Ravel's *Boléro* Factory: The Orchestration of the Machine Age

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In an interview less than three years after the première of his famous *Boléro*, Maurice Ravel described it as an 'orchestral tissue without music.'[1] This description, although uttered somewhat facetiously and in an effort to stress the work's uniqueness, draws attention to the hallmark of Ravel's musical language and style and his most significant contribution to modern music: the elevation of orchestration to a position of central importance to a musical composition. *Boléro* might be more accurately described not as 'orchestral tissue without music' but as one of the first compositions where orchestral tissue *is* music; Ravel himself claimed that the orchestration is the 'only element of variety' in the 'absolutely uniform' melody, harmony and rhythm,[2] and thus constitutes the essence of the musical fabric. Ravel also went to some effort to convey to the public the fact that, despite the work's original use as the basis for an erotic Hispanicist ballet, the composer himself thought of it as a musical reflection of the modern age, the age of machines. He was even inspired by a particular factory, which he referred to as the '*Boléro* factory.'[3]

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[1] Quoted in M.-D. Calvocoressi, 'M. Ravel Discusses His Own Work: The *Boléro* Explained,' *A Ravel Reader: Correspondence, Articles, Interviews*, comp., transl. & ed. Arbie Orenstein (New York: Columbia UP, 1990) 477, original publ. *Daily Telegraph* [UK] 11 July 1931.

[2] Maurice Ravel, 'Autobiographical Sketch,' *Ravel Reader* 33, original publ. 'Une Esquisse auto-biographique de Maurice Ravel' [based on an interview with Roland-Manuel in 1928], *La Revue musicale* numéro spécial (Dec. 1938): 17–23.

[3] Edouard Ravel, letter to Jacques Rouché [Director of the Opéra de Paris], 19 Feb. 1940, *Ravel Reader* 328.

The mechanical nature of *Boléro* has long been acknowledged by musicologists, if not always by the general public. However, detailed studies of the music, such as Deborah Mawer's recent work on what she calls Ravel's 'most rigorously constructed object,'[4] have focused on the elements traditionally privileged in analysis: form, modal and tonal structure and implications, and melodic, harmonic and rhythmic content.[5] This article takes a new approach, one that is informed by the arguments of Dahlhaus and others for the historically contextualised analysis of orchestration.[6] I take as my starting point the composer's own comments on *Boléro* to demonstrate how the work, the musical fabric of which is simultaneously thoroughly mechanical and thoroughly orchestral, is a quintessential expression of the machine age in which Ravel lived and which he embraced with enthusiasm.

Ravel's era was one of unprecedented and rapid infiltration of machines into everyday life, from the factories, steam trains and automobiles of the late nineteenth century to the terrifying destructive forces unleashed in the Great War, the first war that was highly mechanised and involved widespread mobilisation of civilians, including Ravel himself. There was considerable debate about the impact of this increasingly mechanised modern world on the arts, a debate that led to the development of what may be termed a mechanising aesthetic: a fascination with the aesthetic qualities of machines, their nature, functions, processes and sounds, to which many artists felt compelled to respond. For musicians, machines generated a new world of sonic phenomena that challenged established ideas of what constituted legitimate musical sounds and methods of organising them, while radically new musical media such as the pianola, gramophone and radio were widely available. Some musicians attempted to translate the aesthetics of machines into art itself, using mechanical instruments and non-musical machines to make music, and composing works using conventional instruments that imitated mechanistic sounds and processes. The mechanising aesthetic in music was particularly strong in France, where it was linked with the prevailing culture of novelty. In an essay first published in 1908, the renowned music critic and scholar Louis Laloy observed that the French, the 'professed champions' of progressive music, were embracing the novelty of the trend to mechanisation.[7] He predicted a big future for mechanical instruments and voices, speculating on the development of a machine to produce and synthesise musical sounds.[8] While there had been attempts to build such machines since at least the eighteenth century, it was only in the twentieth that these moved beyond the experimental.[9]

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[4] Deborah Mawer, 'Ballet and the Apotheosis of Dance,' *The Cambridge Companion to Ravel*, ed. Deborah Mawer (Cambridge: CUP, 2000) 153.

[5] Mawer, 'Ballet' 155–60. See also Mawer, 'Spain, Machines and Sexuality: *Boléro*,' *The Ballets of Maurice Ravel: Creation and Interpretation* (Aldershot, Hants: Ashgate, 2006) 215–48.

[6] Carl Dahlhaus, 'Zur Theorie der Instrumentation,' *Musikforschung* 38.3 (1985): 161–9. See also Joseph Schmidt-Görg, 'Probleme und Methoden musikalischer Klangfarbenforschung,' *Zeitschrift für Musikwissenschaft* 15.2 (Nov. 1932): 61–9; Jörg Christian Martin, 'Die Instrumentation von Maurice Ravel', PhD diss., Johannes Gutenberg U (Mainz), 1967; Walter Gieseler, Luca Lombardi and Rolf-Dieter Weyer, *Instrumentation in der Musik des 20. Jahrhunderts: Akustik, Instrumente, Zusammenwirken* (Celle: Moeck, 1985).

[7] Louis Laloy, *The Future of Music: Coming Changes Outlined in Regard to Composer, Conductor and Orchestra*, transl. Mrs Franz [Louise] Liebich (London: William Reeves, 1920) 5–7, original publ. 'La Musique de l'avenir,' *Mercure de France* 1 Dec. 1908: 419–34.

[8] Laloy, *Future of Music* 21–2.

[9] The history of mechanical instruments is outlined in particularly interesting fashion in Carolyn Abbate, 'Outside Ravel's Tomb,' *Journal of the American Musicological Society* 52 (1999): 475–84.

Within this milieu, Ravel was more than a mere child of his time. The *enfant terrible* of French music in the early twentieth century, he engaged enthusiastically with the most progressive movements in his cultural environment. Indeed, as Sabine Henze-Döhring has argued, the essence of Ravel's modernity lies in the dominance of mechanisation in his compositional aesthetic, which put him at the forefront of mechanising trends.[10] Ravel was also a composer whose musical thinking was grounded in logic, precision, artifice and detachment, strongly linked to a lifelong fascination with machines and mechanical processes. This musical thinking is manifest throughout his œuvre, most obviously in musical interpretations of abstract logic such as Arithmetic and representations of devices from tiny wind-up toys and clocks to huge factories.

