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Florence Nightingale's Visual Rhetoric in the Rose Diagrams

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Florence Nightingale is usually pictured as an angelic nurse tending to British soldiers in military hospitals during the Crimean War. Although Nightingale was indeed a tender of soldiers, she was also an administrator, advocate for the common soldier, and proponent of the use of statistics and information design. This article examines Nightingale's rose diagrams, which she designed following her service as the director of nurses at a field hospital in the Crimean War. When the war ended, Nightingale was asked by the queen to write a report on the poor sanitary conditions and make recommendations for reform. When, after six months, the government did not act on the reforms, Nightingale decided to write an annex to the report, in which she would include her invention, the rose diagrams. Nightingale's ultimate success in persuading the government to institute reforms is an illustration of the power of visual rhetoric, as well as an example of Nightingale's own passionate resolve to right what she saw as a grievous wrong.

In this article I analyze Nightingale's use of visual and verbal rhetoric in the design and presentation of her rose diagrams. This analysis is important not only because it highlights a woman's role in the early development of information design, but also because it examines all three of the rose diagrams that appeared in the annex to her report on poor sanitary conditions in military hospitals on the front during the Crimean War. Nearly all of the accounts of the rose diagrams now in print discuss only the second rose diagram that Nightingale designed because it is the most dramatic (Cohen, "Nightingale"; Dossey; Goldie; Wainer). However, from a rhetorical point of view, it is important to trace her visual argument as it progressed from the first rose diagram to the third because this progression provides insight into her visual rhetorical approach to persuading resistant audiences.

NIGHTINGALES'S LIFE AND HER CAREER

To understand Florence Nightingale as a rhetorician, we must first understand Victorian expectations of women's roles and how she responded to them. According to Dossey's biography, Nightingale, who lived from 1820 to 1910, was born into a life of privilege as a member of "'the upper ten thousand,' the social, political, and economic class that ruled England" (4). Although her life afforded her choices and opportunities that other women did not have, it also presented her with restrictions. For example, professional roles were discouraged, and women were instead expected to confine their efforts to attaining skills in conversation, embroidery, and hostessing—activities that Nightingale felt were a waste of women's talents. As she wrote in her *Cassandra* essay, "Why have women passion, intellect, moral activity—these three—and a place in society where no one of the three can be exercised?" (25).

Her frustration did not confine itself to the larger arena of society; she was also frustrated that she had to fight with her own family for permission to study mathematics with a private tutor. Later, when she expressed her desire for a nursing career, her parents were opposed because, as Dossey explains, "at this time, 'nurses' were generally drawn from the ranks of the poor and unskilled, and usually remained in that state" (53). Despite her family's objections, she secured three months of training as a nurse in Germany (Dossey 74). When Nightingale was 33, she was able to exercise her administrative skills by serving as the superintendent of the Institution for the Care of Sic[k] Gentlewomen in Distressed Circumstances in London (Dossey 88). Soon, however, she would be able to work in the much larger role of the leader of the nursing expedition sent to the warfront in the Crimean War (1853–1856).

Nightingale's Work in the Crimean War

The Crimean War began when Russian troops moved into territories east of the Baltic Sea. This movement alarmed both Britain and France, who subsequently allied themselves with Turkey by declaring war on Russia in March of 1854 (Hobbs 52). Nightingale's own entrance into the war was precipitated by newspaper reports from the war zone that provided harrowing accounts of the poor treatment of soldiers in the field hospitals. These accounts included reports of a high death toll and descriptions of patients lying either on the floor or on vermin-infested beds made of rotten boards (Osbourne 13). The reporters who wrote the newspaper stories placed the blame for these conditions squarely on the government and the military for clinging to outmoded administrative guidelines while ignoring the intolerable conditions (Hobbs 52). Because the public was incensed at the soldiers' treatment, the government knew it had to act. Its solution was to send a team of nurses to help the doctors and to create better conditions in the field hospitals.

When officials looked for a nurse to lead the expedition, many prominent names were put forward, but in the end Nightingale was chosen, not only for her experience in nursing administration, but also because Sydney Herbert, the Secretary of War, was a family friend (Small, *Nightingale: Angel* 17). This role would be one that would change Nightingale's life. It would provide her with a lasting reputation as a nursing icon and would lead to her appointment as a member of the Royal Statistical Society based on her use of statistics and diagrams in reports that she wrote about the war.

When Nightingale arrived at the war front, she was appalled at the state in which the soldiers were kept, and she was alarmed by the high rate of mortality. She began to institute sanitary and management reforms, even though she met strong administrative resistance from both the doctors in the field hospitals and government officials at the war office in London. This resistance had as much to do with the fact that she was a woman in a supervisory role as it did the nature of her position, which was seen as usurping military and medical hierarchy. Despite this resistance, Nightingale and her team of nurses were able to improve conditions in the hospital, and her work for the 18 months she was there won her lasting fame as "a Lady with a Lamp" (Hobbs 55).

Writing the Royal Commission Report and Annex

Nightingale's tireless work on behalf of the common soldier was not only well-received by the soldiers and the public; it was also well-received by the queen. After the war, with the support of Queen Victoria, Nightingale pressed the government to recognize the need for Army reform. She fought with Lord Panmure, the Minister for War, over the need for a Royal Commission to inquire into the mortality of the army in peace and in war ("Passionate Statistician"). Subsequently, the Royal Commission was established, and it enlisted Nightingale to write a report. She took to this task with a passion and fighting spirit that had already been evident in her early response to Victorian societal norms. Her passionate impetus can also be evidenced in a letter she wrote at the time to a friend and mentor, Lady Canning, in which she expressed her feelings about the soldiers she served: "Oh my poor men, who died so patiently—I feel I have been such a bad mother to you, coming home and leaving you in your Crimea graves—unless truth to your cause can help to teach the lesson which your deaths meant to us." (*Nightingale: Letters* 287). With this in mind she spent months researching, consulting officials, interviewing hospital workers, and poring over varying accounts of mortality to ensure that reforms were made (McDonald, L. xiii).

