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The Functional Art: An Introduction to Information Graphics and Visualization. Alberto Cairo (2016)

8

Creating Information Graphics

A large part of the infographic's intrinsic appeal seems to lie in its visual reductionism of complex information. Reductionism itself is not inherently bad—in fact, it's an essential part of any kind of synthesis, be it mapmaking, journalism, particle physics, or statistical analysis. The problem arises when the act of reduction—in this case rendering data into an aesthetically elegant graphic—actually begins to unintentionally oversimplify, obscure, or warp the author's intended narrative, instead of bringing it into focus.

—Reif Larsen, from "This Chart Is a Lonely Hunter: The Narrative Eros of the Infographic"

Good content reasoners and presenters are rare, designers are not.

—Edward Tufte, from an *AdAgeStat* blog

I'm often asked in workshops and seminars how I develop my own projects. Specifically, people want to know if I have a particular method for designing graphics that inform and attract readers. As a journalist, my approach is infused with lessons learned in the newsroom:

Start with a strong focus, do as much research as you can, organize, summarize, and then deliver your conclusions in a structured and visually appealing manner.

At first glance, there's nothing strikingly original about this. The real lessons come as the graphic is created, in the problems that must be solved and the decisions made along the way. My goal in this chapter is to walk you through my thought process for several projects developed with my team at Brazil's *Época* magazine (see the Acknowledgments to learn more about Marco Vergotti, Gerson Mora, Rodrigo Cunha, Luiz Salomão, Gerardo Rodríguez, Erik Scaranello, and Pedro Schimidt), where I worked as infographics director between 2010 and 2011. As you'll see, the following cases share a common creative methodology:

1. Define the focus of the graphic, what story you want to tell, and the key points to be made. Have a clear idea of how the infographic will be useful to your readers, and what they will be able to accomplish with it.
2. Gather as much information as you can about the topic you are covering. Interview sources, look for datasets, and write or storyboard ideas in quick form.
3. Choose the best graphic form. What shapes should your data adopt? What kind of charts, maps, and diagrams will best fit the goals you set in the first step?
4. Complete your research. Flesh out your sketches and storyboards.
5. Think about the visual style. Choose typefaces, color palettes, etc.
6. If you've been sketching offline, move the design to the computer. Complete the graphic using the appropriate software tools.

Many designers I know skip the preliminaries and jump directly to steps 5 and 6. Big mistake. **Before you think about style, you must think about structure.** Let me show you how.

Brazilian Saints

Brazil is a land of sometimes shocking paradoxes, a reality that Brazilians face with a sense of humor as well as concern. These paradoxes make the country a paradise for journalists.

For example, Brazil has the largest number of Catholics in the world. Yet, among the many hundreds of saints that the Catholic Church has canonized, **only two are of Brazilian origin**. Meanwhile, almost 70 people are on the church's waiting list to be considered for sainthood.

Now, review the paragraph I just wrote in the context of the infographics production process I outlined, and you will see that we've completed step 1: Define the focus. The idea for this focus came from a former intern at *Época*, Eliseu Barreira Júnior, who was a journalism student at Universidade de São Paulo (USP). He became curious about Catholic saints after talking to a couple of sources and thought it would make an interesting visual story. It did indeed: Not many people in Brazil are aware of the sanctity paradox.

The story was approved in an editorial meeting. The next step was to gather all the data, a big challenge, because the Catholic Church has no centralized, online database of all candidates for canonization. Eliseu first had to phone several local dioceses to ask if they had proposed anyone for sanctification in the past. He learned that all candidates were funneled through a retired Brazilian nun who is in charge of reviewing the proposals and sending them to the Vatican. Eliseu used her as a source as well. It took him four days to compile a list of Brazilian candidates for canonization and to gather portraits of 36 of them. That was more than half of the time we invested in completing the entire project!

While Eliseu was doing his research, the rest of the department and I were collecting background information. We wanted to show how many saints were named by each Pope in the past two centuries, explain how someone becomes a saint, and highlight the fact that, despite Latin America's standing as the most deeply Catholic region in the world, it has pushed a relatively small number of people through canonization. In fact, most of the saints made during John Paul II's and Benedict XVI's papacies come from Europe and Asia, apparently in an effort to promote Catholicism in those regions.

Figure 8.1 shows one of our first sketches for the project. I designed the layout in Adobe Illustrator. If you compare it to the final project in **Figure 8.2**, you will notice that the structure survived, but the look is entirely different.

This illustrates the point I made at the outset: You need to build a solid backbone for your information, a reading path, an order, and a hierarchy, before you lock yourself into a style for your display. The structure is the skeleton and muscles of your graphic; the visual style is the skin. With no bones to support it, the skin of your project will collapse.

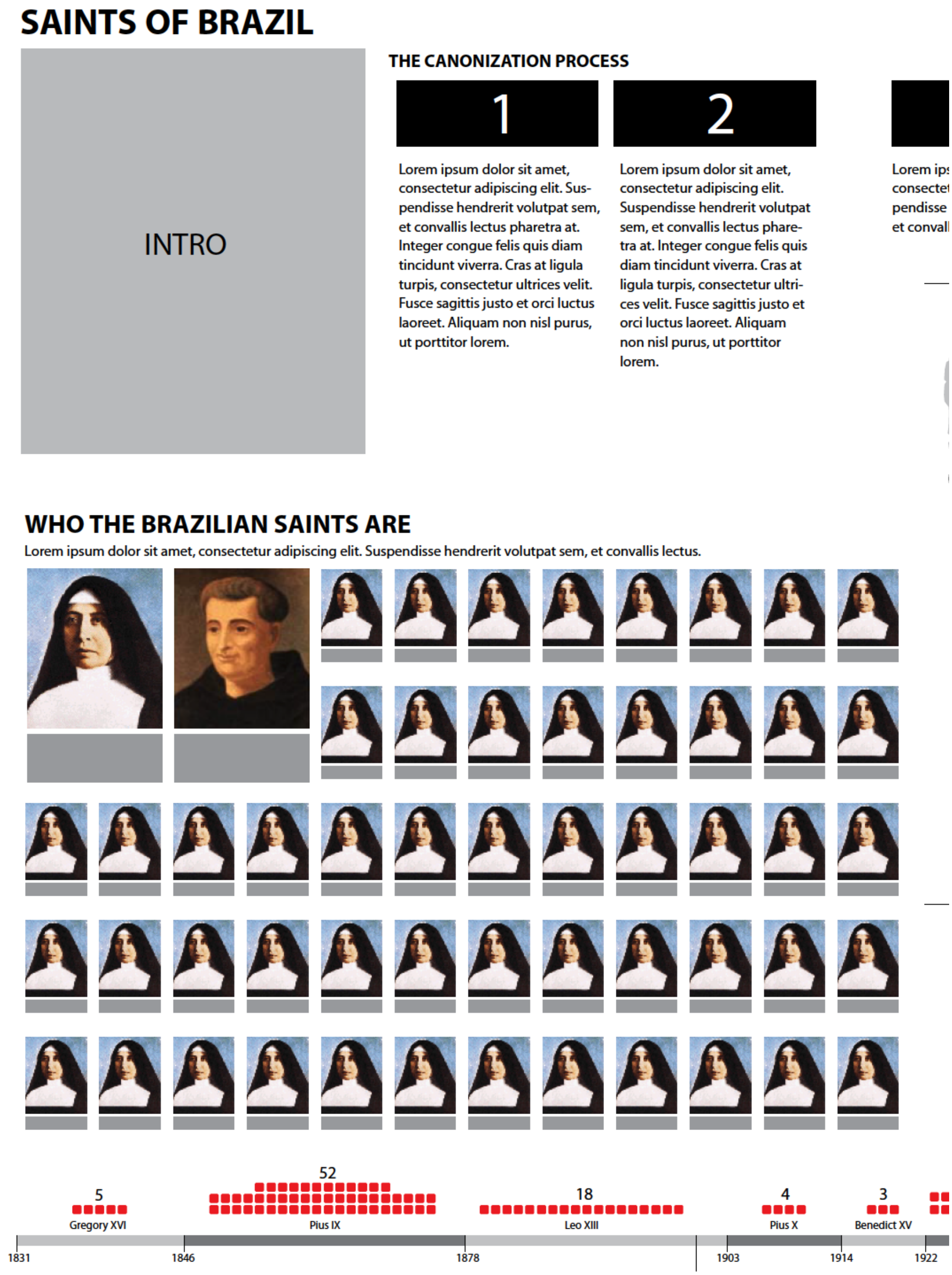

Figure 8.1 First layout for the Brazilian Saints project.

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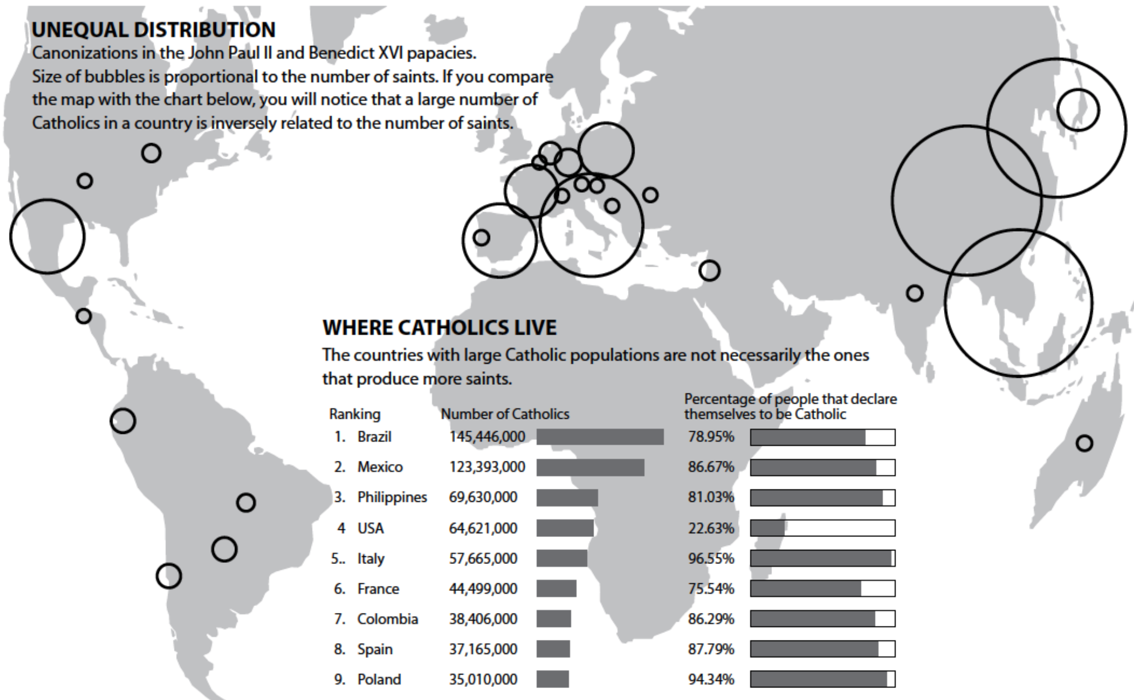
UNEQUAL DISTRIBUTION

Canonizations in the John Paul II and Benedict XVI papacies.
Size of bubbles is proportional to the number of saints. If you compare the map with the chart below, you will notice that a large number of Catholics in a country is inversely related to the number of saints.



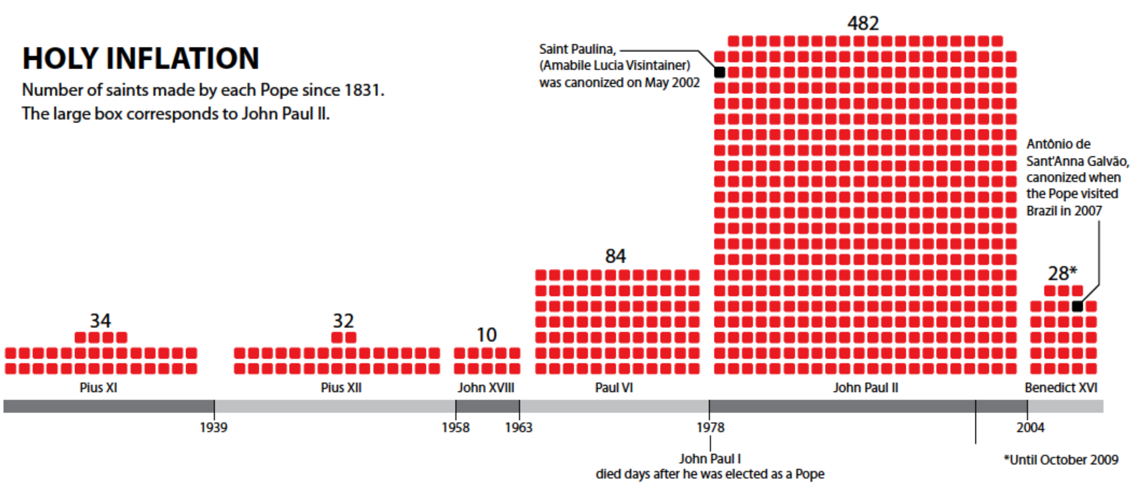
WHERE CATHOLICS LIVE

The countries with large Catholic populations are not necessarily the ones that produce more saints.

Ranking		Number of Catholics	Percentage of people that declare themselves to be Catholic
1.	Brazil	145,446,000	78.95%
2.	Mexico	123,393,000	86.67%
3.	Philippines	69,630,000	81.03%
4	USA	64,621,000	22.63%
5..	Italy	57,665,000	96.55%
6.	France	44,499,000	75.54%
7.	Colombia	38,406,000	86.29%
8.	Spain	37,165,000	87.79%
9.	Poland	35,010,000	94.34%
10.	Argentina	34,480,000	89.25%

HOLY INFLATION

Number of saints made by each Pope since 1831.
The large box corresponds to John Paul II.



