Note to readers: this is chapter 2 of my work-in-progress tentatively entitled From Lincoln to Lenin: The Peculiar Fruits of the Cheap Food Revolution. Chapter 1 (to be presented March 19th) discusses the emergence of the futures market during the Civil War, arguing that the futures market was part of a logistics revolution brought about a group I call the Mercantocracy: the grain and provisions traders who figured prominently in the newly-formed Republican Party. Like most historians my theoretical apparatus is made of spit & vinegar, so please fire away.

SRN

A Nitroglycerin Apocalypse

Boom

At 7 a.m. on April 2, 1866, the S.S. *European* steamed south into the bustling wooden port town of Colón, New Granada on the Isthmus of Panama. Bound from Hamburg and Liverpool, the steamer pulled up to a four hundred foot long pier operated by the Panama Railroad Company. As the day progressed the local freight was removed first. On the following morning, clerks, stevedores, and railway workers awaited the train inside one of the most attractive buildings in town, the slate and stone shed of the Panama Railway Company. The inbound train, however, was delayed. Anticipating its arrival, stevedores had already begun unloading the international freight. They carried hundreds of wooden crates from the steamer into the shed. After the train arrived and was loaded, the cars would exit the shed to the south, cross the Isthmus, and be unloaded at the Pacific wharf where steamers bound for San Francisco and other Pacific ports awaited their arrival. But on this day nothing went according to plan.

At around 7 a.m. on the following day, one of the boxes apparently fell. Seconds later, the clerks and port officials in the southern part of town startled at the sound of a colossal boom. They then dodged flying shrapnel as the *European* exploded upward and outward. The metal knees of the ship shot out in four directions putting a two hundred foot circular hole in and through the wharf and knocking out the pillars of the freight shed. Outside the immediate perimeter of the blast shrapnel spread hundreds of feet further in every direction. An instant later, the slate roof of the freight shed collapsed, killing more than twenty workers underneath it. Two clerks survived by running quickly under a doorframe, which buckled but did not break. The force of the explosion was so violent that it shattered windows in a church nearly a mile away. One observer called it a "noise as terrific as the thunders of Sinai," a reference to the biblical story in which God commanded Moses and the Israelites to receive the Ten Commandments.[1]

Minutes later, as the Royal Mail Steamship *Tamar* tried to pull the smoking ruin of the *European* away from the shattered wharf, the broken hull exploded a second time, causing the ship's skeleton to sink into the Gulf of Limon down to its smokestack. One reporter lamented that there were "mangled and lacerated bodies, or pieces of bodies, to be met with in every direction for a great distance." Identifying casualties proved impossible because most of the bodies were thrown into the water where they were quickly – in the words of one Liverpool reporter – "picked up by the sharks." As was the case in similar explosions that week in San

[1] *Hillsborough Recorder,* 9 May 1866.

Francisco, New York, and on the tracks of the Central Pacific Railway, the mysterious explosions were so instantaneous and so forceful that bystanders hundreds of feet away were pierced by shards of the bones of those killed at the moment of impact.[2]

The source of these explosions were sealed boxes of nitroglycerin packed into zinc tubes, sealed in wax, then packed in sawdust and carefully stowed in wooden boxes. These boxes were bound for the Sierra Nevada Mountains outside San Francisco where the nitroglycerin tubes would be used to create controlled explosions. One tube, when shaken with sufficient energy, could in a few microseconds expel nitrogen at a pressure of 275,000 atmospheres. The best gunpowder, by comparison, expanded one thousand times more slowly and with only one-fiftieth of that force.[3]

These wooden boxes of wrapped nitroglycerin were destined to radically change humans' relationship to the lithosphere, the outermost shell of our rocky planet. Nitroglycerine stabilized in dirt, patented as dynamite in 1867, ushered in what the chemist and historian Vaclav Smil has called an evolutionary saltation, a leap forward in humankind's relationship with the natural world. A convergence of human understanding of the biological, physical, and chemical world produced

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[2] *Reynolds's Newspaper,* Apr. 29, 1866; *Manchester Courier and Lancashire General Advertiser,* May 1, 1866; *Lloyd's Weekly Newspaper,* Apr 29, 1866; "Terrible Catastrophe," *New York Herald,* Apr. 21, 1866; "The Aspinwall Horror," *Daily Cleveland Herald,* Apr. 23, 1866.