Despite Nightingale's best efforts, no action was taken on her recommendations, even some six months after she submitted her report to the Royal Commission with concrete proposals for reform (*Nightingale: Letters* 286). Showing her familiar resolve, however, she threatened to publish the report herself. At the same

time she also became aware of a newly published pamphlet that disputed the statistics that she (with the help of her statistical mentor William Farr) had compiled for the Royal Commission report. The pamphlet had been published anonymously, but Nightingale knew that the doctors with whom she had worked in the Crimea had written it to protect themselves from any blame (Small, "Coxcomb"). Because Nightingale knew that the doctors' pamphlet would have considerable influence and because she was frustrated by the government's reluctance to begin reforms, she decided that she had to establish herself as the preeminent source on statistical findings at the hospitals. The major report was already written and distributed, so she chose to write an annex to the report with the intention of disputing the doctors' statistics and convincing the government to act on reforms. It was in this annex that she included her rose diagrams.

NIGHTINGALE'S USE OF STATISTICS

As Nightingale worked on the annex, she knew that one of the issues she would have to address would be the varying accounts of disease and mortality figures. Some of the mortality figures came from doctors, others from military officials (both during and after the war), and others from those who buried the bodies. To make an accurate report under these circumstances, she needed to have a good understanding of statistics and how they could be assessed. This understanding was developed over a period of time. As stated, Nightingale had been tutored in mathematics. In addition, as a young girl she had compiled statistics of her travels in a daily journal, recording distances traveled and the times of arrival and departure (University Science). According to Dossey, "The format of her entries reflected the developing eye of a born statistician" (36). Her interest in statistics also had led her to a study of the work of the influential Belgian statistician Aldolfe Quetelet, whose ideas had a profound impact on her. Quetelet, who had adopted a model of moral statistics, would conclude "regular patterns invisible at the individual level would emerge at the societal level" (qtd. in Daston 301). Nightingale "considered Quetelet's *Essai de Physique Sociale* to be a religious work—a revelation of the will of God—and felt that his science was essential to all political and social administration" (Dossey 228). For Nightingale, statistics were not merely numbers; they revealed patterns that would allow human beings to control destiny.

In addition to relying on her own knowledge, Nightingale was also influenced, as stated, by William Farr, a well-known statistician of the time who had taken the idea of life tables that had been used only in insurance companies and transferred them to their use as a general statistical device for studying human life and society (Eyler 88). She worked with Farr on the statistical data for the major report, and, as collaborating evidence for her views, she provided in her annex Farr's tables of the

TABLE I.

Deaths and Admissions into Hospital in the British Army in the East:

Date.	Deaths in Hospital, including Bulgaria, Crimea, Scutari, Transports, &c.	Deaths to Force per 1,000 per Annum.	Admissions into Hospital (Primary) to Strength per 1,000 per Annum.
1854.			
April	7	8·4	468
May	21	10·8	1,224
June	17	7·2	1,116
July	382	159·6	2,100
August	859	340·8	3,384
September	939	372·	2,676
October	763	298·8	2,832
November	1,237	499·2	3,336
December	1,970	721·2	3,888
1855.			
January	3,168	1,173·6	4,176
February	2,523	979·2	2,760
March..	1,409	561·6	2,316
April	582	223·2	1,716
May	594	202·8	1,944
June	1,042	318·	3,396
July	382	159·6	2,100
August	672	181·2	2,760
September	485	121·2	2,004
October	199	49·2	1,380
November	243	52·8	1,176
December	137	32·4	1,332
1855.			
January	92	21·6	1,116
February	43	9·6	924
March..	50	10·6	972
April	41	8·4	840
May	29	7·2	720
June	6	2·4	432

FIGURE 1 Example of one of William Farr's tables of mortality and disease rates in field hospitals. Reproduced from Nightingale, *Contribution* 14.

statistical data showing mortality and disease rates in the field hospitals (see Figure 1).

The table in Figure 1 shows four columns, the first of which is the month in which the figures were collected. The phrase "per 1.000 per annum" in the third and fourth columns is a statistical ratio still in use today. The phrase refers to the ratio of the number of admissions to the calculated monthly strength of the army for the year. The word "strength," which is used in the third column, has the same meaning as force—the number of soldiers.

Knowing that her audience might question the inclusion of both monthly and annual figures in the same table, Nightingale explained: "The ratios of deaths and admissions to Force per 1000 per annum are calculated from the monthly ratios given in Dr. Smith's Table B. The annual ratio has been preferred to the monthly ratio because the annual ratio is the unit adopted by statisticians in all civilized countries" (*Contribution* 1). Dr. Smith was the late director-general of the army.

	1854.			1855.		
	October.	November.	December.	January.	February.	March.
Medical Officers' Returns made at the time	250	267	393	262	41	7
Dr. Smith's Return, made up three years after‡	84	153	314	289	43	7

FIGURE 2 Detail of Nightingale's Table II showing the monthly returns of deaths on board transport ships arriving in the Bosphorus. Reproduced from Nightingale, *Contribution* 4.

After introducing this table, Nightingale went on, systematically, to address any objections that could be made about the figures in the three tables that Farr had designed. Well aware that doctors were disputing the statistics, Nightingale presented a detailed argument that examined why varying mortality figures were collected and which ones were likely to be the most accurate. One of the examples she used to demonstrate her reasoning was Table II (see detail, Figure 2), which Nightingale designed.

The table that Nightingale presented shows two different sources of data for "monthly returns of deaths on board transport ships arriving in the Bosphorus" (*Contribution* 5). The first row shows the medical officers' calculations made at the time, and the second row shows Dr. Smith's record of returns that were made up three years after the fact. Because a comparison of each column reveals different mortality figures, Nightingale had to establish which data were more likely to be correct. She did this by stating that the original medical officers' tallies were "nearest the truth" because they approximated "the monthly mortality of the Hospitals at Scutari, exclusive of Kululi" (*Contribution* 5). In this way, Nightingale used previous data to further her argument that her statistics were the correct ones.