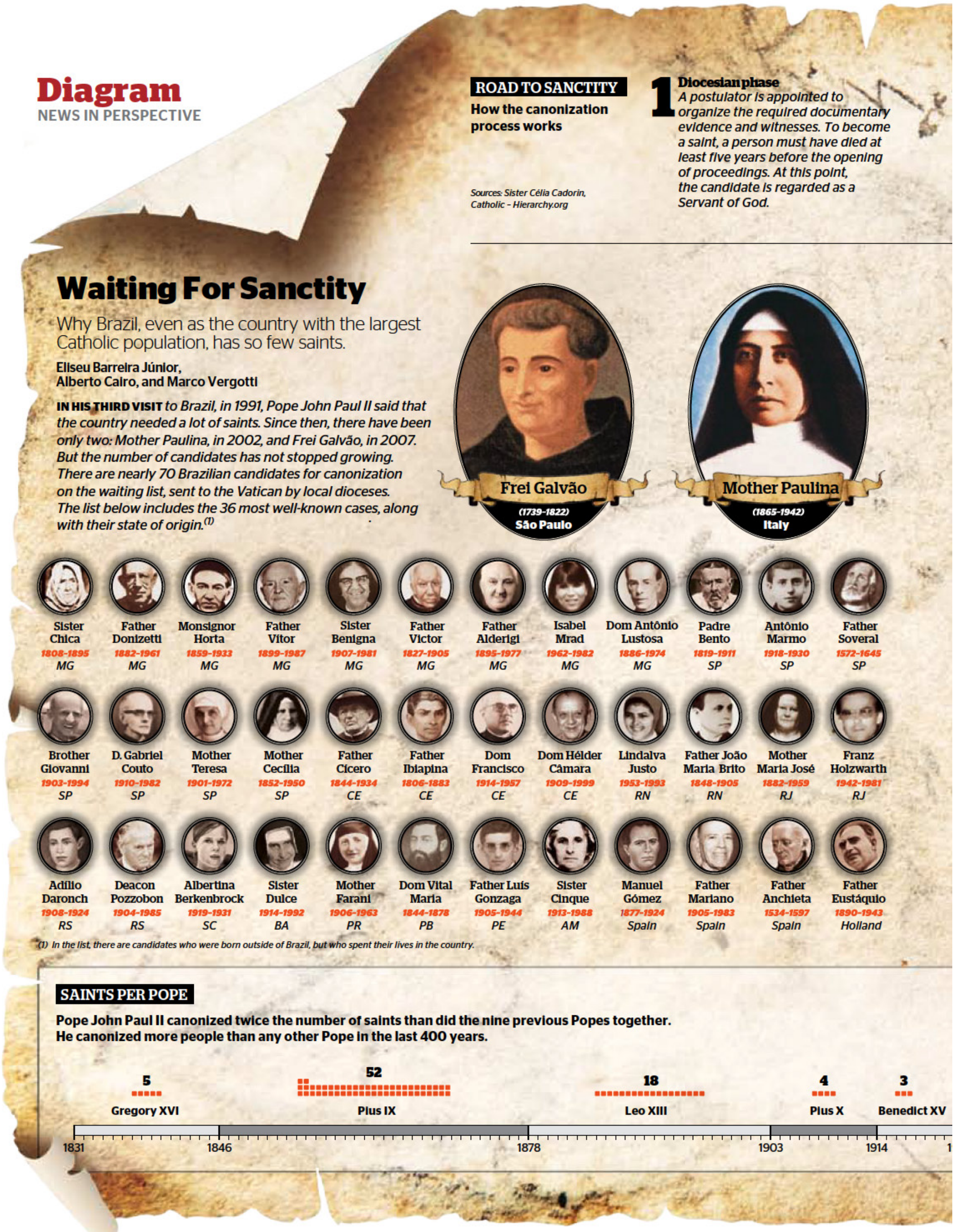
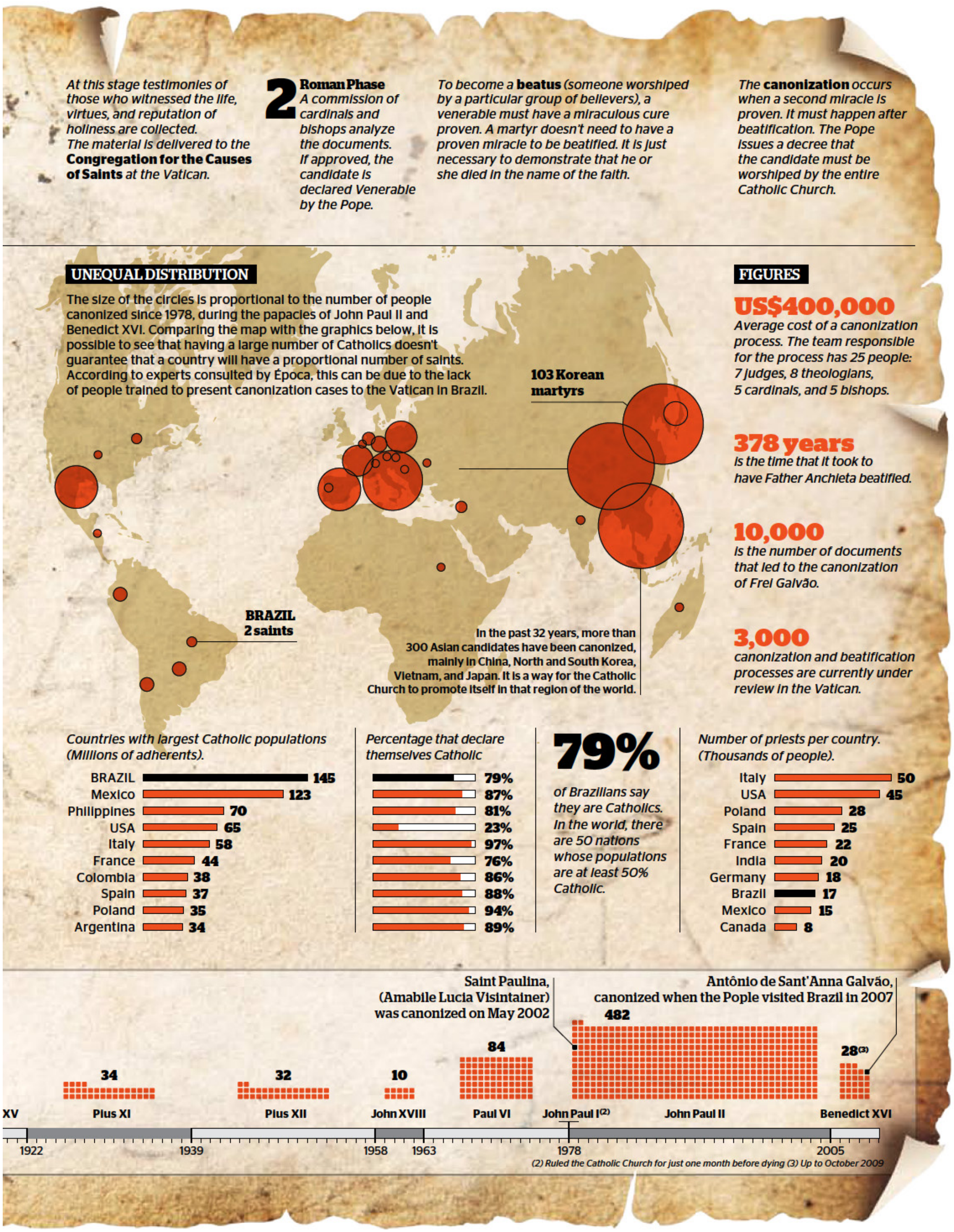


Figure 8.2 Brazilian Saints project, as published by *Época*, São Paulo, Brazil. Translated from Portuguese.


At this stage testimonies of those who witnessed the life, virtues, and reputation of holiness are collected.
The material is delivered to the **Congregation for the Causes of Saints** at the Vatican.
2 Roman Phase
A commission of cardinals and bishops analyze the documents.
If approved, the candidate is declared Venerable by the Pope.
To become a **beatus** (someone worshiped by a particular group of believers), a venerable must have a miraculous cure proven. A martyr doesn't need to have a proven miracle to be beatified. It is just necessary to demonstrate that he or she died in the name of the faith.
The **canonization** occurs when a second miracle is proven. It must happen after beatification. The Pope issues a decree that the candidate must be worshiped by the entire Catholic Church.
UNEQUAL DISTRIBUTION
The size of the circles is proportional to the number of people canonized since 1978, during the papacies of John Paul II and Benedict XVI. Comparing the map with the graphics below, it is possible to see that having a large number of Catholics doesn't guarantee that a country will have a proportional number of saints. According to experts consulted by Época, this can be due to the lack of people trained to present canonization cases to the Vatican in Brazil.
103 Korean martyrs
BRAZIL 2 saints
In the past 32 years, more than 300 Asian candidates have been canonized, mainly in China, North and South Korea, Vietnam, and Japan. It is a way for the Catholic Church to promote itself in that region of the world.
FIGURES
US$400,000
Average cost of a canonization process. The team responsible for the process has 25 people: 7 judges, 8 theologians, 5 cardinals, and 5 bishops.
378 years
is the time that it took to have Father Anchieta beatified.
10,000
is the number of documents that led to the canonization of Frei Galvão.
3,000
canonization and beatification processes are currently under review in the Vatican.
Countries with largest Catholic populations (Millions of adherents).
BRAZIL 145
Mexico 123
Philippines 70
USA 65
Italy 58
France 44
Colombia 38
Spain 37
Poland 35
Argentina 34
Percentage that declare themselves Catholic
79%
87%
81%
23%
97%
76%
86%
88%
94%
89%
79%
of Brazilians say they are Catholics. In the world, there are 50 nations whose populations are at least 50% Catholic.
Number of priests per country. (Thousands of people).
Italy 50
USA 45
Poland 28
Spain 25
France 22
India 20
Germany 18
Brazil 17
Mexico 15
Canada 8
Saint Paulina, (Amabile Lucia Visintainer) was canonized on May 2002
Antônio de Sant'Anna Galvão, canonized when the Pople visited Brazil in 2007
34
32
10
84
482
28(3)
XV
Pius XI
Pius XII
John XVIII
Paul VI
John Paul I(2)
John Paul II
Benedict XVI
1922
1939
1958
1963
1978
2005
(2) Ruled the Catholic Church for just one month before dying (3) Up to October 2009

The Changing Face of Brazil's Population

Sometimes it is not the story that leads you to search for a particular kind of data. Sometimes, it is data that leads you to a story.

Maybe you remember the example on fertility that opened Chapter 1. I made that graphic while working on a real project for *Época* about how Brazilian population trends have changed in the past half-century.

In November 2010, the Brazilian Institute of Geography and Statistics (IBGE) was about to release the data for the latest census, conducted every 10 years. *Época* is a weekly magazine, so it cannot limit itself to summarizing what daily publications have already published during the week. One of my responsibilities as infographics director was to think up unexpected angles for stories that newspapers cover in detail. The fertility graphic was one of those. We knew that all kinds of media would echo IBGE's press releases. Would it be possible to go beyond what we predicted our competitors would do? It was no easy task. Brazilian media, particularly infographics desks, are extremely creative.

I was feeling a bit desperate when I remembered that a few days before, I had seen a story citing preliminary figures disclosed by the IBGE that indicated that the **Brazilian fertility rate** (the average number of children per woman) **was already below 1.9**. The statistic was counterintuitive. I was intrigued. In the minds of many foreigners—and I was one of them, having been there only a few months—Brazil is still an underdeveloped country where women tend to nurture huge families with four or five children, at least.

But **experience tells you not to trust intuition when you can rely on data**. I went to the World Bank databases and downloaded the fertility figures from all countries. Then, I plotted them in a line chart and highlighted Brazil. **Figure 8.3** might look familiar. It's very similar to one of the charts I designed for Chapter 1 when I was trying to find out if the hypotheses in Matt Riddley's *The Rational Optimist* made sense.

Impressive, isn't it? On average, in 1950, Brazilian women had more than six children. But that number has dropped below the replacement rate of 2.1—the minimum number of children couples must have to keep the population stable in the long term. Any country that scores below that will either face an older and

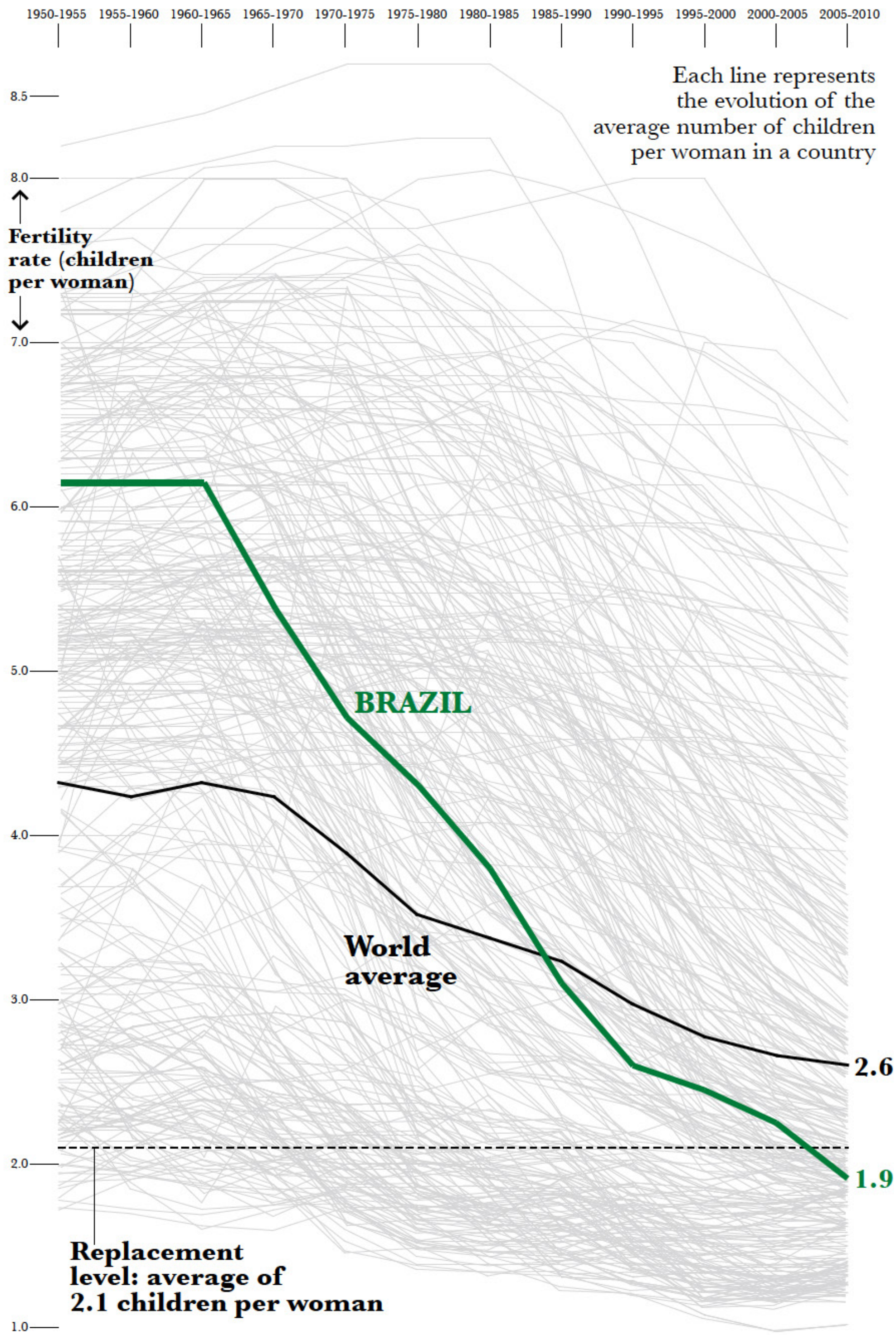


Figure 8.3 The shrinking Brazilian fertility rate, compared to other countries.

smaller population in the future, or will have to open its borders to more young immigrants hungry for opportunities.

