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The public lantern's interplay of light and darkness: between security-based expansions, savings-based extinguishings, and the limitations of technical innovation (Paris, Barcelona, 18th C.)

Abstract
The gap between the early modern policing ideal of a homogeneous—"geometric"—perception of the urban fabric thanks to street lighting, and the persistent reality of dark areas, was particularly clear during periods of turmoil in the public order. In both Paris and Barcelona, the revolutionary episodes of the eighteenth century severely tested the new streetlamps, known as reflector lanterns ("lanternes à réverbères"). This article will explore, by adhering as closely as possible to the object, the limitations of technical innovation in public lighting.

Plan of the article

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INTRODUCTION

1 The intention of evenly lighting the entire city, through the continual installation of lanterns in accordance with the growing urban fabric, drove Paris lighting policy since the institutionalization of public lighting in 1667. In the early eighteenth century, the decision of the Conseil from July 26, 1704 reaffirmed this objective: "for both the convenience and safety of the public, as well as the adornment and decoration of the city, all streets, plazas, and other public spaces must be evenly lit and cleaned.[1] This should be connected to the new policing practices of the time, which recommended a systematic approach to the urban territory.[2] Through the division of the city–its "geometric abstraction"[3]–the street became disconnected from its social uses and locality. Space was treated as a "neutral" variable. This desire to neutralize space through lighting was actually part of a larger reality of developing the territory, which was understood as a homogeneous space for economic and political action. The new administrative culture of the state based on rational thought, on abstraction and mathematics,[4] brought about changes in scale, both national and local. It spread toward the city, the capital in particular. The systematic lighting of all Parisian streets was therefore the expression of a rational interpretation and understanding of space, in this case of urban space.

2 A cultural history of the night has been conducted since the 1990s. Initiated by Wolfgang Schivelbusch[5] and Simone Delattre for nineteenth-century Paris,[6] and followed by the work of Alain Cabantous[7] and Craig Koslofsky,[8] it has included the early modern period within a broader temporal study of nightlife in royal courts, nocturnal sociabilities, and the impact of lighting on criminality—what is generally referred to as the nocturnalization(s) of societies. In keeping with this work, we will use an approach rooted in the history of technology to explore the materiality of lighting measures, and the effect it had in terms of casting both light and shadow, in short of illumination and darkening.

3 While the invaluable work of Auguste-Philippe Herlaut[9] took an early interest in this technical dimension of urban lighting, it suffered from a linear approach to progress, and was based solely on institutional sources. The issues that opposed the general contractor for public lighting in Paris and its adversaries played a central role. Our goal is not at all to update this institutional history, but rather to propose a technical history of lighting that is fully situated within its context, which is to say inclusive of not just institutional aspects, but also social, political, and cultural ones.[10]

4 The renewal of French historiography on the early modern police, led by Vincent Milliot, Brigitte Marin, and Vincent Denis, provides crucial interpretive keys to this end.[11] Jean-Luc-Laffont and

1 Bibliothèque nationale de France (BNF), Département des manuscrits, Français 21684: "il est nécessaire, tant pour la commodité et la sûreté du public, que pour l'embellissement et la décoration de la ville, que toutes les rues, places et autres lieux publics soient également éclairés et nettoyés."

2 On this approach to the police and urban space, see Paolo Napoli, *Naissance de la police moderne. Pouvoir, normes, société* (Paris: La Découverte, 2003).

3 Brigitte Marin, "Administrations policières, réformes et découpages territoriaux (XVII^{e}-XIX^{e} siècle)," *MEFRIM*, 115/2, 2003.

4 Marc Desportes, Antoine Picon, *De l'espace au territoire. L'aménagement en France XVI^{e}-XX^{e} siècle* (Paris: Presses de l'ENPC, 1997).

5 Wolfgang Schivelbusch, *La Nuit désenchantée* (Paris: Gallimard, 1993).

6 Simone Delattre, *Les Douze heures noires. La nuit à Paris au 19^{e} s.* (Paris: Albin Michel, 2000).

7 Alain Cabantous, *Histoire de la nuit (17^{e}-18^{e} s.)* (Paris: Fayard, 2009).

8 Craig Koslofsky, Evening's Empire. *A History of the Night in Early Modern Europe* (Cambridge: Cambridge University Press, 2011).

9 Auguste-Philippe Herlaut, "L'Éclairage des rues à Paris à la fin du 17e et au 18e siècles," *Mémoire de la Société de l'Histoire de Paris et de l'Île de France, vol. XLIII, 1916, and by the same author, L'Éclairage de Paris à l'époque révolutionnaire* (Paris: Mellotée, 1933).

10 A dissertation was recently defended on eighteenth-century public lighting on a national scale (outside of Paris): Sophie Reculin, "L'Invention et la diffusion de l'éclairage public dans le royaume de France (1697-1789)" (Ph.D dissertation, Université Charles-de-Gaulle Lille 3, 2017).

11 Vincent Milliot, "Histoire des polices. L'ouverture d'un moment historiographique," *Revue d'histoire moderne et contemporaine*, vol. 54, n°2, 2007.