Ravel's aesthetic of artifice stemmed from his early interests in the interconnected ideas of mathematics, music and machines. In 1931 he recalled that, as a child,

> [t]he only subject which attracted me a little was mathematics … However, as soon as I began to compose, everyone realized I was on the right path. I even enjoyed it! … [and] my inclination for mathematics surely helped me a bit in that direction.[11]

The logical, objective mode of thinking demanded by and developed through mathematics, coupled with an interest in Symbolist poetry, led him to the writings of Edgar Allen Poe, whom he considered his teacher in relation to technique. He described Poe's 1846 essay 'The Philosophy of Composition' as the 'finest treatise on composition, in my opinion, and the one which in any case had the greatest influence on me.'[12] In this essay, Poe detailed his logical, artisan process of composing poetry, using his recent *The Raven* (1845) as an example. His intention was to dispel Romantic myths of creativity by making it 'manifest … that the work proceeded, step by step, to its completion with the precision and rigid consequence of a mathematical problem.'[13] Although Ravel knew that Stéphane Mallarmé, who translated Poe into French, believed the essay to be a hoax, he personally remained 'convinced that Poe indeed wrote his poem *The Raven* in the way that he indicated.'[14] He also considered Poe's aesthetic to be 'extremely close and sympathetic with that of modern French art.'[15] Ravel frequently mentioned the continuing importance to him of Poe's aesthetic,[16] and made time to visit the writer's former house in the Bronx during his hectic concert tour of the USA in early 1928,[17] a few months before he composed *Boléro*.

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[10] Sabine Henze-Döhring, 'Die Uhr als Herzensmechanik: Ravel's *L'Heure espagnole,' Die Mechanik in den Künsten: Studien zur aesthetischen Bedeutung von Naturwissenschaft und Technologie*, ed. Hanno Möbius and Jörg Jochen Berns (Marburg: Jonas, 1990) 220.

[11] Maurice Ravel, 'Memories of a Lazy Childhood,' *Ravel Reader* 393, original publ. *La Petite Gironde* 12 July 1931: 1.

[12] Ravel, 'Memories' 394.

[13] 'The Philosophy of Composition,' *The Works of Edgar Allen Poe*, ed. C. Stedman and G.E. Woodberry, vol. 6 (London: Lawrence Bullen, 1895) 33, original publ. *Graham's Magazine* Apr. 1846.

[14] Ravel, 'Memories' 394.

[15] Quoted in Olin Downes, 'Maurice Ravel, Man and Musician,' *Ravel Reader* 450, original publ. *New York Times* 7 Aug. 1927.

[16] Ravel, 'Contemporary Music,' *Ravel Reader* 45, original publ. *Rice Institute Pamphlet* 15 (Apr. 1928): 131–45; Downes, 'Maurice Ravel' 450; André Révész, 'The Great Musician Maurice Ravel Talks about His Art,' *Ravel Reader* 433, original publ. *ABC de Madrid* 1 May 1924: 19; 'Ravel Says Poe Aided Him in Composition,' *Ravel Reader* 454–5, original publ. *New York Times* 6 Jan. 1928.

[17] Arbie Orenstein, *Ravel: Man and Musician*, rev. ed. (New York: Dover, 1991) 97.

Some contemporary critics complained that Ravel's music was artificial, cold and recondite, a criticism that puzzled the composer.[18] He reportedly asked his close friend, the music critic Michel-Dmitri Calvocoressi: 'has it not occurred to these people that I could be naturally "artificial"?'[19] He responded to his critics publicly in terms reminiscent of Poe:

> When one allows oneself spontaneity, one babbles and that's all. In art, everything must be thought out … The truth is, one can never have enough control … [I]sn't it better at least to be fully aware and acknowledge that art is the supreme imposture?[20]

In conversation with his friend and former student Roland-Manuel, he argued in even stronger terms that artistic

> conscience compels us to turn ourselves into good craftsmen. My objective, therefore, is technical perfection … Art, no doubt, has other *effects*, but the artist, in my opinion, should have no other aim.[21]

Roland-Manuel subsequently argued that Ravel was a composer who 'does not distinguish between the natural and the artificial, and who appears to believe that everything can be imagined and made real in the material world, if everything is infallibly logical in the mind.'[22] Similar observations were made by the French musical philosopher Vladimir Jankélévitch in his highly insightful 1956 monograph. Jankélévitch considered Ravel a composer preoccupied with a 'mimed version of life' who 'want[ed] to look like a charlatan,'[23] and he declared the aesthetic of artifice to be Ravel's 'most striking characteristic.'[24]

Ravel first attempted to realise this 'mimed version of life' musically in a project begun in his late teens: a setting of Maurice Maeterlinck's play *Intérieur* (1891), which the young composer seems to have discovered even before its first performance in 1895.[25] This miniature play revolves around a highly detached scenario: characters, acted through marionettes, respond to the death of a young girl, a death that has occurred before the action even begins. Although Ravel composed very little of this work, he continued to consider the project until at least 1914.[26] This 'mimed version of life' was, however, realised in a number of aesthetically related works, notably *L'Enfant et les sortilèges* (1920–1925), a *tour de force* of musically animated

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[18] See, for example, Pierre Lalo, review of *Histoires naturelles*, *Le Temps* Jan. 1907, quoted in Roger Nichols and Deborah Mawer, 'Early Reception of Ravel's Music (1899–1939),' *Cambridge Companion to Ravel* 257; Lalo, review of *L'Heure espagnole*, *Le Temps* 28 May 1911, quoted in 'Maurice Ravel et la critique contemporaine,' *La Revue musicale* 3.6 (1 Apr. 1925): 97; André Messager, Review of *L'Enfant et les sortileges*, *Figaro* [Paris] 4 Feb. 1926.

[19] Quoted in Calvocoressi, *Musicians Gallery: Music and Ballet in Paris and London* (London: Faber, 1933) 51. See also the essay dedicated to Ravel by Calvocoressi, 'Les idées d'Edgar Poe sur la musique,' *Bulletin de la SIM* 5 (15 Feb. 1909): 148–58.

[20] Ravel, 'Memories' 395.

[21] Maurice Ravel, 'Some Reflections on Music,' *Ravel Reader* 38–9, original publ. in Roland-Manuel, 'Lettres de Maurice Ravel et documents inédits,' *Revue de musicologie* 38 (July 1956): 49–53.

[22] Roland-Manuel, *Maurice Ravel*, transl. Cynthia Jolly, Contemporary Composers [2] (Paris, 1938; London: Dobson, 1947) 53; see also 27–8.

[23] Vladimir Jankélévitch, *Ravel*, transl. Margaret Crosland, Evergreen Profile 3 (Paris, 1956; London: John Calder, 1959) 78, 85.

[24] Jankélévitch, *Ravel* 72.

[25] The only extant fragment of *Intérieur*, one page of a sketch for the prelude, dates from *c.* 1893–94; Orenstein, *Ravel* 244.

