WILLIAM CONGREVE’S RATIONAL ROCKETS

by

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This article examines the early development of military rockets devised by the English inventor and Royal Society Fellow William Congreve in the first decade of the nineteenth century. Congreve’s efforts to imitate Indian war rockets used against the British in Mysore are set within a number of local and global contexts that saw increasing attempts by Europeans to imitate eastern pyrotechnics while applying economic and scientific principles to reform pyrotechnic production. Congreve viewed his rockets as ‘rational’, operated via an experimental system that dispensed with the need for any skilled labour, save Congreve’s own inventive capacities. But when rockets were put to the test, naval officers, artisans and other inventors all disputed this claim, and this article shows how their various skills proved indispensable in making the rocket work. Congreve responded by erasing both distant Indian and local British contributions to the rocket system. The career of Congreve rockets thus demonstrates how local processes of disciplinary reform around 1800, entailing rational management based on scientific and economic principles, were intimately connected with orientalizing tendencies in Britain, which sought to portray distant cultures of the East as backward and static, justifying imperial domination.

Keywords: Sir William Congreve; Congreve rockets; fireworks; science in the British military, ca. 1770–1810

INTRODUCTION

When Francis Scott Key wrote of the ‘rocket’s red glare’ in ‘The star-spangled banner’ (1814), he referred to the war rockets of Sir William Congreve. ‘Congreve rockets’, invented in about 1805 for use against the French fleet threatening an invasion of Britain, were used extensively in British engagements around the world until the end of the Crimean War. Despite being recognized as a ‘man of science’ in his own time, Congreve, elected a Fellow of the Royal Society in 1811 for his work on rocketry, remains less known today than many of his contemporaries, probably because his military career and royal patronage ill fit the focus on science and industrialization that historians typically bring to late Georgian and Regency history. Examining Congreve’s career thus reveals dimensions of early nineteenth-century scientific culture such as patronage and military science which have tended to be neglected.

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Congreve’s rockets, meanwhile, have typically appeared in historical literature only as antecedents to twentieth-century rockets and missiles; little concern has been shown for the context or conditions in which they were produced, save that they were imitations of Mysore war rockets recovered by British troops during the Anglo-Indian wars of the late eighteenth century.\(^1\)

This article identifies several important local and global contexts for the development of Congreve rockets, and uses the career of the rocket to link distinct historical discourses on science, economy and empire around 1800. Historians have identified key transformations in relations of natural philosophical and artisanal labour and skill at this time, a period of industrialization, when factory models, disciplinary technique and scientific knowledge became increasingly entangled. British dockyards and naval reform are often taken as seminal locations for the rise of disciplinary reason.\(^2\) Here, the institutions of artillery provide the focus, while disciplinary reforms are shown to have been encouraged by military and courtly contexts as much as industrial ones. Elsewhere, historians of colonialism have identified the decades around 1800 with the rise of new European attitudes to non-European arts and sciences. Michael Adas has demonstrated the ways in which Europeans’ assumptions of technical superiority shaped their judgements over Africans, Indians and Chinese as being technically and often morally inferior to themselves, which claims were then used to justify European imperialist policies. More broadly, following the work of Edward Said, this period has been identified with growing ‘Orientalism’, as Europeans developed historical and literary images of Arab, Chinese and Indian cultures as static, sensual and unreflexive, similarly serving as a pretext and a condition for imperialism.\(^3\)

In this article it is argued that Congreve’s rocket experiments, as a process of exerting rational control over artillery through imitations of Indian weapons, entailed both disciplinary and orientalizing projects, and furthermore that these activities need to be seen as part of a single process in which both local (British) and distant (Indian) labour and skills essential to the rocket’s success were made invisible by Congreve in an effort to prove the value of his rational ‘system’. Besides revealing the diverse skills that made rockets into viable weapons, the article offers a more synthetic framework for examining rationalizing programmes circa 1800, taking both metropolitan and colonial contexts into account.

The case of Congreve rockets highlights the Indian skills behind European invention, and also the contingencies of imperial enterprise. As Kapil Raj and Maya Jasanoff have urged, British imperialism was more contingent and collaborative in this period than traditional accounts suggest, facing recurrent obstacles and relying on existing local skills and traditions to build new institutions of fiscal, governmental, technical and scientific control in colonial settings.\(^4\) Geographical divisions between Europe and the East were challenged and remade in such settings. India played host to British and French enmities, while Indian knowledge underwrote Europeans’ efforts to map the subcontinent. Daniel Headrick identifies the problems of transferring European technological projects such as railways and telegraphy to India in the nineteenth century. Whereas the physical transfer of machinery might be relatively unproblematic, the cultural transfer of skills for using new techniques was often restricted or failed.\(^5\) In reverse, the transfer of Indian rockets to Europe led to similar troubles, as Congreve and others sought to replicate distant techniques in novel weapons.

The article is divided into five sections. Under the heading of ‘Contexts’, Congreve’s activities are identified with a long tradition of British efforts to reconstruct fireworks as useful and profitable commodities. The timing of Congreve’s imitation of Indian rockets was not accidental. Congreve rockets emerged at the same time as European attitudes to eastern
pyrotechny switched from reverence to disdain in the late eighteenth century, and as Europeans sought justification for commercial and imperial campaigns into India and China. Congreve’s were among various attempts by Europeans to imitate and improve on eastern pyrotechnics at this time.

The immediate context for Congreve’s rocket experiments, described in the second section, was a series of reforms undertaken at Woolwich Arsenal in London in the second half of the eighteenth century, led by Congreve’s father. Reformers sought to reduce labour costs and bring gunpowder and ordnance production and management under the exclusive control of the Royal Artillery, both projects that Congreve claimed the rocket would also fulfil. Examining these reforms shows that artillery officers’ attitudes to local artisans closely resembled emerging attitudes to distant eastern pyrotechnists, whose traditions were disdained as unprogressive, and whose practices should be imitated, subjected to rational management and orchestrated into a single system under centralized control. Congreve’s rocket programme followed exactly this logic, designed as a ‘system’ under the inventor’s control, which would discipline or remove the need for local trained labour and supposedly owed nothing to Indians’ skills.