All of this was pretty interesting, but it was not enough to be considered a proper journalistic story. I needed a narrative that tied the data together and was compelling enough to be read. Fortunately for me, *Época*'s managing editor, Helio Gurovitz, holds a B.A. in computer science, which he got years before he decided to become a journalist, so he knows numbers. He proposed a headline for the double-page infographic we were planning: *"Brazil's Demographic Opportunity."* Then he outlined a possible narrative:

1. Start with the news: the data from the new Brazilian census. We already knew it would show that Brazil experienced healthy population growth between 2000 and 2010.
2. At the same time, the fertility rate is down compared with other countries and regions.
3. The dramatic loss of fertility will eventually lead to a smaller and older population.
4. In spite of how dire that sounds, Brazil can take advantage of the situation by investing in education now.

I liked Helio's idea so much that I rushed back to my computer and started putting together a layout. I wanted to publish the story as soon as possible. The only catch was that the IBGE had not officially released the census data. But, digging into its website, I had seen that it had published a shaded map with the new numbers. So they did have the figures, although they had not yet told the press.

I phoned the IBGE press department and requested access to the organization's database. I wanted to use it with a software program I had recently become acquainted with, called Estatcart, which was developed by the IBGE itself.

Estatcart is a Geographic Information System, or *GIS tool*. Simply speaking, in any GIS tool, you start with an empty map such as the one in **Figure 8.4** (that is Estatcart's interface). Then, you link the map to a Microsoft Excel spreadsheet or to a database. The colors of the regions change depending on the numbers in the dataset. You can imagine that if you are faced with the task of mapping the variation in population in the more than 5,000 municipalities of Brazil, such a tool is invaluable. If you don't have access to one, you will have to painstakingly color those regions *one by one*.

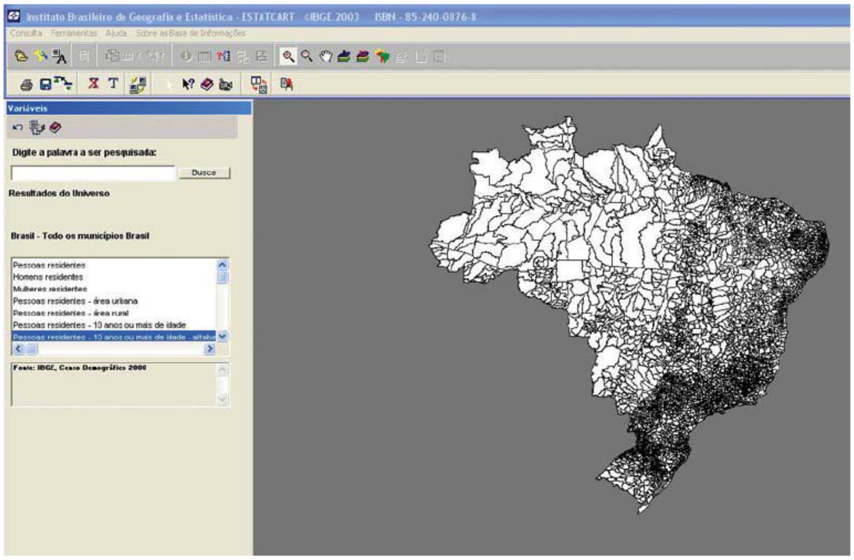


Figure 8.4 Estatcart's interface.

Unfortunately, the IBGE decided to make me wait until it released the data to all newspapers and magazines, my urgency notwithstanding. I still wanted our story to run before they released the official numbers, so I copied the figures from the interactive map. You could call it manual hacking.

I then formatted the data to Estatcart's requirements, which resulted in the map you see in **Figure 8.5**. The green regions had the higher increase in population between 2000 and 2010, while the regions in orange and red suffered declines.

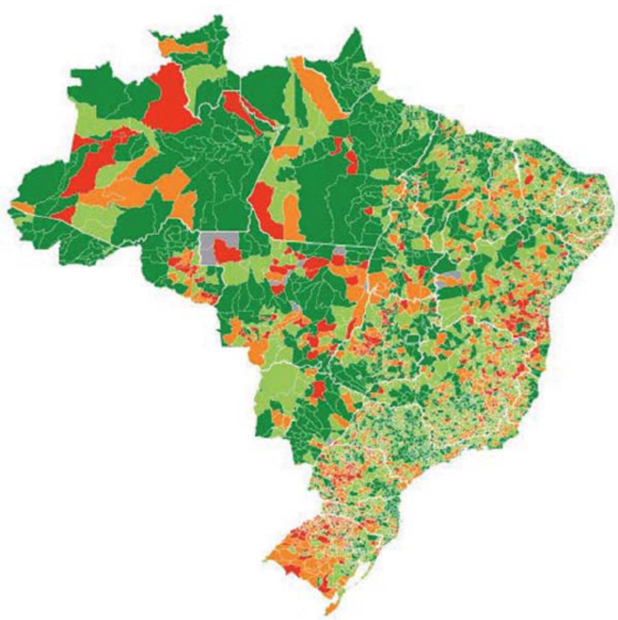


Figure 8.5 A map designed with Estatcart and then styled in Adobe Illustrator.

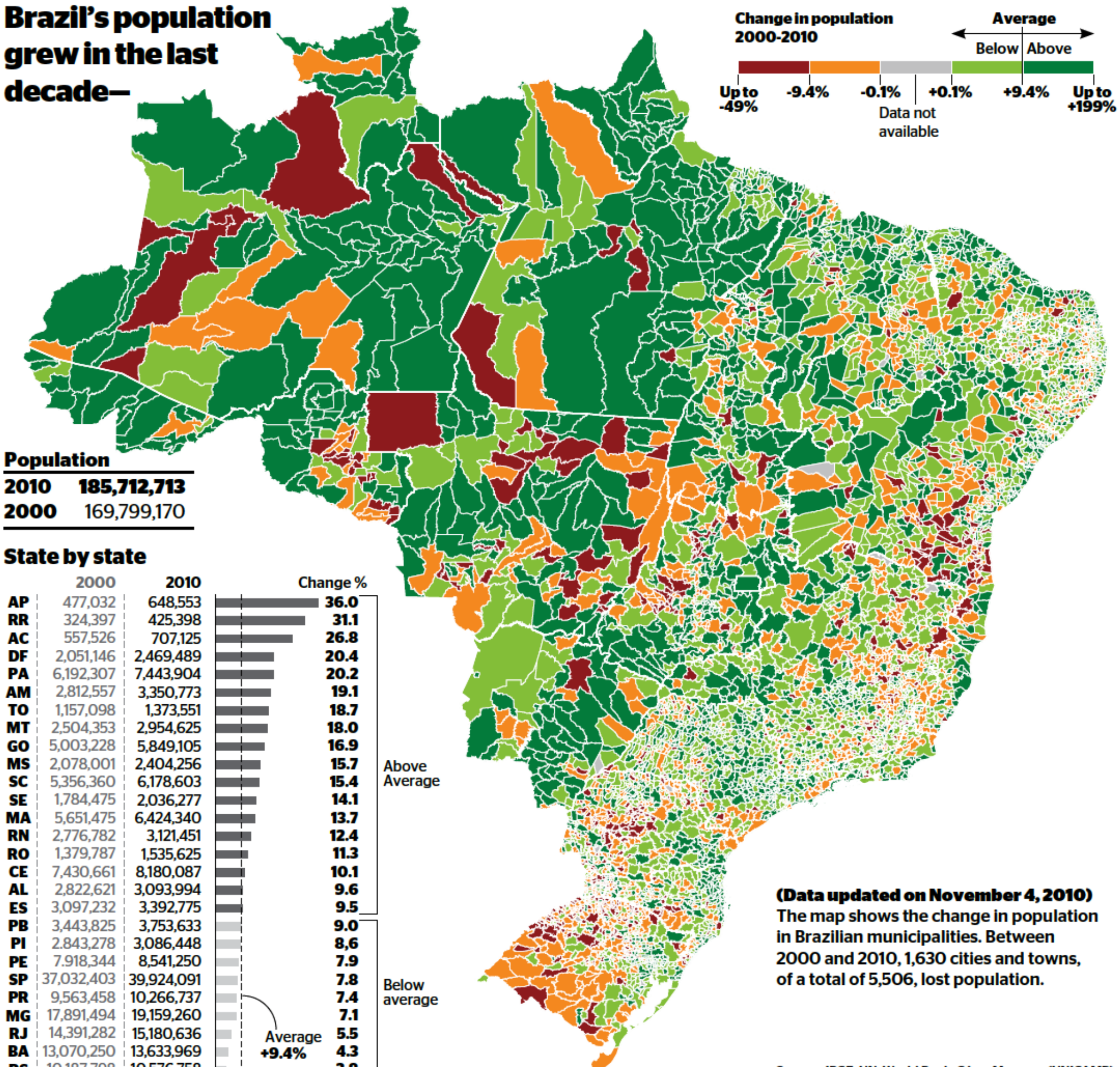
Brazil's Demographic Oportunity

How Brazil can take advantage of a future with fewer children per couple.

Data provided by the Brazilian Institute of Geography and Statistics (IBGE) offer a mixed portrait of the Brazilian population. On one side, the population of the country has increased by 10% in the last decade, but the fertility rate has dropped below the critical average of 2.1 children per woman. Demographers have pointed out that this poses challenges to public officials: how to sustain Social Security, above all. Nonetheless, those same demographers say that Brazil can transform this situation into an opportunity if it starts investing heavily on education now.

Alberto Cairo and Francine Lima

Brazil's population grew in the last decade—



Population

2010	**185,712,713**
2000	169,799,170

State by state

	2000	2010	Change %	
AP	477,032	648,553	**36.0**	Above Average
RR	324,397	425,398	**31.1**	
AC	557,526	707,125	**26.8**	
DF	2,051,146	2,469,489	**20.4**	
PA	6,192,307	7,443,904	**20.2**	
AM	2,812,557	3,350,773	**19.1**	
TO	1,157,098	1,373,551	**18.7**	
MT	2,504,353	2,954,625	**18.0**	
GO	5,003,228	5,849,105	**16.9**	
MS	2,078,001	2,404,256	**15.7**	
SC	5,356,360	6,178,603	**15.4**	
SE	1,784,475	2,036,277	**14.1**	
MA	5,651,475	6,424,340	**13.7**	
RN	2,776,782	3,121,451	**12.4**	
RO	1,379,787	1,535,625	**11.3**	
CE	7,430,661	8,180,087	**10.1**	
AL	2,822,621	3,093,994	**9.6**	
ES	3,097,232	3,392,775	**9.5**	
PB	3,443,825	3,753,633	**9.0**	Below average
PI	2,843,278	3,086,448	**8,6**	
PE	7,918,344	8,541,250	**7.9**	
SP	37,032,403	39,924,091	**7.8**	
PR	9,563,458	10,266,737	**7.4**	
MG	17,891,494	19,159,260	**7.1**	
RJ	14,391,282	15,180,636	**5.5**	
BA	13,070,250	13,633,969	**4.3**	
RS	10,187,798	10,576,758	**3.8**	

Average +9.4%

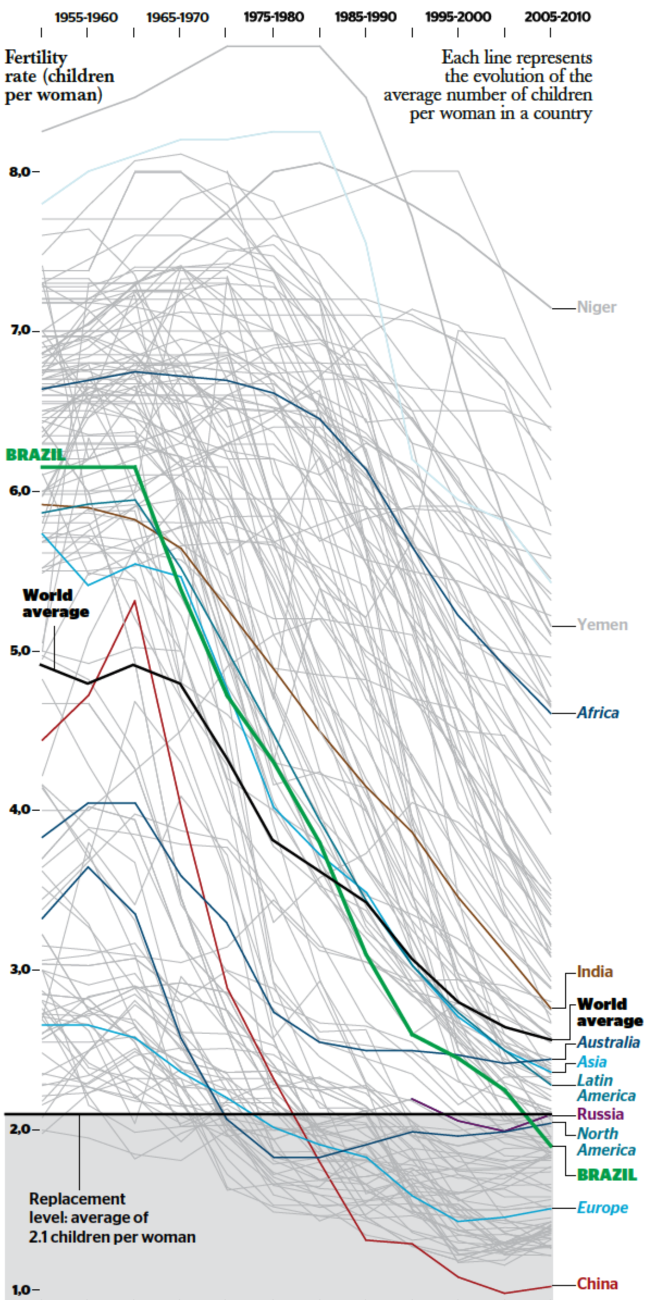
(Data updated on November 4, 2010)
The map shows the change in population in Brazilian municipalities. Between 2000 and 2010, 1,630 cities and towns, of a total of 5,506, lost population.

Sources: IBGE, UN, World Bank, César Marques (UNICAMP)

Figure 8.6 One of the first drafts for the Brazilian population infographic. Translated from Portuguese.