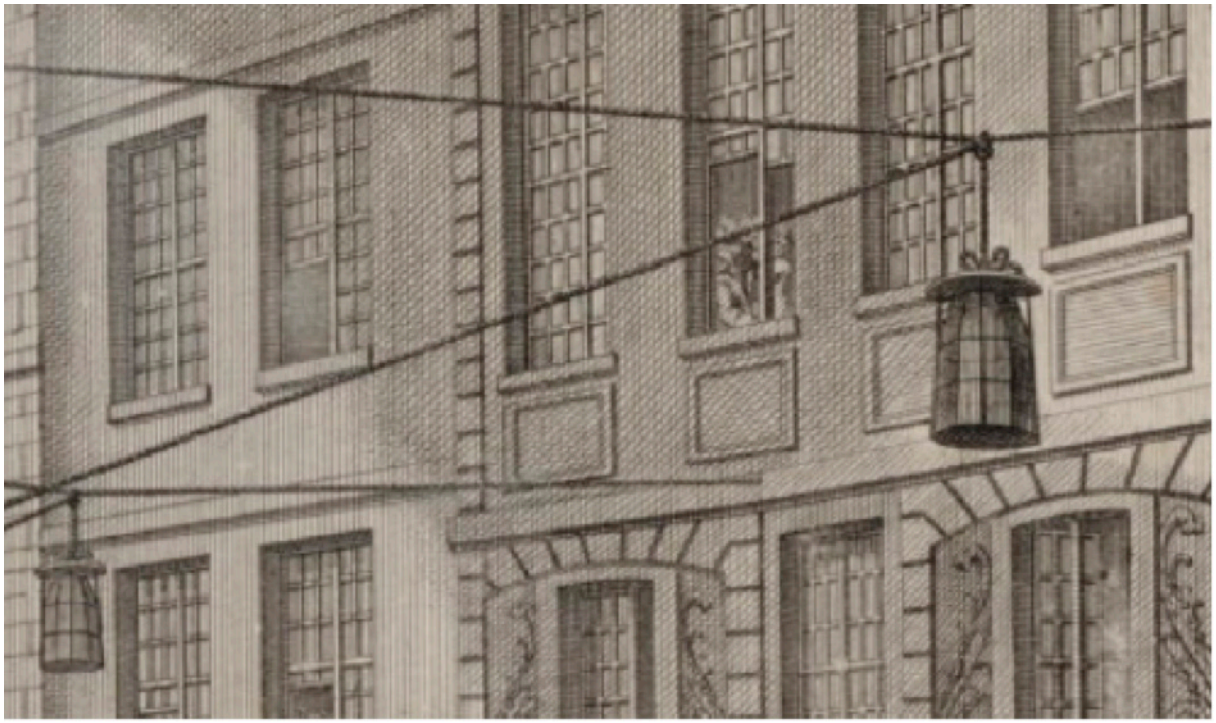

Figure 1: Bucket Lantern. Detail from an engraving by Antoine Humblot, Rue de Quincampoix, made at G. Duchange engraver to the King, rue Saint-Jacques, Paris, 1720. Source: Bibliothèque Nationale de France, Paris [RESERVE FOL-QB-201]).

Catherine Denys, who devoted a sub-chapter to public lighting in their respective theses on Toulouse and the cities along the French-Belgian border, have clearly demonstrated that illumination was a major instrument of police control.[12] We will compare Paris and Barcelona[13]–two cities that had a chronological gap (public lighting appeared in 1757 in Barcelona, nearly one century after Paris), but were connected due to French influence on the technical administration of Bourbon Spain–and identifying what was shared by as well as unique to each context. This comparison will especially include moments of disorder, with the major episode of the *avalot de las quintes* Catalan revolt in 1773, and the French Revolution in 1789. We will more specifically explain why and how hopes of uniformly lighting the territory failed, allowing for light and dark areas to exist side by side, despite the innovative development of the *réverbère* lantern.

FROM THE BUCKET LANTERN TO THE *RÉVERBÈRE* LANTERN: THE PROBLEM OF SHADOWS IS SHIFTED

The first two technical lantern models installed in the streets of Paris from the 1730s onward were the bucket lantern, which later came in a range of varieties, and the *cul-de-lampe* lantern.[14] 5

These lanterns are octagonal in shape, with eight panes of lead glass, totaling 24 pieces of glass. This increase in the glass interface and the 6

12 Catherine Denys, *Police et sécurité au 18e s. dans les villes de la frontière franco-belge* (Paris: L'Harmattan, 2002); Jean-Luc Laffont, "Policer la ville. Toulouse, capitale provinciale au siècle des Lumières" (Ph.D dissertation in history, université de Toulouse II Le Mirail, 1997).

13 For a connected history of public lighting between Paris, Barcelona, and Madrid, see Benjamin Bothereau, "À la lanterne ! Modes d'existence d'un objet banal, entre imaginaire technique et politique. Invention, économie urbaine, publics et circulations du 'réverbère', Paris, Barcelone, 18e s.," (Ph.D dissertation, EHESS Paris, 2018).

14 Reconstructions of these models based on technical descriptions and a few technical drawings were made by the Centre de recherches sur les monuments historiques de France: CRMH, *Lanternes d'éclairage public : 17e-18e s.. Potences d'enseignes et de lanternes du 15e au 19e s.* (Paris: Ministère de la Culture et de la Communication, Direction du Patrimoine, 1986).

thickness of the lead–"five lines wide including the center, which measures one line"[15]–obstruct the light emitted by the candle. Furthermore, a plate and two candle rings were attached to the bottom of the lantern to hold the two types of candles used, whose weight varied according to needs in lighting duration, which themselves varied depending on the season and moonlight. This "cluttering" of the lantern bottom was a second obstacle to light radiation. The combination of dark cones projected by the candle-holders, and the shadow cast by the thick lead of the many glass panes, generated a great deal of variation in light intensity on the street.

7 Descriptions of moving shadows can be found in both general and technical literature. For the former, Louis-Sébastien Mercier provides an invaluable account: "Formerly, 8 thousand lanterns, with poorly-placed candles that the wind blew out or made to gutter, offered dim and unsteady light, interspersed with shifting and dangerous shadows."[16] This description matches the more technical one from the treatise by the glazier Le Vieil: "The candles, which could not be snuffed out, maintained a shifty daylight, while the lead cast large shadows on the street, which increased with the number of lanterns."[17] Police chief Delamare explained the limits of ordinary lanterns to lieutenant de La Reynie, questioning their effectiveness on the street for the same reasons:

> Yet as all things have their perfections and flaws, regardless of the care and caution applied to them, one nevertheless does not find the full effect that was proposed, as experience has shown that the great number of lanterns installed at the outset, and subsequently increased, have not produced as good an effect as expected, with no great improvement in brightness or the advantage to be drawn therefrom; they amount to providing lights similar to those found in ports and along the coast, which are used to indicate but not to light paths.[18]

The lighthouse analogy proposed by the police chief is especially revealing: the lantern is visible because it is illuminated, although its local field of action–in terms of lighting capacity–is limited, for there is a shadowy cone beneath where it hangs. 8

The réverbère directs useful light, but does not eliminate shadows

The competition "for the best method for lighting the streets of a major city at night, by combining brightness, ease of service, and economy,"[19] jointly established by the police force and the Académie des Sciences in 1763, expressed the desire to centralize and improve technical knowledge related to lighting, in order to transition from the network of occasional light markers described by Delamare to a system offering more even and continuous light. 9

For Bourgeois de Chateaublanc, the inventor-mechanic who won the competition, resolving the problem involved a device, a concave metallic mirror (a *réverbère* or reflector) that would counteract natural propagation–the freedom of light rays "to escape based on their natural direction" and "become lost in the haze of air"–and to direct the rays, knowing that otherwise "a certain 10

15 BNF, Département des manuscrits, Français 21684 fol 334 335: Devis pour la fabrication et l'entretien des lanternes publiques des quartiers du Louvre, du Palais Royal, de Montmartre et de Saint Eustache du 6 avril 1730 (Estimate for the production and maintenance of public lanterns in the Louvre, Palais Royal, Montmartre, and Saint Eustache neighborhoods, 6 April 1730: "de cinq lignes de large, compris le cœur qui sera d'une ligne."