Having established this point, she then decided to make the figures in each of William Farr's three tables "more intelligible" (*Contribution* 5). Her decision reveals her awareness that her audience would be diverse: from members of parliament to the queen to military and government officials. Knowing that it was unlikely that each of these audience members would or could read statistical data, she decided to translate the most important numbers in her data tables into diagrams. She was also aware, of course, that her most important audience members were already resistant to her argument, having failed to act on her recommendations for six months. Thus, she wrote, "To make the figures which have been adopted in Tables I, II, and III more intelligible, they have been transferred to three diagrams, constructed of wedges arranged around a centre, each wedge representing by its area the amount of mortality for the period to which it refers" (Nightingale, *Contribution* 6). These were the rose diagrams, so called because of their shape, which resembles a rose.

The First Rose Diagram

In her first rose diagram (see Figure 3), Nightingale provided the reader with a picture of the mortality in the war from April 1854 to March 1855.

The larger graph in what I refer to as Nightingale's first rose diagram, shown in Figure 3, indicates the mortality in the war for the first year, thus revealing the casualties transported from April 1854 through March 1855. The smaller rose diagram at the left, which is connected to the larger diagram by a dotted line, shows the mortality in the second year of the war from April 1855 to March of 1856. In both of the diagrams, a smaller circle in the middle of each rose diagram represents "what the mortality would have been for the whole year if the army had been as healthy as men of the army ages are in Manchester, which is one of the most unhealthy towns in England" (*Contribution* 7).

Nightingale's comparative use of data from the city of Manchester was included to argue the point that the mortality in the warfront was so high that it was "far beyond, in fact, what it ever attains in Manchester" (*Contribution* 7). She chose the city of Manchester because "innumerable reports and surveys had been carried out in Manchester during the 19th century, and they all told much the same story: poor wages, impossibly long working hours, dangerous and unsanitary working conditions, even more unsanitary dwellings, little or no health provisions, high infant mortality and a short life expectancy" ("Victorian Manchester"). Her diagram, then, was constructed to reveal how bad the Crimean War mortality was because it

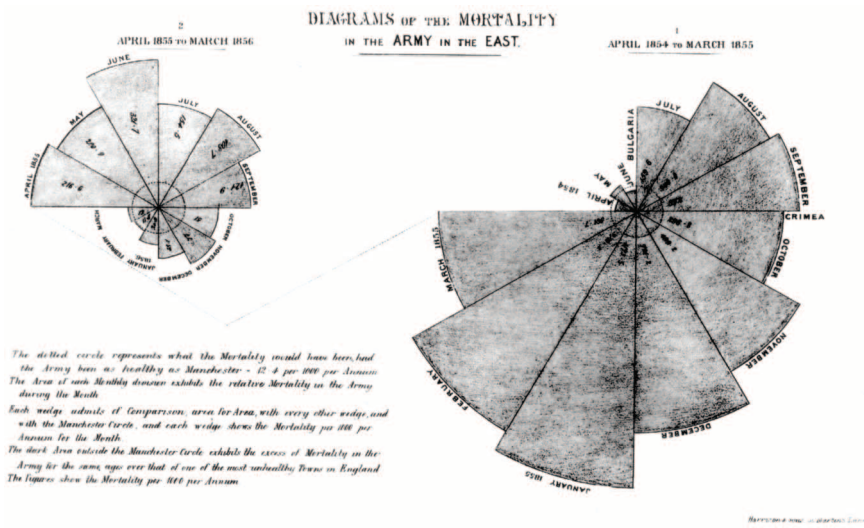

FIGURE 3 Nightingale's first rose diagram, consists of two graphs. Reproduced from Nightingale, *Contribution* Appendix.

exceeded Manchester's well-known high mortality rate. (For better viewing, I have included Figure 4, which shows an enlarged view of the larger rose from Figure 3.)

Her comparative argument of Manchester mortality to Crimean War mortality can be clearly seen by comparing the size of the wedges representing mortality in the war (the wedges outside the circle) with the wedges representing mortality in Manchester (the wedges inside the circle). Clearly, the wedges representing the war dead far exceed in size the wedges representing mortality for the city of Manchester.

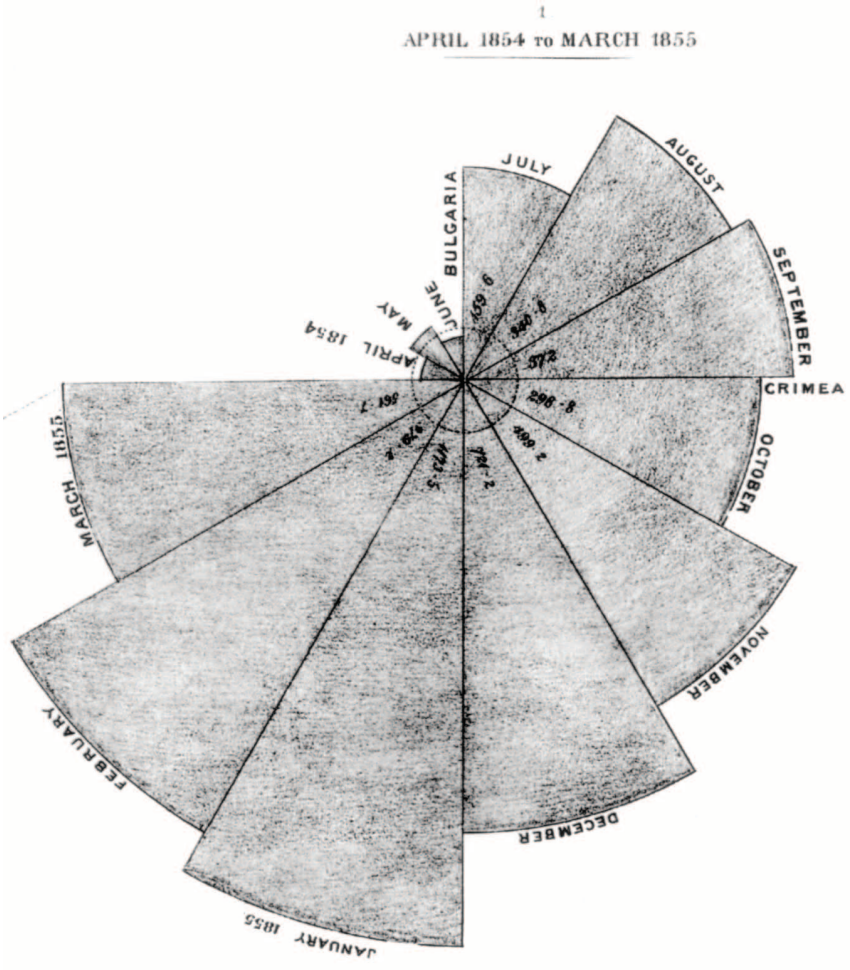

FIGURE 4 Enlarged view of the large rose diagram in Nightingale's original first rose diagram. Reproduced from Nightingale, *Contribution*.