[3] On packing method: "The Nitro-Glycerine Case," *New York Herald,* Apr. 26, 1866; on force see George Ingham Brown, *The Big Bang: A History of Explosives* (Phoenix Mill, U.K.: Sutton Publishing, 1999), 101-102.

between 1867 and 1914 what he has called the "Age of Synergy." This understanding produced technologies that are, even in the twenty-first century, foundational aspects of modern life. These discoveries range from the understanding of plant respiration to the creation of the periodic table, from antiseptic medicine to the long-term storage of food, and above all the production of synthetic fertilizer that would allow mankind to extract more food from the biosphere. This new understanding would end the physical constraints that produced famine and in our own time usher in societies limited by the problem of obesity.[4] Few of these changes derived from the understanding of chemistry were as profound as the perfection of portable explosives, and none made a bigger boom.

Using the force of nearly 275,000 atmospheres in nitroglycerin, humans could shatter molecular bonds in shale, limestone, or slate, bonds produced by planetary and interplanetary forces measured in millions of pounds per square inch. Civil engineers thought of it more viscerally: this new explosive could rip tunnels in the world's mountains. Nitroglycerin oil would soon break apart boulders blocking the Suez Canal, opening up a route between the Indian Ocean and the Mediterranean that bypassed the Horn of Africa.[5]

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[4] Vaclav Smil, *Creating the Twentieth Century: Technical Innovations of 1867-1914 and their Lasting Impact* (

[5] Suez hard rock was removed at Chalouf using Lobnitz' rock dredger, not explosives, though the boulders generated by the dredger did require blasting. "The Removal of Rock Under Water without Explosives," *Engineering and Building Record,* 12 Oct. 1889.

Yet in 1866 the science was still poorly understood. When the engineer Alfred Nobel and his assistants carefully placed seals on the crates outside Hamburg that March they had failed to account for gradual leakage. Once a teaspoon full of loose nitroglycerin collected into a pocket, intense heat and a sudden shock could cause the oil pocket to explode. If that small blast took place close enough to the boxes, the little blast could exert force enough to cause all the zinc tubes to explode at once.[6] In April of 1866, stabilized nitroglycerine – not yet stable – had arrived to remake the modern world. "Nobel…has shown us," declared one dynamiter, "how to chain and guide the wild forces that once seemed too strong to control."[7] As these wild forces came under human control, new ones were unleashed. Within five years nitroglycerin would penetrate the planet's most difficult mountains, create fissures miles deep in the earth, and topple empires.

Terraforming the World

It is ironic that stabilized nitroglycerin grew out of military projects for the Russian Empire. Beginning in 1840, the empire had tasked Alfred Nobel's father Immanuel with designing undersea mines to protect Russian ports on the Baltic Sea. He did so with gunpowder barrels and an ingeniously-balanced underwater

[6] On the initiation of detonation see Stanley Fordham, *High Explosives and Propellants* (Elmsford, NY: Pergamon Press, 1980), 25-28.
[7] Drinker, *Tunneling, Explosive Compounds, and Rock Drills*, 31.

fuse that fired when it was tipped.[8] Around 1850, Immanuel's son Alfred learned about nitroglycerin while working in the laboratory of Théophile-Jules Pelouze. He devoted more than a decade to trying to stabilize it.[9]

Yet by the middle of the 1850s the Russian empire had bankrupted the Nobels. Although the Nobel family's underwater mines had helped prevent a British seaborne invasion during the Crimean War, Czar Nicholas I's untimely death near the end of the conflict provided an opportunity for the Imperial Army and Navy to renege on open military contracts with the Nobels for ships, steam engines, and cannon. When Alexander II, Nicholas's son and heir to the throne, refused to hear the Nobel family's complaints about these dishonored contracts, the Nobel fortune declined rapidly. Under bankruptcy proceedings the Nobel family works were turned over to another contractor in 1862.[10]

And so the Nobel family quickly relocated their nitroglycerin discoveries to Sweden. Though Alfred had successfully demonstrated how to remotely explode a mine filled with nitroglycerin in the spring of 1862 in the waters of a canal near Petersburg, he would later claim that his substantive discoveries began in Sweden the following year.[11] With peace in Europe after the Crimean War, nitroglycerin's first users would be railroad companies devoted to terraforming the earth,

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[8] Robert W. Tolf, *The Russian Rockefellers* (Stanford: Hoover Institution Press, 1976), 8-18.
[9] Kenne Fant, *Alfred Nobel: A Biography* (New York: Arcade Publishing, 1993), 96-99.
[10] Tolf, *Russian Rockefellers*, 21-24.
[11] Tolf, *Russian Rockefellers*, 36-37.

shortening the distance between wheat farms and population centers all around the globe.[12]