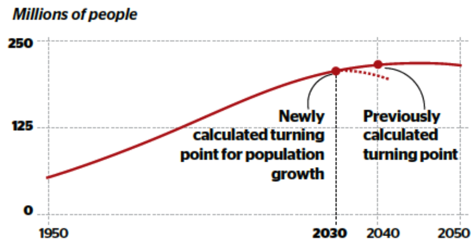
—but fertility rate is below what was expected—

A study in 2004 estimated that in 2010, the fertility rate would be 2.4 children per woman, on average. But new data collected by the IBGE prove that the fertility rate is already 1.9, below the threshold called "replacement rate." When the fertility rate drops below this number, the population of a country will eventually start to shrink and grow older.



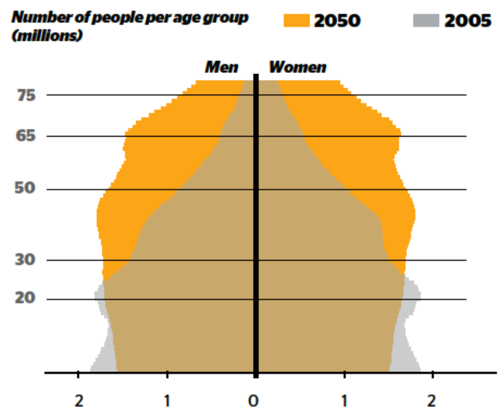
—and population will be smaller—

Forecasts made in 2004 anticipated that Brazil's population would stop growing in 2040. But the most recent data from the IBGE suggests that this could happen much earlier, in 2030.



—and older—

Comparing the current population pyramid with the one predicted for 2050



How Brazil can transform the population challenge into an opportunity

As the population ages, the proportion of people of working age increases. The country will therefore have more people producing wealth (if the labor market can absorb them) and fewer children to consume investments. It is a window of opportunity, because in some cases the number of people of working age tends to decline when older people are leaving the market.

The population under 15 years of age is falling today. A smaller number of students in public schools will facilitate the quality of teaching, if the amount invested in education stays the same.

Educational policy focused on low-income youth favors the formation of a more skilled workforce and greater social mobility. In the future, Brazil will reach the stage of Europe and Japan, which struggle to support their elders. This is why it's so important to prepare a more balanced retirement system.

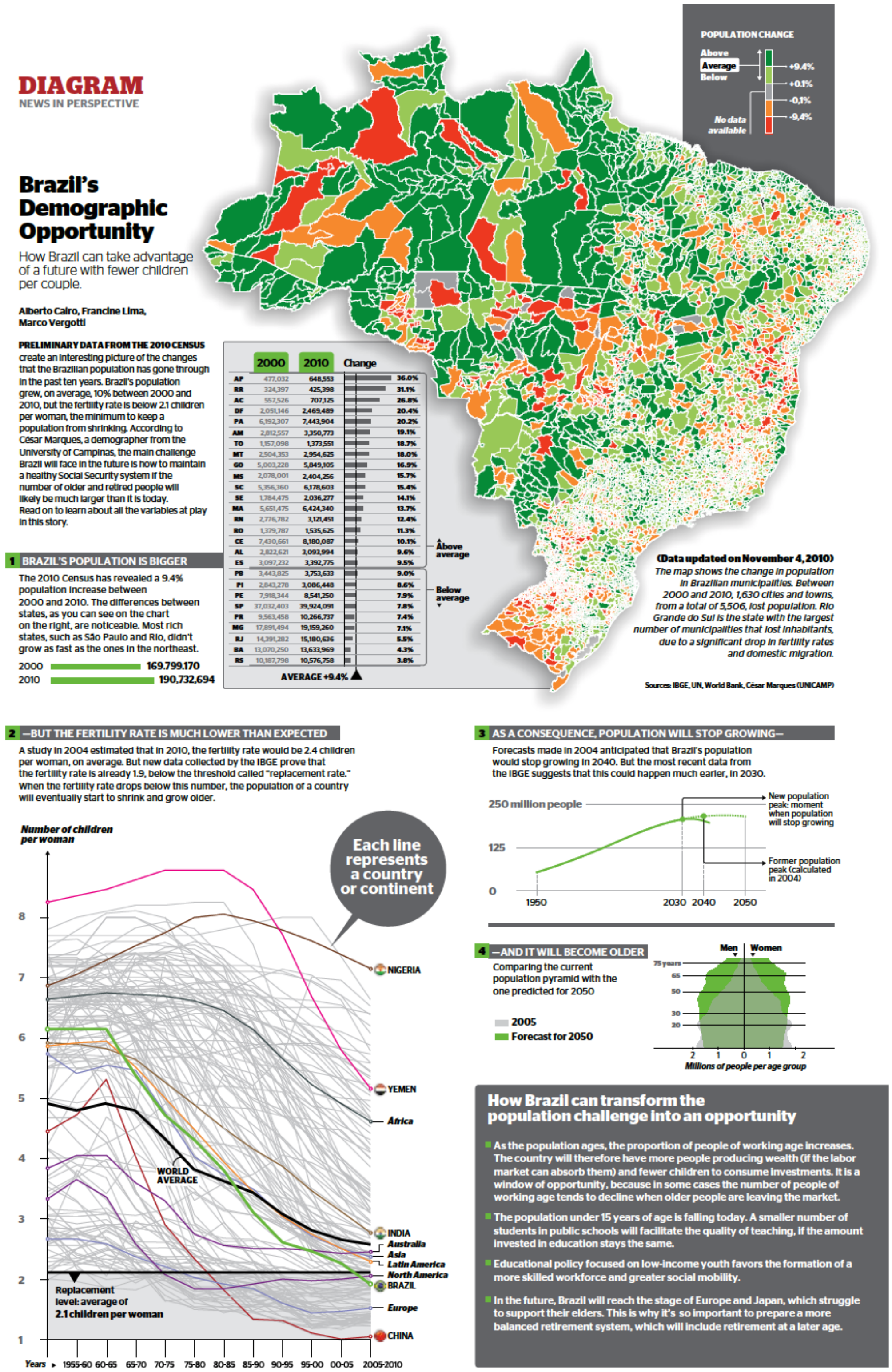


Figure 8.7 Brazil's Demographic Opportunity. Published by *Época*, São Paulo, Brazil. Translated from Portuguese.

While I was taking care of the nerdy stuff, one of our reporters, Francine Lima, interviewed a well-known demographer to give context to the data and provide insights into how a challenge can be transformed into an opportunity. In brief: Brazil could support an older population in the future if it starts preparing right now. The next 20 years will see a swell in numbers of people between 16 and 60 years old. They will be eager to work. If Brazil manages to give them the right education in the present, they will transform the country's economy for the better. They will generate not only more taxes, but also more internal and foreign investment. We decided to make those points in the last part of the graphic.

With all the material in hand, I put together the layout you see in **Figure 8.6**.

As my layout was quite rough (I am not a good designer, lacking an eye for color and font choices), Marco Vergotti, the head of *Época's* print infographics, transformed it into the gorgeous display that was finally published in the magazine (**Figure 8.7**). You could say that this project is an example of low-tech data journalism and highly effective teamwork.

Inequality and the Economy

I am not ashamed to admit that I copy from the people I admire. You should not be either. As Austin Kleon reminds us in his inspiring *Steal Like an Artist* (2012), "Every new idea is just a mashup or a remix of one or more previous ideas." The thin red line between elegant theft and plagiarism is defined by how much you can pay homage to someone else's ideas by adding something that is truly yours.

In May 2010, *The New York Times* published a chart titled "Driving Shifts Into Reverse," made by Hannah Fairfield. It was a most uncommon kind of scatter-plot (**Figure 8.8**). You will learn more about Hannah in the Profiles section.

Remember that a scatter-plot allows you to see the relationship between two variables, one on the horizontal axis and the other on the vertical axis. What was surprising about Hannah's graphic was that the points on the line were years, so her scatter-plot had to be read as if you were following a path marked by years instead of miles. The position of each dot-year depends on the average miles driven per capita (horizontal axis) and the price of a gallon of gasoline (vertical axis). In other words, the farther to the right a dot is, the more miles Americans drove, and the higher the dot on the vertical scale, the more expensive gasoline was.

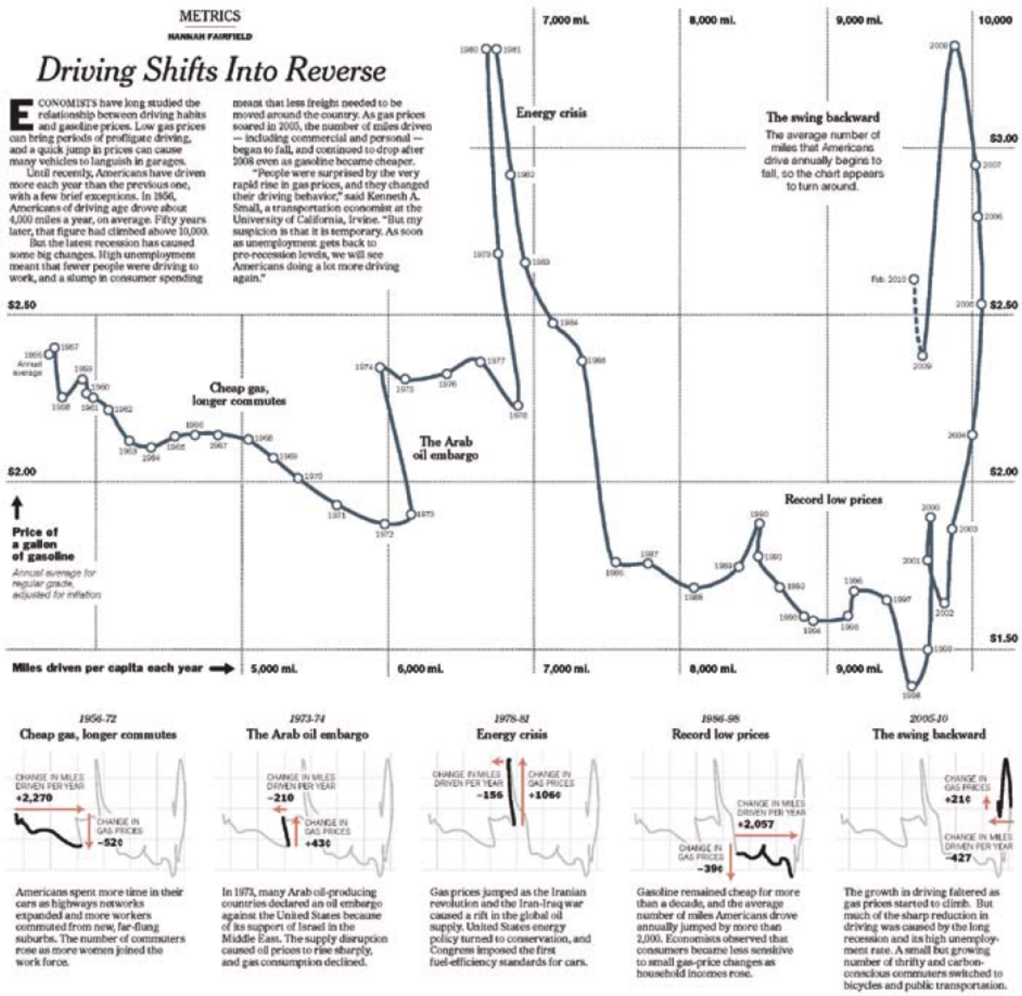


Figure 8.8 "Driving Shifts Into Reverse," a graphic by Hannah Fairfield for *The New York Times*.

The chart is not intuitive at first, but, once you understand how it works, it's illuminating. See, for instance, the Arab oil embargo between 1973 and 1974: Oil prices spiked, and the line turns backward (left to right), meaning that the miles driven per capita that year went from around 6,150 to nearly 5,900. During the energy crisis at the beginning of the 1980s, oil prices soared, and Americans tended to keep their driving to a minimum. If you go back in time to the period from 1956 to 1972, you will notice that oil prices were stable, and the population tended to increase commutes. I considered this graphic a masterpiece at the time, and still do.

I was so inspired by Hannah's project that I used it as a template for a graphic I was working on at the time, mentioned in the introduction to this book.

In February 2011, Letícia Sorg, a reporter for *Época*, recommended I read *The Spirit Level: Why Greater Equality Makes Societies Stronger* (2009), by Richard Wilkinson and Kate Pickett. Letícia was planning to interview Wilkinson, a professor at the University of Nottingham. She wanted to enrich the interview with some graphics.

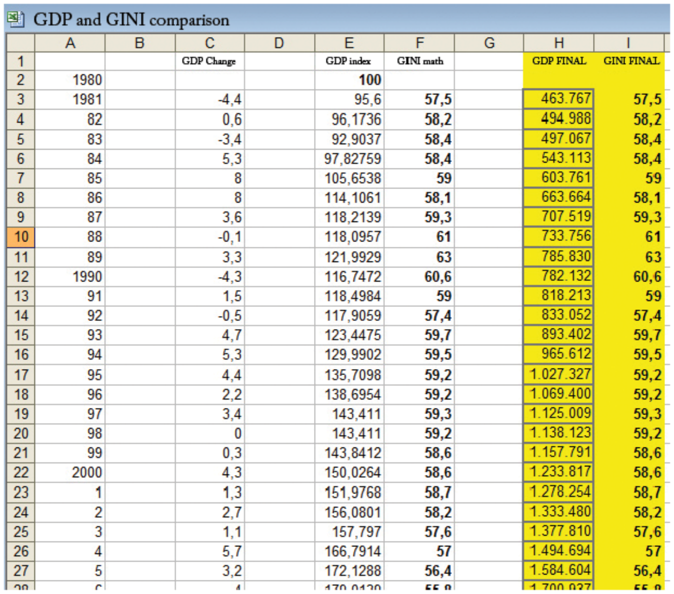
The Spirit Level itself includes plenty of charts. The book uncovers the tight connection between inequality (measured with an index called GINI, developed by Italian sociologist Corrado Gini) and several negative social indicators, such as the number of people in prison, the rate of teenage pregnancy, the prevalence of obesity, and the impact of mental diseases. But we wanted to go a bit beyond the book, and discuss the problem of inequality in Brazil.

Historically, Brazil has been one of the most unbalanced countries in the world. After democracy was reinstated in the 1980s, Brazil experienced spurts of rapid economic development, interspersed with periods of stagnation and hyperinflation. The chronic economic instability was accompanied by unpredictable variations in inequality. In good times, most of the benefits of growth accrued to the rich portion of the population. In bad times, it was the poor who suffered the most, as the rich were able to shelter their money from crisis and inflation using varied investment tricks.