Nightingale's decision to compare mortality figures from the Crimean War to the mortality figures from an English town is one of her most interesting rhetorical decisions. She could have simply used the data from William Farr's tables, repeating information that had already been presented in the earlier report, but, instead, she chose a visual comparison. This tactic was also used by Farr, but, as far as we know, her comparison was her own decision, a fact reinforced by a table that Nightingale had designed earlier in the annex that compared data from Farr's tables with data from eleven general hospitals, fever hospitals, and military and naval hospitals in London.

The rose diagrams are remarkable not only in their ability to communicate this kind of comparative argument, but also because of their ability to show the progression of the war as revealed both through their circular shape and their textual features. These features can be seen clearly in Figure 4. Nightingale indicated the progression of the war by labeling the month on each wedge. She also added more information by indicating the location of the casualties as they were transported at key junctures. For example, because July of 1854 was the point at which the casualties entered Bulgaria, she placed the word Bulgaria on the line that begins the wedge representing mortality data in July. Then, when the troops arrived in the Crimea, she placed the word Crimea on the line that begins the October data wedge. In addition to these troop location markers, Nightingale also reinforced the visual rhetoric that is shown in the size and length of the wedges with labeling that appears near the apex of each wedge (illegible in this reduced reproduction) to show the ratio of mortality for every 1,000 soldiers per annum in the field. Her emphasis on textual support of the diagram is also apparent in the detailed explanation of the diagram that she placed within the "frame" of the diagram. It reads, in part:

> The Area of each Monthly division exhibits the relative Mortality in the Army during the Month. Each wedge admits of Comparison, area for Area, with every other wedge, and with the Manchester Circle, and each wedge shows the Mortality per 1000 per Annum for the Month. The dark Area outside the Manchester Circle exhibits the excess of Mortality in the Army for the same ages over that of one of the most unhealthy Towns in England. The figures show the Mortality per 1000 per annum. (*Contribution* 7)

The Design of the Rose Diagram

Although the rose diagram is not the first kind of diagram that Nightingale used in her work (she had designed line and bar charts as well), the design is significant because it is her own, unique, invention. The rose diagram is not measured like a pie chart or a stacked bar graph where all sections make up part of one whole. Such presentations would not have allowed Nightingale to show the progression of the monthly mortality, the location of the army at certain points, and the comparative data about the town

of Manchester. Instead, she measured from the center of a circle and used square roots to calculate the area of the wedges, resulting in a unique picture. "[I]n a Nightingale rose, each segment subtends the same angle from the center, but it is the square root of the radius that varies with the data. Each data value is divided by the sum of the data to determine the size of the slice" ("Grapher").

We do not know the origins of Nightingale's own thinking in creating the rose diagram. However, Nightingale was likely familiar with wind rose charts and rose-based nautical charts, which had frequently been used to show how winds blow from one month to another at certain points in the ocean (Wainer 109). An example of this kind of diagram, called a compass rose, can be seen in Figure 5.

The diagram of the nautical compass rose seen in Figure 5 bears remarkable similarity to Nightingale's rose diagrams with two exceptions. First, the nautical compass rose chart portrays representational data (wind, movement on the sea), whereas the rose diagrams portray abstract data (mortality figures). Second, the wedges within the circle of the nautical compass rose do not represent different

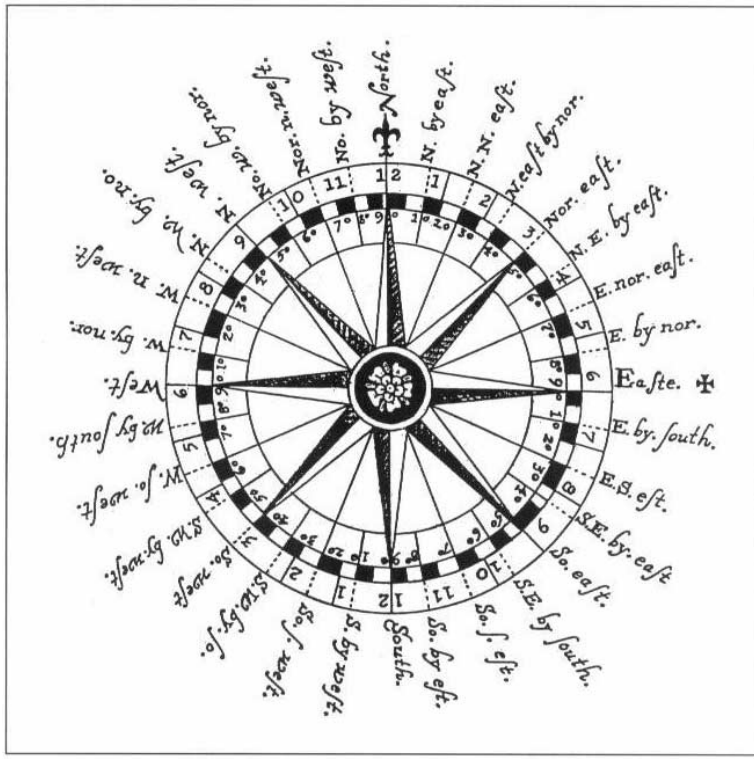

FIGURE 5 The compass rose, a navigational instrument used by sailors in the seventeenth century (Cline). Reproduced by permission from Cline, *The Pilgrims & Plymouth Colony.*

squared data and do not, thus, vary in size, as the wedges in Nightingale's rose diagram do. The strength of Nightingale's rose diagram, like that of nautical diagrams and wind charts, however, is that all segments have the same angle. According to Wainer, this design "means that in a repeated sequence of roses with different data, corresponding segments in different roses are always in the same relative position. This allows us to be able to make effective comparison" (105). In addition, the circular shape of the diagram is well-suited to showing the progression of the war in a time-based genre that, like the sundial or clock, would be familiar to readers. Another advantage is that, from a perceptual standpoint, Nightingale's choice of a circle takes keen advantage of a human being's ability to seek what Arnheim deems one of the simplest of visual forms, a circle.