On land, the effect of stabilized nitroglycerin was world-changing. Some of the most important tunnels in the world were completed between 1866 and 1873. The nitroglycerin that accidentally exploded in 1866 had been purchased by the Central Pacific Railway to pierce a seemingly impossible summit in the Sierra Nevada Mountains that separated California from the Great Plains. President Lincoln's wartime government viewed the project as demonstrating its territorial sovereignty. A small group of well-connected Republicans successfully lobbied Congress in 1862 and 1864 for federal bond guarantees for the route.[13] "In the midst of a causeless and desperate rebellion," said one promoter, "we assemble here today under the authority of the National Legislature to organize an enterprise of the vastest proportions…[a] railway across a continent, a connection between two great oceans of the globe, and a change in the traffic of Europe, Asia, and America."[14] The first federally chartered institution since the Second Bank of the United States, the pacific railroad was crucial for demonstrating to European monarchs that the massive territory of the United States was not doomed to splinter. In this way nitroglycerin could facilitate consolidation of sprawling states.

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[12] It also allowed humans to harvest petroleum energy trapped by millenia of decay and compression. While the first drilled oil well in Pennsylvania in 1859 did not use nitroglycerin, it was used to shoot any well after 1866 that was not a "gusher." See Charles A. Whiteshot, *The Oil Well Driller: A History of the World's Greatest Enterprise, the Oil Industry,* (Mannington, WV: Charles A. Whiteshot, 1905), 77.

[13] Richard White, *Railroaded,* chapter 1.

[14] "Pacific Railroad," *Merchant's Magazine and Commercial Review,* Oct. 1862, 314.

But the project seemed impossible. The Sierra Nevada range was a steep 7000 feet above sea level. Just before the war surveyor Theodore Judah had found what appeared to be a perfect route through the remote Donner Pass, named after an infamous group of emigrants – the Donner Party – who became trapped in the snow for over a week and apparently ate one another to survive. While contractors could imagine a costly ascent up the western side of the pass, there was a nearly impossible 1000-foot drop on the eastern edge. As one surveyor noted in 1865 he, "couldn't conceive any set of men would seriously undertake a railway over such a country…a railway across the Semmening Alps, from Vienna to Trieste – is a bagatelle as compared with the projected line…"[15]

The problems of the Donner Pass notwithstanding, it appeared the only practical route to connect San Francisco and Sacramento with the Mississippi River, 2000 miles to the east. Ten tunnels were planned during the war but the longest, through over 1600 feet of solid granite, was required at the summit, and only nitroglycerin seemed the workable solution. After the unfortunate explosions in Panama, the Central Pacific hired Scottish chemist James Howden to manufacture nitroglycerin next to the tunnel. By April of 1867 Howden was producing one hundred pounds a day, making the blasting relatively easy. "You see," Crocker wrote Huntington, "we are getting up pretty near to two feet per day

[15] George Kraus, *High Road to Promontory: Building the Central Pacific Across the High Sierra*, 101.

per [rock] face. *Nitroglycerin tells*." The tunnel was completed in August of 1867.[16]

Within five years of its application in California, portable nitroglycerin was used in the Hoosac tunnel in Massachusetts, the Lewis Tunnel in Western Virginia, the Mont Cenis tunnel in France, and the St. Gotthard tunnel in Switzerland. Jules Verne's novel, *Around the World in Eighty Days*, first published in 1873, describes an imagined journey in 1872 that used nearly all of these global shortcuts, all built by nitroglycerin blasts.

Tunnels were not the only use for the new terraforming explosives. Contractors exploded thousands of packages of nitroglycerin underwater in the five years after the accident in Colón. They had a dramatic effect on international trade. Improved blasting shrunk the distance between ports: After the Suez Canal was completed in 1869, partly using Nobel's 'blasting oil,' ship times for traveling from London to Calcutta dropped from six months to less than thirty days.[17] The Suez prompted the Dutch government to spend over three million Dutch guilders to blast through the "Hook of Holland," turning the inland town of Rotterdam into a seaport city. Once the route opened to steamship travel in 1871, Rotterdam –

[16] David Bain, *Empire Express,* 321.
[17] David A. Wells, "Great Depression of Trade: A Study of its Economic Causes," *The Contemporary Review* (Aug. 1877), 277

with easy access to German cities along the Rhine – vied with Antwerp for the biggest grain port in continental Europe.[18]

It is difficult to overestimate nitroglycerin's effect on trade. Because ocean delivery is roughly thirty times cheaper than land delivery, a deepwater port expands the hinterland for a city by a factor of thirty.[19] For ports accepting food that are already near city centers this effect is further multiplied by what logisticians call the last-mile problem. The last mile of delivery of any final product, like bread, will consume up to eighty percent of the total travel costs. For food-receiving port cities like London, Liverpool, Antwerp, Rotterdam, and Amsterdam cheap food helps explain their explosive growth. Just as the port cities of New York and Philadelphia grew substantially faster than the second-tier cities between 1830 and 1850, so these European cities grew dramatically by their proximity to grain ships after 1870. [20]

What nitroglycerin did to bring food closer to population centers around the world was, for many grain traders, cataclysmic. The Suez Canal was the place where the change was most obvious. Sailing ships in the India trade could not use prevailing winds to carry them through the canal. Only the new screw steamers – marked with an S.S. in their titles – could make the journey. More than two

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[18] Veraghtert, "Antwerp Grain Trade, 1850-1914" in Friedland, ed., *Maritime Food Transport*, 90. Van Ysselsteyn, *The Port of Rotterdam*, 45.