16 Louis-Sébastien Mercier, *Tableau de Paris*, chapter 54 (Paris, 1782-1788).

17 Pierre Le Vieil, *L'Art de la peinture sur verre et de la vitrerie* (Paris, 1774).

18 BNF Msfr 21684: "Mais comme toutes choses ont leurs perfections et leurs défauts, quelque soin et quelque précaution que l'on ait pu prendre en celles-ci, l'on n'y rencontre pas néanmoins tout l'effet que l'on s'en était proposé, car l'expérience fait voir que toute cette grande quantité de lanternes qu'on a mises d'abord et l'augmentation qu'on en a faite depuis ne produit pas un si bon effet que l'on en attendait, la clarté n'en étant pas de beaucoup augmentée et tout l'avantage qu'on en tire, c'est de faire voir des feux semblables à ceux qui sont sur les ports et les cotes de la mer pour marquer et non pas pour éclairer les chemins."

19 The Lighting prize of the Académie des Sciences (1763-1766), also called the "Sartine Prize" or "Sartine Competition."

quantity (...) travels into places where it is not useful."[20] The reflector increased light intensity. In the submission by Lavoisier, another winner of the competition, a metallic reflector directs the light flow toward the ground, or generally toward the object one wants to illuminate, such that "all of the rays emanating from the light source are directed toward this object, with none of them dissipating or moving toward another."[21] Lavoisier insisted on harnessing and rationalizing light. For the inventor, the "reflector" was the only way of maximizing the system's luminous potential: "the total light emitted by the reflector is equal to the sum of direct rays and reflected rays." While other innovations appeared during this competition, and were integrated starting in 1768 with the new models installed on public streets–oil lamps, hexagonal cages, chimneys, etc.–the reflector was the primary vector for eliminating shadows, by optimizing and guiding light rays toward the useful surface of the street, in other words the pavement.

11 In his first submission for the competition, Lavoisier worked on the reflector's shape by geometrically simulating its effects on light. He concluded his study on the elliptical reflector by noting that its interest varied according to the conditions of local use and urban topography: "The elliptical spheroid spreads light equally, forming a circle of light of considerable size on the ground. This arrangement is highly advantageous for intersections, wide streets, and other spacious locations, but not so much for narrow streets."[22] In this final configuration, the light rays that fall on either side of houses–"largely useless"– are lost for the public street. How to prevent this? In order to "carry in length what is lost in width," Lavoisier explains that one can modify the spheroid's parameters so that the circle of light cast on the ground is as close as possible to a (more or less stretched) ellipse. This lengthening of the range of light does not produce shadows, on the condition of course that the fields of two successive lanterns are superimposed on one another.

The problem is that the administration took advantage of the doubled light range offered by the new models with reflectors to space out lanterns in the streets as much as possible. As a result, the transition from the old to the new model did not eliminate shadowy areas, but instead shifted them, as parts of the street still remained outside the cones of light. A perfectly even and continuous lighting remained out of reach. 12

SHADOW AND LIGHT: DIVERSE METHODS FOR EVALUATING LIGHT PERFORMANCE

Visual sensibilities varied across time periods, in accordance with the hierarchy of the senses,[23] and as the gaze became accustomed to new generations of lanterns, especially with the integration of the reflector. This makes the retrospective evaluation of the light performance of lanterns in street situations difficult. However, it is both possible and useful to explore the evaluation methods for this performance used by contemporaries themselves, in order to understand how they distinguished between shadow and light. 13

The hanging of new technical models in streets provided contemporaries with an opportunity to compare–whether quantified or not–between these new devices and the lanterns used formerly: "brighter," "x times superior," "equivalent to x ordinary lanterns," etc. But what is being measured and/or evaluated? And on what basis? 14

20 Archives de l'Académie des Sciences (Paris), *Mémoire de Chateaublanc* (Submission by Chateaublanc), 1765: "de s'échapper selon leur direction naturelle" et "de se perdre dans le vague de l'air," "une certaine quantité (...) se porte dans des endroits où ils sont inutiles."

21 Archives de l'Académie des Sciences, *Mémoire de Lavoisier* (Submission by Lavoisier), 31 December 1765: "tous les rayons qui partent du point lumineux tournent au profit de cet objet, qu'il n'y en ait aucun qui se dissipe ou qui se porte vers un autre."

22 *Id.*: "Le sphéroïde elliptique répand également la lumière et forme sur le plan un cercle lumineux d'une étendue très considérable. Cette disposition si avantageuse pour les carrefours, les rues larges et tous les endroits spacieux, ne l'est pas tant pour les rues étroites."

23 Robert Mandrou, *Introduction à la France moderne. Essai de psychologie historique. 1500-1640* (Paris: Albin Michel, 1961).

15 First, some submissions use the terms "brightness," "brilliance," "lighting," "luminosity," and "lighting power" without distinguishing between them. These notions are quite vague. The terminology is important, because it partially conveys the evaluation method used for this light. Luminosity applies to primary light sources (the light produced by the lantern), while the term brightness applies to secondary sources of light (reflected light). As a result, the central question is to identify where the person conducting the experiment is focusing their eye: on the technical object or the street? The direct emission of light by the lantern (luminosity), or the actual light reflected by the street (lighting)? In his entry for the competition, Chateaublanc dismissed criticism of the glare created by these reflectors, indicating that the public's gaze must be educated, so that it knows where to direct its gaze.[24] The same argument was used by the commissioners from the Académie in their *Avis* (Notice), when they clarified evaluation methods for two distinct systems (two lamps in a single lantern, or two lanterns with a single lamp each):

> In order to judge the actual illumination effect, one must look not at the lantern but at the street, which is where it is important to see clearly. This remark results from what was said in the submission, although the public is flattered to see powerful light coming from lanterns.[25]

16 It is therefore important to distinguish between the gaze of a curious person, who stares at the primary source, and evaluation of the object, which also assumes a street-level observer, someone who is not interested in novelty (the reflector lantern), but is instead considered as a pedestrian walking, in other words someone concentrated solely on utility, the light reflected on the street.

17 In their respective essays, both Lavoisier and Le Roy–another inventor who won the competition–used the ability to read characters as a criterion for evaluating light. The eye is drawn to the printed paper, and it is therefore the light reflected by this sheet that is being evaluated, in other words its brightness. Nevertheless, there is no normalization for the type character or the font–"small" for Le Roy,[26] no precise details for Lavoisier–in addition to the sheet's distance from the reader, the color of the sheet, etc. The visual sensation of whether a surface seems to emit more or less light, which itself already depends on the observer's eye, makes it difficult to compare the "real value" of light. Chateaublanc chose as a criteria of evaluation the distance (in steps) at which a person is recognizable. This is once again a matter of measuring brightness, which is to say light as it is reflected by a surface, in this case the face. This attempt at quantification is based on a fairly subjective criterion, one that is ultimately surprising given that Bourgeois de Chateaublanc wrote a *Traité d'Optique* in 1760 in which he used a device, the lucimeter, which tries to objectify the measurement, with Lavoisier mentioning in his submission that he drew inspiration from it.