Clearly, nothing like Nightingale's rose diagram had been seen before. According to Kopf, "Her graphical diagram was at the time an innovation in statistics, and had no significant precedent save in the statistical works of A. M. Guerry, a contemporary of Quetelet" (392). William Farr, Nightingale's statistical mentor, was so impressed by her diagrams that he mentioned them specifically when he applied for Nightingale's admission to the Royal Statistical Society. After his application, she was elected as the first female member of the statistical society in 1858, and she also became an honorary member of the American Statistical Association ("Passionate Statistician").

The Second Rose Diagram

We have already seen how Nightingale used the first rose diagram to argue that the mortality in the war zone was high, especially when compared to that of the worst town in England. However, this observation could not be the end of her argument because she also knew that her readers would question the cause of the high mortality. She acknowledged her concerns by writing: "What can have been the cause of this?" and "Let us now ask, how it was that our noble army all but perished in the East?" (*Contribution* 7). With her second diagram, then (see Figure 6), she provided answers to the questions raised by the first diagram. (As with Figure 5, I have elected to show in Figure 6, for better viewing, only the larger rose diagram. Nightingale had designed the second rose diagram like the first, presenting a larger and smaller rose.)

In this second diagram, an enlargement of one of the two graphs in the second rose diagram, Nightingale not only showed through the diagram's wedges that the mortality rate was high, but she also divided the areas within each of the wedges to show which portion of the mortality data for that month could be allotted to each cause of death. Then using the data that pointed to different causes of deaths, she calculated how much of the area within each wedge would represent the data. By focusing on the high rate of mortality for each month, as well as the causes of death, Nightingale helped the reader understand the reasons for death. She also

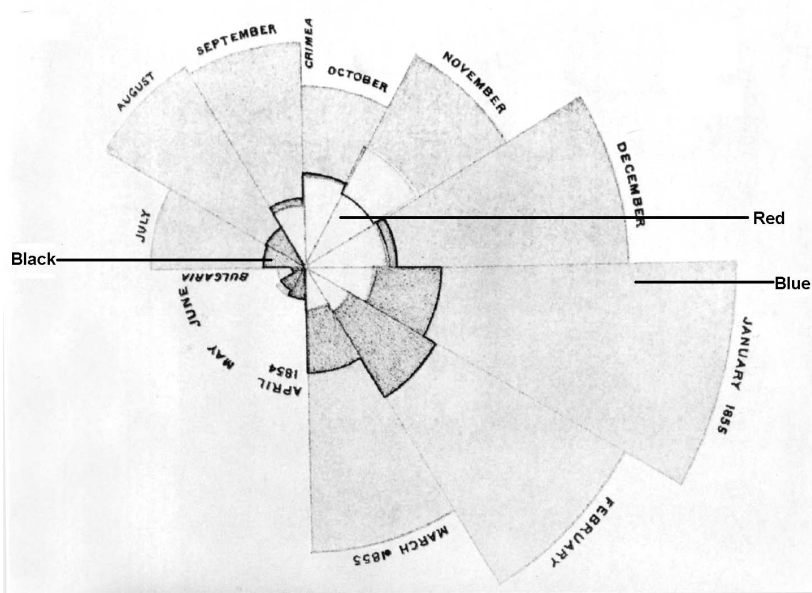

FIGURE 6 Enlarged view of the large rose in Nightingale's second rose diagram, "Diagram of the Causes of Mortality in the Army in the East." (Callouts are the author's.) Reproduced from Nightingale, *Contribution*.

helped the reader see each cause clearly when she drew solid dark lines to separate the areas of each wedge that represented the different causes. She then shaded each of the areas with a distinct color to represent the different causes of death. Deaths that were due to wounds were colored in red; deaths from disease were in blue; and deaths that resulted from any other causes were colored in black. (In Figure 6 I have inserted lined callouts to show how the colors were arranged.) Nightingale arranged these colored areas so that the main cause of death (and the largest sections)—deaths by disease—would be at the end of the wedges and would be more easily noticed. The resulting picture was a powerful indictment of the military's handling of the care of its soldiers at the field hospitals; the large size of the blue wedges spoke volumes about disease as the main cause of death. As Wainer writes, "This second graph makes it abundantly clear that for the British soldier the least dangerous aspect of the Crimean War was the opposing army" (103). Linehard writes in a similar vein:

> Except for the bloodiest month in the siege of Sevastapol, battle deaths take up a very small portion of each slice. Even the awful Charge of the Light Brigade yielded only a modest fraction of the total deaths in that month. Once you see Nightingale's graph,

> the terrible picture is clear. The Russians were a minor enemy. The real enemies were cholera, typhus, and dysentery.

The second rose diagram, then, answers the question that viewing the first diagram raised among readers: "Why was the mortality rate so high?" It is the kind of argument that both supports Nightingale's contention that the mortality rate was excessively high and that the soldiers died more from disease than from war wounds. Having established this part of her visual argument, Nightingale then needed to supply an answer to the reader's obvious question in response to the second rose diagram, "Why was disease the most frequent cause of death?"

The Third Rose Diagram

Nightingale answered this question in a most interesting way. Her third rose diagram argued that the mortality in two field hospitals in the Bosphorus—Scutari and Kulali—was significantly higher than military hospital mortality in London (see Figure 7).