After a short section under the heading ‘Rockets’ considers William Congreve’s background and engagement with Indian war rockets, the fourth section, ‘Trials’, explores early experiments with Congreve rockets to consider how the ‘system’ worked in practice. During a series of trials on the English Channel in 1805–06, naval officers and sailors charged with firing Congreve rockets at the French fleet stationed off Boulogne repeatedly challenged Congreve that rockets worked only if they were fired by skilled naval men. Congreve’s claims to success for his system then hinged on his own skills as a journalist and writer, as a final examination of publishing in Congreve’s career after the trials shows. In a series of books and pamphlets Congreve rehearsed the claims of Woolwich reformers and orientalist authors that the contributions of local skills (in this case naval) and distant arts (Indian rocketry) were negligible in the success of his rational system of rocketry. Congreve’s election to the Fellowship of the Royal Society and royal patronage finally helped secure such claims. Congreve rockets were thus products of, and contributions to, a wider context of transformations in Britain’s artillery, empire and economy, whose career has consequences for current ideas concerning science, industrialization and orientalism around 1800, discussed in the conclusion.

CONTEXTS: RATIONAL PYROTECHNICS, EMPIRE AND ORIENTALISM

Congreve rockets developed during an important era in the history of pyrotechnics, which saw diverse attempts to make traditional fireworks more ‘philosophical’.

From the Renaissance to the mid eighteenth century, courts across Europe staged grand displays of ‘artificial fireworks’ as potent demonstrations of princely power. Typically set off around elaborate allegorical decorations, court displays included spinning wheels, fiery candles, star-filled bombs, and rockets, the latter used originally in warfare but primarily in festive fireworks from about 1600. Performed to music, fireworks typically ended in a great ‘girandola’ or burst of several thousand rockets at once. In the eighteenth century, critics, particularly in Britain, increasingly attacked court fireworks as expensive and wasteful, while others offered alternative uses for fireworks. In Britain, natural philosophers proposed more profitable uses for pyrotechnics. The Newtonian lecturers William Whiston and Humphrey Ditton thus suggested using rockets as signals to solve the longitude in 1714, and the
mathematician Benjamin Robins measured the ascent of rockets in 1748 to use them in surveying and navigation. Congreve rockets followed this 'philosophical' tradition, seeking to make fireworks more useful and economic through experimental inquiry.

Simultaneously, Europeans entangled imperial projects with pyrotechnics in various ways in the eighteenth century. Imperial victories were celebrated with fireworks both in the European capitals and at the edge of empire. The artillerist John Muller urged the British army to train artillermen overseas in pyrotechny, 'for how often does it happen, when a detachment is sent to the East or West-Indies, where having powder, shells, and shot, it is necessary … after having gained a victory, to make fireworks for rejoicing.' Fireworks could also challenge empire. In October 1759, Voltaire staged a satirical firework in disdain of his own nation, celebrating the English conquest of Quebec by General Wolfe with martial music, 'savage trophies' and the illuminated motto 'Spite to the French'.

Alternatively, imperial ventures returned novel forms of pyrotechnics to Europe. An important precedent for Congreve rockets was the ‘Bengal Fire’ or ‘Blue Light’ made with sulphur and antimony by Indian troops and used to illuminate enemies at night. French and British troops dismissed these flares on first encountering them in India, but by the late 1750s ‘Bengal lights’ were advertised in Europe, first as festive pyrotechnics, then as military.

After Whiston and Robins’s experiments, rockets and then Bengal lights were used as signals in surveying. Simultaneously with Congreve’s rocket experiments came proposals to use Bengal lights as coastal signals warning against French invasion, and to support British armies in India.

Indian rockets were thus not the first eastern pyrotechnics to appear in Europe, and fireworks were of course a Chinese invention, appearing in Europe in the fourteenth century. The interest in imitating eastern pyrotechnics was more recent. In the seventeenth and eighteenth centuries, Europeans often considered Chinese and Indian fireworks superior to their own, but attitudes had changed by the early nineteenth century. Opinions fitted broader orientalist attitudes, claiming that eastern culture was stagnant in comparison with European progress. The change reflected transformations in European empires and economies. Efforts by the British and French to control territory and trade in the East coincided with metropolitan attempts to imitate and substitute imports of eastern luxury goods, until Europeans identified their own goods and production processes as being superior to those of Chinese, Japanese and Indians, whose work was represented as ‘rude’: static, caught in the past, and lacking the inventiveness and scientific literacy of Europeans. The ‘superiority’ of European arts then provided a pretext for expanding European trade and dominion. Pyrotechnists participated in the denigration of eastern arts. In the early nineteenth century, having claimed that Chinese fireworks were superior to those of Europe, the French artificer Claude-Fortuné Ruggieri changed his mind, proposing that Chinese rockets ‘turned out to be no different from what the Chinese have made for the last three or four centuries. That convinced me that we in Europe are much superior to the Chinese.’ Similar attitudes marked the efforts of Lord Macartney’s embassy to Peking in 1793, intended to secure trade with the Chinese by a display of supposedly superior British craftsmanship. Macartney’s retinue included various scientific instruments and machines intended to demonstrate British mastery in the arts and sciences to the Chinese emperor, including ‘philosophical fireworks’ devised by the mechanic James Dinwiddie. Success proved elusive. The emperor was unimpressed with British ingenuity and refused to trade. Subsequently, Macartney’s secretary, George Staunton, printed descriptions of a complex Chinese firework witnessed on the embassy, the ‘Chinese Drum’, a container from which different fireworks fell in orderly succession. Europeans set out to
imitate the drum, but in 1805, chemist William Nicholson was still perplexed as to how the effect was achieved. Only in 1830 did Congreve’s collaborator, the Scots chemist John MacCulloch, offer an explanation.15

REFORMS: ECONOMIES OF LABOUR AT WOOLWICH ARSENAL

Congreve rockets emerged within these contexts of rationalizing pyrotechnics, imperial spectacle and the interest in imitating eastern fireworks. Congreve’s distinction was to develop rationalizing principles to produce military fireworks. Congreve championed a mode of reason characteristic of ‘industrial enlightenment’, which found its roots in Adam Smith’s division of labour and attempts by philosophes such as Denis Diderot to render crafts transparent and subordinate to enlightened management.16 Customary practices and embodied craft skills associated with private manufacturers were thus to be subjected to rational analysis, improved through experiments and then reorganized into an economizing system under the centralized control of the state’s enlightened officials. Systems should be transparent, demanding no tacit skills and capable of producing maximum utility for minimum costs. Such principles, together with Congreve’s rockets, emerged in the context of attempts to reform Woolwich Arsenal along rational and economic lines. Congreve presented British versions of Indian rocketry as solutions to Woolwich reform projects, already closely connected to the culture of ‘philosophical fireworks’.