Brazil stabilized during Fernando Henrique Cardoso's (FHC) tenures, first as finance minister (1993–1994), and later as president of the Republic (1995–2002). Cardoso got inflation under control, transformed Brazil's economy, and laid the groundwork for Luiz Inácio "Lula" da Silva's presidency (2003–2011), who was the most successful in raising the quality of life for millions of Brazil's poor people. Under Lula, continued economic growth was accompanied by a steady drop in income inequality, thanks in part to many income distribution and social advancement programs.

For this project, inspired by Fairfield's scatter-plot, I put my data in an Excel spreadsheet (**Figure 8.9**). Note the columns highlighted in yellow. The first is GDP in billions of dollars; the second is inequality, measured with the GINI Index. The higher the score, the higher the inequality.

Next, I selected the two columns and told Excel to create a scatter-plot. I also told it to connect the dots (which, remember, represent years) with a line. **Figure 8.10** shows the result. Notice the slow economic growth between 1981 (first dot) and 1993 (twelfth dot); they are not that far apart in the horizontal axis. Also note the huge vertical variations of the line in between those years, visual evidence of the wild changes in inequality.



GDP and GINI comparison

	A	B	C	D	E	F	G	H	I
1			GDP Change		GDP index	GINI math		GDP FINAL	GINI FINAL
2	1980				100				
3	1981		-4,4		95,6	57,5		463.767	57,5
4	82		0,6		96,1736	58,2		494.988	58,2
5	83		-3,4		92,9037	58,4		497.067	58,4
6	84		5,3		97,82759	58,4		543.113	58,4
7	85		8		105,6538	59		603.761	59
8	86		8		114,1061	58,1		663.664	58,1
9	87		3,6		118,2139	59,3		707.519	59,3
10	88		-0,1		118,0957	61		733.756	61
11	89		3,3		121,9929	63		785.830	63
12	1990		-4,3		116,7472	60,6		782.132	60,6
13	91		1,5		118,4984	59		818.213	59
14	92		-0,5		117,9059	57,4		833.052	57,4
15	93		4,7		123,4475	59,7		893.402	59,7
16	94		5,3		129,9902	59,5		965.612	59,5
17	95		4,4		135,7098	59,2		1.027.327	59,2
18	96		2,2		138,6954	59,2		1.069.400	59,2
19	97		3,4		143,411	59,3		1.125.009	59,3
20	98		0		143,411	59,2		1.138.123	59,2
21	99		0,3		143,8412	58,6		1.157.791	58,6
22	2000		4,3		150,0264	58,6		1.233.817	58,6
23	1		1,3		151,9768	58,7		1.278.254	58,7
24	2		2,7		156,0801	58,2		1.333.480	58,2
25	3		1,1		157,797	57,6		1.377.810	57,6
26	4		5,7		166,7914	57		1.494.694	57
27	5		3,2		172,1288	56,4		1.584.604	56,4

Figure 8.9 A screenshot of the Excel spreadsheet I used to compare GDP growth with income inequality.

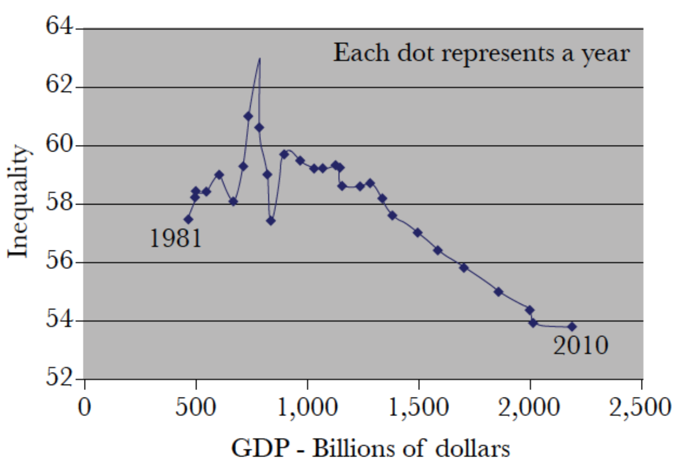


Figure 8.10 Excel's default options could be improved. I am not very fond of blue lines over gray backgrounds.

The chart made in Excel didn't look very good. By default, Excel creates graphics with strange-looking gray backgrounds and seemingly random color choices. So I switched to Adobe Illustrator, refining the style and adding the copy and explainers (**Figure 8.11**). To those familiar with Brazil's recent history, the visual impression is shocking: Prior to 1993–1994, the line goes up and down. Once you get to Itamar Franco's and FHC's presidencies, the line stabilizes and stretches out. **The pace of economic growth increases, and inequality plunges non-stop.**

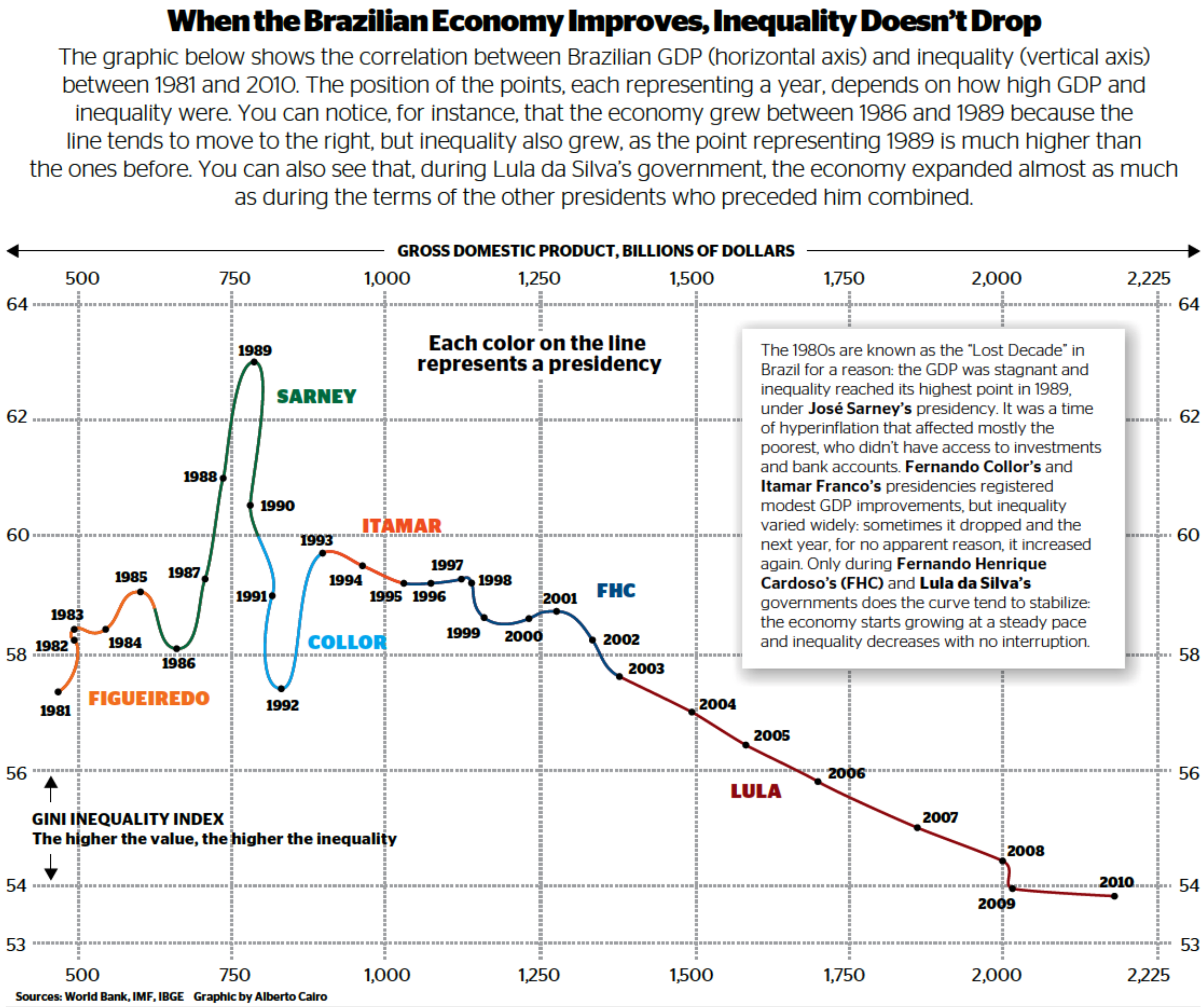


Figure 8.11 Income inequality and GDP in Brazil.

A Word on Structure, Color, and Type

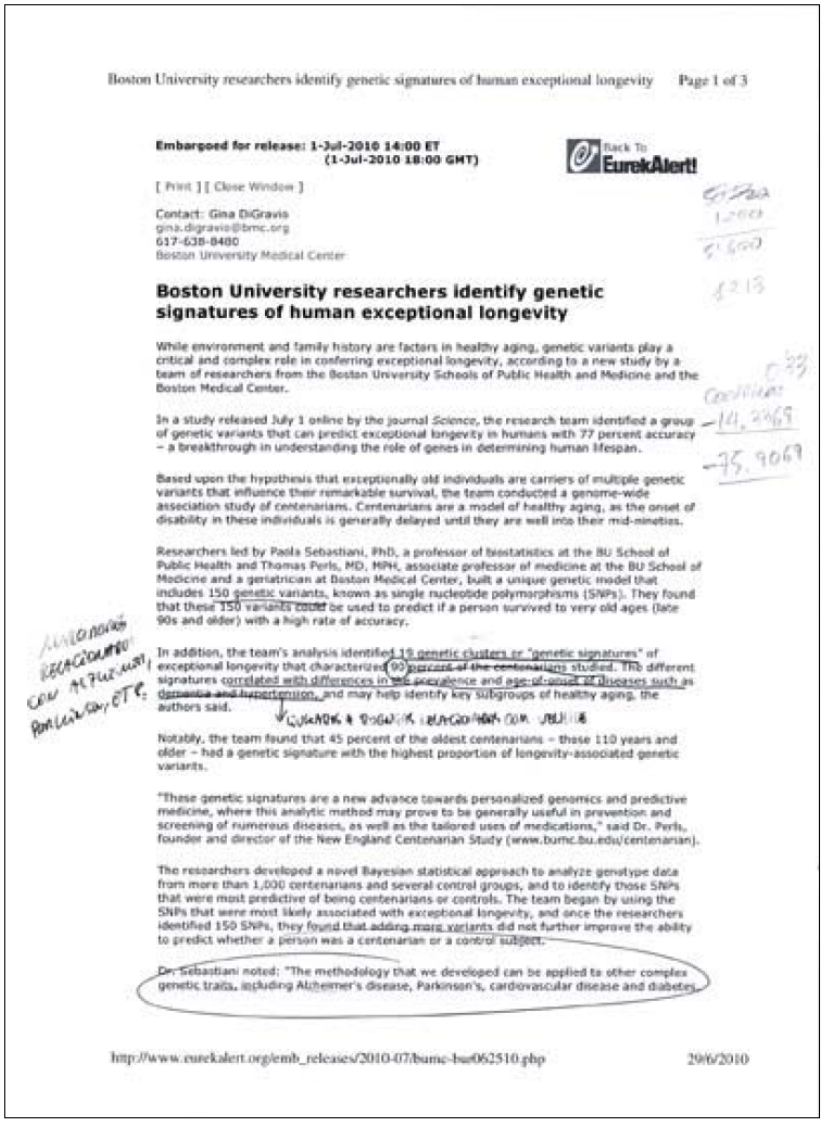
To end this chapter, I would like to show you some infographics that illustrate two lessons I've learned through the years on how to design effective information graphics:

Keep type and color under control, and

Create a solid layout by imagining your graphics as if they were groups of rectangles.

In July 2010, *Science* magazine published an article on "genetic signatures of exceptional human longevity" written by researchers from Boston University. The scientists identified certain combinations of genes that are extremely common in people who live beyond 100 years.

Época magazine published a long story on the article. As a key part of it, during the planning meeting, my colleague Gerson Mora—arguably the best 3D news artist in Brazil—and I decided that we needed a big information graphic that



Boston University researchers identify genetic signatures of human exceptional longevity Page 1 of 3

Embargoed for release: 1-Jul-2010 14:00 ET (1-Jul-2010 18:00 GMT)

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Boston University Medical Center

Boston University researchers identify genetic signatures of human exceptional longevity

While environment and family history are factors in healthy aging, genetic variants play a critical and complex role in conferring exceptional longevity, according to a new study by a team of researchers from the Boston University Schools of Public Health and Medicine and the Boston Medical Center.

In a study released July 1 online by the journal *Science*, the research team identified a group of genetic variants that can predict exceptional longevity in humans with 77 percent accuracy – a breakthrough in understanding the role of genes in determining human lifespan.

Based upon the hypothesis that exceptionally old individuals are carriers of multiple genetic variants that influence their remarkable survival, the team conducted a genome-wide association study of centenarians. Centenarians are a model of healthy aging, as the onset of disability in these individuals is generally delayed until they are well into their mid-nineties.

Researchers led by Paola Sebastiani, PhD, a professor of biostatistics at the BU School of Public Health and Thomas Perls, MD, MPH, associate professor of medicine at the BU School of Medicine and a geriatrician at Boston Medical Center, built a unique genetic model that includes 150 genetic variants, known as single nucleotide polymorphisms (SNPs). They found that these 150 variants could be used to predict if a person survived to very old ages (late 90s and older) with a high rate of accuracy.

In addition, the team's analysis identified 19 genetic clusters or "genetic signatures" of exceptional longevity that characterized 90 percent of the centenarians studied. The different signatures correlated with differences in the prevalence and age-of-onset of diseases such as dementia and hypertension, and may help identify key subgroups of healthy aging, the authors said.

Notably, the team found that 45 percent of the oldest centenarians – those 110 years and older – had a genetic signature with the highest proportion of longevity-associated genetic variants.

"These genetic signatures are a new advance towards personalized genomics and predictive medicine, where this analytic method may prove to be generally useful in prevention and screening of numerous diseases, as well as the tailored uses of medications," said Dr. Perls, founder and director of the New England Centenarian Study (www.bumc.bu.edu/centenarian).

The researchers developed a novel Bayesian statistical approach to analyze genotype data from more than 1,000 centenarians and several control groups, and to identify those SNPs that were most predictive of being centenarians or controls. The team began by using the SNPs that were most likely associated with exceptional longevity, and once the researchers identified 150 SNPs, they found that adding more variants did not further improve the ability to predict whether a person was a centenarian or a control subject.

Dr. Sebastiani noted: "The methodology that we developed can be applied to other complex genetic traits, including Alzheimer's disease, Parkinson's, cardiovascular disease and diabetes.

http://www.eurekalert.org/emb_releases/2010-07/bumc-bur062510.php 29/6/2010

Figure 8.12 Notes on a press release.

answered three interrelated questions: **why we get old**, **why and how cells stop reproducing**, and **what factors make those processes faster or slower**. That's the first step for any project: defining its goals and scope.