[19] Laurence Evans, "Bread and Politics: Civil Logistics and the Limits of Choice," in Klaus Friedland, ed., *Maritime Food Transport* (Cologne: Böhlau Verlag, 1994), 581.

[20] [note to self, discuss Prussia's nationalization of rrs, and Prussia's use of American railroad logistics in the Franco-Prussian War 1870]

million pounds of international carrying capacity in sailing ships was "virtually destroyed" in the words of British merchant Charles Magniac.[21] This global shortcut not only turned sailing ships for the India trade into antiques, "the Suez Canal, in conjunction with steam and ocean telegraphy," Magniac wrote in 1875, rendered obsolete "all the old machinery – warehouses, sailing vessels, capital, six months' bills, and the British merchant, whose occupation is gone."[22]

How did merchants become obsolete? Just as wartime Cincinnati grain dealers were outdone by the Union Army's use of futures markets, telegraphed orders, and inland waterways, so English millers, provisioners, and merchants were devastated by the reach of grain merchants like Leopold Louis-Dreyfus who could use the futures market to buy grain in America and sell it on the same day in London or Liverpool.[23] A comparison of business failures in 1866 (the Overend, Gurney Crash) and 1873 (the Great Depression) show a pronounced increase in failures in the English countryside, particularly among corn merchants & millers, provisioners, and merchants.

[21] Wells, "Great Depression of Trade," 277.
[22] Testimony of Charles Magniac in "Effect of the Suez Canal…," *The Economist*, 11 Mar. 1876, 48.
[23] In the family's retrospective on his Dreyfus's life, he attributed his great success to his ability to use the futures market to manage risk. Louis Dreyfus & Co, *A L'occasion De Son Centenaire La Maison Louis Dreyfun & Cie Rend Hommage A Son Fondateur Qui Reste Present Dans Son Oeuvre* (privately printed, 1951).

	1866			1873		
	London	L’pool & Manchester	country	London	L’pool & Manchester	country
Agents, Commission, Yarns & c.	62	37	23	27	15	33
Bankers	14	1	6	2		2
Boots & Shoes	10		23	9	11	60
Brewers		1		1		20
Calico Printers		3	3		2	1
Cigars & Tobacco	2			4	1	3
Coals	3	1	7	13	3	80
Corn Merchants & Millers	7	14	10	8	5	50
Colonial & Cotton Brokers	9	20	1	6	14	
Cotton Spinners & Manufacturers		4	73		3	28
Curriers & Leather Merchants	17	3	28	6	3	20
Chandelier Manufacturers						4
Electro Platers			4			5
Discount & Bill Brokers	7	1		3		
Druggists, Wholesale & Chymists	6	1	6	5	5	15
Drysalters, Oil Merchants, &c.	6	6	7	11	4	23
Engineers, Founders, Iron, Steel, Metal & c.	30	18	161	40	11	184
Flax & Jute			2			25
Financial Agents	10			3		
Contractors	28	2	12			
Harness Furniture			2			3
Glass & Lead	3		3	6		7
Hats & Caps	1		1			12
Hops	7	1	5	2		
Jewellers, Wholesale	8		5			28
Merchants	169	69	33	137	40	68
Provisions	16	10	8	7	12	40
Ship Owners & Brokers	45	31	21	21	7	21
Shipbuliders	4	1	14			3
Stationers, Wholesale & Paper	8	2	3	4	2	9
Manufacturers of Silks, Stuffs, Woollens, Worsted, Elastics & c.		5	163		11	152
Rope & Twine	3	1	4	2	2	12
Timber	11	5	19	9	5	26
Tea & Coffee	6			8	1	4
Woolstaplers			19	1	1	16
Woollen Wastes						12
Wines	51	9	10	46	12	61
Warehousemen, Importers of Foreign Goods, Manufacturers, &c.	82			90	5	7
Dyers & Finishers			7		2	25
Sugar Refiners	3		2			
Gunpowder	1					
Earthenware			2			

