ARTISTS' NOTE

# *Robocygne*

## *Dancing Life into an Animal-Human-Machine*

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ABSTRACT

*Robocygne* is an artistic project that revolves around the development of a custom-built robotic bird, dancing to a remix of Tchaikovsky's *Swan Lake*. The artists created the choreography through a process in which movements were danced into the robot by the choreographer's manipulation of the bird's limbs, by hand, to the music. To enable this multitracking procedure, the artists, in collaboration with the engineers, developed novel software that allowed overlying recording of motions in synchronization with an audio track. From an artistic perspective, the authors discuss the search for choreographic and musical qualities and emphasize how material aspects of body and technology interrelate with emotional expression in *Robocygne*.

As a prelude to the dance festival Internationale Tanzmesse in 2012, an innovative reinterpretation of Tchaikovsky's *Swan Lake* titled *Robocygne* was performed entirely without dancers. In cooperation with Mälardalen University, choreographer Åsa Unander-Scharin and composer Carl Unander-Scharin created the work as a part of the exhibition *Opera Mecatronica*. *Robocygne* featured a custom-built birdlike robot [1] (Article Frontispiece).

From time immemorial, humans have imagined hybrid creatures, merged together in remarkable ways. In Ovid's *Metamorphoses*, Pygmalion kisses life into his ivory sculpture, and in modern times, other mythical creatures have crossed the boundary between life and death, one example being the man-machine-monster that Frankenstein brought to life through electricity [2]. Today computers, digital technology, artificial intelligence, robotics, genetic manipulation, cloning, prostheses and implants generate further new expressions and novel concepts and forms of life, often in accordance with ancient myths. Robotic artworks appeared in the 1950s and 1960s, including Nicolas Schöffer's *Robocybernétique*; Nam June Paik and Shuya Abe's *Robot K-456*; Thomas Shannon's *Squat*; and Edward Ihnatowicz's *The Senster* [3]. Later, the artist Stelarc explored the intimate interfaces between technology and prosthetic augmentation in *Third Hand* [4]; in *Quartet Project* by Margie Medlin and Gerald Thompson, virtual, mechanical and live elements came together onstage in a dancer's sensitive interaction with a robotic arm [5].

Technological development continuously challenges and expands our self-image, changing our understanding of ourselves and bringing new ontological issues to the fore. According to roboticist John Craig, robotics concerns itself with the desire to synthesize some aspects of human function by the use of mechanisms, sensors, actuators and computers and requires a multitude of ideas from various "classical" fields [6]. Craig describes how scientists often have the feeling that through their work they are learning about some aspect of themselves and claims that such connections between the field of study and ourselves are unusually obvious in robotics.

In a move away from digital screen–based aesthetics, artist John Richards suggests an approach that he calls dirty electronics, and he observes that there is a current DIY movement in art: "Crafting is back" [7]. As mediated digital culture becomes mainstream, a renewed interest in material expression and an urge to reclaim physicality are seen in the arts.

In our project *Robocygne*, our artistic intention was to create a hybrid creature that shifts between being the white swan, Odette; the black swan, Odile; and the terrifying owl magician Rothbart (Figs 1–3) [8]. We wanted this fragile body to tremble with electronic life, emotionally exhilarated by an unattainable dream of dancing on a grand stage. In recent articles, we have argued that such human-machine creatures start to "live" on their own, producing new kinds of scenic subjects [9,10]. The choreography of *Robocygne* was danced into the robotic body, reminding us of the ambiguous cyborg described by Donna Haraway as an "ontologically new,

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**Article Frontispiece.** *Robocygne*, robotic dance performance, 2010. (*Robocygne* © Åsa and Carl Unander-Scharin. Photo © Elias Lindén.)

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**Fig. 1.** *Robocygne*, a custom-built robotic bird, dancing to a remix of Tchaikovsky's *Swan Lake*. (*Robocygne* © Åsa and Carl Unander-Scharin. Photo © Elias Lindén.)

**Fig. 2.** The robotic bird strives but fails to take off and fly away. (*Robocygne* © Åsa and Carl Unander-Scharin. Photo © Elias Lindén.)