In this diagram Nightingale's visual rhetoric reveals a before and after view of mortality rates for one year at hospitals in the Bosphorus, highlighting the point at which reforms were made. As Nightingale wrote:

> The long wedge on the right hand of the diagram represents the mortality for the first half of October 1854, and each of the succeeding wedges denotes by its surface the mortality per 1,000 of sick treated for the periods stated on them. The area within the dotted circle shows the average annual mortality on cases treated in the Military Hospitals at home, through which, it must be remembered, every man not fit for duty from any disease, however trivial, must pass. (*Contribution* 10)

Nightingale's rhetorical purpose in the third rose diagram was both comparative and progressive. Her progressive argument began when she indicated the juncture at which sanitary reforms began by labeling the date that reforms were initiated with the words "Commencement of Sanitary Improvements." This label appears on the left side of the diagram in Figure 7 above the wedge for March 18th to April 7th, just at the point where the wedges dramatically decrease in size. Nightingale helped the reader understand the specifics of this situation by explaining in the text that the problems with the sanitary conditions at these hospitals were defective drains, lack of water-closets and ventilation, as well as overcrowding (*Contribution* 10). She then went on to detail the sanitary improvements (which she had recommended) that were instituted. These included improved ventilation, drainage, and cleaning. (I should note here that Nightingale's view of disease rested on a theory current at the time that bad air contrib-

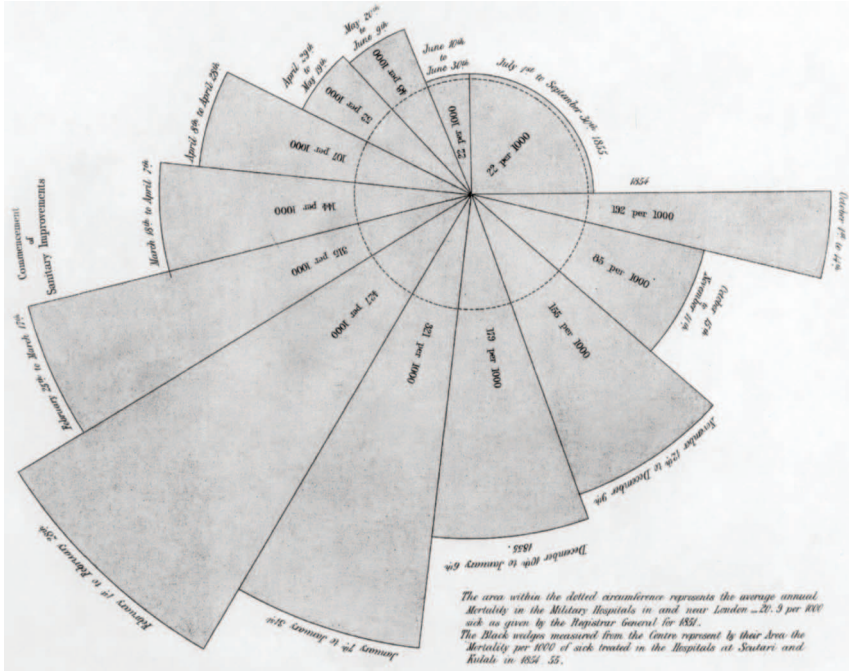

FIGURE 7 Nightingale's third rose diagram, "Diagram Representing the Mortality in the Hospitals at Scutari and Kulali, from Oct. 1st 1854 to Sep 30th 1855." Reproduced from Nightingale, *Contribution.*

uted to illness; she had not been persuaded, as yet, of the efficacy of the new germ theory. However, her multifaceted approach to sanitary reform proved successful.)

Her comparative argument in the third rose diagram consists of examining the difference between mortality rates at two of the wartime hospitals with those of military hospitals in London. As she wrote concerning the point at which sanitary reforms began, "[T]he result is shewn [*sic*] on the diagram, by the successive contraction of the areas of the wedges, until they have nearly the same area as that presented by the wedges of mortality in the Military Hospitals at home" (*Contribution* 10). The reader can see not only that the mortality in wartime hospitals at the front was significantly higher than in London's military hospitals, but also that it decreased once reforms were made and became much closer to what might be expected of a military hospital at home. This fact also leads the reader to see the solution for the problem of high deaths in warfront military hospitals. As she wrote: "It appears a mere truism to insist that an army taking the field should be provided with supplies, transport, clothing, shelter, and appliances for the sick and

wounded. And yet the army in the Crimea almost perished for want of these" (*Contribution* 11).

With the third diagram, Nightingale provided the answer to the question posed by the second diagram. She then summed up her visual argument by writing, "The first two diagrams represent what can be done by attending to the conditions required for preserving health among the large bodies of men. The third diagram shews [*sic*] what may be done by observing the conditions required for the recovery of the sick in Hospital" (*Contribution* 11). She then concluded:

> If the reforms in Army Hygiene and Hospital management advocated by the Royal Commission be faithfully carried out, and if the Army Medical Officers so instructed are entrusted with the preservation of the health of the army to the same extent that they are now entrusted with the treatment of the sick, we shall hear little more of high army mortality, and of the great loss of efficiency from disease; and our General Hospitals in war will cease to be what they have ever been, pest-houses. (*Contribution* 13)

NIGHTINGALE'S RHETORICAL ACHIEVEMENT

Following Nightingale's progression from the first rose diagram to the third, we have seen her craft her rhetorical goals in a visual tour de force. She has progressed in her argument from using the first and second rose diagrams to show that mortality was too high and that disease was the leading cause of death to a third diagram that offers a solution to the problems revealed in the first two. To be sure, the tables she presented were also key to persuading her audience. However, tabular data was not likely to persuade audiences at the time, in part because these audiences were unlikely to be schooled in the use of data in social science. Thus Nightingale's use of the rose diagrams illustrates her understanding of her audience and also highlights her efforts to make complex data clear to a resistant audience. Because those who had already seen the full report had refused to act, it was incumbent upon her to make them see the truth of her argument. Her faith in this argument can be found in a letter she wrote in which she stated that the rose diagrams should be hung on every office wall (Woodam-Smith). As she wrote in the annex, "The most cursory inspection of these diagrams will show that the whole question as to the cause of the mortality narrows itself into an inquiry as to what laws of health had been so violated as to lead to so great a destruction of life" (*Contribution* 8). This sentence reveals once more her trust in the diagrams' ability to communicate the awful truth of the Crimean War dead. At the same time, however, it is clear that she did not rely on the diagrams only; her textual introductions to them reveal her verbal rhetoric, which was designed to help influence her audience.

