Institution:
University of Cambridge

Unit of Assessment:
UoA32B

Title of case study:
Embryo images

1. Summary of the impact (indicative maximum 100 words)

Nick Hopwood's *Embryos in Wax* (2002) has impacted on museum practice by enabling curators of many local and national collections to catalogue the most important embryological models and display them informatively in permanent and major temporary exhibitions. Especially the online exhibition *Making Visible Embryos* (2008) and a 2006 article in *Isis* have greatly stimulated discussion and use of historic embryo images, providing evidence and interpretation to debates over abortion, developmental biology, evolution and creationism. The research has impacted on undergraduate and postgraduate teaching at other HEIs by opening up new topics and enabling new kinds of collections-based project and class.

2. Underpinning research (indicative maximum 500 words)

Hopwood produced the research between 1998 and the present as University Assistant Lecturer, Lecturer and since 2005 Senior Lecturer in the Cambridge HPS Department. He uncovered how in the nineteenth and twentieth centuries anatomists and zoologists collaborated with artists to produce serial representations of embryonic development that came to stand for the course of a pregnancy and the history of life on earth and so to replace competing views. Hopwood argued in 'Producing development' (2000) that these developmental series resulted from linked practices of collecting, image-making, ordering, selecting and publication or display. This contributed specifically and significantly to the interpretation of embryological artefacts, especially wax models and printed images, and more generally to historical studies of visual culture.

Embryos in Wax (2002) was the first and remains the definitive guide to the output of the leading producer of academic wax models between the 1850s and the 1930s. With *Embryos in Wax* and his contributions to *Models: The Third Dimension of Science* (2004) Hopwood took a lead in promoting a reevaluation of the history of 3-D models in the sciences. He demonstrated how engaging with this previously neglected medium could (i) uncover important aspects of past research as well as teaching, (ii) highlight the politics of medium choice, and (iii) inform reflection on the digital revolution.

Hopwood's other major focus has been on interpreting the making and uses of printed pictures, both agreed technical standards and images that have become standard through copying. The articles in *Bulletin of the History of Medicine* (2000) and *History of Science* (2005) revealed how normal plates, tables and stages were made authoritative visual standards in embryology and developmental biology. The *Isis* article offered the first archivally-based history of the most controversial and some of the most successful pictures in the history of science. Originally published in 1874, their author, the German Darwinist Ernst Haeckel, was accused of fraud in major debates in the 1870s and 1908–10, but the figures were nevertheless reproduced in twentieth-century high-school and college textbooks until 1997, when they sparked a third controversy. In this recent debate, creationist advocates of so-called 'intelligent design' targeted authors and publishers through activism around textbook adoption, science standards and legislation. Hopwood's article showed definitively that Haeckel's questionable actions are not well described as fraud, and that few competent contemporaries initially saw the plates in this way, and opened up the case as a prime example of the making of an icon of knowledge.

The online exhibition *Making Visible Embryos* synthesized all this work, added new research and presented the result as the only substantial, long-term survey of the history of human embryology in any medium. It stresses the work of visualization and contains many expertly interpreted, high-quality images, most of them displayed online for the first time. Produced in collaboration with Tatjana Buklijas, a postdoc employed by the University for the academic year 2004–5 as website researcher and designer, the exhibition has been an influential experiment in presenting research in history of science and medicine online.

3. References to the research (indicative maximum of six references)

All URLs are available at http://www.hps.cam.ac.uk/people/hopwood/

2008: Tatjana Buklijas and Nick Hopwood, *Making Visible Embryos*, www.hps.cam.ac.uk/visibleembryos. *c.*125 images, *c.*36,000 words. Wellcome Trust funded. Reviewed in e.g., *Bulletin of the History of Medicine*, *Nursing History Review*, *Nature*, *New Scientist, Sapere*; and on influential blogs. In 'Public history and the public understanding of medicine: The case of embryology', *Hist. Workshop J.* **70** (2010), 217–21, Ludmilla Jordanova called it 'brilliant … a major contribution both to the public history of science and medicine and to the public understanding of science and medicine as integral to contemporary life.'

2006: Nick Hopwood, Pictures of evolution and charges of fraud: Ernst Haeckel's embryological illustrations, *Isis* 97, 260–301. In September 2010 this was CrossRef's seventh most-cited article in *Isis*.

2005: Nick Hopwood, Visual standards and disciplinary change: Normal plates, tables and stages in embryology, *History of Science* 43, 239–303.

2004: Nick Hopwood and Soraya de Chadarevian, 'Dimensions of modelling', and Hopwood, 'Plastic publishing in embryology', in Soraya de Chadarevian and Nick Hopwood (eds), *Models: The Third Dimension of Science* (Stanford, 2004) 1–15 and 170–206.