**Fig. 3.** The head diving underneath the left wing. (*Robocygne* © Åsa and Carl Unander-Scharin. Photo © Elias Lindén.)

historically specific entity," where "the machine is not other to the organism, nor is it a simple instrument for effecting the purposes of the organism. Rather the machine and the organism are each communication systems joined in a symbiosis that transforms both" [11].

After two years of artistic technological work, *Robocygne* premiered in 2010 as part of our exhibition *Opera Mecatronica* [12]. In the next two years, the swan toured and performed approximately 150 times. We constantly kept our eyes on the mechanical parts of the body, tightening loose screws, adjusting motors, gluing cracks, replacing cables and changing burned-out servos. However, in August 2012, our robotic bird danced for the last time. Fulfilling the dream, *Robocygne* was invited to inaugurate the International Tanzmesse on the grand stage of the Deutsche Oper am Rhein in Düsseldorf. In the very last moment of the performance, the body started to move in a worryingly jerky manner. The neck and wing attachments were cracking due to mechanical fatigue. The body could no longer be repaired.

In Heinrich von Kleist's "Puppet Theatre," the *premier danseur* Herr C. declares his fascination with puppets and marionettes, in particular the grace of their mechanical dance, "entirely devoid of self-consciousness" (p. 184), as opposed to the "disturbing effect consciousness had upon the natural grace of human beings" (p. 182). Herr C. discusses how "the miming of these puppets gave him great pleasure" (p. 179) and that "a dancer who wanted to educate himself could learn a great deal from them" (p. 179) [13]. Unlike the movements of marionettes, manipulated by hand in Kleist's 19th-century world, a computer operates our robotic bird. What, then, can we learn about dance from a robot? In order to explore that, we will look at the following aspects:

- how material aspects create secondary movements, beyond recorded choreography, when played back in performance;
- how these secondary movements add sound and emotional qualities to the performance;
- how technological and mechanical solutions interrelate with material qualities and thereby influence the expressions of the robotic dancer.

## PRODUCTION OF THE ROBOTIC SWAN

*Robocygne* is part of a series of dancing robots that our team has developed since 1998, including in *The Lamentation of Orpheus*, *Petruschka's Cry* and *Olimpia* [12,14,15]. In these projects, we used the custom-built software Motographicon [16], in which choreography is created through writing script codes that define the coordination of rotations within the joints.

In 2008, robot researcher Lars Asplund invited us to collaborate on a new robot project. We proposed both the idea of a swan and a novel technological solution to create it: allowing recording of its movements by manipulating its

skeleton. Rather than numerically programming movements, as is done in Motographicon, this would allow the choreographer to *dance movements into the robot.*

To capture the movements, we used sensors in the engines to sample the positions of the body parts. Thus a computer could record the robot's movements while the choreographer physically manipulated it with her hands. We developed our new software to simultaneously handle playback of recorded motion and the added motion of other body parts, as well as synchronization with an audio track [17].

Once the software and the structure of the skeleton were in place, we could explore the movement potential of each body part. There followed a time-consuming trial phase of recording, playback, skeleton adjustment and reordering of engines. This explorative construction of the body was crucial and actually was the first choreographic phase in our project—an artistic endeavor concerned with the movements and appearance of our robotic bird. For instance, when we first attached the lowermost vertebra in front of the torso plate, the neck seemed unrelated to the torso when it moved. We found that the neck performed more convincingly when the attachment was placed between the shoulders (Fig. 4).

As the engines rotate in only one dimension, the ordering of them was crucial. We reordered the engines, particularly in the neck and shoulders, several times in our search for more lifelike motion. Another task was to make all 19 engines perform simultaneously in a stable manner, without hardware failure or software crashes. After months of work, the robot was stable enough for us to start to work with the choreography in relation to the music.