[26] Letter to Roland-Manuel, 1 Oct. 1914, *Ravel Reader* 155.

objects in which furniture, clocks, crockery, a storybook picture and even Arithmetic himself are brought to life, again in response to a traumatic event, in what Carolyn Abbate has called 'the music natural to artificial objects.'[27]

This detached, 'naturally artificial' aesthetic and the logical approach to composition are concomitant with Ravel's life-long fascination with machines and factories. This was initially stimulated by his father Joseph, an engineer, inventor and amateur musician who often made small mechanical toys for Maurice and his younger brother Edouard. Ravel recalled in 1927 that:

> in my childhood I was much interested in mechanisms … I visited factories often, very often, as a small boy with my father. It was these machines, their clicking and roaring, which, with the Spanish folk songs [sung by my mother] … formed my first instruction in music! [28]

Ravel found further such instruction in music everywhere in his mechanised modern world. On a boating holiday in the summer of 1905, for example, he cruised past a huge factory on the Rhine employing 24,000 workers, a factory he found hugely inspirational. He wrote several enthusiastic letters to his friend and fellow composer Maurice Delage, excitedly describing

> these smelting castles, these incandescent cathedrals, and the wonderful symphony of traveling belts, whistles, and terrific hammerblows which envelop [*sic*] you … How much music there is in all of this!—and I certainly intend to use it.[29]

On his return to Paris, Ravel immediately began several compositions inspired by this experience. His first attempt at a full-length opera, *La Cloche engloutie*, was based on Gerhart Hauptmann's play *Die versunkene Glocke* (1896), which is set partly in a giant bell foundry. He described the setting to his librettist André-Ferdinand Hérold, in terms recalling his letters to Delage, as a 'huge factory, equipped like the most grandiose one sees today,' employing 'the sounds of hammers, saws, files and sirens.'[30] Ravel worked on *La Cloche* intermittently until the Great War,[31] and later incorporated some of the sketched musical ideas into *L'Enfant et les sortilèges*.[32] He began another dramatic composition that also had resonances with his youthful *Intérieur* project: a setting of E.T.A. Hoffman's *Das Sandmann* (1816), the story on which Delibes's ballet *Coppélia* (1870) is based. Ravel's work, entitled *Olympia*, was the story of the mechanical doll so life-like as to elicit emotional responses from humans, where the boundary between human and marionette is opaque. *Olympia* was partly drafted but then abandoned. However, Ravel recycled some material into his first completed opera, *L'Heure espagnole* (1907–1909),[33] in which clocks and their mechanisms play a central role both literally and as a metaphor for

[27] Abbate, 'Outside Ravel's Tomb' 507.

[28] Quoted in Downes, 'Maurice Ravel' 450.

[29] Letter to Delage, 5 July 1905, *Ravel Reader* 70. See also other letters to Delage, 24 June, 12 July, 20 July 1905, *Ravel Reader* 69–72.

[30] André-Ferdinand Hérold, 'Souvenirs,' *La Revue musicale* numéro spécial (Dec. 1938): 198; transl. Orenstein, *Ravel Reader* 71 n5.

[31] See the letter to Roland-Manuel, 1 Oct. 1914, *Ravel Reader* 155.

[32] Orenstein, *Ravel* 10n, 48. Fifteen pages of a piano-vocal score for *La Cloche engloutie* are extant; Orenstein, *Ravel* 50, 244.

[33] Roland-Manuel, *Ravel* 27.

the human condition. The metaphysical themes of *L'Heure* are established from the very first bars of the introductory symphony of clocks, metronomes and mechanical toys.

Such toys were the main characters in the only mechanical work Ravel finished in 1905, *Noël des jouets*. For this song he wrote his own text describing a clockwork nativity scene in which the wings of the angels, 'clicking in symmetrical sounds / Harmonise with the mechanical livestock / Whose thin voices bleat: / "Noel! Noel! Noel!"'[34] Although *Noël des jouets* initially had only piano accompaniment, Ravel later scored this tiny song for large orchestra with quadruple wind, four percussionists, two harps and celeste, the sound of the great factory on the Rhine perhaps still lingering in his ear.

Throughout his life, Ravel continued to find musical inspiration in machines and factories. His home outside Paris, Belvédère, acquired shortly after the Great War and decorated to his own specifications, embodied his preoccupation with the mechanical and the artificial. Surrounded by a bonsai garden, Belvédère contained a room full of *chinoiserie*, displays of miniature glass and porcelain figurines, mechanical toys and clocks, and several music boxes including a tiny, realistically coloured nightingale in a gilded cage.[35] During the 1920s Ravel spoke increasingly often about his interest in factories and the musical inspiration they gave him. During his USA tour he visited the Ford car factory in Detroit—a highly unusual activity for a touring composer-pianist—which he described enthusiastically to his brother, who had followed their father into the profession of engineer.[36] In 1930 Ravel mentioned in letters to his old friend Manuel de Falla and to his pupil and amanuensis Manuel Rosenthal that he planned two works based on flight, although he never began either due to his rapidly failing health: *Dédale 39*, 'an airplane in C,' and a symphonic poem *Icare*, based on the Greek legend.[37] In an interview in 1932 he stated his belief 'that the mechanics and machinery of the age would also leave their imprint on music of the present day.'[38] The following year he confessed: 'I gained much of my inspiration from machinery. I love going over factories and seeing vast machinery at work.'[39] Ravel waxed lyrical about their artistic potential:

> What a musical story there is in a factory! Musicians, together with historians and writers of fiction must carry on the tale of the mechanics of this age to our children and our children's children. We have had nature, war, and a hundred other themes in music, and it amazes me that musicians have not yet captured the wonder of industrial progress …
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> [O]ver all would be the triumph of the machine, the vast monster that man has created to do his bidding. What a noble inspiration! Surely one that will in future years be felt by hundreds of our composers, who will bring into being music that will faithfully

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[34] 'cliquette en bruits symétriques / S'accorde au bétail mécanique / Dont la voix grêle bêle: / "Noël! Noël! Noël!"'

[35] Belvédère remains as Ravel left it at his death, and has recently been restored. See Emily Kilpatrick, 'A Summer at Ravel's Home,' *Clavier* 45.7 (Sept. 2006): 38–43. Numerous photographs of its interior and ornaments are found in Vladimir Jankélévitch, *Ravel*, ed. Jean-Michel Nectoux, 3rd ed., Solfèges New Series (Paris: Editions de Seuil, 1995).

[36] Orenstein, *Ravel* 10.

[37] Quoted in Orenstein, *Ravel* 100n.

[38] Ravel, 'Factory Gives Composer Inspiration,' *Ravel Reader* 490, original publ. *Evening Standard* [London] 24 Feb. 1932.