The second step is to gather your information. Obviously, we needed to read *Science*'s article. You can see a printout of the press release in **Figure 8.12**. It's filled with notes and underlines scribbled in English, Spanish, and Portuguese made as I was trying to understand it. At the same time, on another piece of paper, I was drawing a very rough node chart (**Figure 8.13**). I learned to do such organizational trees from my father, who taught me to use them as study aids for my high school exams.

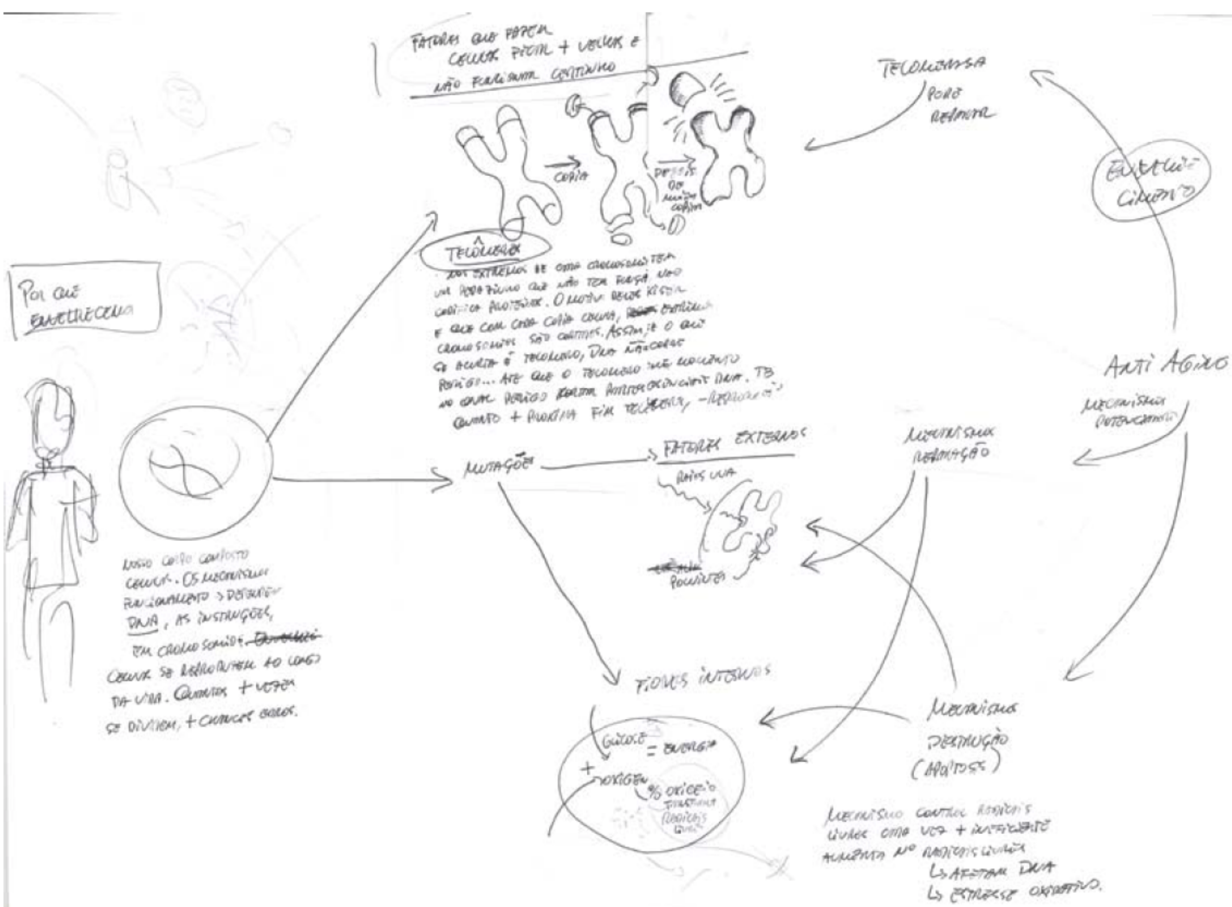


Figure 8.13 Get used to sketching ideas while you research a project.

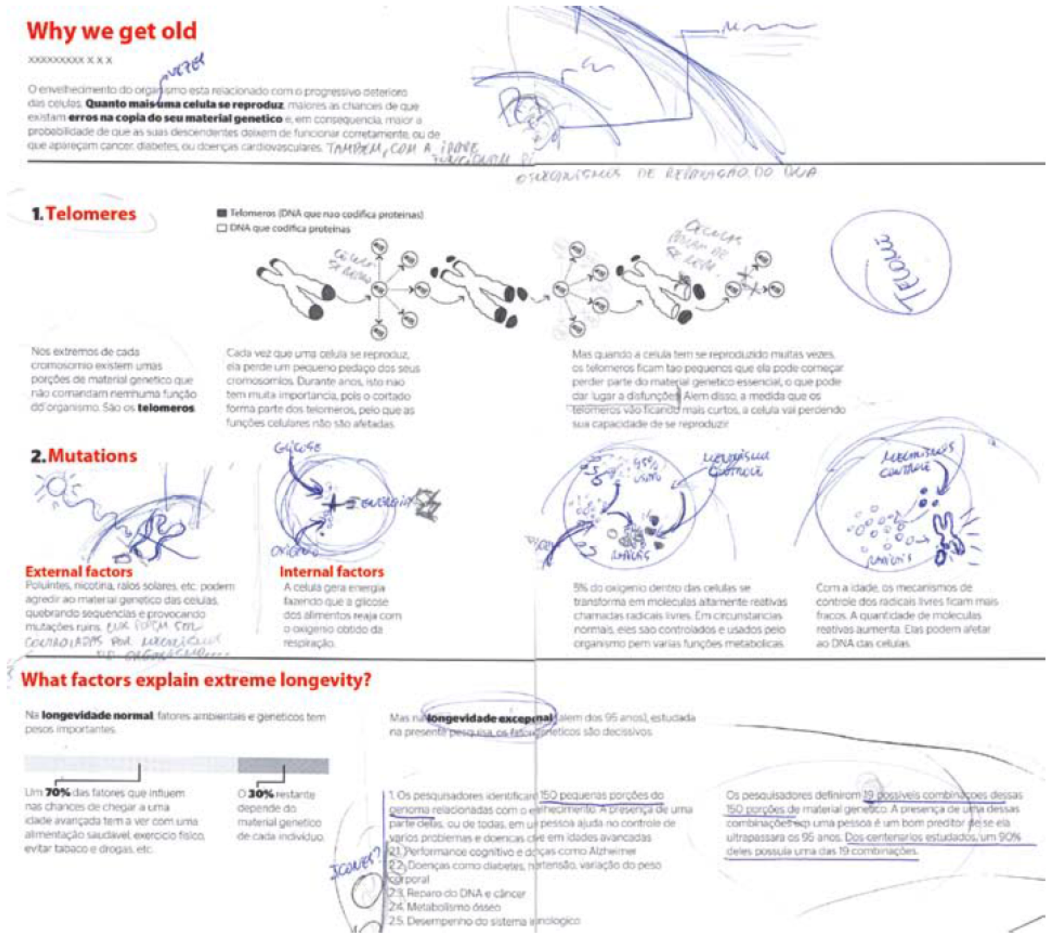


Figure 8.14 Sketching the layout.

We used other sources for this project. I am a fan of popular science books, so I retrieved some volumes from my shelves, including Matt Ridley's *Genome: The Autobiography of a Species in 23 Chapters*, and Mel Greaves' *Cancer: The Evolutionary Legacy*.

With my notes in front of me on my desk, I created a sketch of the layout, shown in **Figure 8.14**. (I've translated the headlines into English so you can understand its structure.) That's the narrative backbone I mentioned earlier. You should not proceed to developing a graphic on the computer before you've devised something like this—a precise outline of the graphic's elements and how they relate to one other. If you compare the sketch with the actual infographic we published (**Figure 8.15**), you will see that we followed it quite closely. Planning your content in advance saves a lot of time down the road.

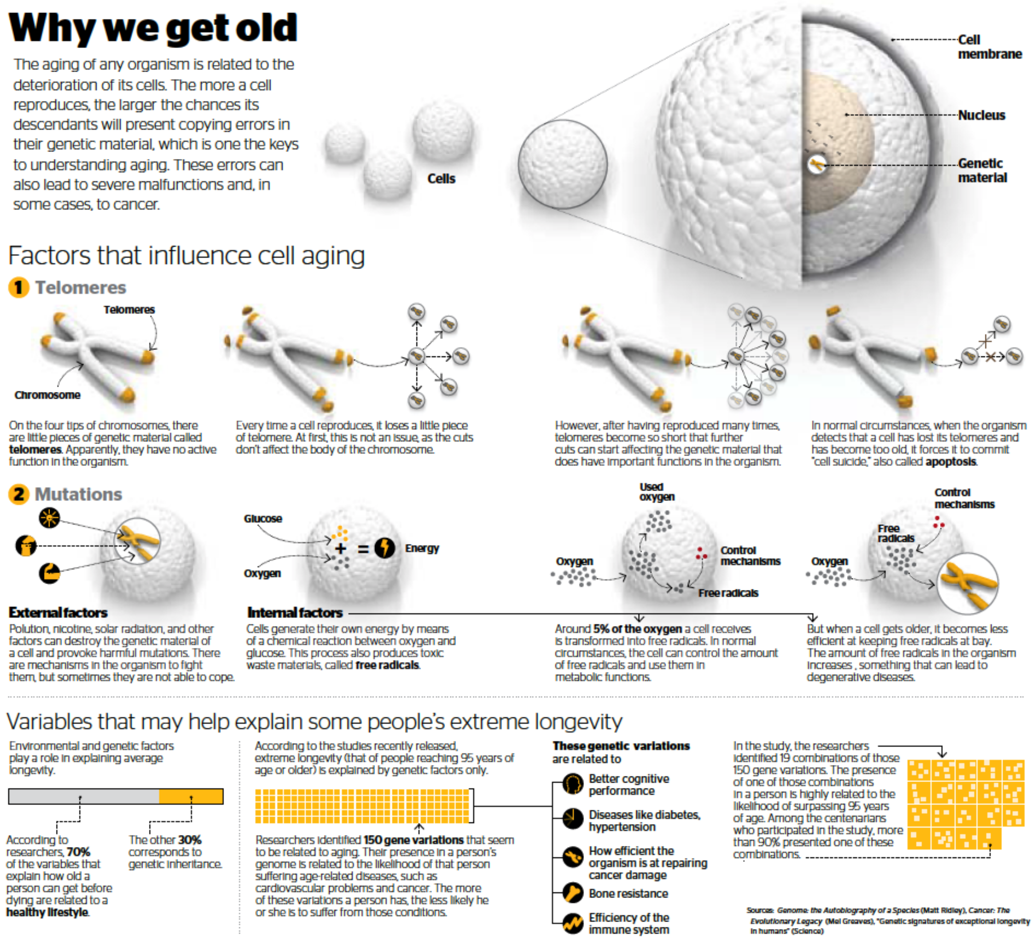


Figure 8.15 Why We Get Old. *Época*. Translated from Portuguese.

Notice something else about the sketch: the relative lack of color and sameness of the type. This is not just a minimalist aesthetic choice, but a practical one. **Limiting the amount of colors and different fonts in your graphics will help you create a sense of unity in the composition.** I usually recommend to my students at the University of Miami and the University of North Carolina at Chapel Hill to **stick to just two or three colors** and **play with their shades**. You may pick a neutral tone for the background elements (bluish gray in this case), and an accent color to highlight the most relevant stuff (yellow). **Do the same with fonts. Choose just one or two**: a solid, thick one for headlines, and a readable one for body copy.

Regarding the structure, notice that almost all parts of the graphic fit into rectangles (**Figure 8.16**). This is because I tend to be a bit conservative in my layouts. Visualizing my projects as sets of rectangles of different sizes before I even start designing charts, maps, and illustrations helps me come up with a clear hierarchy and to guide readers through a logical reading path.

You can see this organizational principle at work in many of the projects I've designed alone or with colleagues and friends since I started doing infographics back in 1997. **Figure 8.17** and **Figure 8.18** contain two examples, one an infographic on giant waves and another on new telescopes that are being built in South America. In **Figure 8.19**, you can see the invisible rectangles that enclose the different sections and how they compare to the rough layouts we created to organize their contents.

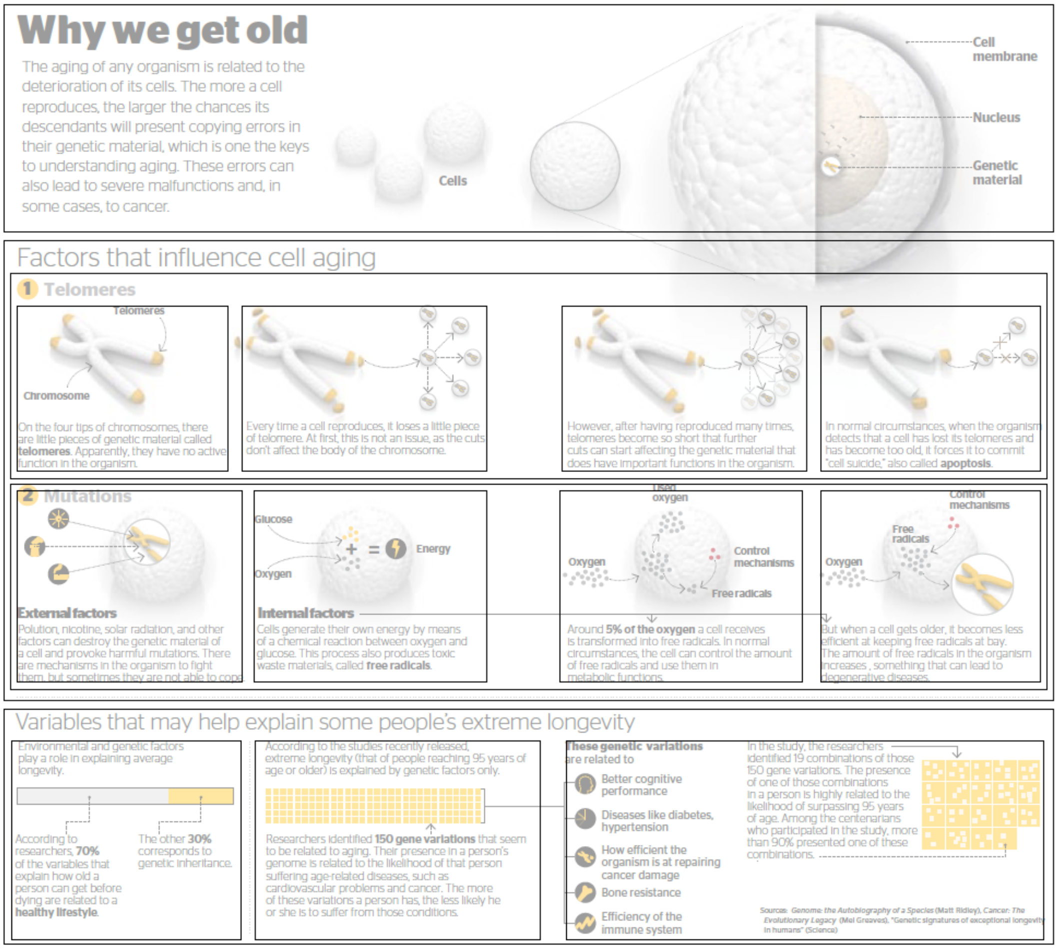


Figure 8.16 Organizing your composition as if it were a set of rectangles of different sizes helps you design a structure and a hierarchy.