## PRODUCTION OF THE MUSIC

The music draws on a fusion of the fundamentals of the Odette and Rothbart themes from Tchaikovsky's *Swan Lake*. When seeing the robot dance for the first time, we decided that the rendering of the music should correspond with the frail trembling of the robotic wings. Therefore an underlying shivering character is the basis of our remix. Furthermore, in order to elaborate on the expressive impact of our robot, we wanted to enhance the music's emotional climaxes. This we did in two ways: First we time-stretched the buildup to the first culmination, when the grand theme enters, so that the orchestral waves of the music almost collapse and "tip over" just at the entrance of the theme. In quite a contrary fashion, at the end of the performance—when the music is supposed to be at its high point—we filtered it to its bleak opposite to let the fragility of the mechanical dancer shine through. In this way, we created a grand anticlimactic curve in which heavy filtering conveys a sentiment opposite to the well-known music.

## DANCING LIFE INTO THE ROBOTIC SWAN

Since the choreographer has only two hands, each body part of the swan had to be recorded separately. Using the software's capacity to superimpose movements, we constructed the dance layer upon layer, limb after limb. However, in order not to break the robot, we needed to find a choreographic strategy that prevented the body parts from tangling or colliding when they all danced together. When we recorded the first body part, we had to imagine the dance of the other

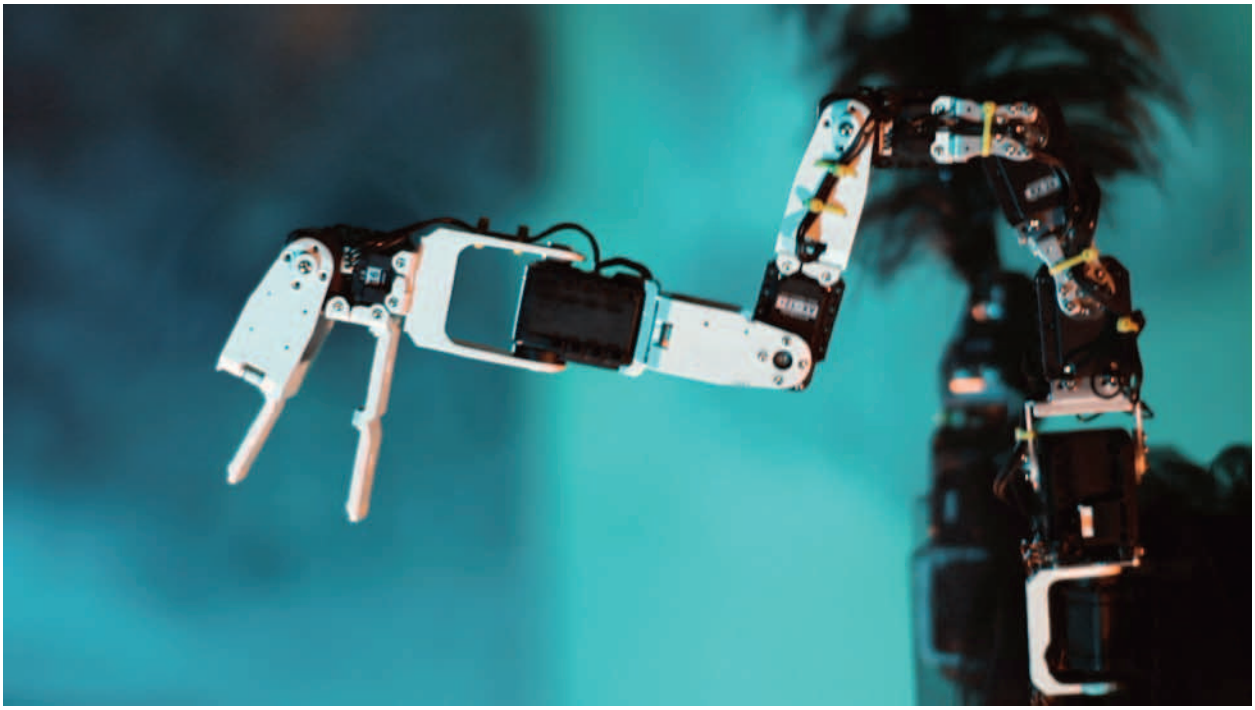

**Fig. 4.** Detail of neck and beak, showing the eight engines. (*Robocygne* © Åsa and Carl Unander-Scharin. Photo © Kersti Grunditz-Brennan/The Flock.)

limbs. Then, as we recorded the next part, the first body part was moving while the choreographer modeled the dance of the new limb, and so on.