[39] Ravel, 'Finding Tunes in Factories,' *Ravel Reader* 398, original publ. *New Britain* 9 Aug. 1933.

and beautifully reflect the spirit of the age in which machinery struggled to lighten the burdens of man.[40]

Such comments naturally evoke comparison with the Futurists, the most extreme manifestation of the mechanising aesthetic in the 1910s and early 1920s. One of the leading figures, Luigi Russolo, argued in the widely circulated manifesto *The Art of Noises* (1913) that it was essential to 'conquer the infinite variety of noise-sounds' with machines that could produce a range of timbres in a controlled fashion, many of them inspired by what he considered the 'intoxicating orchestra' of the factory.[41] For Russolo, the inclusion of sounds usually considered 'noise' was an inevitable step in the evolution of European music.[42]

Ravel had some sympathy with Futurist ideas. In early 1917 he accepted a commission from Serge Diaghilev to write a mechanistic ballet, *The Zoo,* based on a libretto by the Futurist poet Luigi Cangiullo.[43] The Russian impresario had conceived the idea for *The Zoo* after seeing the futurist ballet *Printing Press* in 1914.[44] Although Ravel never fulfilled the commission, he was interested in the new instruments devised by Russolo and demonstrated at concerts in Paris in 1921,[45] as well as in the theremin,[46] first heard in Paris in 1927. However the impact of Futurism on French musicians was mostly indirect, through its connection with existing mechanising trends.[47] These produced works that were machine-inspired and / or mechanistic in nature, written for conventional musical forces but sometimes including a machine or two. The most important of these include Satie's *Parade* (1917), Milhaud's *Machines agricoles* (1919), Stravinsky's *Les Noces* (1914–1922), Honegger's *Pacific 231* (1923), Schoenberg's *Die glückliche Hand* (1924), Antheil's *Ballet mécanique* (1925), Prokofiev's *Pas d'acier* (1925) and Mosolov's *Iron Foundry* (1927), all of which Ravel knew.[48]

However he was not sympathetic to all manifestations of the mechanising aesthetic. He commented privately of *Parade* that he 'did not understand the technique of a piece "which was not bathed in any sonorous fluid",'[49] and said in 1933:

> Do I think that at some future date we shall see on a concert platform rows of typewriters, lathes and saws in place of the usual instruments? It is not improbable; it has already been tried in one of the Russian ballets [i.e., *Parade*], where a typewriter being tapped was a legitimate instrument of the orchestra.

> But, if it does come about, I do not think it can truly be called art. I do think it is art to make violins, horns, trombones, and all the other instruments of the orchestra sound like

[40] Ravel, 'Finding Tunes in Factories' 398–9, 400.

[41] Russolo, 'The Art of Noises: Futurist Manifesto [1913],' *Source Readings in Music History. Volume 7: The Twentieth Century*, ed. Robert P. Morgan (New York: Norton, 1998) 62, 64.

[42] Russolo, 'Art of Noises' 60.

[43] Ravel, letter to Diaghilev, 12 Jan. 1917, *Ravel Reader* 179.

[44] Lynn Garafola, *Diaghilev's Ballets Russes* (New York: OUP, 1989) 80–1, 428 n18.

[45] Russolo, letter to Nicolas Slonimsky, 24 Aug. 1934, quoted in Slonimsky, *Music since 1900*, 6th ed., updated Laura Kuhn (New York: Schirmer, 2001) 119.

[46] Roger Nichols, *Ravel*, Master Musicians Series (London: Faber, 1977) 157–8.

[47] André Cœuroy, *Panorama de la musique contemporaine*, 5th ed., Les Documentaires, (Paris: Simon Kra, 1928) 159.

[48] Ravel, 'Finding Tunes in Factories' 399; Orenstein, *Ravel Reader* 491 n3; Mawer, 'Musical Objects and Machines,' *Cambridge Companion to Ravel* 61; Bruno Sébald, comp., 'Ravel's Personal Record Collection,' *Ravel Reader* 604.

[49] Quoted in Orenstein, *Ravel Reader* 491 n3.

machinery. If machinery were put on a concert platform instead of musical instruments, however, it would conversely only be art if that machinery were made to sound like music. At present I do not see how this could be done.[50]

Ravel himself aimed for a poetic rather than a literal interpretation of the machine, music that 'does not necessarily suggest the noises, but … can tell … the story [*histoire*] of the machine and interpret the machine's works.'[51] While he realised this idea in many works throughout his career, the one in which he did so most thoroughly, consistently and effectively is *Boléro*.

According to the Spanish pianist Joaquín Nin, with whom Ravel was staying when he began the work, the extremely mechanical nature of *Boléro* is due in part to the circumstances of its composition.[52] Ravel had been commissioned by the dancer Ida Rubinstein early in 1928 to write a 'Spanish' ballet, whose première was to launch the winter season at the Opéra de Paris on 22 November. He started to orchestrate music from Isaac Albéniz's *Iberia* before discovering copyright problems in the summer of 1928.[53] Although Ravel usually spent months or years on a work and often missed deadlines, he rashly decided to compose a new work, but needed an idea he could realise quickly. Using the sort of logical, technical process described by Poe in 'The Philosophy of Composition,' Ravel devised two very simple ostinatos of two bars each, which are repeated continuously throughout the work. One is predominantly rhythmic (Example 1a) while the other articulates the three beats of the bar and harmonises the $\hat{1}$-$\hat{5}$-$\hat{5}$ bass-line with diatonic added-note chords (Example 1b). Superimposed on these are two sixteen-bar melodies in C major, one diatonic and the other chromatic; these are repeated four times in alternating pairs then again once each, before an abrupt modulation to the mediant major for an eight-bar

Example 1a. *Boléro*, rhythmic ostinato
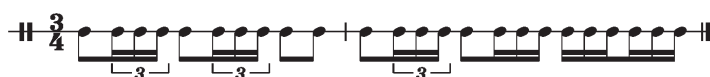
Example 1b. *Boléro*, harmonic ostinato, Fig. 5 bars 1–2, strings only

[50] Ravel, 'Factory Gives Composer Inspiration' 490.

[51] Ravel, 'Finding Tunes in Factories' 399.

[52] 'Comment est né le "Boléro" de Ravel,' *La Revue musicale* numéro spécial (Dec. 1938): 213.

[53] Ravel, letter to Mme Albéniz, 27 June 1928, *Ravel Reader* 295–6; Nin, 'Comment' 213.

development of motives from the two melodies. *Boléro* concludes with a return to the tonic for a six-bar coda containing only the ostinato material. This simple, rigid musical mechanism that runs for over fifteen minutes, without the need to accommodate any of the dramatic or textual elements found in Ravel's other mechanistic works, is perhaps the purest example of what Derrick Puffett has called the 'ostinato machines'[54] of the early twentieth century.