18 The commissioners also discussed the best method for evaluating the luminous performance of lanterns. While one member of the Academy proposed the ability to see a coin as a criterion, another colleague rectified this by replacing the *sou* with a small silver coin (a metal that is shinier and therefore more reflective). In any event, the eye is drawn to the street, once again an evaluation of brightness. However, in the same *Avis des commissaires*, the chapter on bridge lighting suggests comparing the light of the old and

24 Archives de l'Académie des Sciences, *deuxième Mémoire de Chateaublanc,* Mémoire sur les matières combustibles qui peuvent servir à éclairer les rues d'une ville (second Submission by Chateaublanc, Submission regarding the fuels that can be used to light a city's streets), 13 March 1766.

25 Archives du Musée des Arts et Métiers, *Réserves de Saint-Denis*, N89, Avis des Commissaires: "Pour juger du bon effet d'une illumination il ne faut pas comme on fait communément regarder la lanterne mais le pavé qui est l'endroit où il est important de voir clair. Il est vrai que cette remarque est une conséquence de ce qui est dit dans le mémoire mais le public est flatté de voir sortir des lanternes une grande lumière."

26 Archives de l'Académie des Sciences, *Supplément au Mémoire Le Roy* (mémoire original 25 décembre 1765 présenté à de Sartine) (Supplement to Le Roy's submission, original submission presented to de Sartine on December 25, 1765).

new lanterns in the following manner: "the lanterns would have five panes in order to illuminate all sides, and to have the same effect at a distance as ordinary lanterns." Here the eye is drawn directly to the lantern, or the primary source of light, with the "effect" evaluated by the commissioners being luminosity rather than brightness. Yet here once again, as shown by the comparison of "brilliance" (direct luminosity of the source) between the devices proposed by Bailly, the placement of the eye is not normalized. The measurement methods and results vary accordingly. The different evaluation criteria used by competitors, which is expected, was also present within the commissioners' institution. The measurement of lantern "light" was not settled. In fact, this instability was not shocking, as long as it wasn't questioned. As shown by Shapin and Schaffer, the development and evaluation of experimental knowledge–the terms "exactitude" and "objectivity"–are the result of conventions and agreements, in other words they are productions and judgments specific to historic actors.[27]

EXPANDED LIGHTING IN PARIS AND BARCELONA DURING REVOLUTIONARY PERIODS: EXTENDED ILLUMINATION AND PRIORITY LIGHTING ZONES

19 In both Barcelona and Paris, the revolutionary unrest of the late eighteenth century translated into extended lighting hours and schedule, as well as the installation of new lanterns in areas deemed to be sensitive. More light for more order, such was the principle that seemed to guide authorities.

Extended lighting schedule: extension of lights

20 In 1773, the revolt known as the "*avalot de las Quintes*" took place in Barcelona. The protests were chiefly driven by the obligatory random selection of young men for enlistment in the royal army.[28] A list of the lighting measures taken on a day-to-day basis can be established using the "Acuerdos" series in the archives of Barcelona, and the *Ephemérides comentáreas de la Quinta del Principado de Cataluña* manuscript from 1773.

While tensions began on April 18, the massive revolt did not begin until May 4. On that date Captain General O'Connor O'Phaly gave the order to keep lanterns lit all night until June 10. There was thus a dual expansion–in terms of both hours and the schedule–as normal service stopped at 10:00 p.m., and in mid-April. In his *État des dépenses pour le service spécial du 4 mai au 11 juin*[29] (State of expenses for the special service from May 4 to June 11), the quartermaster for lighting oil, Pablo Fochs, shows the material impact of this measure: 1,569 pounds of oil were needed, double the normal average monthly consumption compared, for instance, to the previous season–6,177 pounds from October 1, 1771 to late-April 1772,[30] or 882 pounds per month. Similarly, a presentation of accounts from June 26–which was released publicly–made this official, and provided visibility to this expanded lighting by calculating its cost at 17,000 Catalan *libras*, an amount that included supplemental lighting costs (back-up torches and mobile lanterns for patrols) and "other things for maintaining order in the city."[31] 21

In Paris, an "extraordinary service" for lighting was established following riots, in the immediate aftermath of the days of July 1789. An assessment by the Comité de Police from September 23, 1789 confirmed that the contractor Tourtille Sangrain had been performing an "extraordinary service since July 14." In the summary tables for lighting expenses submitted by the contractor to the municipality for payment, an entry clearly mentions "special service during the riots."[32] 22

27 Simon Schaffer, Steven Shapin, *Léviathan et la pompe à air. Hobbes et Boyle entre science et politique* (Paris: La Découverte, 1993).

28 Santalo i Peix Jaume, "L'Avalot de les quintes de 1773...," *in* Ramon Arnabat (ed.), *Moviments de protesta i resistencia a la fi de l'Antic Régim* (Barcelona: Publicacions de l'Abadia de Montserrat, 1997).

29 Arxiu Historic de la Ciutat de Barcelona AHCB, series Accords 1D.I-56 fol 376.

30 AHCB, series Accords 1D.I-55 fol 580.

31 *Id.*: "autres choses pour maintenir le calme de la ville."

32 Archives Nationales (AN) F 13 351 "Récapitulation des dépenses annuelles" (Summary of annual expenses), December 1789 and December 1790.

23 The method for inscribing this excess is particularly interesting. Instead of traditionally presenting and dividing the expenses for each lease year between ordinary and extraordinary forms of lighting, Sangrain produced a special document in late 1790 entitled "Récapitulation des dépenses annuelles[33]" (Summary of annual expenses), in which expenses are organized based on the event: "before the revolution" and "after the revolution." Lighting methods (ordinary or extraordinary) are combined:

> Before the Revolution, the illumination of Paris cost, accessories included, the sum of 389,537 pounds per year. Ordinary lighting, along with extraordinary lighting due to the Revolution from July 1789 to July 1790, cost 606,622 pounds.[34]

24 The causal relation between the excess lighting (+55.7%) and the political event is clearly marked by the phrase "due to."