The recording of a new body part while the others moved proved to be not only choreographically prolific but also problematic. At first, we recorded the two wings, with the notion of later modeling the dance of the neck-beak in relation to the wings. However, it proved difficult to manipulate the neck while the wings were moving. It was easier to start by recording the neck-beak, then adding the right wing, then adding the left wing and last adding the legs. As the neck-beak was the most significant and expressive body part, the choreographer realized that she had to "move herself" into the vertebral column and "dance through it" to create its expressivity. In this way, the choreographer could model the dance of the body parts in relation to one another—thus *dancing life into the robot* [18]. We repeated the recording procedure 74 times before all movements, gestures and transitions could perform in a convincing manner (Fig. 5a–c).

## CHOREOGRAPHIC CONSIDERATIONS

When *Robocygne* performed, observers noted strong emotional identification by audiences [19–21]. What gave rise to these emotions? The actor Antonin Artaud argued that in order to engage the audience, theater should return to the idea of the physical, to a "theatre of cruelty" that directly affects the anatomy and reverberates throughout the spectator's whole sensibility [22], as, so we intend, with *Robocygne*.

Interestingly, we learned that the influence of gravity and friction added emotional expression to the swan's performance (Fig. 6). Usually in robotics, one aims to eliminate so-called hysteresis and noise [6]. In *Robocygne*, on the contrary, such phenomena added emotional expression. Unpredictable material aspects and secondary movements enhanced expressive qualities beyond the computer-controlled movements, boosting corporeal characteristics unique to this particular dancer. For instance, we noticed that the engines' tension, when they held a limb in a strenuous position, created vibrations in the body that added a sense of effort and crying to the performance. From a medical point of view, it is known that involuntary tremors increase during emotional stress, strong emotions and/or physical fatigue. Such physical sensations allow for tangible qualities that we, as spectators—in line with Artaud's reasoning—perceive emotionally. While recording the wings, the choreographer had been supporting them without being aware of doing so. Later, when the wings' movements were played back without that support, the motion became heavier and more sluggish, emphasizing the impression that the bird was striving but failing to take off and fly away (Fig. 6).

At the end of the dance—again as a result of support during choreography—the robot's limbs chafed against one another in ways that they did not do during the recording. When the head dove under the left wing to stretch out the neck, the stress on the engines' operation under the pressure of the wing created a trembling expression beyond the actual recorded movement. The friction between neck and wing could even be heard, reinforcing the feeling of struggle and resignation. Similarly, the screechy noise of the leg engines when they threw the body forward, and the squeaking when the swan repeatedly opened and closed its beak, enhanced the emotional expression of those gestures.


**Fig. 5.** The choreographer recording the left wing while the neck and right wing move—dancing life into the robot. (*Robocygne* © Åsa and Carl Unander-Scharin. Sequence of photos © Åsa Unander-Scharin.)

## CONCLUSION

Returning to what we can learn about dance from robots: Rather than displaying the "natural grace" of mechanical movements in traditional puppeteering appreciated by Kleist, our digitally controlled robot not only obeyed but also worked against the laws of physics. Like human ballet dancers, *Robocygne* struggled with physical conditions while performing the choreography. While watching it dance, we

**Fig. 6.** The robotic swan's head, neck and wings falling backward due to gravity. (*Robocygne* © Åsa and Carl Unander-Scharin. Photo © Elias Lindén.)

perceived its struggle and its succumbing to gravity as signs of an inner life—a mind, intentions and emotions.

