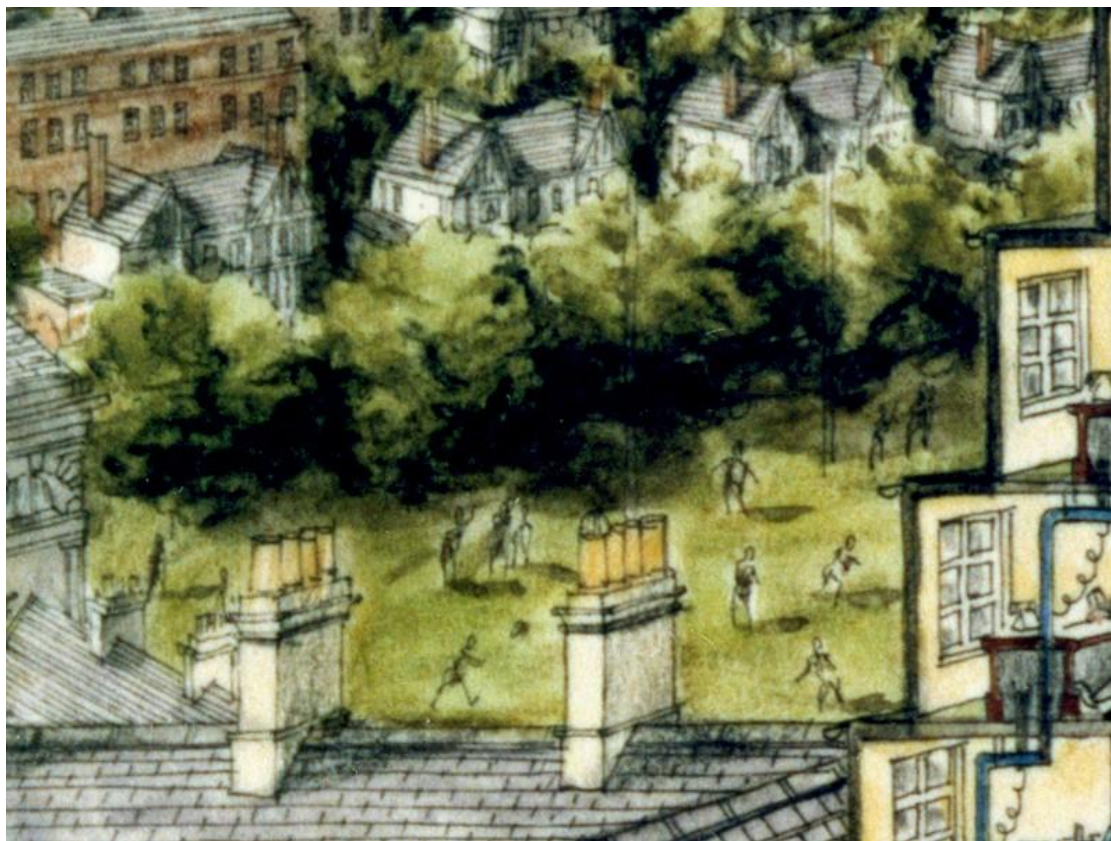


Figure 11: Richardson's *Fantastic Forecast Factory* closeup of recreation area

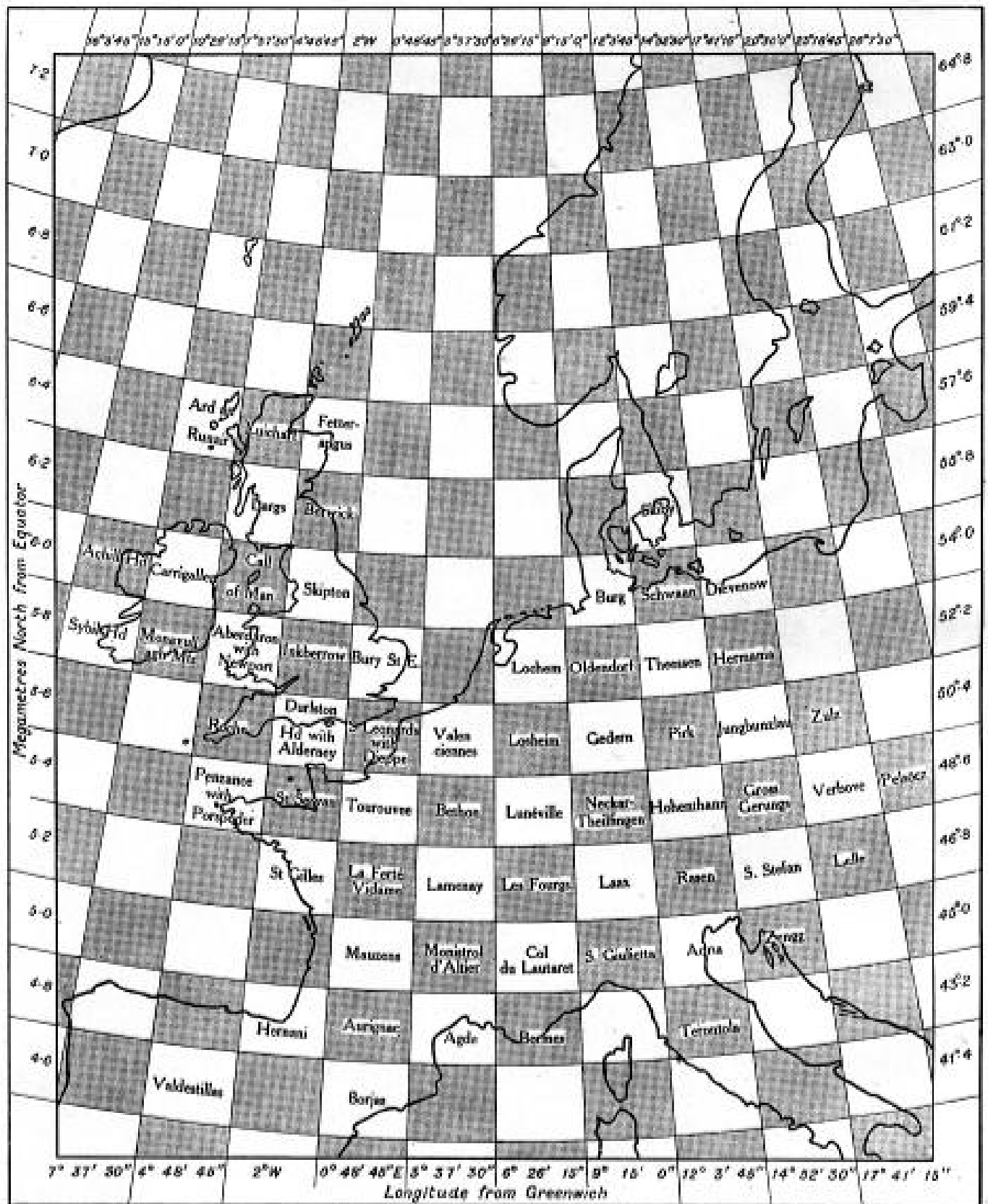


Figure 12: Example grid for computation of weather predictions