Woolwich Arsenal, known as the ‘Warren’ in the eighteenth century, was situated in east London on the Thames, and had been home to the Royal Artillery since the 1690s.17 Supplying ordnance to imperial armies around the globe and fireworks for the English court, the site consisted of a cannon foundry, ordnance stores, the Royal Military Academy for training young officers, and the Royal Laboratory, which produced fireworks. Here, during the second half of the eighteenth century and in the context of a difficult war in the American colonies, artillery officers set out to overhaul practices in gunnery, to improve the manoeuvrability of ordnance over difficult terrain, and to economize labour and costs in the process. The principal reformers were Thomas Desaguliers and William Congreve, 1st Baronet, father of the rocket improver. Their activities also led to increasing integration between the Royal Artillery and the Royal Society.18

Desaguliers, who served as chief firemaster of the Royal Laboratory from 1748, was the son of Jean Theophilis Desaguliers, Newtonian curator of experiments at the Royal Society.19 Thomas sought to put artillery on an experimental footing, and in about 1772–73 he established a Military Society at Woolwich with Congreve senior and others for experiments on improving ordnance.20 Subsequent reforms sought to reduce costs and bring artillery production and deployment under stricter control. Both Desaguliers and Congreve senior designed new lightweight carriages and guns to make ordnance more manoeuvrable over difficult terrain, and introduced training in handling the new guns. Lighter carriages were more economical, requiring fewer horses and men to pull them. Congreve centralized control over artillery deployment, replacing hired labour and horses used to haul ordnance with a new regiment of Royal Horse Artillery.21 Congreve also oversaw an extensive programme of reforms in gunpowder production across England, which reduced the Artillery’s reliance on private powder suppliers in favour of centrally controlled Crown powder-works.22 For these efforts, Desaguliers became the first artillerist to be elected to the Fellowship of the Royal Society, just before his death in March 1780.23 Congreve also collaborated closely with the men of science, studying chemistry with
the Scots physician George Fordyce in London, experimenting on charcoal with the Cambridge chemist Richard Watson, and asking for advice from the Royal Society on his gunpowder reforms.24

As the later decades of the eighteenth century witnessed changing attitudes to Chinese and Indian fireworks, so they also saw a growing disdain among British officers for local labour. ‘Orientalism’ applied at home, as reformers represented artisans working in artillery in similar terms to the Chinese (indeed, Desaguliers and Congreve’s light cannon were among the gifts sent to the emperor of China with Macartney).25 Watson cast artisans as static and complacent, and so in need of control and guidance from learned men like himself:

artists themselves are generally illiterate, timid, and bigoted to particular modes of carrying on their respective operations. Being unacquainted with the learned, or modern, languages, they seldom know any thing of new discoveries, or of the methods of working practiced in other countries... From this apprehension... they acquire a certain opiniâtreté [sic], which effectually hinders them from making improvements, by departing from the ancient traditinary precepts of their art.26

Similarly, Congreve urged centralized surveillance of private gunpowder manufacturers because they were ‘too indolent to go into the dirty work of their Mills and have generally left the Superintendence thereof to artful but ignorant Foremen.’27 As in imperial ventures to the Far East, representing artisans as incapable of governing themselves warranted rational management by the learned. Congreve ordered mills ‘to do the most work with the fewest men and in the least time’.28 Those who failed to meet standards were sacked.29

ROCKETS: WILLIAM CONGREVE AND INDIAN ROCKETRY

The goals, methods and attitudes of Desaguliers and Congreve senior in Woolwich were continued in the younger William Congreve’s efforts to produce military rockets: indeed, in the younger Congreve’s case, orientalizing views of the East and efforts to bring local labour under control became closely integrated. The younger Congreve’s career began after studies of mathematics and chemistry at Richard Watson’s Cambridge college Trinity, and at the Royal Military Academy in Woolwich. After studying law at Middle Temple, Congreve set about editing a Tory newspaper, The Royal Standard, while writing A Second Century of Inventions, an unpublished compendium of mechanical inventions and speculative history whose accounts of the arts echoed his father’s centralizing tendencies and disdain for craft traditions.30 Congreve lamented how the arts continued to rely on ‘the effect or accident of the gradual operations of artificers’ and proposed mathematical training of artisans in a ‘grand national institution’ as the only solution.31 In a long historical section, Congreve claimed that the division of labour had shaped a natural hierarchy in which rational elites, especially military reformers, were best placed to govern society and the arts to bring progress and prosperity.32 ‘Equality in a State is not only inconsistent with the Arts but with the Happiness of Man.’33 This was Congreve’s programme, and such rational principles were next applied to Mysore rockets. After a lawsuit scuppered The Royal Standard, Congreve senior appointed the hapless graduate to a salaried position in the Royal Laboratory, in which he had unrivalled access to men and materials.34 Here the younger Congreve turned his attention to schemes for defending Britain from a looming invasion by the French fleet stationed at Boulogne, and fixed on the Indian rocket as a solution.

The Indian war rocket that inspired his efforts was a product of military reform in the armies of Mysore, India, during a period of prolonged war. From 1767 to 1799 the armies of Haidar Ali and his son Tipu Sultan fought the British, who sought to extend their dominion
over southern India after gaining control of the east at the battles of Plassey and Buxar. Three Anglo-Mysore wars culminated in Tipu's death and British victory at the siege of Seringapatam in 1799, signalling the beginning of British dominance of the Indian subcontinent. To combat the British, who from 1780 to 1786 were led by Macartney before his Chinese embassy, Haidar Ali undertook major reconstructions of the Mysorian army. Reform ideas resembled those in Woolwich, with French artillerists employed to cast ordnance. An efficient system of cart and bullock transport was established. Tipu added a potent Islamic ideology to these forces, centring on the symbolic motif of the tiger (Haidar), linking him to Haidar, sacred cousin of the prophet Mohammad. Tipu also established shipbuilding arsenals, canals, irrigation works and workshops boring tiger-muzzled cannon.