25 The consideration of natural phenomena was eliminated when the new schedule was established. While maintaining extended lighting "from daylight to daylight," the city of Paris also sought to take advantage of the savings provided by moonlight: "authorizing them to continue this lighting in the same manner as they have since July 14, although during periods of strong moonlight, lighting will be halved to two *réverbères* each."[35] City authorities requested that alternate lighting be applied on naturally lit evenings, without taking the street's topography into consideration, which is to say without considering
29 whether the moonlight penetrates within narrow streets. This measure was deemed insufficient two months later. In a letter dated November 20, 1789, lighting master Damour mentioned police instructions, which contradicted the usual lighting schedule based on the lunar month:

> We will cease on Wednesday the 26th of the present month given the moon's power, during which time we will light only one lantern out of two, and by specific order. However, given present circumstances, you have deemed it appropriate to light everything from daylight to daylight.[36]

26 The evaluation of natural lighting, which considered the utility of moonlight, was the result of negotiations and conventions between attempts to save on the part of the city, and security priorities on the part of police authorities, which were based on the course of the sun rather than the moon.

Prioritization of lighting sites

27 The expanded lighting in response to social and political unrest also had an effect on lighting equipment.

28 While license requests in Barcelona for the installation of new lanterns in June 1772 "along the wall from La Puerta del Mar to the Convent of St Francisco" set a goal of "maintaining public entertainment and convenience, with the wall promenade remaining open until 11:00 p.m. in warm weather,"[37] the installation orders from military authorities for the year 1773 were purely based on security. For example, an order to install four additional lanterns in front of the military quarters and buildings of Barceloneta (la Ciutadella) were given by Captain General O'Connor O'Phaly on May 4, the very day of the massive revolt, in addition to the extension of lighting hours.

In Paris, lighting prioritization appeared from the beginnings of the Revolution, independent of any extension of the urban fabric. On October 14, 1789, the Capucins Saint-Honoré district sent a letter to the Comité de Police requesting the installation of lanterns to compensate for the

33 AN F 13 351 "Récapitulation des dépenses annuelles," Decmeber 1790.

34 *Id.*

35 AN F 13 351, Rapport du Comité de Police (Police committee report), September 23, 1789: "les autorise à continuer cette illumination à la manière faite depuis le 14 juillet, cependant que dans le fort de la lune, la dite illumination ne se fera qu'à moitié de deux réverbères un."

36 AN F 13 351, lettre de l'inspecteur de l'illumination Damour (Letter from lighting inspector Damour) dated November 20, 1789.

37 AHCB, series Accords 1D.I-55 fol 288, request for installation license, June 22, 1772: "le long de la muraille depuis La Puerta del Mar jusqu'au Couvent de St Francisco"; "maintien, la diversion et la commodité du public, la liberté de la promenade de la muraille jusqu'à 23h les temps chauds."

lack of patrols on the Champs-Elysées: "The king's stay at the Tuileries requires particular surveillance on the Champs Elysées, where ill-intentioned people can meet thanks to the darkness, and also calls for these streetlamps to be installed as quickly as possible."[38]

30 The royal presence was one reason used to request additional lighting, in order to secure the area. In the middle of the Revolution, in May 1792, the Comité de Salut Public requested lighting for the most sensitive and vulnerable areas: chiefly warehouses for storing flour and arsenals, along with the homes of precinct captains. Four years later, the *Mémoire des sommes réclamées par Fricault pour l'éclairage de divers ateliers* (Entry for the sums requested by Fricault for the lighting of various workshops)[39] from July 18, 1796, mentions the cost of lighting provided for various manufacturing sites: the small coins office in the rue de Tournon, the saltpeter transformation plant in Saint-Germain des Prés Abbey (21 burners), the weapons workshop in rue Feydeau, and finally the bayonet factory on the "*Le Républicain*" boat, docked beneath the Pont-au-Change (10 burners). Lighting was always a part of the security measures used to protect production sites, military ones in particular. As a result, lighting measures can provide a map of sensitive sites, which were either locations linked to the authorities, or areas marked by tension.

31 This expansion of urban lighting–via the lighting schedule or equipment–is a reminder of the major security concern of eighteenth century police, the legibility of space and individuals.[40] In this sense, the technical goal was part of the broader instrument of identification (identifying mobility, the circulation of individuals, etc.).

SCHEDULED EXTINGUISHINGS: WHEN DARKNESS WON OUT DUE TO SAVINGS

32 There was a tension between the desire to systematically and evenly light the entire urban territory, and the need to save, given the extraordinarily high price of fuel (plant and animal oils), notably during periods of unrest. The "*réverbère* revolution," which provided better lighting for an equal or lesser amount of fuel, was not enough to offset increased lighting needs due to the development of the urban fabric and the security emergencies of revolutionary episodes. Authorities therefore had to program a schedule and geography for extinguishings. The *État du nombre de lanternes et de becs qui n'ont pas été éclairés pendant la cessation du 24 au 30 mars 1790, conformément aux ordres de M. Cellerier, lieutenant de maire* (The State of the number of lanterns and burners that were not illuminated during the suspension between March 24-30, 1790, pursuant to the order of M. Cellerier, lieutenant mayor),[41] lists the first scheduled extinguishings in March 1790.

33 While quays, plazas, and bridges were foreseeably given priority for these extinguishings, the decision to plunge the thoroughfare between the gates Saint-Antoine and Saint-Honoré into total darkness is more surprising, as is that of the sensitive sites that were the city's gates. It is also striking that an alternating system was not proposed for the locations that were extinguished, which would have limited the impact on each one. For each of the seven nights in March 1790, 395 lanterns were voluntarily extinguished, or 11% of total lighting units (3,554 lanterns). However, the urban sections concerned (paths, quays, plazas, courtyards, and bridges) were plunged into total darkness, as this was not an alternating extinguishment–one lantern out of two–but an overall suspension of all installed lanterns. Conversely, this list informs us of the locations where lighting

38 AN F13 351, Lettre du district des Capucins St Honoré au Comité de Police (Letter from the Capucins St Honoré district to the Comité de Police), October 14, 1789: "Le séjour du roi aux Tuileries exige une surveillance particulière dans les Champs Elysées, où les gens mal intentionnés peuvent se réunir à la faveur de l'obscurité, demande que l'on fasse placer le plus promptement possible des réverbères."

39 AN F 13 1032, Mémoire des sommes réclamées par Fricault pour l'éclairage de divers ateliers, 30 messidor year IV.

40 See the research conducted in the history of the police by Vincent Milliot (dir.), *Les Mémoires policiers, 1750-1850. Écritures et pratiques policières du Siècle des Lumières au Second Empire* (Rennes: Presses universitaires de Rennes, 2006); and Paolo Napoli, *Naissance de la police moderne*, (cf. note.2).