The Chicago futures market – the product of the Civil War – made pre-arranged delivery for pre-graded grain possible. After nitroglycerin provided global shortcuts for trade, inland port cities – Antwerp, Rotterdam, and Chicago – would be the communication nodes for future sales and the waypoints for goods-in-transit. It was not just the steamship *European*, but an entire global commercial infrastructure centered in London that would shake to its foundations.[24]

The sudden drop in shipping prices brought by nitroglycerin’s collapse of travel times helped usher in the period economic historians call the first wave of globalization, from 1871 to 1914. Colonial goods like coffee, sugar, silver, and cotton had already traveled across the Atlantic since the 1600’s. After nitroglycerin’s elimination of expensive barriers, bulkier, lower-value goods like wheat, beef, and kerosene became cheaper to ship. By the 1880s nitroglycerin was also being used by farmers to blow up stumps, break through rock, and generally flatten soil for the expansion of wheat monocultures.

The first surge of wheat from the US to Europe the Atlantic had come just as the Civil War started. Before the war, between 1855 and 1859, the five-year average for wheat imports into Antwerp was a mere twenty thousand tons. Between 1860 and 1869 it nearly quadrupled to seventy-five thousand tons, much of it from America. Between 1870 and 1874, the yearly average nearly quadrupled

[24] On attempts to quantify this change see Luigi Pascali, "The Wind of Change: Maritime Technology, Trade and Economic Development," The Warwick Economics Research Paper Series (TWERPS), University of Warwick, Department of Economics (2014).

again, averaging 276 thousand tons a year. Much of the increase again came from the United States. It had become clear in the words of one historian of European transport "that the USA could become Western Europe's abundant grain shed."[25]

Between 1871 and 1880 the value of U.S. food exports to Europe rose from 32 to 231 billion dollars, or 611 percent. The single largest commodity was wheat, which saw a tripling of yearly shipments from 31 to 154 million bushels, or two bushels a year for European living west of the Rhine.[26] While economists and contemporaries have emphasized the elimination of tariffs in Continental Europe (1860-1884) and the reduction in freight rates brought by steam ships,[27] they have generally missed the decline in transaction costs brought by the futures market and how this in combination with nitroglycerin, helped shrink the warehousing margin charged on wheat.

The cheapening of transport had more important secondary effects than just financial and commercial ones however. Most notable is that two great human migrations followed. Over four decades more than thirty million Europeans crossed the Atlantic to the Americas while almost thirty million left China and Northern India to work in parts of Asia, the Pacific Islands, and the Americas

[25] Veraghtert, "Antwerp Grain Trade," 82-84.
[26] Calculated in 1913 dollars. See Matthew Simon and David Novack, "Some Aspects of the American Commercial Invasion of Europe, 1871-1914: An Introductory Essay," *The Journal of Economic History* 24 (Dec. 1964): 591-605, statistics on page 599. While economists have written a great deal about shipping costs, they have not considered the annihilation of distance by tunneling.
[27] Matthew Simon and David Novack, "Some Aspects of the American Commercial Invasion of Europe, 1871-1914"

(many as indentured servants).[28] At the same time many more Europeans moved from countryside to city, in part because food was for the first time cheaper in cities than in the countryside. In this period, according to one historian, "[o]ut of every seven persons added to Europe's population, one went abroad and four or five went to the city."[29]

The Chemistry of Nitrogen: Gunpowder to Dynamite

While the nitroglycerin compound allowed the penetration of the lithosphere, it was an engineered product of the biosphere. A single drop of nitroglycerin produced in 1866 was a chemical crystallization of centuries of organic interactions between animals, microbes, and plants. Nitrogen-fixing bacteria convert nitrogen into nitrogen-oxygen compounds in the form of nitrites (NO_2); other microbes turn that product into nitrates (NO_3). Nitrates are the building blocks of terrestrial life from ATP to DNA, though animals and fungi cannot absorb nitrates directly. Instead plants absorb nitrates; animals and fungi then consume nitrate compounds by digesting their stems and seeds. Animal intestines absorb minerals and energy bonded to the nitrate molecules, bloodstreams use the nitrates to build up or replace the available store of them. Kidneys and livers then expel the excess nitrogen in urine and feces mostly as ammonia (NH_3). Microbes in marshy water recycle ammonia back to nitrites and

[28] Testimony of Alfred Nobel transcribed in "The Nitro-Glycerine Case," *New York Herald,* Apr. 26, 1866.
[29] Binkley, *Realism and Nationalism,* 77.

finally to nitrates again. So while nitrates are a crucial building-block that plants will absorb, NO_3 in its crystalline form (usually potassium nitrate) is potentially explosive.