The use of military rockets, or baana, had flourished in India since the reign of the Mughal emperor Akbar in the second half of the sixteenth century. Under Haidar and Tipu, production expanded in Mysore, probably in the fort of Tirthahalli, in the northern part of their kingdom. Rockets consisted of bamboo sticks or wootz steel blades attached to iron cases, about eight inches long and weighing from six to twelve pounds, charged with one to two pounds of gunpowder. Rocket making was skilled work, undertaken by specialized artisan castes, whose expertise reflected long Indian traditions of working the high-quality iron ores and saltpetre deposits found in India. By the end of Tipu’s reign, some 5000 Mysorean troops fired off huge volleys of rockets against the enemy, although, as in Britain, rockets served other functions besides the military (figure 1). Like Macartney, Tipu deployed his best technologies as diplomatic gifts, sending rockets to the Ottoman sultan, Abdülhamid I, on an embassy to Constantinople in 1783 (unlike the Chinese emperor, the sultan was impressed and sent a tiger throne to Tipu in return). Rockets were also used as a measuring tool.
unit in India, and in Mysore they were subject to the princely practice of ‘name-changing’, whereby the prince signalled his power by creating new names for things.\textsuperscript{43} To Mir Miraan, the commanding officers of his armies, Tipu ‘presented dresses of gold embroidery … and jewelled gorgets. About this time the sultan changed the names of the different arms, as for instance … a ban, or rocket, Shuhab.’\textsuperscript{44}

British and French troops returning to Europe from India regularly assessed Indian rockets, some identifying them as trivial, others as formidable.\textsuperscript{45} Commentators linked rockets with orientalizing condemnations of Muslim culture. East India Company servant Quintin Craufurd, whose \textit{Sketches … of the Hindoos} (1790) featured Indian rockets on the title page, proposed that Muslim domination of southern India created ‘an enslaved, ignorant, and bigotted race of men, whose history … creeps through one continued gloom of cherished barbarism.’\textsuperscript{46} Tyranny exerted a ‘baneful influence’ on scientific inquiry. If Indians had discovered gunpowder before the Europeans, which Craufurd doubted, they failed to invent the ordnance to exploit it, relying instead on the ‘less ingenious invention of the rocket’. Even with ordnance available, Indians rejected change: ‘being accustomed to [the rocket], they may still continue to use it.’\textsuperscript{47}

These reports led to attempts at replication, perhaps assisted by the presence of Indian rockets in Europe. Indian skyrockets were already on show as oriental exotica in London as early as the 1750s, and after the siege of Seringapatam several Mysore rockets were brought to London and displayed as trophies in Woolwich’s Royal Military Repository.\textsuperscript{48} Some time before his death in February 1780, an ageing Thomas Desaguliers experimented with war rockets, although no details are known.\textsuperscript{49} In the 1790s, the French pyrotechnist Claude-Fortuné Ruggieri also tried replicating Indian war rockets, collaborating with a French officer returned from Mysore. His efforts stalled during the revolutionary wars, but Ruggieri later claimed French priority in the invention, ‘which we do not owe to the Chinese, much less to the English.’\textsuperscript{50} If these replications were attempts to copy specimens of Indian rockets returned from Mysore, they probably failed because Indian rockets were highly refined, using gunpowder mixtures designed to burn effectively in Mysore’s humid environment, and containing ingredients of a high quality, particular to India.

Congreve never identified the source of his interest in rockets, erasing any debt to local or distant inventors. Congreve was also quick to dismiss Indian rockets, which he represented as another unchanging eastern art, negligible compared with his own rockets devised through experimental science. The capacity of his rockets, ‘the results of much thought and experiment’, were thus ‘infinitely beyond any thing ever before conceived … or known in India, where they have been used … time out of mind. But what are the Indian rockets compared to our own?’\textsuperscript{51} Congreve may have witnessed Indian rockets in the Woolwich Military Repository, and probably did so. In any case, Congreve’s rocket experiments followed directly from his father’s and Desaguliers’s reforms at Woolwich. As the reformers had sought to reduce reliance on hired labour in gunpowder production and artillery haulage, Congreve identified the rocket as a way to eliminate labour from artillery altogether, explaining in 1807 that

The rocket carcass is not only fired without re-action upon the point from which it is discharged, but is also unencumbered with the necessity of heavy ordnance to project it, as is the case with every other carcass. These are the points which first induced me to speculate upon it. … It is ammunition without ordnance, it is the soul of artillery without the body.\textsuperscript{52}
Because rockets had no recoil, there was no need for ordnance or carriages on which to mount them, nor for the skilled labour needed to do so.

Installed at Woolwich, Congreve began developing the new war rocket following Desaguliers and his father’s experimental methods, seeking to extend the range of common skyrockets while subjecting local pyrotechnic artisanship to further rationalization. Congreve depended on traditional pyrotechnic skills and privileged connections to make these trials. Skyrockets bought from the London firework makers proved of limited range, but after his father’s superior ordered Royal Laboratory fireworkers to make larger rockets for trial, Congreve extended their range to 2000 yards. This, he reckoned, was sufficient to attack the French port of Boulogne. Congreve also applied rational principles to the use of rockets, making them suitable for an attack on Boulogne. The result was a new form of philosophical firework, the ‘rocket system’, consisting of scaled-up rockets modified to carry incendiary explosives in the nose cone. Some 30 feet long including the stick, the rockets weighed from six to eight pounds (figure 2). Congreve argued that the rocket would work only if all aspects of its deployment were subject to the rational system of the inventor. Thus, war rockets were to be fired at sea from frames on small flat-bottomed rafts or ‘launches’, also devised by Congreve. Congreve claimed this as a ‘universally effective system’ based on the ‘best principles’. Because the rocket eliminated any need for heavy gun carriages, it was ‘a measure of economy both as to men and money’. Rational instructions should make the system work, with no need for embodied skills; ‘it may be made and adapted by any workman’.

Assessment of the rocket system demanded trials at sea and collaboration with the Royal Navy, whose officers would take the rockets out to the English Channel to fire them at the French ships stationed off Boulogne. In the process of making these trials,
however, naval officers disputed Congreve’s ‘system’. Although Congreve was sure that inventors’ principles would secure the rockets’ success, naval officers argued that skilful boat-handling and artful judgement were more important. In the event, nautical skills proved critical to the rockets’ success, but just as Indian skills in rocketry were erased in Congreve’s accounts, so too were the contributions of the navy men, as Congreve sought to credit his system.