41 AN F13351, Mémoire "État du nombre de lanternes," April 1790.

Figure 2: Map of scheduled extinguishings of public lanterns in Paris for March 1790. © B. Bothéreau (QGIS).

was expanded, such as the place Louis XV, where all of the lanterns had four wicks. Unlike the lanterns for the new posts planned during those same years, which systematically had two burners, here we see multi-wick lanterns, which provided more light but also consumed more oil, and were associated with sites of power, and therefore had a highly symbolic dimension.

NON-SCHEDULED EXTINGUISHINGS

34 The first reports regarding unscheduled or early extinguishings of lanterns date from the implementation of the expanded lighting schedule immediately after July 14, 1789. While there were many of them,[42] and they were centralized by district assemblies in order to be sent to Bailly's city hall, they nevertheless include little numerical data. For all that, the quantity of the reports bears witness to the powerful connection for contemporaries between artificial illumination and the security of an area. For instance La Fayette, commander of the garde nationale, collected the complaints and reports of his subordinates, and wrote to Bailly early during the winter of 1789 to criticize his "negligence with respect to *réverbères*," which he associated with a threat to the city's security: "It is impossible to ensure the security of Paris if we add the extinction of streetlamps on top of all the differences that exist between this winter and the last."[43] Cellerier then wrote to Minister of the Interior de Gouvion, a genuine architect of expanded illumination, to announce the measures taken to address the criticism that "*réverbères* remain lit only until one in the morning." The corrections made included increasing the number of employees in the lighting office: "I required the contractor to dispatch fifty lamp-lighters each night, in order to repair premature extinguishings." Yet according to city hall, what was most important was to obtain perfect knowledge of the problem, notably topography: "It is important to have daily reports on the state of illumination

42 The series AN F13 351 includes numerous district reports.

43 AN F13 351, Lettre du commandant La Fayette au maire Bailly (Letter from Commander La Fayette to Mayor Bailly), December 1789: "Il est impossible de répondre de la sûreté de Paris si, à toutes les différences qui existent entre cet hiver et l'hiver dernier, on joint l'extinction des réverbères."

in all streets, in order to determine, based on the number of extinguished *réverbères,* whether the contractor is truly reprehensible."[44]

35 According to the City, there was a need to quantify the problem, in order to gain leverage over the street-lighting company. The question arose regarding which agents would be the most appropriate for performing this control, it being undesirable of course to have the lighting company provide them. The City asked de Gouvion to require the Commander General and patrol captains to "carry out this surveillance objective" and "provide daily reports indicating the number of extinguished *réverbères*, as well as the streets and times at which they observed it." The City thus wanted to establish an actual map and chronology for extinguishings, in other words a quantification that could serve as a valuable tool for the company in alleviating the faults it dared not admit.

36 The *Rapport de l'illumination pour la nuit du 4 au 5 mai 1790* (Lighting report for the night of May 4-5, 1790) for the four neighborhoods of Saint-André-des-Arts, Place Maubert, la Cité and Saint-Benoît[45] was prepared by detective Le Roux, and certified by mounted detective Bruneseau. It quantified the lanterns that were totally or partially extinguished–with a precision down to each extinguished burner–by specifying the location and time of the extinguishment observed, with a precision down to every fifteen minutes.

37 On that night in that area, 29 total extinguished streetlamps were observed, distributed across 35 streets. It is difficult to compare this with other reports, as the counting methods (listing by street or neighborhood, patrol during one or more nights) were not normalized. This data nevertheless provides use with a representation–on the scale of the neighborhood and the duration of one night–of the distribution of shadowy areas, which challenged the police's desire to treat the territory in a neutral and even manner. The change in the number of extinguished burners according to the time of night shows that the share of shadowy areas increased over time.[46]

localisation de l'extinction (rue concernée)	lanternes totalement éteintes	lanternes partiellement éteintes (nombre de becs)	Heure d'extinction
Rue Judas		1	12H30
Fbg St Jacques		5	12H45
des Sansonnets	1		1H
des Bourguignons	1		1H
de l'Oursine		1	1H
des Anglaises	1		1H30
Mouffetard	1		1H30
neuve d'Orléans		1	1H30
en gris	1		1H30
jardin du roi	1		1H30
faubourg st Victor	2		1H45
en face st Victor	1		1H45
rue st victor	2		1H45
place Maubert		1	1H45
Galande	1		1H45
de la juiverie	1		2H
du haut moulin	1		2H
vieille draperie		3	2H
st Eloy	1		2H
de la calandre	1		2H
Barillerie		1	2H
Marché neuf	1		2H15
St Louis		1	2H15
en face st André des Arts	1		2H45
Jardinet	1		2H45
de l'epron	1		2H45
du cimetière St André des Arts	2		2H45
St André des Arts	2		2H45
contrescarpe	1		2H45
Christine	1		3H
St Avoye		2	3H
quai des Augustsins		3	3H15
Gilles Cœur	1		3H30
Haute Feuille	1		3H30
des cordeliers	1	4	3H45
TOTAL	**29**	**23**	

Figure 3: Early extinguishings for the night of May 4-5, 1790 for the four neighborhoods of Saint-André-des-Arts, Place Maubert, la Cité, and Saint-Benoît (Paris). Source: AN F13 351.

44 AN F13 351, Lettre du maire Bailly (Letter from Mayor Bailly), January 1790: "Il serait important d'avoir chaque jour des rapports sur l'état d'illumination dans toutes les rues afin de pouvoir juger si d'après le nombre de réverbères éteints l'entrepreneur est vraiment répréhensible."

45 AN F13 351, Rapport de l'illumination pour la nuit du 4 au 5 mai 1790 sur quatre quartiers, May 5, 1790.

46 In order to quantitatively process this data, we weighted the extinguishings, considering that a total extinguishing corresponded to two burners, as the vast majority of lanterns installed in the streets of Paris consisted of two lights.

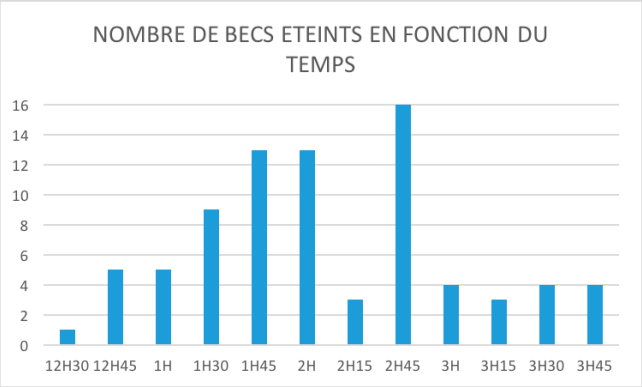

Figure 4: Number of burners extinguished in Paris during the night (4-5 May 1790) according to time, for the neighborhoods Saint-André-des-Arts, Place Maubert, la Cité and Saint-Benoît. Source: AN F13 351.