The circumstances of *Boléro*'s composition also explain why orchestration is so central to the musical fabric in a way that is unique even in the output of a composer renowned for his invention and skill in orchestral writing. Ravel was able to complete the work with such unusual speed because of the skill and fluency with which he formulated his orchestral ideas at this mature stage of his career; the ostinatos and repeated melody lines serve as production lines for the orchestral tissue that is the musical fabric of *Boléro*. Ravel apparently saw at the time the 'analogy between the alternation of these two themes riveted one to the other and the links of a chain or a factory assembly-line [*chaîne*].'[55] He stated that *Boléro* 'owed its inception to a factory.'[56]

For the original production of the ballet, Ravel wanted the designer Alexandre Benois to incorporate a factory-style production line into the décor.[57] Ida Rubinstein and the choreographer Bronislava Nijinska, however, set the ballet in a Spanish tavern, a picturesque scenario which the composer considered inappropriate.[58] Since Rubinstein was not only the principal dancer but had also commissioned the ballet, her wishes prevailed. Ravel remained committed to his original concept, however, and said in 1933, with a tone of wistful longing: 'Some day I should like to play it with a vast industrial works in the background.'[59] In 1935 he discussed a factory scenario with the art deco sculptor Léon Leyritz while they were on holiday together. Leyritz produced a model of his intended décor which Ravel probably saw before his death in December 1937,[60] and which was exhibited at the Salon des Artistes Décorateurs.[61] For the production that eventuated at the Opéra in 1941, Leyritz's backdrop was an Arabic-Spanish factory, its harshness reflected in the use of spiky cacti among the props, which was intended 'to underline the mechanical aspect of the construction of the music.'[62]

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[54] Derrick Puffett, 'Debussy's Ostinato Machine [1996],' *Derrick Puffett on Music*, comp. and ed. Kathryn Bailey Puffett (Aldershot, Hants: Ashgate, 2001) 231. Puffett's essay focuses on the first movement of Debussy's orchestral *Ibéria*, and mentions works by other composers including Berg, Stravinsky and Messiaen. *L'Heure espagnole* is described as 'an ostinato machine run riot!' (285) but, curiously, *Boléro* is not even mentioned.

[55] René Chalupt and Marcelle Gerar, comp. and ed., *Ravel au miroir de ses lettres*, Collection Musicale (Paris: Robert Laffont, 1956) 237; transl. in Mawer, 'Ballet' 156.

[56] Ravel, 'Finding Tunes in Factories' 399. He also made almost exactly the same comment in 'Factory Gives Composer Inspiration' 490.

[57] Chalupt and Gerar, *Ravel* 237–8.

[58] Ravel, letter to Roger Haour, 4 Dec. 1928, *Ravel Reader* 299.

[59] Ravel, 'Finding Tunes in Factories' 399. He made similar comments in 'Factory Gives Composer Inspiration' 490.

[60] Chalupt and Gerar, *Ravel* 238. Manuel Rosenthal, *Ravel: Souvenirs de Manuel Rosenthal*, with Marcel Marnat (Paris: Éditions Hazan, 1995) 179.

[61] François Lesure and Jean-Michael Nectoux, eds., *Maurice Ravel* [Catalogue de l'exposition] (Paris: Bibliothèque nationale de France, 1975) 66.

[62] 'pour souligner le côté mécanique de la construction de la musique.' Leyritz, 'Leyritz parle de ses décors,' ts., Nov. 1940 (Paris, Bibliothèque-Musée de l'Opéra, Dossier d'œuvre Boléro), quoted in Mawer, 'Spain' 235.

When the conductor Philippe Gaubert and choreographer Serge Lifar complained about Leyritz's visual interpretation to the Opéra's director Jacques Rouché, he sought confirmation of Ravel's intentions from his brother Edouard, who reassured him of the appropriateness of the factory concept to the composer's aesthetic:

> My brother admired everything which was mechanical, from simple tin toys to the most intricate machine tools. He would thus spend entire days … in front of street vendors' stalls, and was delighted to come with me to factories or to expositions of machinery. He was happy to be in the midst of these movements and noises. But he always came out struck and obsessed by the automation of all these machines.[63]

Edouard also revealed that Ravel's '*Boléro* factory' was a particular one, in the industrial district of Le Vésinet on the north-west outskirts of Paris.[64]

Rouché might also have reassured himself of the appropriateness of the mechanistic understanding of *Boléro* by listening to Ravel's own interpretation of the work, which he conducted many times in concerts and recorded in January 1930 with the Orchestre de l'Association des Concerts Lamoureux.[65] According to Roland-Manuel, Ravel conducted the work mechanically, 'with a stiff gesture, and at a steady, fairly slow, uniform pace.'[66] His conducting in the recording session itself was described by one critic, who presumably witnessed it: 'With rigid gestures, his wrist traces the three beats which, in a mechanical way, govern this melody in C.'[67] In the compositional process and in performance, *Boléro* rendered its own creator a musical automaton who obeyed the demands of the mechanical processes.

The most fascinating product of the *Boléro* factory is, of course, the orchestration; without it, in piano reduction, the work is virtually pointless. It is surprising, then, that this crucial element has been largely neglected in interpretations of the work in relation to Ravel's mechanising aesthetic. The precision and rigid consequence of the processes established in *Boléro* make instruments act and even sound like machinery; they also make the orchestra into a machine that combines and blends instruments whose overtones interact to produce new synthetic timbres. Roland-Manuel argued that one of the hallmarks of Ravel's artifice [*imposture*] was in fact the use of 'paradoxical trickery' in orchestration such as using, instead of an actual trumpet, 'the shadow of a trumpet evoked by a flute.'[68] Ravel's own explanation of this kind of artifice was recorded by his pupil Rosenthal:

> If, for example, you give a certain melodic line to the clarinet, everyone knows it, and at the most one can think: 'Yes, the clarinet goes very well there.' But if you want to

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[63] Letter to Jacques Rouché, 19 Feb. 1940, *Ravel Reader* 328.

[64] Edouard Ravel, letter to Jacques Rouché, 19 Feb. 1940, *Ravel Reader* 328.

[65] *Boléro* (Polydor (France) 566030/1, 1930), re-released on *Maurice Ravel: Orchestral Music* (Andante, 2001).

[66] Roland-Manuel, *Maurice* 99.

[67] 'Evariste,' Review of *Boléro* (Polydor (France) 566030/1, 1930), *L'Edition musicale vivante* (Jan. 1930) 15, quoted in Touzelet, 'Historical Interpretations (1911–1988),' *Ravel Reader* 535. *L'Edition musicale vivante* was edited by Ravel's former Conservatoire classmate and friend, Émile Vuillermoz, so it would not have been difficult for the critic to gain access to the recording session. Although the published score has the tempo ♩ = 72, in the copy Ravel used to conduct the work he altered this by hand to ♩ = 66. His own recording, taken at this tempo, lasts 15'50", while other recordings range between 13'00" and 18'00"; Touzelet, 'Historical Interpretations' 540–1, 590–1.