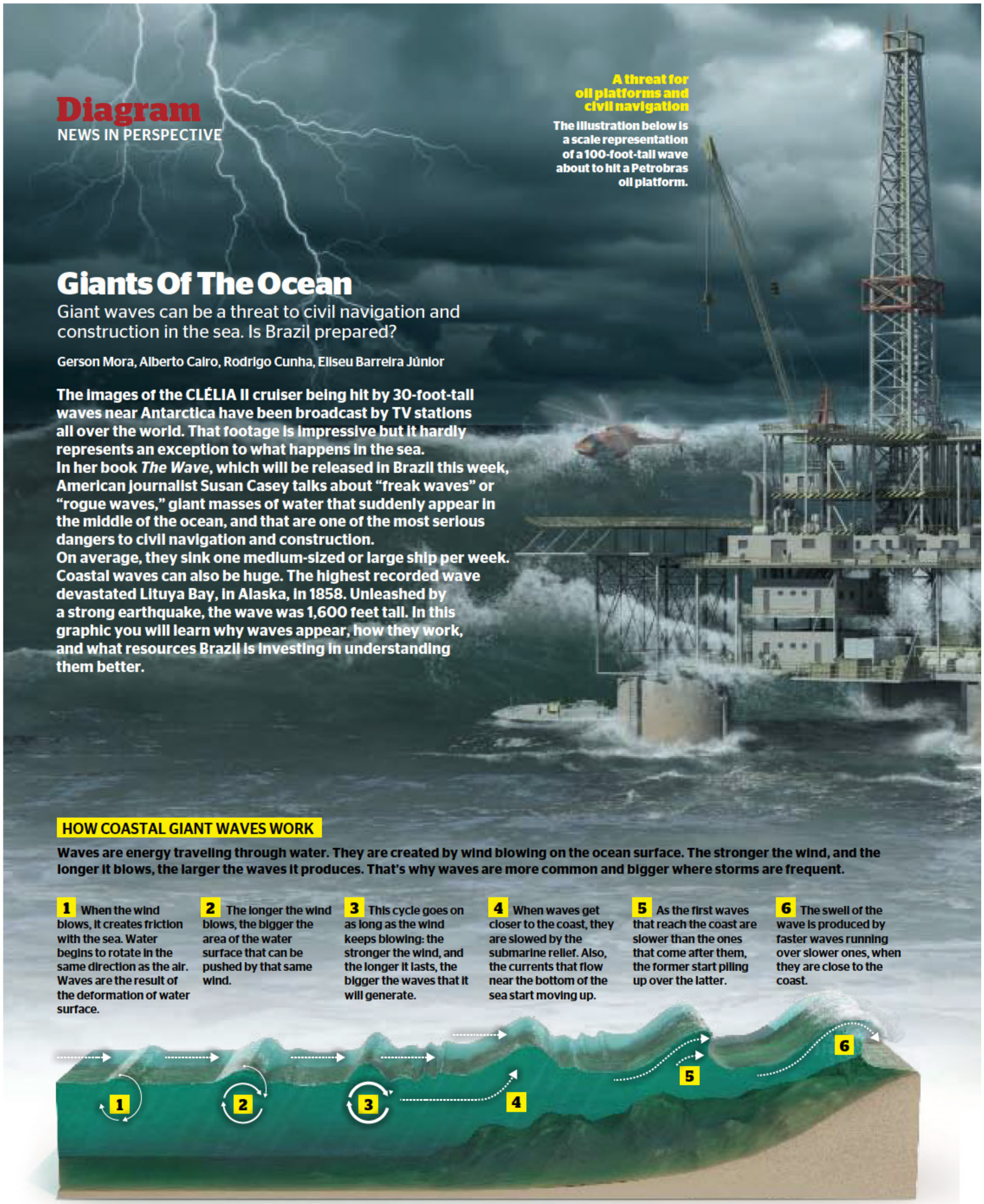


Figure 8.17 Giant Waves, for *Época*. Translated from Portuguese. The illustration in the center is not mere decoration, but a proportional representation of how big a 100-foot wave is, compared to an average oil platform.


GIANT WAVES IN BRAZIL
Brazil doesn't keep a centralized record of giant waves in national waters. But Petrobras, the public oil company, takes them into consideration when it builds extraction platforms.
Campos Basin
Mathematical models have predicted that waves during a storm can reach an average of 26 feet with a maximum of 48 feet.
Santos Basin
Simulations developed in 2010 have predicted that the maximum height of a wave in Santos (never observed) is 67 feet.
WAVE SIMULATOR
The Polytechnic School of the University of São Paulo (Poli-USP), using funding from Petrobras, opened a lab to study giant waves in December 2009. The main element in the laboratory is a 36-foot-wide and 13-foot-deep pool for simulating giant wave patterns . The waves are generated by 148 rubber flaps, attached to small engines and controlled by a computer.
SOURCES: The Wave (Susan Casey), Poli-USP, BBC Science and Nature
HOW FREAK WAVES WORK
"Freak" or "rogue" waves are giant waves that appear in the middle of the sea. They are very dangerous due to their unpredictability. Recent research has identified three different factors that influence their likelihood.
A
B
C
Cold water
Warm water
A Regions where storms are common, such as the North Atlantic, are also the ones where freak waves appear with higher frequency. The strong winds that stir those waters are a key factor.
B Submarine relief is another factor. Shallow waters in the North Sea, between the UK and Scandinavia, are prone to freak waves for the same reason that big waves appear in coastal areas.
C The confluence of warm and cold currents (see map on the right) creates dynamics that make giant waves more likely.
Frequency and height of freak waves
Lower
Higher
Freak waves are more common in regions near the Poles. They are also frequent in South African national waters. In that area, the Agulhas Current meets cold water that is pushed from the South Pole by strong winds.

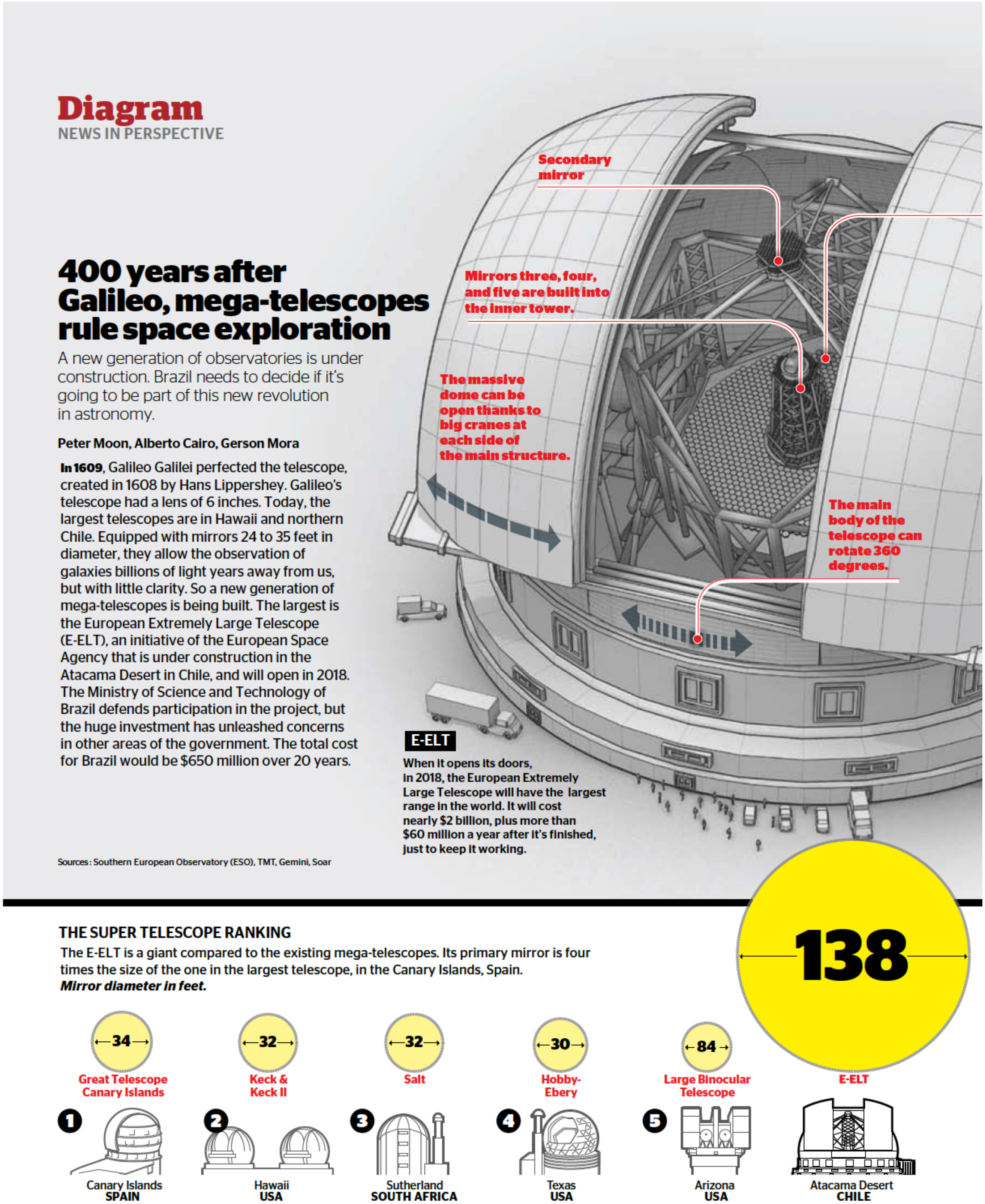


Diagram
NEWS IN PERSPECTIVE

400 years after Galileo, mega-telescopes rule space exploration

A new generation of observatories is under construction. Brazil needs to decide if it's going to be part of this new revolution in astronomy.

Peter Moon, Alberto Cairo, Gerson Mora

In 1609, Galileo Galilei perfected the telescope, created in 1608 by Hans Lippershey. Galileo's telescope had a lens of 6 inches. Today, the largest telescopes are in Hawaii and northern Chile. Equipped with mirrors 24 to 35 feet in diameter, they allow the observation of galaxies billions of light years away from us, but with little clarity. So a new generation of mega-telescopes is being built. The largest is the European Extremely Large Telescope (E-ELT), an initiative of the European Space Agency that is under construction in the Atacama Desert in Chile, and will open in 2018. The Ministry of Science and Technology of Brazil defends participation in the project, but the huge investment has unleashed concerns in other areas of the government. The total cost for Brazil would be $650 million over 20 years.

Sources: Southern European Observatory (ESO), TMT, Gemini, Soar

E-ELT

When it opens its doors, in 2018, the European Extremely Large Telescope will have the largest range in the world. It will cost nearly $2 billion, plus more than $60 million a year after it's finished, just to keep it working.

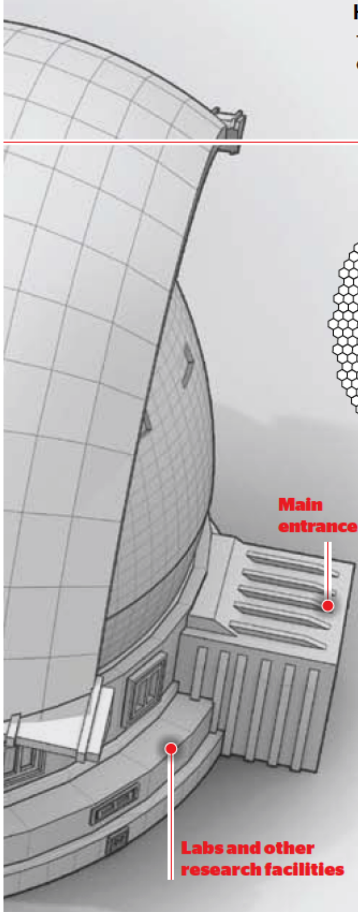
THE SUPER TELESCOPE RANKING

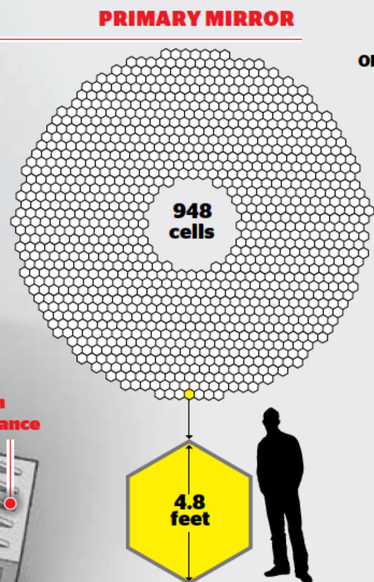
The E-ELT is a giant compared to the existing mega-telescopes. Its primary mirror is four times the size of the one in the largest telescope, in the Canary Islands, Spain.
Mirror diameter in feet.

Figure 8.18 New Telescopes in South America, for *Época*. Translated from Portuguese.

HOW THE E-ELT GATHERS HIGH-RESOLUTION IMAGES

The E-ELT will be the first telescope able to shoot pictures of planets outside the solar system, which will be useful for analyzing their atmospheres.