NIGHTINGALE'S VERBAL RHETORIC

Nightingale's use of pathos to further her argument can be seen in a comparison of the introductions she wrote to the tables in the annex and to the introductions she wrote for the rose diagrams; such an examination reveals significant differences in their approach. Following is her introduction to one of the tables in the annex:

> Table I represents, month by month, the total mortality in the Army of the East, and the ratio of primary admissions into Hospital, from the time the Expeditionary Force arrived there until the evacuation of the Crimea. The numbers in the first column are the same as those given by the late Director-General in his Report, Table A. (*Contribution* 2)

This introduction reveals a straightforward, factual, and concise approach to the presentation of tabular data. However, when she wrote her introduction to the rose diagrams, (which, like the table discussed previously, were placed in an appendix and sized to fit an 8-1/2 x 11 paper), she began with a similar straightforward approach; yet, she followed it with an emotional appeal. Following is her introduction to the second rose diagram:

> It was not by wounds, it was not by ordinary diseases that the army well nigh perished. But it was by those five mitigable and preventible pestilences that the British force before Sevastapol was all but swept away. Expunge the blue wedges, and within what insignificant bounds would not that great calamity have shrunk! These diagrams give the whole history of the disaster. (*Contribution* 8)

With these words Nightingale clearly intended to influence the emotional response of her audience and to make the numbers in the diagram come alive. That is, she intended it to do what a diagram should do—encapsulate the essence of a situation and communicate that to readers. Because the essence of this situation was the occurrence of needless deaths, the message itself is infused with emotional content, and this content is mimicked in her writing. Witness her third sentence in the previous quote, which challenges the reader to "expunge" the blue wedges that represented deaths by disease, so they could see how much less the mortality rate would have been without that factor. Her word choices, including "insignificant" and "calamity," as well as her exclamation point at the end of the sentence, are clear examples of her emotional engagement with the data and, subsequently, of her emotional appeal. She drove home her point by ending this section with,

> The three things that all but destroyed the army in the Crimea were ignorance, incapacity, and useless rules; and the same thing will happen again, unless future regulations are framed more intelligently, and administered by better informed and more capable officers. (*Contribution* 10)

In this sentence we see once again how Nightingale has used emotion-laden words such as "ignorant" and "useless" in her emotional appeal to the audience before it is instructed to refer to the diagram itself. She then goes on to present details that support the contentions of both her verbal introduction and the rose diagrams themselves. These include the fact that, "no transport was provided for bringing in supplies … that blankets were stacked at Balaklava, some six miles away, and that despite the army having thousands of cattle, none were brought to the hospitals for meat" (*Contribution* 9). She also relates information about the army's lack of organization, including its reliance on rules and hierarchy while ignoring the obvious common sense efforts that were needed. For example, the military sent a great deal of green tea to the soldiers, but the "men had nothing whatever to roast or prepare it with" (*Contribution* 9). These kinds of textual explanations help to convey to the reader the kind of senseless actions taken by the government. In so doing, she furthers her pathetic appeal that reform is needed. As Hobbs concluded, "The result of her efforts is not merely a polemic on military reform but a passionate elegy for the ordinary British soldier" (57).

RESPONSE TO NIGHTINGALE'S REPORT

Nightingale's *A Contribution to the Sanitary History of the British Army during the Late War with Russia* and the annex in which the rose diagrams were published had a considerable influence. Nightingale helped ensure this by having 2,000 copies of the annex with the rose diagrams printed at her own expense and sent "to the Queen, the Commander-in-Chief, Members of both Houses, Commanding Officers and doctors" (Woodham-Smith 310). She also had three copies framed and sent to the War Office, the House Guards, and the Army Medical Department (Woodham-Smith 311). In response, four subcommissions were established to carry out the reforms that had been recommended (Cohen, "Florence Nightingale"). The first commission presided over physical alterations in military barracks and hospitals and improvements in ventilation, heating, sewage disposal, water supply, and kitchens. Other subcommissions were to draft a sanitary code for the army, establish a military medical school, and reorganize the army's procedures for gathering medical statistics" ("Passionate Statistician").

STATISTICAL VISUALIZATIONS IN VICTORIAN ENGLAND

How does the rose diagram fare when compared to other important statistical visualizations at the time? A similar portrayal of wartime mortality was designed by Charles Joseph Minard, who plotted the strength of the Napoleonic Russian Cam-

paign as it progressed through the Russian winter. This diagram, featured in Edward Tufte's *The Visual Display of Quantitative Information*, is shown in Figure 8.

Minard's diagram, which was created in 1869, is a more visually complex view of mortality in war than Nightingale's rose diagrams because it places all of its argument in one diagram. Nightingale, of course, chose to present her argument progressively through three diagrams. Both presented information relating to the cause of the high mortality rate in a war: Nightingale used the colored sections in the wedges of the second diagram to indicate deaths due to disease and wounds; Minard used the temperature scale to show how freezing temperatures during the winter contributed to high morality. The diagrams differed in that Minard chose a more literal representation by selecting a cartographic model; Nightingale chose a more abstract representation in a diagrammatic model. Both are excellent examples of information design. However, it is important to note that Nightingale's diagram came some ten years before Minard's and addressed a resistant audience. Small believes that Nightingale's diagrams were actually better than Minard's because they were "more topical and conveyed a call to action—they were prescriptive rather than descriptive" ("Passionate Statistician").