Human understanding of nitrates evolved in fits and starts for seven centuries before the Age of Synergy. In the ninth century humans (probably in China) had discovered that animal wastes that had been converted to nitrates and bound to potassium could be collected from bogs, chicken coops, and outhouses before they were reabsorbed into plants. Over the next five centuries European and Ottoman alchemists experimented on this substance they called saltpetre, or Chinese snow. Diluted and stabilized with sulfur and charcoal, saltpetre could make what we call gunpowder.[30]

Military historians and historians of science assert that unfolding human analysis of nitrates created almost all the technologies we associate with modernity: cannon packed with gunpowder altered international warfare by leveling medieval castles; guns in the hands of infantry could annihilate the heavily armored warrior classes of the Middle Ages. Ottoman troops and a Czech alchemist crafted the bombards filled with gunpowder that brought down the walls of Constantinople in 1453. Scholars of science tell us that sustained analysis of gunpowder led to the discovery of oxygen, the understanding of crystallization, the discovery of steam power, and the science of ballistics. Modern states,

[30] Stephen R. Bown, *A Most Damnable Invention: Dynamite, Nitrates and the Making of the Modern World* (Thomas Dunne Books, 2005).

including the so-called gunpowder empires of the Ottomans, the Moguls, and the Safevids, not to mention the early modern Spanish and the English empires all expanded through the bureaucratic organization of war using nitrates in the form of gunpowder as its roaring, bleeding edge. Only wealthy republics or kings backed by merchants could afford to harvest, hoard, and deploy these bound nitrates produced by human-plant interactions to threaten and subdue their enemies. This, we are told, created the modern era.[31]

But this poorly-understood gunpowder proved insignificant compared to the molecular perfection, the brilliant and radical instability, of the purest drop of nitroglycerin. In the 1850s, nitrates collected from guano produced chemically pure nitric acid. Glycerine infused with concentrates of nitric and sulphuric acid produce a little cluster of nitrates (NO_3), each bound to the other in an unstable pyramid, which is loosely bound to glycerine. If the molecule is disturbed by a blast of external energy, the three nitrates do not just separate from each other, all the bonds between the atoms crack apart. The nitrogen atoms rush toward one another to form the triple-bonded N_2, a vastly more stable compound than NO_3. The interatomic rush to form N_2 expels oxygen outward at 7700 meters per second, more than twenty-two times the speed of sound. This is why a teaspoonful of nitroglycerin when exploded can produce an audible boom.[32]

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[31] J.D. Bernal, *Science in History* (Hammondsworth, U.K.: Penguin, 1969), 1: 320-323; William H. McNeill, *The Pursuit of Power: Technology, Armed Force and Society Since A.D. 1000* (University of Chicago Press, 1984).
[32]Stanley Fordham, *High Explosives,* 14-18.

A method for building the three-nitrate pyramid of nitroglycerin had been discovered in the late 1848, but making it stable enough to transport and to apply to rock surfaces proved impossible until the time of Immanuel Nobel and his son Alfred Nobel. The younger Nobel was no chemist, but a Russian-trained civil engineer, and a tireless and dogged experimenter. He discovered a simple method for stabilizing the liquid, then spent the rest of his life defending the patent on his simple process for blowing things up.[33]

What no one predicted was how the radical instability of nitroglycerin could destabilize political regimes as well. If gunpowder strengthened states, nitroglycerin might weaken them. Nitroglycerin’s instability made it problematic for military use at first. Exploding it required close observation; its tendency to leak meant that it could not remain long in an armory; its explosive force could not be forced in a single direction in the way that gunpowder could.[34] Nor could nitroglycerin initially not match the ancient battlefield regime of horse, soldier, archer or its later iteration of tank, infantry, and artillery. Using nitroglycerin could be suicidal. But European radicals forced underground by state repression since the time of the Decembrists, had developed a new technology of clandestine operations that nearly came to its fruition in 1866: the revolutionary cell. And the

[33] Bown, *A Most Damnable Invention.*
[34] Fordham, *High Explosives,* 41.

cell, rapidly improving its operational strategy, would by 1881 combine with nitroglycerin to threaten empires.

Roots of the Cell

On the same day of the explosion in Colón, Dmitry Karakazov, April 2, 1866, a twenty-five-year-old university student and son of a nobleman, entered Czar Alexander II’s Summer Garden in Petrograd where the Czar was having his afternoon walk in the park. Karakazov was in disguise: Underneath the plain red shirting of a peasant was the fine white linen of a nobleman’s son. The young man apparently attracted attention, appearing to sweat and shake in the presence of onlookers. When the Czar turned to enter his carriage the man suddenly pulled out a flintlock pistol and leveled it at him. A shout from a policeman led a hatter standing nearby to knock Karakazov’s pistol aside as it fired. As people rushed to seize the young man, the Czar allegedly seized him and asked him, “Are you a Pole?” The Czar and his private police imagined that his highness had no enemies among the Russian people and only a Polish nationalist, angered by the Russian empire’s brutal crackdown of an independence movement three years earlier, would try to kill him.