[68] 'jonglerie paradoxale … l'ombre d'une trompette évoquée par la flute.' Roland-Manuel, 'Maurice Ravel ou l'ésthetique de l'imposture,' *La Revue musicale* numéro spécial (1 Apr. 1925): 21.

seduce the listener (seduce? fool?) then you're going to put something else with the clarinet that the listener won't recognise: you alone know there is something else, for example cello *pizzicato* notes. One doesn't hear them, because you will have made the clarinet *mezzo forte* and the cello *pianissimo*, but it will be enough to change slightly the sound of the clarinet and one will hear a sort of aura, a strange shadow, behind the clarinet. … [T]hat's what I call 'fooling the listener.'[69]

Ravel's *Boléro* factory manufactures these sorts of sophisticated timbres on several different levels, in relation to each of the repetitive elements: the rhythmic and harmonic ostinatos and the twin travelling belts of melody.

To begin with, all the changes in the orchestration, which are the only changes in *Boléro*, are not organic or gradual but abrupt, as if a switch has been flicked or a gear suddenly changed in the orchestral machine in order to add another element to the production line. The mechanistic quality of the most obviously mechanistic element—the rhythmic ostinato—is emphasised by its being played continuously in the hard, penetrating timbre of the snare drum. This not only brings to mind the sound of meshing gears and grinding cogs, it also transforms the human drummer into a metaphorical musical automaton,[70] like one of the mechanical characters in *L'Enfant* or *L'Heure esagnole*. The only element of change in the snare drum part is the stepped crescendo from *pp* at the start to *ff* at Figure 16, from which point the second snare drum doubles the first, underpinning the orchestral crescendo to the climactic modulation and the coda. This doubling only serves to intensify the mechanical quality of the ostinato. With two drummers, the ostinato is even louder but also spatially diversified; metaphorically the *Boléro* factory has manufactured an identical copy of the first drumming automaton, the second item in a production run that could continue indefinitely.

The rhythmic ostinato is reinforced by the orchestration of it with other instruments, a new timbral synthesis for each melodic repetition, each stage in the production line (see Table 1). Initially this orchestration comprises a single wind instrument playing the rhythm on a repeated g', a pivotal, hovering and inconclusive $\hat{5}$. The synthesis of snare drum and solo wind adds dimensions of colour and pitch to the timbre of the former while giving the latter a much more percussive quality. At Figure 8, the beginning of the third cycle of melodic repetition, the solo instrument is replaced by instrumental combinations that synthesise two or more pitched timbres and merge the rhythmic ostinato with the harmonic progression, especially from Figure 16 onwards. The listener is fooled by combinations such as the horn *mf* shadowed by the flute *mp* an octave higher (Figure 8) or the horn and trumpet in octaves doubled by the violins playing with highly percussive *jeté* (thrown bows) (Figure 11). As the climax approaches (from Figure 16), the rhythmic ostinato is proclaimed in a fanfare of brass mixed with woodwind

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[69] 'Si, par exemple, vous confiez une certaine ligne mélodique à une clarinette, tout le monde peut en faire autant, et tout au plus pourra-t-on penser: 'Oui, la clarinette va très bien là.' Mais si vous voulez séduire l'auditeur (séduire? tromper?) alors, sous la clarinette, vous allez mettre autre chose, que l'auditeur ne saisira pas: vous seul savez qu'il y a quelque chose en plus, par exemple des pizzicati de violoncelle. On ne les entendra pas, car vous aurez mis sous cette clarinette mezzo forte un violoncelle pianissimo, mais cela va suffire à déformer légèrement le son de la clarinette et on percevra comme une sorte d'aura, d'ombre étrange, derrière la clarinette … [C]'est que j'appelle "tromper l'auditeur."' Rosenthal, *Ravel* 77; my translation. Rosenthal recorded another very similar definition in Roger Nichols, *Ravel Remembered* (London: Faber, 1987) 67–8.

[70] For discussion of this metaphor, see Abbate, 'Outside Ravel's Tomb' 477–81.

Table 1. Orchestration of the rhythmic ostinato in *Boléro*

Figure	Snare drum(s)	Pitch(es) used	Wind	Brass	Strings
—	*pp*	—			
1	*pp*	g'	fl 2 *pp*		
2	*pp*	g'	fl 1 *pp*		
3	*p*	g'	fl 2 *p*		
4	*p*	g'	bn 1/2 *mp*		
5	*p*	g'		hn 1 *p*	
6	*p*	g'		tpt 2 muted *mp*	
7	*p*	g'		tpt 1 *mp*	
8	*mp*	g-g'	fl 1 *mp*	hn 2 *mf*	
9	*mf*	g-g' + strings outlining chord		tpt 3 muted *mf* hn 4 *mf*	vn 2 div. mf va div. **mf**
10	*mf*	g-g'	fl 1 *mf*	hn 2 *mf*	va div. *jeté mf*
11	*f*	g-g'		hn 4, tpt 1 *f*	vn 2 div. *jeté f*
12	*f*	g-g'		hn 1 & 2 *f*	
13	*f*	g-g'		hn 3 & 4 *f*	
14	*f*	g-g'		hn 1 & 2 *f*	
15	*f*	g-g'		hn 1–4 *f*	
16	x 2 *ff*	outlining chord	2 ob ff 2 cl ff	hn 1–4 *ff*	vn 2 div. pizz. *ff* va div. pizz. *ff* vcl div. pizz. *ff*
17	x 2 *ff*	outlining chord	2 ob *ff* 2 cl *ff*	hn 1–4 *ff*	vn 2 div. arco *ff* va div. arco *ff* vcl div. arco *ff*
18: 1–8	x 2 *ff*	outlining chord	2 ob *ff* 2 cl *ff*	hn 1–4 *ff*	vn 2 div. arco *ff* va div. arco *ff* vcl div. arco *ff*
18: 9–12	x 2 *ff*	outlining chord	pic *ff* 2 fl *ff*	hn 1–4 *ff* pic tpt *ff* 3 tpt *ff*	vn 2 div. arco *ff* va div. arco *ff* vcl div. arco *ff*
last 2 bars: tutti *ff*					

and strings. Everywhere, the percussiveness of the snare drum permeates the orchestration, with consistent use of staccato and, for the strings, extended passages of *jeté* bowing (Figures 10–12) and multiple stopping.