38 There were three peaks at 1:45 a.m., 2:00 a.m., and 2:45 a.m., when practically all of the extinguishings involved lanterns that were totally extinguished, with these times resulting in the creation of genuine black areas. The different extinguishing times can be explained by different parameters, including the quality of the oils used, the positioning of the wicks, the care taken by the different lantern keepers, the punctuality of lighting times, etc.

39 We doubly change scale with the list of extinguishings in the *Rapport de l'illumination du mois de vendémiaire de l'an IV* (Lighting report for month *vendémiaire*, year IV):[47] this time the report lists the production of all 20 detectives who made their rounds, and reported the number of extinguishings during an entire month (*vendémiaire*) rather than a night. This year was chosen as a case study because we have a coherent series of reports that can be used to reconstruct a count of extinguishings, which are of course less accurate with regard to location (streets do not appear), but are on the scale of the entire city. The spatial distribution of extinguishings during the month was carried out by neighborhood.

40 The most extinguishings for the month studied were in the second lighting arrondissement.[48] Once again there was no homogeneity, as there were four times more extinguishings in the second arrondissement as in the one consisting of the Luxembourg, Germain-des-Prés, and gros Caillou neighborhoods.

41 The second interesting aspect of this report is to compare the number of extinguishings between 1790 and 1795-1796 (year IV). We observed the transition from an average of three totally extinguished lanterns to one extinguishing per night. The consistency between the established lighting schedule and the reality in the field was thus reinforced between 1790 and 1796. This shows the results of the campaign to identify the system's shortcomings–jointly conducted by the City and the Ministry of the Interior (Cellerier and de Gouvion)–which mobilized the forces of the Commander General and patrol captains. However, improvements in burning time for lamps should also include other parameters, such as oil quality, the awareness and training of lamp-lighters, and weather conditions.

42 Reports on the lighting service at any rate show a gradual improvement over the long term. The first report was created on September 18, 1790 by the Petits Pères Place Victoire police precinct. It mentions a number of volunteer citizen national guards, sergeants, and corporals who complained to the comité de graves dysfonctionnements (committee for major dysfunctions):

> For over eight days now, and once again tonight, all of the patrols they respectively command were required to make their rounds in the shadows, as three-quarters of the *réverbères* were extinguished at 2:00 a.m., and those that were lit cast such dim light that the patrols could not make out anyone during their rounds.[49]

47 AN F13 351, Rapport de l'illumination du mois de vendémiaire de l'an IV.

48 The neighborhoods of l'Égalité (formerly Saint-Honoré), Eustache, the Louvre, Faubourg Honoré, and Chaillot.

49 AN F13 351, Rapport du département de police de la section des Petits Pères (Report by the Petits Pères police precinct), September 18, 1790: "Depuis huit jours et plus, nouvellement cette nuit, toutes les patrouilles qu'ils ont respectivement commandées ont été obligées de marcher dans les ténèbres, les réverbères se trouvant aux trois quarts éteints à deux heures et ceux qui ont été trouvés allumés, rendaient une lumière si sombre que les patrouilles ne pouvaient apercevoir qui que ce fut dans leurs marches."

Quartiers	Nombre LANTERNES	Nombre BECS	LANTERNES en %	BECS en%
1er arrondissement d'éclairage : Denis / Martin/Montmartre/Jacques la Boucherie/les Halles/opportune	18	61	14%	12%
2eme arrondissement d'éclairage : Egalité (Honoré)/Eustache/Louvre/Fbg Honoré/Chaillot	52	159	41%	32%
3eme arrondissement d'éclairage : Luxembourg/Germain des Prés/gros Caillou	12	46	10%	9%
4ème arrondissement d'éclairage : Cité/andré des arcs/place Maubert/Benoit/l'isle de la Fraternité	18	129	14%	26%
5ème arrondissement d'éclairage : Marais/Paul/antoine/Fbg Antoine/la Grève/avoye	26	102	21%	21%

Figure 5: Spatial distribution, by neighborhood, of extinguishings during one month (october 1795). Source: AN F13 351.

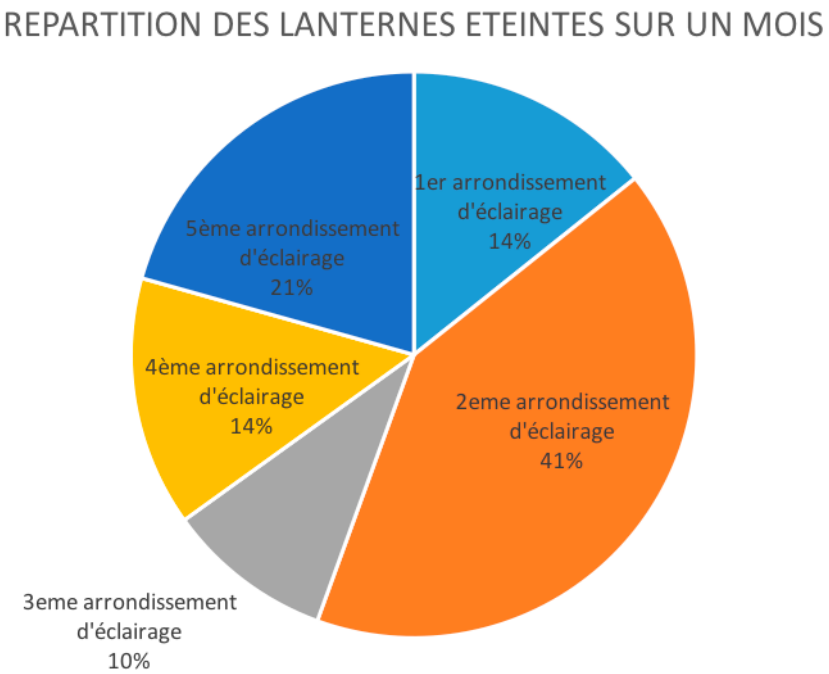

Figure 6: Distribution of extinguishings in Paris during one month (october 1795). Source: AN F13 351.