TRIALS: DISPUTING SKILLS IN THE ROCKET SYSTEM

Following these trials reveals the labour implicit in making rockets work. Even before the first trials Congreve faced opposition. The navy was also being subjected to reforms at this time, by men such as George Fordyce’s son-in-law, Samuel Bentham, whose introduction of block-making machinery by Henry Maudslay at Portsmouth docks was designed to work ‘independently of the need for skill or manual dexterity in the workman’.58 Naval officers had little time for Bentham’s or Congreve’s ideas. George Elphinstone, Viscount Keith, commander of the North Sea fleet and a veteran of sea campaigns, wrote to the Navy comptroller, Charles Middleton, Lord Barham, ‘Mr. Congreve, who is ingenious, is wholly wrapt up in rockets, from which I expect little success, for Mr. Congreve has no idea of applying them professionally.’59 Keith agreed with many other navy officers that personal judgement and experience, not newfangled rational principles, were the keys to military success. They disliked any systematization of naval practices or production: ‘all formality … only tends to keep the main point out of question and to give knaves and fools an opportunity to justify themselves on the credit of jargon and nonsense.’60

To make his rational system work, Congreve relied on powerful patronage. Congreve was a client of the Prince of Wales, later George IV, and often presented projects to the prince at Carlton House on Pall Mall or at that archetypical orientalist site of the early nineteenth century, the Marine or Royal Pavilion in Brighton. Originally built as a Palladian villa in 1787, from 1803 revisions of the pavilion transformed it into a mock Mughal temple, with chinoiserie interiors inspired by accounts of the Macartney embassy.61 Like Congreve’s rockets, the pavilion imitated the East with science and engineering. Indian turrets thus rested on an innovative cast-iron structure, while the recipe for chromatic yellow and red paint used in the chinoiserie interiors was worked out with chemistry. At the pavilion, Congreve showed the prince plans for imitating Indian rockets and used the prince’s patronage to ‘ride over’ opposition. After George ordered William Pitt to pay ‘immediate attention to the rockets adoption’ the Prime Minister turned to Robert Stewart, Viscount Castlereagh, his Minister of War, to organize sea trials.62

In autumn 1805, Congreve and Castlereagh sent the rockets out to sea. Castlereagh ordered 10 specially designed launches to be constructed in Woolwich dockyards, to be fitted out with standing ladder frames for firing rockets. Each frame would carry 50 eight-pounder rockets fixed to launch at 55° elevation, which Congreve determined would give them sufficient range to strike the French ships. Towed to within 2000 yards of Boulogne by gun-brigs, the launches would be led by a naval officer to a station determined by a survey of the harbour. From here, according to Congreve’s plans, using leaders fed through gunlocks as fuses the ten boats … would discharge 500 [rockets] in one flight, which would, by one single and momentary operation, convey as much carcass matter as could be thrown in four hours by ten 8-inch mortars; so that the boats need scarcely be five minutes exposed to any fire [before retreating].63
The key phrase in Congreve’s plan was ‘one single and momentary operation’, the firing of the rockets instantaneously, recalling the tradition of firing a great girandola volley of rockets in festive royal fireworks. This for Congreve was another critical element in the economy of his system, because the possibility of firing rockets without ordnance saved time and labour; ‘the principle difference is in the labour, which may be very much reduced when the thing is properly systematized.’\textsuperscript{64} Whereas firing shot from mortars on a ship required gunners’ skills and time to charge and reload, rockets could be fired in one great discharge, without ordnance, and so by unskilled mariners, maximizing the quantity of ammunition fired in a fixed time, and minimizing opportunities for the enemy to return fire.

However, when rockets moved out from the laboratory into the field, in this case the choppy waters of the English Channel, they failed dramatically. An enthusiastic naval officer, Sir William Sydney Smith, oversaw the first trial. In the event, 12 double canoe launches were fitted with rocket-firing frames, each carrying 48 paper-case six-pounder and eight-pounder rockets, a total of nearly 600. The launches sailed from Dover to anchor three miles outside Boulogne, and on the night of 20 November they made the attack. There were many conflicting reports of what happened. Opponents pointed to a lack of range and irregularities in the rockets. Keith reported ‘Congreve rockets could not reach by miles…’. The rockets were fired without effect, some of them burst in our own boats, and none went in the intended direction.\textsuperscript{65} Even Congreve conceded that the attack was a failure, but blamed high winds and rough seas.\textsuperscript{66}

Critics thus cast Congreve’s plans as over-optimistic and impracticable despite the fact that they were ‘carried on upon the best principle’.\textsuperscript{67} Keith claimed that the failure was due to a lack of ‘professional’ skill needed to handle the boats and rockets in more order. Smith agreed, supposing ‘there is no use in firing rockets at random in the air at [the French] line.’\textsuperscript{68} The ‘girandola’ technique of festive rockery could not be extended to military application. After the trials, Keith was pleased to report that Smith had ‘confessed the impracticability of the plan succeeding.’\textsuperscript{69} Smith informed Barham apologetically, ‘My own opinion … of Mr. Congreve’s rockets … is that they are a valuable addition to the force of swift-rowing boats, as the smallest can throw a six-pounder carcass … without being encumbered with the weight of ordnance.’\textsuperscript{70} But he pointed to the need for naval skill in managing the weapons: ‘this must be carefully kept and skillfully managed, or there is danger in the application.’\textsuperscript{71}

The conflict of artful skill and rational principles was now to become a major point of contention between Congreve and the naval officers. After the November escapade, the Navy Board replaced Sydney Smith with Captain Edward Campbell Rich Owen of the HMS Clyde (figure 3). At 34 years old, Owen was a veteran of the Navy. At sea since the age of four, he had served on and commanded numerous ships in the West Indies, North America and around the British coast. On the Immortalité, Owen had achieved great success in destroying or capturing French vessels off the coast of Dunkirk and Boulogne.\textsuperscript{72}