Unintentional and secondary movements, due to materiality, added emotional expression to the dance of physical bodies, human or nonhuman. "Devoid of self-consciousness and affection," our robot couldn't pretend emotions. Rather, its emotional expression was embodied in the very moment of performance, in the trembling of the lower cervical vertebrae as it lifted its neck, in the release when its neck fell backward due to gravity, in the jerking of its legs when its body was thrown forward and back, in its head cowering underneath the weight of its wing, and in its beak's crying-biting movements toward the audience. The emotional effects were not separated from the body—they were neither inside, behind nor prior to the movements.

Just as different dance techniques shape various bodies and the movement potentials of human dancers, the technology of our robot shaped its unique bodily and choreographic potential. Reaching beyond the common notion of technologies as tools for command and control, robotics extends the domain of choreography by introducing cyborg human-animal-machine dancers that challenge the boundaries and bodies of traditional ballet.

## References and Notes


1 *Opera Mecatronica* is described by the Internationale Tanzmesse festival as "expressing the most ancient of desires—to bring life to the forms we create—and inquiring whether human nature can be represented in the absence of the human. Viewers were deeply moved when the birdlike robot body, made of metal, feathers and tulle, began its trembling, vibrating and inspired dance. *Robocygne* is a work of art full of beauty and melancholy" <www.tanzmesse-nrw.com/pages/messe2012/performances/companies/opening1-en.htm>.

2 Mary Shelley, *Frankenstein; or, The Modern Prometheus* (1818) (Engage Books, 2008).

3 Eduardo Kac, "Origin and Development of Robotic Art," *Art Journal* 56 (1997).

4 <http://stelarc.org/?catID=20265>.

5 See <www.quartetproject.unsited.org/> and <https://vimeo.com/9345247>.

6 John Craig, *Introduction to Robotics Mechanics and Control* (Pearson, 2005).

7 John Richards, "Lost and Found: The Mincer," *Leonardo Music Journal* **7** (1997), <www.leonardo.info/isast/articles/Richards-Mincer_LMJ07.html>.

8 Video of *Robocygne*: <http://vimeo.com/21269998>.

9 Åsa Unander-Scharin, "Three Interactive Scenes of the Crystal Cabinet," *Body, Space and Technology* (Brunel Univ., 2011).

10 Carl Unander-Scharin, Åsa Unander-Scharin and Ludvig Elblaus, "Singing Interaction: Embodied Instruments for Musical Expression in Opera," *Leonardo Music Journal* **24** (2014).

11 Donna J. Haraway, "Cyborgs to Companion Species: Reconfiguring Kinship," in *Chasing Technoscience: Matrix for Materiality*, Don Ihde and Evan Selinger, eds. (Indiana Univ. Press, 2003) p. 62.

12 See <www.operamecatronica.com>.

13 Heinrich von Kleist, "Puppet Theatre" (1810), in *What Is Dance?*, Roger Copeland and Marshall Cohen, eds. (Oxford Univ. Press, 1983).

14 Åsa Unander-Scharin, "Mänsklig mekanik och besjälade maskiner" ("Human Mechanics and Soulful Machines"), Ph.D. diss., Luleå Univ. of Technology (2008).

15 See the abbreviated English version of the dissertation by Åsa Unander-Scharin, "Moving Mechatronics," in *Tedance: Perspectives on Technologically Expanded Dance* (ed. Daniel Tércio, Lisbon Univ., 2009).

16 Motographicon is a choreography software developed by Magnus Lundin and Peter Rajka; see <http://hdl.handle.net/2027/spo.bbp2372.1994.048>.

17 A detailed description of the technological construction is found in Alexander Larsson, *Creation and Choreography of Robotic Bird*, report on master's degree project at Mälardalen University, November 2009.

18 Neck: <http://youtu.be/jTLgFwCg770>; left wing: <http://youtu.be/oP2idb_NfHU>; leg: <http://youtu.be/K4UytJGVriw>.

19 See <http://news.cnet.com/8301-17938_105-20017286-1.html>.

20 Örjan Abrahamsson, *Dagens Nyheter*, November 6, 2011.

21 Anna Ångström, *Svenska Dagbladet*, November 18, 2010.

22 Antonin Artaud, *The Theatre and Its Double* (1938) (London: Calder and Boyars, 1976).

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