After days of torture, Karakazov broke, and the police found their worst fears realized. The young man had been a student who had joined a secret society or cell devoted to reorganizing Russian society into a group of autonomous

communes in the style of the revolutionary novel *What is to be Done?* The novel, written in 1863 by an ex-seminary student, had described an ascetic revolutionary man, Rakhmetov, who disappeared but would return in 1866 when it would be necessary for him to be in Russia. The novel referred to another work by Isaac Newton that mentioned the same year. After being expelled from university, Karakazov apparently decided to fulfill the novel's prophecy by killing the czar and then swallowing strychnine. In this way he might bring about the thorough reorganization of society that he hoped for.[35]

Why did the novel predict that a single man would do this revolutionary act in 1866? For Protestants in the West and Russian Orthodox Believers in the East the year 1866 had been predicted as the beginning of the end of days. Many accounts attributed the prophesied date to Newton, who spent the last decades of his life closely reading the books of Daniel, Paul, and Revelation.[36]

In the Book of Revelation, the last book of the Catholic, Orthodox, and Protestant Bibles, an angel describes the end of the world to a man named Paul. In the vision God holds a scroll or book with seven seals, each associated with a tribulation or judgment to be visited on the earth. In these the four horsemen – conquest, war, famine, and death – will bring terror to the world. The sixth of seven tribulations appears as the reign of the Whore of Babylon who rides a horse

[35] *Lloyd's Weekly Newspaper* (London), Apr. 29, 1866; Verhoeven, *The Odd Man Karakazov*. On his being Polish see p. 45. On the three years see p. 62. On the walk in the park see p. 67.
[36] Eugen Weber, *Apocalypse: Prophesies, Cults, and Millenial Beliefs through the Ages* (Harvard University Press, 1999), 96-98.

with seven heads and holds a cup with the blood of martyrs. During the sixth tribulation two witnesses with God's authority will testify against her for 1260 "days", but they will be clothed in sackcloth, and mostly ignored.[37]

Since well before the 1600s Protestants had decided that the Catholic Church was the whore of Babylon and saw themselves as witnesses against her. When, then, would the seventh and final seal be opened? In a widely-circulated calculation attributed to Newton the whore's reign began in the year 606, when the Byzantine Emperor Phocas declared the Catholic Pope in Rome to be supreme over the Orthodox Patriarch of Constantinople, effectively splitting the church into the powerful western and the weaker eastern branch. After 606, then, the Catholic Church, once a holy institution, had become the Whore of Babylon. Indeed Martin Luther, Oliver Cromwell, Quakers, Rangers, Diggers, and Fifth Monarchy men all agreed that the Roman Catholic Church was the Whore of Babylon, though they differed about how to interpret the signs that followed.[38] Eastern Orthodox Believers translated the works of some of these Protestants, Newton in particular. They had their own reasons for liking the date of 606 because that date had placed the Catholic Church over the Eastern Orthodox Church. Did this make the

[37] And I will give power unto my two witnesses, and they shall prophesy a thousand two hundred and threescore days, clothed in sackcloth.

[38] Henry Forest Burder, *Notes on the Prophecies of the Apocalypse*, 124-126, 187 (London: Ward & Co., 1849). On prophecy belief in the period of the English Civil War see Paul Boyer, *When Time Shall Be No More: Prophecy Belief in Modern American Culture* (Harvard University Press, 1992) and Weber, *Apocalypses.*

Catholic Church the Whore of Babylon? Some Eastern Orthodox followers believed it might.[39]

When would the world end? A stray line in the book of Daniel suggested that a day might be reckoned as a year. Thus the year 606 plus 1260 years of struggle led some Protestants (and some members of the Russian and Greek Orthodox Churches) to expect this tribulation to come to its terrible climax in 1866. According to the Book of Revelation there would be earthquakes, the moon would turn red, stars would fall, while "every mountain and island were moved out of their places." Rich and mighty men would hide in their mountain "dens," calling on the rocks to hide them, yet all would face "the wrath of the Lamb." Just as a few Protestants saw end times in the violent explosions of 1866, many Russian observers were convinced that Karakazov had ties to the Whore of Babylon – the Catholic Church – through Jesuits and Polish nationalists. Forced confessions had led some to identify a secret revolutionary group that called itself "Hell."[40]