The harmonic ostinato production line naturally produces more complex orchestration. It relies on the plucked string chords (refer to Example 1b), interlocked to exploit best the resonance of open strings and acting as a set of cogs rotating in the machinery of the *Boléro* factory. Even in 1928, it defied orchestral convention to give this sort of rhythmic, percussive and colouristic role to the strings, treating them like a giant chord-plucking mechanism instead

of the lyrical core of the orchestra. The plucked-string mechanism is continuous except for Figure 15–16 (see Table 2), where it is temporarily replaced by brass and lower woodwinds, with timpani and *arco* double basses underpinning the chord progression. From Figure 6 onwards the plucked-string timbre is synthesised with that of other instruments, which are at first almost unnoticeable (low flutes and clarinet at Figure 6, bass clarinet and bassoons

Table 2. Orchestration of the chordal ostinato in *Boléro*

Figure	Wind (accented quavers)	Brass (accented quavers)	Strings (pizzicato crotchets)	Percussion
—			va, vcl *pp*	
1			va, vcl *pp*	
2			va, vcl, hp *p*	
3			va, vcl *p* hp *mp*	
4			vn 2 div., va, vcl, db *p*	
5			vn 1 div., va, vcl, db *p*	
6	2 fl (low) → fl 1, cl 1 *p*		vn 2, va, vcl, db *mp*	
7	2 ob, ca *p*		vn 1 div., va, vcl, db *mp*	
8	b.cl, 2 bn *mf*		vn 2 div., va, vcl, db hp *mf*	
9	b.cl, 2 bn *mf*	tpt 1 & 2 *mf*	vn 1 div., vn 2.2, va 2 *mf* vcl, db, hp *mf*	
10	2 cl, b.cl, c.bn *mf*		vn 2 div., va div., db div. *mf* hp *mf*	
11	b.cl, 2 bn, c.bn *f*		vn 1 div., va, vcl, db, hp *f*	
12	2 bn, c.bn *f*	hn 3 & 4 *f*	vn 2 div., va, vcl, db *f*	timp *mf*
13	b.cl, 2 bn, c.bn *f* s'ino sax *f*	hn 1 & 2 *f*	va div., vcl, db, hp *f*	timp *f*
14	2 cl, 2 bn, c.bn *f* s'ino & ten sax *f*	hn 3 & 4 *f* tbn 1 & 2, tb *f*	va div., vcl, db, hp *f*	timp *f*
15	b.cl, 2 bn, c.bn *f*	3 tpt, tbn 2 & 3, tb *f*	db arco quavers, hp *f*	timp *f*
16	b.cl, 2 bn, c.bn *ff*	3 tbn, tb *ff*	vn 2, va, vcl, db, hp *ff*	timp *ff* [rest bars 3–9]
17	b.cl, 2 bn, c.bn *ff*	tbn 2 & 3, tb *ff*	vn 2 div., va div., vcl, db, hp *ff*	timp *ff*
18: 1–8	b.cl, 2 bn, c.bn *ff*	tbn 2 & 3, tb *ff*	db, hp *ff*	timp *ff*
18: 9–12	2 ob, ca, 2 cl, b.cl *ff* 2 bn, c.bn *ff* sop & ten sax *ff*	3 tbn, tb *ff*		timp *ff* TamT *ff* BD *f* cymb *f*
last 2 bars: no chordal ostinato				

at Figure 11). From Figure 12, where the timpani join the bass line, the heavily accented quavers of the wind instruments emphasise the dissonances in the added-note chords (see Example 2). For the coda, the harmonic ostinato is entirely taken over by the reeds and low brass, timpani and bass drum, polished up and finished with the sparkle of tam-tam and cymbals. This emphasis on the percussive in the rhythmic and the harmonic ostinatos is typical of Ravel's mechanising aesthetic, and of the widespread contemporaneous association between percussiveness and the artistic response to noisy, highly mechanised post-War urban life.[71] Percussion instruments also, of course, embody the detachment and objectivity of the mechanising aesthetic in the indirectness of the player's contact with the instruments through sticks, beaters and mechanisms, and in their crisp, dry articulation and timbre, qualities that are imitated by other orchestral instruments in this work.

Example 2. *Boléro*, orchestration of harmonic ostinato, Fig. 14.3–4 (sounding pitch)

The most fascinating orchestration produced by the *Boléro* factory is what comes off the assembly line of Ravel's twin travelling belts of melody (see Table 3). At first, the two melodies are played, in stark relief against the rhythmic and harmonic ostinatos, by individual wind instruments in distinctive tessituras with complementary timbres. The diatonic melody (A)

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[71] Tadeusz Jarecki, 'Jazzing Up the Symphony Orchestra,' *Chesterian* 64 (July–Aug. 1927): 268; Jarecki, 'Taming the Percussion,' *Chesterian* 76 (Jan.–Feb. 1929): 119.

Table 3. Orchestration of melody in *Boléro*

Fig.	Mel.	Type of Doubling	Wind	Brass	Strings	Perc.
—	A1	———	fl 1 (low) pp			
1	A2	———	cl 1 (mid) *p*			
2	B1	———	bn 1 (high) *mp*			
3	B2	———	pic cl (mid) *p*			
4	A3	———	ob d'amore *mp*			
5	A4	‖ 8^{ve}s	fl 1 *pp*	tpt 1 (mid) con sord *mp*		
6	B3	———	ten sax (high) *mp* *espressivo vibrato*			
7	B4	———	s'ino ® sop sax *mp* *espressivo vibrato*			
8	A5	‖ 8^{ve}s & 15ths ‖ Perfect 12ths ‖ Major 17ths	2 pic *pp*	hn 1 *mf*		cel *p*
9	A6	‖ 8^{ve}s ‖ Perfect 5ths	ob, ca, 2 cl *mf* ob d'amore *mf*			
10	B5	———		tbn 1 (v high) *mf* *sostenuto*		
11	B6	‖ diatonic triads in 8^{ve}s	pic, 2 fl, 2 ob, ca *f* 2 cl, ten sax *f*			
12	A7	‖ 8^{ve}s	pic, 2 fl, 2 ob *f* 2 cl *f*		vn 1 div. *f*	
13	A8	‖ diatonic triads in 8^{ve}s	pic, 2 fl, 2 ob, ca, 2 cl, ten sax *f*		vn 1 div. à 4 *f* vn 2 div. à 4 *f*	
14	B7	‖ 8^{ve}s	pic, 2 fl, 2 ob, ca *f*	tpt 1 *f*	vn 1 div. *f* vn 2 div. *f*	
15	B8	‖ diatonic triads in 8^{ve}s	pic, 2 fl, 2 ob, ca *f* 2 cl, s'ino & ten sax *f*	tbn 1 *f*	vn 1 div. *f* vn 2 div. *f* va, vcl *f*	
16	A9	‖ diatonic triads in 8^{ve}s	pic, 2 fl *ff* 2 sax *f*	pic tpt, 3 tpt *ff*	vn 1 div. à 4 *f*	
17	B9	‖ diatonic triads in 8^{ve}s	pic, 2 fl *ff* 2 sax *f*	pic tpt, 3 tpt *ff* tbn 1 *ff possibile*	vn 1 div. à 4 *f*	
18	C	‖ modified triads in 8^{ve}s	pic, 2 fl *ff* 2 sax *f*	pic tpt, 3 tpt *ff* tbn 1 *ff possibile*	vn 1 div. à 4 *f*	
last 6 bars: no melody						

is played first by the flute in its sensuous, breathy lowest octave, then by the clarinet in its pragmatic middle range, giving it clarity and definition. The chromatic melody (B) is first heard in the strained tone of the high bassoon—surely a deliberate reference to the famous opening of Stravinsky's *Le Sacre du Printemps*—then repeated in the lighter, more relaxed