Further trials now began at sea, where Owen, in his element, began to erode Congreve’s authoritative position as it had developed under Smith. Like his father, Congreve believed his position to be that of an overseer, in complete control of the enterprise he was reforming. This was why Congreve referred to a ‘system’, over which he presided. ‘I am convinced’, he argued on another occasion, ‘that the most rapid way to perfection is by experiment entirely under the control of the inventor.’\textsuperscript{73} Owen disagreed, and wrote to Keith to complain that ‘he [Congreve] will consider himself the Commanding … officer as to the mode of employing the vessels in this attempt.’\textsuperscript{74} Owen reckoned that such ‘interference’ must undermine the confidence of sailors who only respected officers for their experience ‘in service’:
I know Mr. Congreve has formed plans of attack which can never be realized... An attentive observation last year, when a similar plan was preparing, convinced me it could not be executed in that manner and the failure which followed was wholly the consequence of the wrong system on which we set out... I... most decidedly approve the rocket as an auxiliary weapon... but if we wish to use them with effect the means and mode must always be within ourselves. 75

Owen was claiming that for the rocket to work it must depend not on the rational principles of the inventor but on the practical skills of the sailor. Owen called Congreve’s ‘the wrong system’, and now devised his own method for firing rockets. Congreve had demanded a single instantaneous discharge of rockets to reduce the time of an engagement and so its cost. But Owen and Keith argued that the technique was fundamentally
impracticable, and they identified the solution on the basis of their own competences. Success thus depended on ‘the number of vessels and boats employed’, not the system. Spread out in a line, several small vessels would fire rockets in twos over a period, making it possible to keep the rocket boats steady by skilful handling, because ‘On the water the machine is never a second in the same position.’ Rational principles gave way, as Owen put it, to ‘the greatest order and regularity’ of sailing combined with good discipline and ‘seaman’s courage’.

Congreve chose the more predictable location of Woolwich Arsenal as the place to meet these criticisms, conducting new experiments with larger 32-pound rockets ranging up to 3000 yards in the spring of 1806, before stage-managing a spectacular demonstration to Lord Howick, the new First Lord of the Admiralty. Howick was impressed, advising Lord Keith, ‘As the inventor of the weapon, [Congreve] is best instructed in the use of it, and … his knowledge and judgement seems almost of indispensable necessity to assist Captain Owen.’ Owen responded by saying that success by no means depended on the judgement of the inventor. Congreve’s further presence at the trials was even unnecessary, ‘for as we act in separate divisions each commander of these ought to be perfect in their work.’

For Owen, local skills mattered in assessing competence. Woolwich’s stage-managed shows were no match for seamen’s experience of the Channel seas. He later praised the value of the ‘local knowledge & long service’ of his men for conducting the rocket trials; ‘to whatever our want of success in the great object of destroying the flotilla is to be ascribed it was certainly neither owing to want of judgment, nor of skill in those officers.’ Keith also supported Owen’s proposals and lambasted Congreve, replying to Owen, ‘I hope that [Congreve] has satisfied you that he will never think of … setting his opinion in opposition to your well attested experience and nautical skill.’ Keith supposed that Owen should soon be ‘master of the whole plan’.

The next time that rockets left Woolwich for an attack on Boulogne, on 8 October 1806, they were under Owen’s command. As night drew in on the Channel, 24 cutters under Owen’s supervision, fitted with rocket frames, formed the line and fired Congreve’s rockets at Boulogne. Significantly, the bombardment lasted half an hour, dispensing with Congreve’s ‘instantaneous volley’. Once again, reports of the attack varied. The French dismissed it, one journal proposing that of ‘a hundred incendiary rockets … most … were without effect.’ Congreve himself, however, now believed the attack a success, and wrote to Grenville, First Lord of the Admiralty, to claim that this success proved the viability of his system. But in so doing Congreve redefined what counted as ‘system’. Discarding the previously essential idea of instantaneous firing, Congreve instead claimed Owen’s methods as his own:

The number of rockets thrown was about 400 in less than half an hour & in fact nothing could succeed the regularity and rapidity of the attack … it is indeed … in this power of throwing great quantities of combustible matter in a short time, that one principal advantage of the system exists.

The ‘short time’ here was critical, because it incorporated precisely the tacit skills that rational rocketry was supposed to eliminate. But Congreve made no mention of this, and never referred to the necessity of nautical skills in subsequent public pronouncements on rocketry. Just as Indian skills were absent from Congreve’s accounts, so were those of the navy men. Artful boat-handling and judgement disappeared as Owen’s practical success was turned into a triumph of Congreve’s rational principles.
Congreve had succeeded in persuading the government of the technical feasibility of rocket warfare, seeking, like earlier Woolwich reformers, to erase expensive skills in artillery. Making rockets work, however, had necessitated hiding, rather than eliminating, skill in artillery, as Congreve passed over both Indian rocketry and nautical skills in accounts of the rocket’s success. Congreve’s publications on rocketry provided an important venue for these arguments. In numerous books and pamphlets on rocketry, appearing from 1805 until his death in 1828, Congreve sought to overcome two remaining obstacles to the acceptance of the rocket: moral objections to its use in war, and priority claims from rival inventors. The acceptance of rocketry thus came to rely on another set of embodied skills: Congreve’s own experience as a journalist on the Royal Standard, whose publisher, James Whiting, collaborated with Congreve in his publishing efforts to promote the rocket’s credit. However, publications further elided both local and eastern skills in rocketry, as Congreve’s critics were quick to point out.

Patronage remained central to Congreve’s schemes. Congreve’s first pamphlet on rockets was written in February 1806 and dedicated to the Prince of Wales. Here Congreve made no mention of Indian rocketry or sailors’ skills, and instead focused on playing up the threat of a Napoleonic invasion, while attempting to justify the use of rocket bombardments as a mode of warfare. Many officers objected to rocketry on principle, as an offensive weapon liable to inflict severe civilian casualties. Rockets seemed to make traditional martial honour and heroism redundant. Already in 1805, Horatio Nelson had written to Castlereagh:

> The rockets, if the account of them is true, must annoy their fleet very much; but I depend more upon hunger for driving them out, and upon the gallant officers and men under my command for their destruction, than any other invention.

Congreve responded by emphasizing the honour of rocketry in comparison with traditional artillery. Rockets were no different from other shells, except in their form of impulsion, and ‘both means are equally open and manly, both equally conducted by a fair and honourable approach to the enemy’, though only rockets could ‘annihilate’ the Napoleonic fleet.