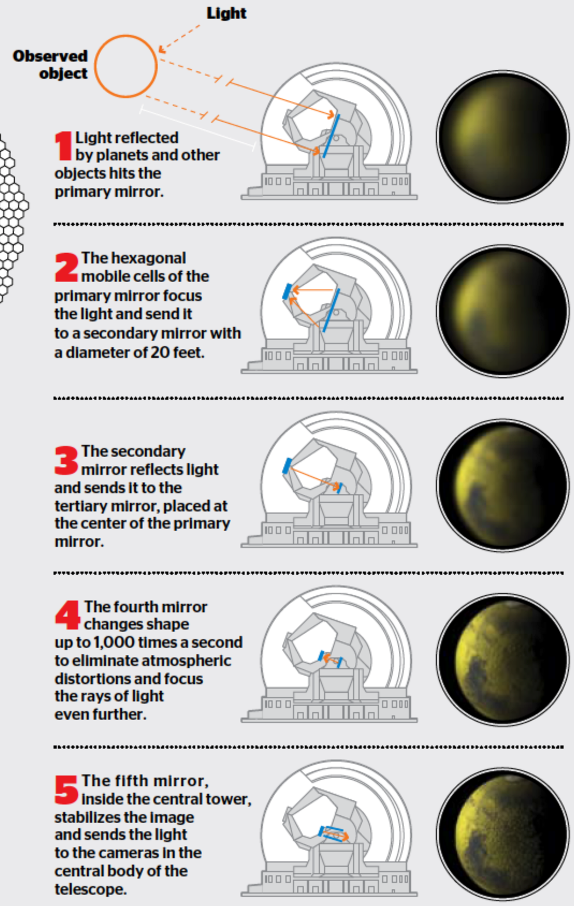




Why is the telescope so large?

The sensitivity and acuity of a telescope depend on how well it gathers light reflected by objects that sometimes are many light years away from Earth. The larger the reflecting surface of the telescope's primary mirror, the more photons of light it will be able to capture.

The telescope has a diameter of 330 feet and a height of 260 feet.



1 Light reflected by planets and other objects hits the primary mirror.

2 The hexagonal mobile cells of the primary mirror focus the light and send it to a secondary mirror with a diameter of 20 feet.

3 The secondary mirror reflects light and sends it to the tertiary mirror, placed at the center of the primary mirror.

4 The fourth mirror changes shape up to 1,000 times a second to eliminate atmospheric distortions and focus the rays of light even further.

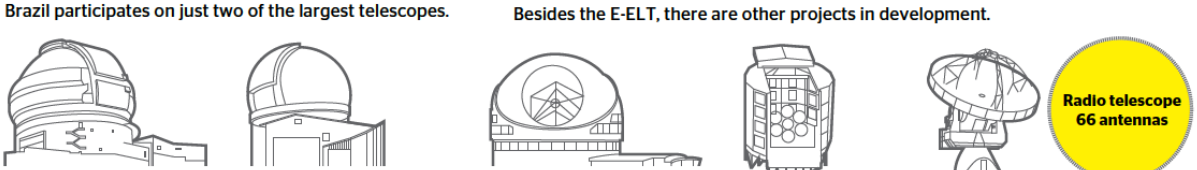
5 The fifth mirror, inside the central tower, stabilizes the image and sends the light to the cameras in the central body of the telescope.

TELESCOPES WITH BRAZILIAN INVOLVEMENT

Brazil participates on just two of the largest telescopes.

OTHER LARGE TELESCOPES UNDER CONSTRUCTION

Besides the E-ELT, there are other projects in development.



Gemini
Built in Cerro Pachón, Chile, and the Mauna Kea volcano, Hawaii, these twin telescopes have mirrors with a diameter of 26.5 feet. Brazil participates by covering 2.4% of the total cost in exchange for the right of using them for observations.

Soar
Built in Cerro Pachón, Chile, the Southern Astro Physical Research Telescope has a mirror with a diameter of 13.5 feet. The Brazilian National Scientific Development Council covers a great portion of its costs.

Thirty Meters Telescope (TMT)
Opening: 2018
Cost: $1 billion
Mirror: 98 feet
Place: Hawaii
Built by: USA, Canada, China, India

Telescópio Gigante Magalhães (GMT)
Opening: 2018
Cost: $600 million
Mirror: 80.4 feet
Place: Chilean Andes
Built by: USA, Australia, South Korea

Atacama Large Millimeter Array (Alma)
Opening: 2012
Cost: $1.3 billion
Place: Atacama, Chile
Built by: European Union, USA, Canada, Japan, Taiwan, Chile

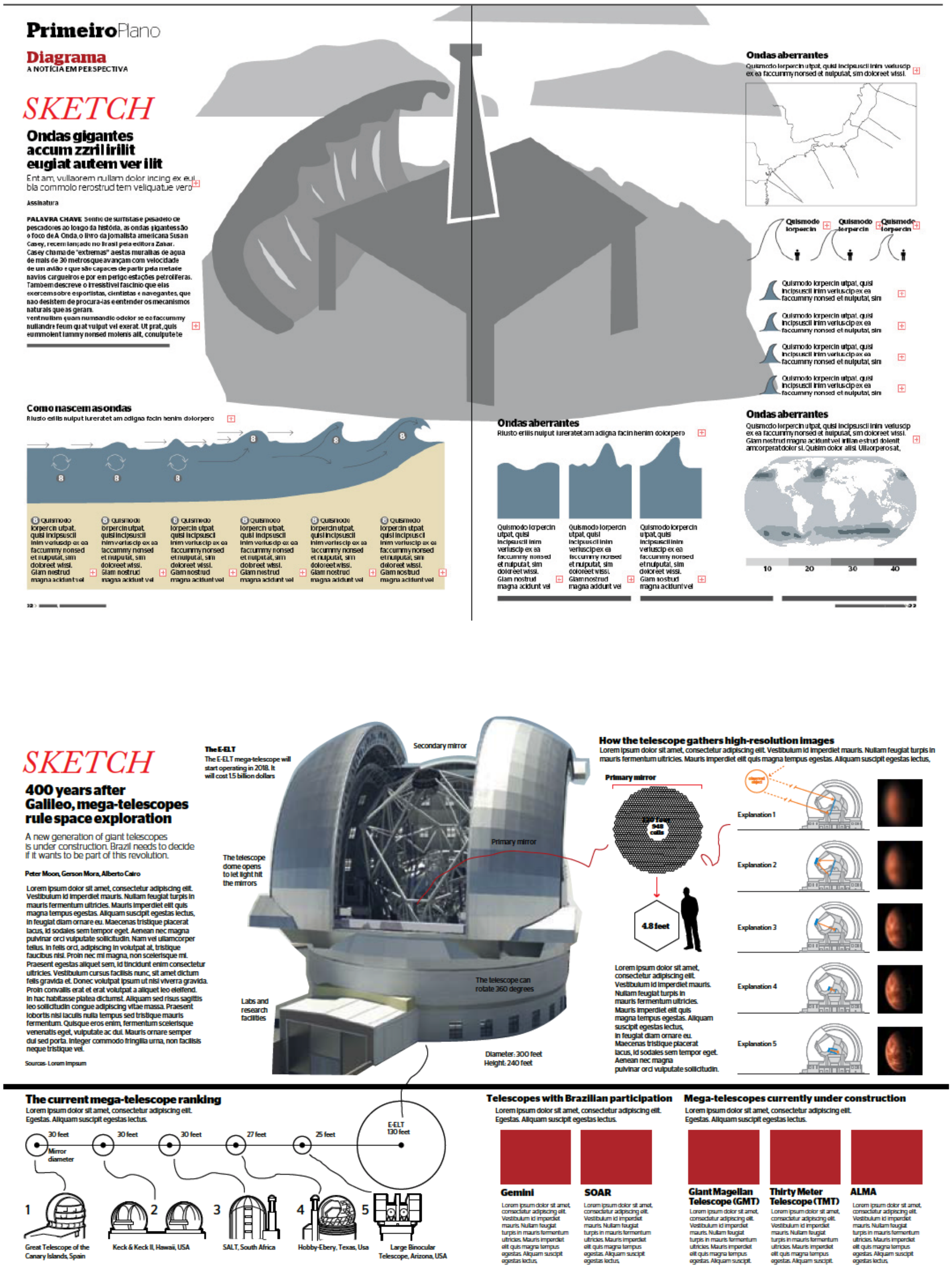


Figure 8.19 Sketches and structures for the Giant Waves and Telescopes projects.

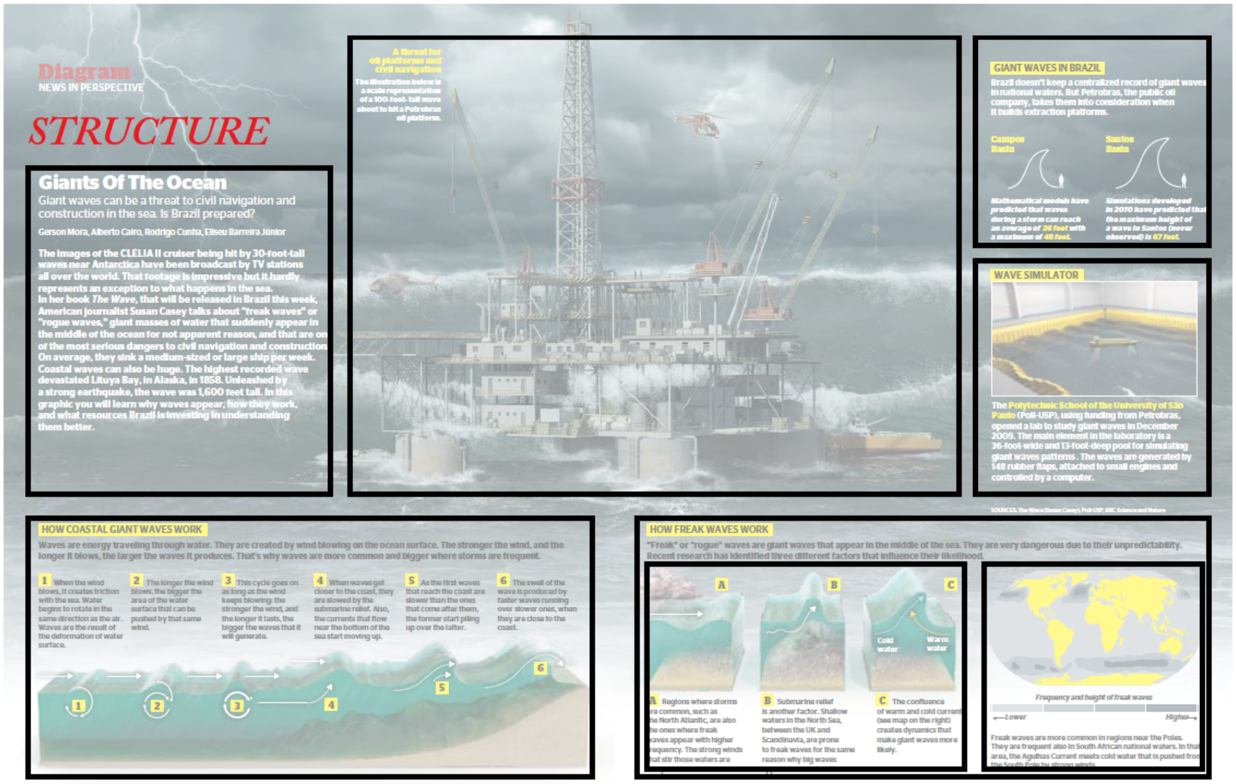


Diagram
NEWS IN PERSPECTIVE
STRUCTURE
Giants Of The Ocean
Giant waves can be a threat to civil navigation and construction in the sea. Is Brazil prepared?
GIANT WAVES IN BRAZIL
WAVE SIMULATOR
HOW COASTAL GIANT WAVES WORK
HOW FREAK WAVES WORK

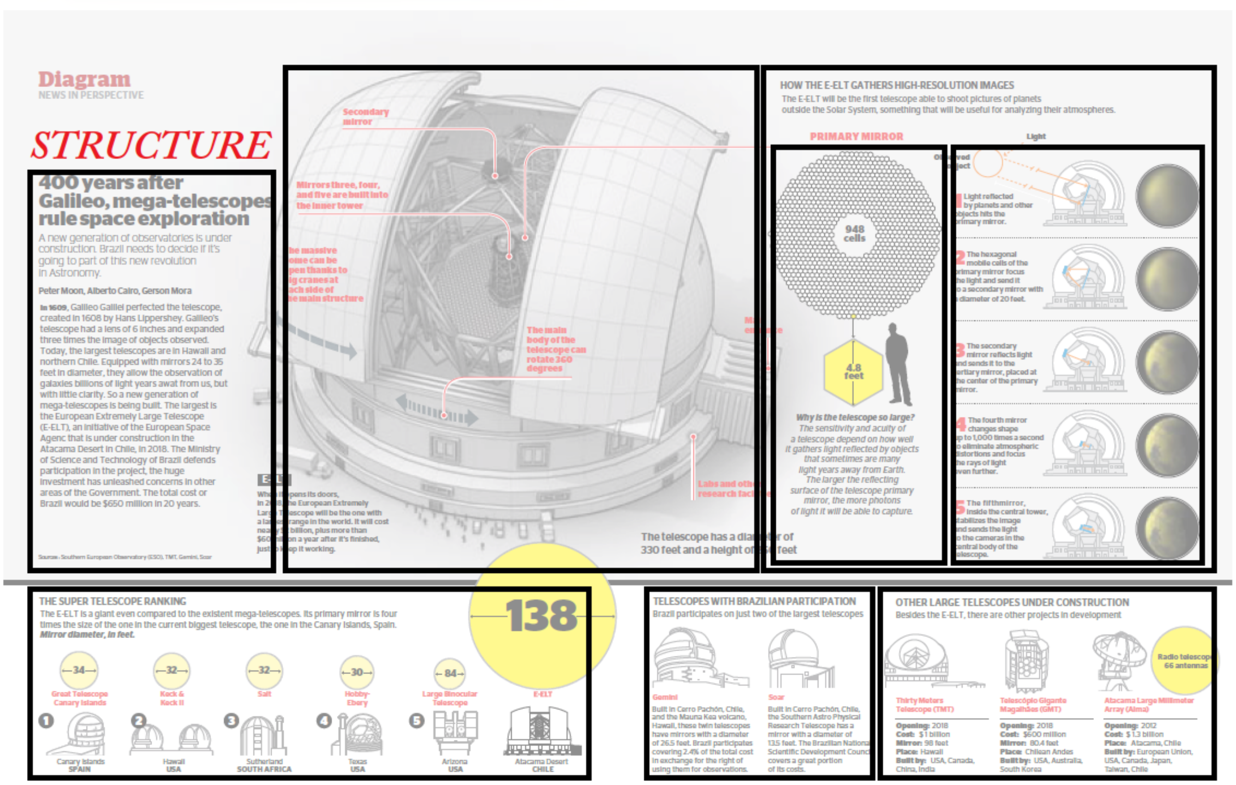


Diagram
NEWS IN PERSPECTIVE
STRUCTURE
400 years after Galileo, mega-telescopes rule space exploration
HOW THE E-ELT GATHERS HIGH-RESOLUTION IMAGES
PRIMARY MIRROR
948 cells
4.8 feet
THE SUPER TELESCOPE RANKING
138
TELESCOPES WITH BRAZILIAN PARTICIPATION
OTHER LARGE TELESCOPES UNDER CONSTRUCTION