"Hell" was a new kind of revolutionary conspiracy. It relied on a combination of two activities: anonymously published documentary critique of the

[39] Ana Siljak, *Angel of Vengeance: The Girl Who Shot the Governor of St. Petersburg and Sparked the Age of Assassination* (St. Martin's Press, 2009). **Need more on Russian orthodoxy and apocalypse**

[40] On Protestants see Henry Forest Burder, *Notes on the Prophecies of the Apocalypse*, 124-126, 187 (London: Ward & Co., 1849). On the idea of a Catholic conspiracy linked somehow to a secular conspiracy see Verhoeven, 50-54. A conspiracy that combines revolutionary anarchists and non-revolutionary Catholics looks less paradoxical given the Orthodox reading of the Protestant interpretation of the Book of Revelation in which the Catholic Church, in overpowering the Orthodox Church in 606, became the Whore of Babylon.

state (usually called propaganda) combined with spectacularly violent actions against public agents designed to attract attention. The cell – or commune – was to be a model of the new society that would emerge when the old society collapsed. The commune first described in the novel *What is to be Done*, in which the traditional bonds of wedlock were ignored, suggested a group identity that would transcend the family. By the 1870s cell members of would not know the identity of those outside the cell; all operated under assumed names. Propaganda and action were deliberately separated so that intellectuals could not, even under torture, reveal the names of those who carried out the violent actions. While this movement separated into many different tendencies including anarchists, syndicalists, socialist revolutionaries, and communists, most Russian revolutionaries who would never speak to one another later drew their origins back to these so-called populist or nihilist origins of middle 1860s.[41]

These two events on April 2, 1866 did not begin the end of days, but they did suggest the radically destabilizing potential of nitroglycerin on one hand, and on the other an oath-bound group of radical intellectuals who might use a single, designated agent to kill himself and in so doing kill an imperial autocrat or the autocrat's agent. Karakazov sought to use a pistol as a force multiplier. He failed. But by 1881, in London and Petersburg, the committee and its instrument would

[41] Franco Venturi, *Roots of Revolution: A History of the Populist and Socialist Movements in Nineteenth Century Russia.* Criticism among Russian revolutionaries came, after 1869 or so, to be called Nechaevism or the decline of the collective sensibility with the related rise of the self-absorbed, Machiavellian revolutionary character.

meet, and continental empires around the world would be in danger. By 1917, three empires would fail: the Russian, the Ottoman, and the Qing. As nitroglycerin caused transportation lines around the world to shift, and oath-bound cells of radical intellectuals gathered to destroy these empires, no den would protect the rich and mighty. The wrath of the lamb would arrive.

The following year one of those lambs was Alexander Helphand, the son of a locksmith or mechanic born in Belarus in 1867. At a young age his family fled Belarus, perhaps because of a Jewish pogrom. He remembers at a young age being delivered from chaos and burning buildings in Belarus. Helphand then grew up in Odessa where he received – somehow – an unrivaled private education in the classics and the humanities.[42] By 1885 he had become involved with a populist cell, probably "Chornyi Peredel" or Black Repartition, a reference to the redistribution of land that took place in the mir, or collective peasant communities. He sought to recruit workers on the Odessa waterfront using propaganda that he found himself doubting. After a crackdown the following year and "to resolve [his] political doubts," Helphand went to Zurich and entered university in Berne. Shortly thereafter he traveled to Basel where, at the age of 24, he finished a PhD in political economy.

His dissertation was extremely unorthodox, and would lead him to become a fierce critic of traditional and portions of Marxist economics. He began to doubt

[42] Zeman & Scharlau, Merchant of Revolution: The Life of Alexander Israel Helphand (Parvus), 1867-1924 (London: Oxford University Press, 1965), 9-10.

doctrine that land redistribution alone would solve Russia's problems, believing that American farm families using family labor were producing a revolution in international markets for grain. He believed – as a Marxist – in socializing manufacture but *not* in collectivizing agriculture. He also came to question Marx's unstated assertion that the heart of capitalist relations was on the factory floor alone. Altering the flow of goods, the location of ports, the location of production, and trade provided economies of scale that could liberate workers from the drudgery of the twelve-hour workday.[43] Shortly under the pen name of Parvus – Latin for poor or little – Parvus would become one of the lambs who would help to destroy an empire, and help build new states – including the Turkish and Bolshevik states – on their ashes.

[43] His 1890 dissertation focused on the division of labor outside of the factory system, particularly in grain trading, transportation, and financial markets. Much of this book relies on insights gleaned from him. Through Rosa Luxemburg he is indirectly the intellectual force behind **both** Lenin's theory of imperialism and World-systems theory, though he has never been acknowledged as such.