Congreve’s claims evidently worked, because after the sea trials the government officially approved the use of Congreve rockets in military engagements. After a bombardment of Copenhagen in 1807, Congreve collected testimonies of the damage inflicted and proposed that this was enough ‘to establish the credit of the rocket as a carcass’. The government agreed, and ordered regular rocket attacks, in Baltimore in 1812, at Leipzig in 1813, then on the Barbary Coast and in India. Although Congreve never patented the rocket, numerous people identified him as claiming priority in the invention, and in the course of these engagements several challenged that priority. Congreve’s own skills were in danger of being erased from rocketry’s history, and he responded in A Concise Account of the Origins and Progress of the Rocket System in 1807. These early critics’ particular claims are unrecorded, but they evidently emphasized Indian contributions to rocketry, prompting Congreve to make the only pronouncements he ever made on Indian rockets. Congreve thus accepted that rockets were invented by some ‘heroes of Chinese antiquity’, while their application in war belonged to ‘the remote ages of the mogul empire’. However, because no one in England was capable of making them, he claimed priority in the invention:
The only merit I claim, as the author of the rocket system in this country, is that I have obtained from the power of the rocket, by a just combination of its parts ... ranges, and the power of carrying weights infinitely beyond any thing ever before conceived ... or known in India, where they have been used ... time out of mind. But what are the Indian rockets compared to our own? Congreve’s orientalist response was that his rational rockets were effectively a different invention from those of Indians, and no one else claimed the invention in Britain. ‘What I have done, therefore, towards the perfection of this weapon, is as much my own as if the original invention of rockets in general were mine.’ In contrast with other inventors of this period, Congreve did not patent his rocket. A patent would probably have been rejected, and furthermore Congreve could rely on his patron to provide protection and rewards outside the patent system. The Prince Regent thus gave Congreve a pension of £1200 a year in 1814 and the gift of an honorary rank in the Hanoverian Artillery three years later (figure 4). In print, however, Congreve claimed that his not seeking a patent was a sign of his disinterestedness and his desire to serve the nation in a time of war, ‘unlike the generality of projectors’ and self-seeking rivals.

One such rival claimant to the invention of rocketry, the Scots chemist Joseph Hume, lost no time in pointing out how Congreve’s rockets really relied on hidden skills, while his credit relied on hidden patronage. In 1808, Hume used the Gentleman’s Magazine and The Times to claim he had submitted plans and drawings for ‘pyrotechnic arrows’ or incendiary war rockets to the Board of Ordnance in 1803. Hume saw the Board reject his proposals, despite keeping his plans, only to find Congreve experimenting on rockets in subsequent years. This prompted the suspicion that the Arsenal had ‘taken undue advantage of me ... and have been nibbling at my inventions.’ Hume identified exactly the artillerymen’s unwillingness to rely on outside labour as the cause of his troubles and of Congreve’s success, claiming that Congreve succeeded only through ‘technical aid and patronage’, which an outsider could not obtain: ‘I must have been considered as an intruder, a layman, and ... quite extra-parochial.’

Hume also pointed to Indian skills in the development of war rockets, strenuously asserting Indian rights to the invention in the pages of William Nicholson’s Journal of Natural Philosophy to counter Congreve’s priority: ‘in the use of rockets as “implements of warfare” [the Indians] have a prior claim to any man in this country.’ When Hume then claimed priority over Congreve, he sought to do so in a manner that revealed the skills implicit in rocketry, by identifying himself as an improver rather than an inventor of rockets: ‘There is a most obvious distinction between an inventor and an improver; for improvement depends upon others, as well as the genius and abilities of him who undertakes the management of the article to be improved.’

CONCLUSION

Congreve’s response, in the pages of The Times, reasserted his claims to priority as an inventor, but Congreve made no further efforts to counter Hume. In 1811 Congreve’s reputation was further secured by election to the Fellowship of the Royal Society, with several other honours following from his royal patrons. As had been the case throughout his career, royal and institutional patronage, together with a range of Indian, artisanal, naval and publishing skills, contributed to making the rocket into a viable weapon, and to attaching Congreve’s name to its invention. This article has unpacked some of these skills and the ways in which Congreve worked to erase his debts to them during the early stages of the rocket’s
career. In the process, we have seen how rationalizing programmes, intended to discipline and economize artillery, simultaneously entailed the exercise of control over both local and distant skills, justified by assimilating techniques and downplaying or making invisible the value of those techniques in securing the feasibility and credit of the ‘rocket system’. Congreve thus minimized the contributions of both Indian rocketeers and British naval officers—contributions that Congreve’s critics were quick to make visible again. This was the case in Europe at least, and further research might reveal whether Indian masters criticized Congreve’s claims to rocketry in the nineteenth century.

To see these processes of orientalizing and discipline in action, this essay has looked away from the traditional historical focus on Britain’s factories and dockyards to the Arsenal, whose culture of reform was as pervasive in the late eighteenth century as at any other
location. From the 1770s, Woolwich became a key site for philosophical experiments, labour rationalization and economies, whose full significance remains to be assessed. Certainly Desaguliers and Congreve’s rationalizing measures pre-date the naval reforms of figures such as Samuel Bentham, which began in the 1790s, and may have had an impact on Britain’s successes in India during the 1790s, and hence on the transformation of the British Empire subsequently.

Finally, economic and labour reforms in late-eighteenth-century Britain have often been identified with liberal, private or manufacturing concerns, and have been contrasted with the conservatism of the Crown and state. Yet in Congreve’s case, royal patronage, family connections and pyrotechnic tradition proved critical to the success of his rationalizing schemes. The Prince Regent was a significant supporter of such schemes, also patronizing the first gas-lighting projects of the German entrepreneur Frederick Winsor, another technology with roots in ‘philosophical fireworks’. Congreve spent much of his later career promoting gas lighting, and he regularly relied on royal and aristocratic patronage to do so. The court therefore continued to serve as a significant site of philosophical activity well into the nineteenth century.

NOTES


7 William Whiston and Humphry Ditton, A New Method for Discovering the Longitude both at Sea and Land, humbly proposed to the Consideration of the Publick, 2nd edn (London, 1715); Benjamin Robins, ‘Observations on the Height to Which Rockets Ascend’, Phil. Trans. R. Soc. 46, 131–133 (1749).
See, for example, the account of the ‘Meshianza’ celebrations for General Howe on the Delaware river in 1778. John McGregor, British America (London, 1832), vol. 1, pp. 63–69.

John Muller, A treatise of artillery ... With large additions, alterations, and corrections, according to the second London edition (Philadelphia, 1779), p. 159.