tone of the piccolo clarinet's middle range. Melody A returns in the unexpected timbre of the archaic oboe d'amore, followed by the plain-speaking trumpet and flute, playing in octaves, a standard orchestral device that Ravel habitually employed in innovative ways.[72] Here, the trumpet, muted but marked *mp*, is doubled an octave higher by the flute *pp*; the flute is therefore barely audible and serves primarily to lighten the first overtone of the trumpet notes, manufacturing a synthetic timbre that is mellow but not sombre. Similarly at Figures 12 and 14, the conventional parallel octaves of evenly blended winds and strings are leavened by a single piccolo a fifteenth above the fundamental melody notes (see Example 3). Ravel used more modern tones for the third and fourth appearances of the chromatic melody: solo tenor, sopranino and soprano saxophones in succession (Figures 6 and 7). Although saxophones were not uncommon in French orchestration from the late nineteenth century onwards, their use here as solo instruments for the chromatic melody, with its syncopation and triplets, alludes to the impact of jazz, which in 1920s Europe was often associated with the mechanical. This reference to jazz is reinforced by the next rendition of the chromatic melody (Figure 10), in the sensuous tones of the trombone, with its silky glissandos.

Example 3. *Boléro*, doubling at Fig. 12.3 & Fig. 14.3 (starting notes of melody)

Apart from this last solo digression into an overtly modernist sound-world, the twin travelling belts of melody produce increasingly complex synthetic timbres from Figure 8 onwards, by doubling the melody in parallel octaves and fifteenths, fifths and twelfths, and thirds, tenths and seventeenths (refer to Table 3). Mawer has interpreted these doublings variously as polytonal (Figure 8), bitonal thickened with thirds (Figure 13) and even simultaneously bitonal, organum-like and as a composite mode with Lydian tendencies (Figure 9).[73] However, in light of the composer's description of *Boléro* as orchestral tissue, these passages cannot be considered any more harmonically complex than the earlier renditions of the melodies. Ravel's doublings are the means by which the melodic lines of the *Boléro* factory manufacture new synthetic orchestral products, many of which fool the listener with their deceptive combinations and blends of timbre.

At Figure 9, for instance, the melody is played in parallel fifths and octaves by the three instruments of the oboe family (see Example 4), so that the overtones of the cor anglais are reinforced by the oboe d'amore and oboe. The potentially overwhelming nasal quality of the double-reed combination is blended with the more mellow clarinets doubling the outer notes of the parallel chords. The most complex and innovative synthetic timbre is at Figure 8, where the principal melody instrument is the horn, playing *mf*; its octaves and fifteenths are coloured by the celeste *p*, and its twelfths and seventeenths by the piccolos *pp* (see Example 5). The careful balancing of dynamic levels according to each instrument's importance to the

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[72] Martin, 'Instrumentation' 188–9.
[73] Mawer, 'Ballet' 159–60.

timbral blend is mirrored in the combination of contrasting articulations of the same melody: the fundamental horn has idiomatic tongued notes and short slurs, the main overtones are heard in the clear attack and bell-like quality of the celeste, while the subsidiary overtones in the piccolos are made more resonant by being played legato. The temporary use of different key signatures for the piccolos is purely a notational convenience, not an indication of competing tonal centres or modal structures. These kinds of doublings do not establish competing tonal or modal centres, but modify the timbre of the principal melody instrument by colouring its overtones in carefully calculated ways.

Example 4. *Boléro*, Fig. 9.3, melody instruments only (sounding pitch)

Example 5. *Boléro*, Fig. 8.3, melody instruments only (sounding pitch)

The argument for bitonality/bimodality might be considered more convincing where Ravel's instrumental combinations use diatonic, rather than exact, parallelism (Figures 11, 13 and 15–end), resulting in a mixture of major, minor and diminished triads (see Example 6). Even here, however, the composer's intention appears to be to create even more complex synthetic timbres through the close spacing of similar-motion triads, rather than to imply multiple simultaneous tonal centres or modal patterns. In each melodic repetition (see Table 4), instrumental timbre and tessitura remain carefully balanced, with high reed instruments and violins blending in the principal set of parallel chords while piccolo and flutes add brilliance in the octave above. From Figure 17, as the climax of the abrupt modulation approaches, the oboes and clarinets are replaced on the principal melody line by the first trombone playing

Example 6. *Boléro*, Fig. 11 bar 3, melody instruments only (sounding pitch)

Table 4. *Boléro*, distribution of melodic doubling from Fig. 11 (starting notes)

Fig. 11 (Melody B)		Fig. 13 (Melody A)		Fig. 15 (Melody B)	
b♭'''	pic	c''''	pic	b♭'''	pic
g'''	fl 1	g'''	fl 1	g'''	fl 1
e'''	fl 2	e'''	fl 2	e'''	fl 2
b♭''	ob 1 cl 1 ten sax	c'''	ob 1, cl 1 ten sax vn 1.1, 2.1	b♭''	ob 1 s'ino sax vn 1.1, 2.1
g''	ob 2	g''	ob 2 vn 1.3, 2.3	g''	ob 2 cl 1 vn 1.2, 2.2
e''	ca	e''	cl 2 vn 1.4, 2.4	e''	ca, cl 2, va
b♭'	cl 2	c''	ca vn 1.2, 2.2	b♭'	tbn 1, vcl

Fig. 16 (Melody A)		Fig. 17 (Melody B)		Fig. 18 (Melody C)	
c''''	pic	b♭'''	pic	b♮'''	pic
g'''	fl 1	g'''	fl 1	g♯'''	fl 1
e'''	fl 2	e'''	fl 2	e'''	fl 2
c'''	pic.tpt s'ino sax ten sax vn 1.1	b♭''	pic.tpt s'ino sax ten sax vn 1.1	b♮''	pic.tpt s'ino sax ten sax vn 1.1
g''	tpt 1 vn 1.3	g''	tpt 1 vn 1.2	g♯''	tpt 1 vn 1.2
e''	tpt 2 vn 1.2	e''	tpt 2 vn 1.3	e''	tpt 2 vn 1.3

ff possibile, topped with the blaring trumpet quartet. It is the triumph of the brass, the most modern of the orchestral instruments.

    Examination of these details of the orchestration produced by Ravel's *Boléro* factory reveals the close relationship between the composer's mechanistic qualities and his preoccupation with and skill in orchestration. Following a simple and logical process, Ravel used his violins, horns, trombones, and all the other instruments to create an intoxicating orchestra of the factory, but one much more bathed in sonorous fluid than the works of the Futurists or Satie. Ravel, believing in the ability of conventional musical instruments to sound like machinery, as well as to tell the story of the machine and interpret the machine's works, created in his *Boléro* factory the quintessential orchestration of the early machine age.