43 In the later reports examined above, extinguishings were occasional, not consecutive in time, and less than eight days in duration. The repetition of the event, and the high percentage of the units involved, were not favorable statistics for the service, as the phenomenon could no longer be ascribed to weather-related or external events. Police authorities subsequently requested penalties against the contractor, with the revolutionary situation calling for greater reliability:

> The lighting contractor should provide for such malfunctions, from which an infinite number of unfortunate events can result for the national guard while on patrol, as well as for public order and security; in a moment of ferment, with streetlamps unlit, the enemies of public peace and the revolution may subsequently take advantage to attack peaceful citizens with impunity, as well as patrols that are exposed to attack at intersections, who due to their care and zeal for the Republic, end up becoming the first victims.[50]

44 Another report from the Bureau du Comité in 1790 bears witness to the extent of the problem: "The patrol captains that I sent out last night reported that all of the *réverbères* within the precinct were extinguished before 1:00 a.m., contrary to all regulations."[51] This was therefore a global extinguishing, which plunged an entire area–in this case one precinct–into total darkness. Unlike the previous case, whose causes could depend on various parameters both technical and human, an overall extinguishing of so many units could only have been caused by oil of poor quality, or by a mixing error in the depot that prepared lighting oil for this geographic sector. The lighting company was in the hot seat:

> This mistake on the part of the lighting contractor can have the gravest consequences under the current circumstances, which is why I call for informing both the police tribunal and the administrators of public works.[52]

45 In view of this body of reports on lighting, what distinguished acceptable from insufficient lighting? Acceptability, or the tolerated number of extinguished lanterns, was the product of conventions–negotiated agreements between the different parts of the lighting administration–and was a function of sociopolitical events. Lighting inspectors transmitted a report to the national agent in order to assess a penalty against the contractor Fricault, observing that "a large number of streetlamps were extinguished in the night of messidor 11-12 of the year II (June 29-30, 1794) between 1:30 and 2:00 a.m.."[53] However, the administration and its control auxiliaries did not produce a quantification of extinguishings. Fricault used this as leverage to prove that his service was not perfect but tolerable, by conducting an investigation the following night, accompanied by a lighting inspector: at 2:00 a.m. they counted "a maximum of twenty-four or thirty extinguished lanterns." The number of defective lanterns is of course acceptable compared to the *Rapport de l'illumination pour la nuit du 4 au 5 mai 1790*, which mentions 29 extinguishings for one night

50 *Id.*: "L'entrepreneur d'éclairage doit pourvoir à pareil inconvénient d'où il peut résulter une infinité d'événements très fâcheux, soit pour la garde nationale en patrouille, soit pour l'ordre et la sûreté publique ; que dans un moment de fermentation, les réverbères n'étant pas allumés, il peut s'en suivre que les ennemis du repos public et de la révolution, en profiteraient pour attaquer impunément les citoyens paisibles, et les patrouilles exposées à être assaillies dans un carrefour, et devenir les premières victimes de leur soin et de leur zèle pour la chose publique."

51 AN F13 351, Rapport du Bureau du Comité du 10 septembre 1790, émis par le Bureau du Comité à la Caserne de la section de la rue Beaubourg (Report by the Bureau du Comité from September 10, 1790, issued by the Bureau du Comité at the rue Beaubourg station): "Les commandants des différentes patrouilles que j'ai fait sortir la nuit dernière m'ont rapporté que tous les réverbères qui sont dans l'étendue de la section étaient éteintes avant une heure du matin, ce qui est contraire à tous les règlements."

52 *Id.*: "Ce défaut de la part de l'entrepreneur de l'illumination peut devenir de la plus grande conséquence dans les circonstances actuelles, ce pourquoi je requiers d'en informer tant le tribunal de police que les administrateurs des travaux publics."

53 AN F13 352, Rapport des inspecteurs de l'illumination (Lighting inspectors' report), August 1, 1794.

and for just four neighborhoods:[54] by conducting a quick estimate to make the data comparable, this would mean that for the entire territory–all twenty neighborhoods–there were five times fewer lanterns extinguished in 1794 than in 1790. This comparison, which was not established by the contractor, would indeed make the extinguished rate "acceptable." Armed with this quantification, Fricault wrote to the administrator of public works Avril on 17 messidor (July 5, 1794): "I therefore assure you, Citizen, that aside from being the Supreme Being, we cannot defend against such minor faults."[55]

46 "Minor faults" or "unacceptable" dysfunction, the subjectivity of how extinguishings were described could only lead to rhetorical jousting and a succession of contradictory discourses, as long as the administration did not generate a threshold of acceptability for the number of prematurely extinguished lanterns.

CONCLUSION

47 During the Enlightenment, lighting was one of the favored instruments within the policing ideal of an even perception of urban space. This ideal of lighting nevertheless had to contend with its limits.

48 The causes of lighting asymmetries were primarily technical, connected to the very structures of the first lantern models.[56] While other innovations[57] were integrated within the new model that grew out of the Academy prize for lighting (1763-1766), it was truly the *réverbère* reflector device–by rationalizing the optical path and guiding rays toward the useful surface of the street (the pavement)–that would become the driver for both the increase of lighting intensity, and the decrease of shadowy areas. However, what was gained on the surface of luminous action was lost through unit density, this time driven by attempts to balance between performance and economy. As the establishment of the *réverbère* lantern took hold only in proportion to its dissemination, new shadowy spots were created at the edges of the luminous cones. In the end, luminous asymmetry simply underwent a change of scale.

Furthermore, as we have shown, this interplay 49
of shadow(s) and light(s) was accentuated by the diverse methods for evaluating light performance.

Finally, lighting asymmetries appeared throughout the urban fabric, amid both expanded lighting–through a special schedule or a hierarchization of sites to be lit during periods of revolutionary unrest in Paris and Barcelona–and the darkness generated by extinguishings, which were scheduled to generate savings or due to technical shortcomings. 50

It would now be worthwhile to compare the 51
lighting asymmetries produced by the subject of our study, the autonomous and self-sufficient unit of the lantern, with that of gas lighting, in other words a "system" or a "networked"[58] infrastructure, in order to reveal new interactions and scales between shadow and light.

54 St-André-des-Arts, Place Maubert, la Cité and St-Benoît.

55 AN F13 352, Lettre de Fricault à l'administrateur des travaux publics Avril le 17 messidor an II (Letter from Fricault to the administrator of public works Avril on 17 messidor year II): "Je vous assure donc Citoyen, à moins d'être l'Etre Suprême, qu'on ne peut parer à des défauts aussi légers."

56 The models known as "bucket" and "cul-de-lampe."

57 Oil lamps, hexagonal shape of cages, chimney, etc.

58 Thomas P. Hughes, *Networks of Power: Electrification in Western Society, 1880-1930* (Baltimore: Johns Hopkins University Press, 1983); Pierre Musso, (dir.), *Réseaux et société* (Paris: Presses universitaires de France, coll. La politique éclatée, 2003); Antoine Picon, *La Ville des réseaux : Un imaginaire politique* (Paris: Editions Manucius, 2014).

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