21 Smith, *op. cit.* (note 1), pp. 41 and 79–81; the archives of the James Clavell Library, Royal Artillery Museum, Woolwich, contain numerous papers by Congreve senior on carriage reforms. See, for example, ‘A Particular Account of the Alterations made in the Light 6 Pounder Carriages in the Year 1776’, Royal Artillery Historical Trust collection, RA/93; and ‘Exercises and Manoeuvres for the Light Six Pounders or Two Heavy Three Pounders of General Desaguliers Construction, by William Congreve, Capt. of Artillery’, MD/213/9, reproduced in Major J. P. Kaestlin, ‘Firemaster: The Life and Trials of Sir William Congreve (1772–1828)’, Royal Artillery Library, Woolwich, MD 213/14, no. 6, supplement of illustrations, MD 939/15.

22 Congreve senior listed his reforms in ‘A State of Facts relative to the Grounds on which the late and present Master General have had so much Reason to doubt the goodness and durability of Gun Powder which was delivered into the Royal Magazine for the King’s Service’, dated 17 January 1788, James Clavell Library, Royal Artillery Museum, Woolwich, MD213/8; and *A Statement of Facts, relative to the Savings which have arisen from manufacturing Gunpowder at the Royal Powder Mills; and of the improvements which have been made in its strength & durability since the year 1783* (London, 1811); for discussion, see Mauskopf, *op. cit.* (note 18).

23 For Desaguliers’s certificate, Royal Society, London, GB 117: EC/1779/26; Desaguliers had been proposed for election in December 1779.


28 William Congreve, 1st Bart., to the Board of Ordnance, 14 July 1801, attached to a letter from Congreve to Joseph Planta, Secretary, Royal Society, 29 June 1801, Royal Society, MM/4/34.

29 On sacking, see Smith, *op. cit.* (note 1), p. 76.


31 Ibid., f. 11v.

32 Ibid., ff. 309r–313r.

33 Ibid., f. 258r.

34 Smith, *op. cit.* (note 1), p. 133.


Edward Moor, *A narrative of the operations of Captain Little's detachment, and of the Mahrrata army, commanded by Purseram Bhow: during the late confederacy in India, against the Nawab Tippoo Sultan Bahadur* (London, 1794), at p. 169.

Winter, *The first golden age of rocketry* (op. cit. (note 1)), pp. 6–7; the range was between 900 and 1500 m.


Winter, *The first golden age of rocketry* (op. cit. (note 1)), p. 7.


See, for example, Moor, *op. cit.* (note 38), p. 509.


Ibid., pp. 295–296, at p. 296.

A *Catalogue of the Rarities To be seen at Adams's at the Royal Swan, in Kingsland Road, Leading from Shoreditch Church*, 3rd edn (London, 1756), at p. 7; The *Britannic Magazine; or entertaining repository of heroic achievements* (London, 1798–1807), vol. 9, pp. 287–288, describes the repository contents; on rockets brought back from Seringapatam to London, see East India Company, *Copies and Extracts of advices to and from India* (London, 1800), pp. 262–263.


Ibid., p. 7.

See the brief accounts of Congreve’s experiments appended to Congreve, *A Concise Account* (op. cit. (note 49)); William Congreve, *Memoir on the possibility, the means, and the importance, of the destruction of the Boulogne flotilla, in the present crisis: With the outline of a general system for the attack of all the enemy’s naval depots and arsenals* (London, 1806), p. 12.

Congreve, *Memoir on the possibility...* (op. cit. (note 53)), pp. 11–12.

Ibid., dedication.

Ibid., p. 7.

Ibid., p. 24.


Quoted in Smith, *op. cit.* (note 1), p. 137; Winter, *The first golden age of rocketry* (op. cit. (note 1)), p. 17.


For Congreve’s assessment, see the appendix to Congreve, *Memoir on the possibility*… (op. cit. (note 53)), pp. 28–30.


Owen to Keith, 20 July 1806, in Lloyd and Hardin, *op. cit.* (note 65), pp. 441–442.


Markham to Keith, 25 September 1806, in Lloyd and Hardin, *op. cit.* (note 65), pp. 446–447, at p. 446.

Keith to Grenville, 12 October 1806, in Lloyd and Hardin, *op. cit.* (note 65), p. 454.

See Owen’s general orders, 19 August 1806, in Lloyd and Hardin, *op. cit.* (note 65), pp. 444–446, at p. 444.

For details of the new rockets and demonstration, see Congreve, *A Concise Account*… (op. cit. (note 49)), p. 7.

Howick to Keith, 19 August 1806, in Lloyd and Hardin, *op. cit.* (note 65), pp. 443–444.

Owen to Keith, 20 August 1806, in Lloyd and Hardin, *op. cit.* (note 65), p. 443, n. 1.

Owen to Grenville, 30 November 1806, in Lloyd and Hardin, *op. cit.* (note 65), pp. 460–461.

Keith to Owen, 22 July 1806, in Lloyd and Hardin, *op. cit.* (note 65), pp. 442–443.


Congreve to Grenville, 12 October 1806, in Lloyd and Hardin, *op. cit.* (note 65), pp. 455–457.


88 Congreve, *Memoir on the possibility*... (*op. cit.* (note 53)).

89 The role of honour in enlightened warfare is analysed in Armstrong Starkey, *War in the Age of Enlightenment, 1700–1789* (Praeger, Westport, CT, 2003), pp. 69–104.

90 Nelson to Castlereagh, 3 October 1805, Stewart, *op. cit.* (note 64), vol. 5, p. 111; see also Barham to Castlereagh, 4 October 1805, *ibid.*, vol. 5, p. 115.


95 Ibid., p. 142.


97 *The Times*, no. 7827 (14 November), 3 (1809); *Gentleman’s Mag.* 78 (February), 129 (1808).

98 *The Times*, no. 7827 (14 November), 3 (1809).


100 Ibid., p. 65.

101 Congreve went on to become Comptroller of the Royal Laboratory in 1814, and inherited his father’s baronetcy in the same year. He was appointed senior equerry to the Prince of Wales in 1817.

102 See Werrett, ‘From the Grand Whim...’, *op. cit.* (note 6).

103 Congreve and other Royal Society Fellows formed a commission to investigate gas explosions in London in 1813, after which Congreve founded his own gas company, the Imperial Continental Gas Association, in 1824. Smith, *op. cit.* (note 1), pp. 195–207.