The fact that Nightingale and Minard were creating diagrams in the same ten-year time span also highlights the fact that 1859–1899 was an active period in the development of information design. Indeed, the period has been called the "Golden Age of Data Graphics" (Friendly and Denis). During the same period

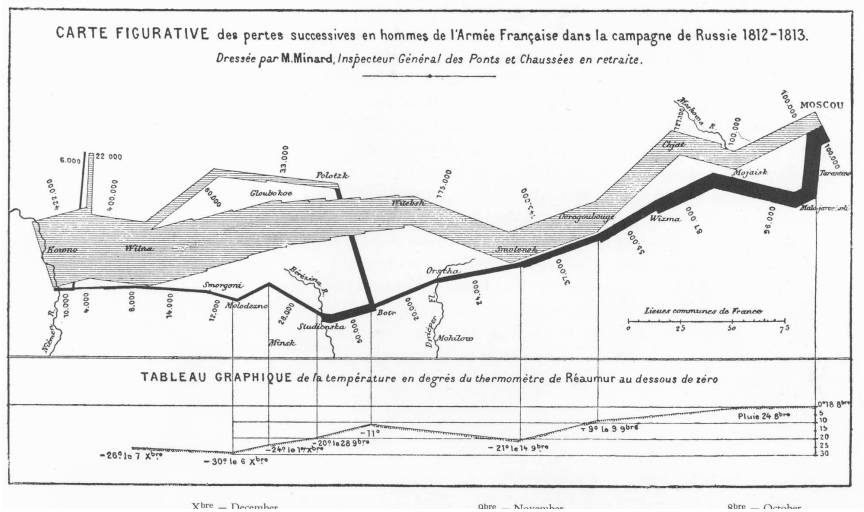

FIGURE 8 Joseph Minard's graph, "Napoleon's March to Moscow: The War of 1812." Reproduced from Tufte, *The Visual Display of Quantitative Information*. Courtesy of Edward R. Tufte.

John Snow also produced his map that displayed epidemiological data leading to the discovery of the source of a cholera epidemic in 1885.

The increasing use of information visualizations was a result of several societal factors. First, government officials were beginning to collect data on their citizens and the environment in which they lived. "In 1837 the General Registry Office at Somerset House, led by William Farr who later helped Nightingale with her Crimean statistics, began to systematically record births, deaths, and marriages in the UK. This gave people the opportunity to examine new cause and effect relationships using registration statistics" (Small, "Statistical Diagrams"). Second, Victorian social scientists were now aware of the theory of probability—the likelihood of a particular event occurring, given a particular set of circumstances. Probability theory had previously been used in game theory and was only now being applied to social science. (Cohen, "Scientific" 37). Third, the idea of predicting risk was increasingly used to address such critical issues of the time as infectious disease. As a result, officials would, for example, examine data collected from families of victims of contagious diseases and use this to predict recurrence.

NIGHTINGALE'S VISUAL LEGACY

In her later years, Nightingale believed that much of the statistical work gathered by the government was not accessible because it languished in tables of data. She, of course, had designed the rose diagrams to help communicate this kind of data, and she would later improve the collection of hospital data by designing forms to be used by hospital administrators and nurses. These forms, aspects of which are still in use today, provided a means of collecting data as it occurred so that it could be used more efficiently in the assessment of patients' medical conditions and hospital procedures. Today "she is often quoted with regard to healthcare auditing and quality management, and she is regarded as a pioneer of epidemiological methods for her use of public health statistics" ("Passionate Statistician").

Nightingale's rose diagrams are still used today, though they are not generally well-known. For example, her rose diagrams have been used to illustrate percentages of linguistics proficiency in Canadian public employees and to show age-specific displays of respiratory symptoms among coal miners (Wainer 106–7). More recently, rose diagrams have become increasingly used in information visualization—an interactive information design tool that allows the reader to interact with the data in the diagram. Robert Spence writes in his book, *Information Visualization*, about the importance of Nightingale's invention of the rose diagram and concludes, "The author of a visualization tool must represent abstract things in some way" (9). In addition to their use in information visualization, they are also still featured as an option in a number of graphing programs, an example of which we can see in Figure 9.

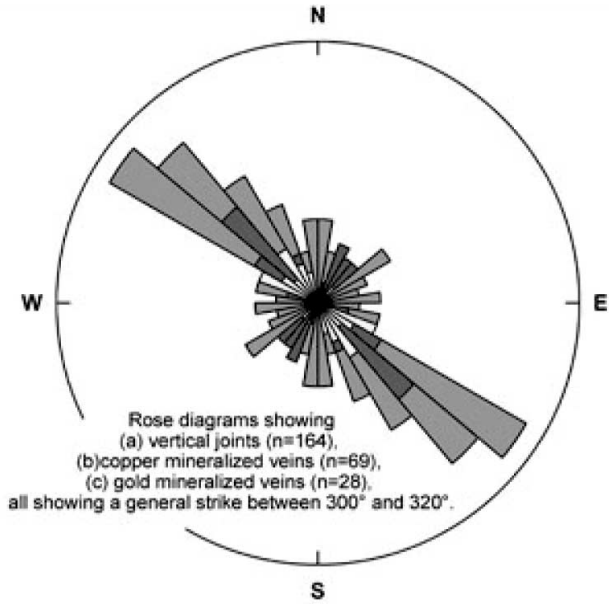

FIGURE 9 Example of a modern-day rose diagram by Keri Fox. Courtesy of Golden Software, Inc.

The example of a rose diagram shown in Figure 9 was part of a thesis written by Keri Fox and used by Golden Software, Inc., to demonstrate what a rose diagram would look like, once plotted using its Grapher™ program. As the software company explains on its website example, "Like histograms, Rose Diagrams display statistical data, showing the number of occurrences of an event that fall within a specific angular region" ("Grapher"). The users of this software program are able to experience the same kind of rhetorical possibilities that Nightingale displayed as she portrayed complex and progressive data.

CONCLUSION

Nightingale's rhetoric in her use of the rose diagrams is an important example of how visual abstraction of data can help further an argument. With her diagrams, Nightingale was able to capture the whole picture of the disaster, from the high mortality rate to the cause of death to the reasons for the disaster and its solution. She allowed both the diagrams and their verbal explanations to work together to create an appeal that went beyond merely exciting inquiry to inciting action. This

is the legacy of Florence Nightingale as a statistician and as a visual rhetorician. It is also a legacy that is often overshadowed by her role as a nurse. But just as important, as we have seen, is her pivotal role as nursing administrator, statistician, and information designer. We have also seen how her early life experiences helped shaped her approach to rhetorical messages, an approach that has resulted in her often being referred to as "the passionate statistician." Clearly, Nightingale's approach to visual rhetoric in her rose diagrams is an important example of a triumph in early information design.

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