2002: Nick Hopwood, *Embryos in Wax: Models from the Ziegler Studio, with a Reprint of 'Embryological Wax Models' by Friedrich Ziegler* (Whipple Museum of the History of Science, University of Cambridge; Institute of the History of Medicine, University of Bern). xi, 216 pp. Reprinted in 2013. Publication was funded by (among others) Netherlands Institute for Developmental Biology, Company of Biologists, Universiteitsmuseum Utrecht, National Museum of Health and Medicine, Washington, D.C. Reviews: http://www.hps.cam.ac.uk/embryos/reviews.html.

2000: Nick Hopwood, Producing development: The anatomy of human embryos and the norms of Wilhelm His, *Bulletin of the History of Medicine* 74, 29–79.

All outputs can be supplied by the University of Cambridge on request.

4. Details of the impact (indicative maximum 750 words)

Museum practice: *Embryos in Wax* has stimulated many medical, anatomical, zoological, and embryological museums and institutes internationally to catalogue and effectively display permanent collections of Ziegler models that previously languished unlabelled in store cupboards. By providing an accessible illustrated history, photographs of almost all models, tabulated information and extensive documentation, it has enabled curators to label and contextualize once-nondescript objects. As a result many institutes engage with their own histories by exhibiting the oldest objects routinely to have survived on their premises. The initial impact was between 2002 and 2008, but has continued strongly as new institutions make use. Recent examples include Oxford University Museum of Natural History (2008), Birmingham Medical School (2011), the Alfred Denny Museum, Sheffield (2011) and a major new database of German university collections (2010–12) **[1]**. At Oxford, Hopwood's work was 'absolutely crucial' to stimulating and justifying the expense of a project to catalogue, conserve and properly house about 90 models that were 'forgotten' and now have 'scientific specimen status' **[2]**. At Birmingham and Sheffield, *Embryos in Wax* also enabled the models to be displayed in a wider context to students and the general public. At the National Museum of Health and Medicine, Washington, D.C., one of the world's premier collections with some 50,000 visitors a year, *Embryos in Wax* and *Making Visible Embryos* have regularly provided curators, interns and their clients with information to aid identification and contextualization. *Making Visible Embryos* directly informed the choice of several images and their interpretation in the new permanent display (2012) **[3]**. The research further shaped such major temporary exhibitions as 'Exquisite Bodies' at Wellcome Collection, London (July–October 2009), for which Hopwood acted as a consultant **[4]**. *Embryos in Wax* was

read by the lead curator, directed the choice of exhibits, informed the loan of Ziegler models and was made available in a reading area, bibliography and bookshop to the 52,667 visitors **[5]**. *Embryos in Wax* is also used in auction catalogues **[6]**.

Public engagement and debate: *Making Visible Embryos* has stimulated discussion and use of historic embryo images. Google analytics counted approximately 36,000 (29,000 unique) visitors between October 2008 and October 2012, 13,500 from USA and 6,500 from Britain, with interest sustained through 2011 and 2012 **[7]**. Specific impacts include: a review at jezebel.com, the major postfeminist critique site (1.5M visits per month in 2010) that generated several pages of comments on uses of embryo images in abortion debates **[8]**; bloggers, other writers and academics copying selected images and adding their own comments or histories; schoolchildren using the site for projects; and use by embryologists, sonographers and others to provide a historical perspective on their work. Hopwood's *Isis* article intervened authoritatively in the international controversy in evolutionary developmental biology, and especially in the United States between creationists and evolutionists over Haeckel's embryos, to improve the quality of evidence and argument. E.g., it has been cited since 2008 on the website of the leading anticreationist organization, the National Center for Science Education, as a 'comprehensive' investigation that rebuts claims of fraud **[9]**.

Teaching: The research has enriched undergraduate and postgraduate teaching at other HEIs by opening up new topics and approaches in HPSM and neighbouring fields. Since 2009, for example, the 'Visualising Science' module of the University of Kent Science communication MSc has included a session on embryo images, using *Making Visible Embryos* as the main resource and *Embryos in Wax* and other work by Hopwood as key readings **[10]**. Innovatively, *Embryos in Wax* and *Models* have not only brought the history of 3-D models as a topic into the higher-education curriculum—chapters from *Models* feature on many reading lists internationally (e.g., a history of medicine survey, University of Toronto)—they have also inspired collections-based pedagogical projects. At the HPS Centre at Leeds, for example, *Embryos in Wax* has since 2007 'been central to our ways of thinking about our collection', which in 2012 was built up into a Museum of the History of Science, Technology and Medicine **[11]**. Thanks to *Embryos in Wax*, Ziegler models—previously all but unknown to non-specialists—have become 'the flagship objects' in this teaching collection, and the book 'has typically been the first port of call for students conducting collections research and has greatly informed their thinking' **[12]**. Through student projects the book 'involved students in new kinds of learning about conservation, display [and] research'. Hopwood's research inspired a regular third-year philosophy of biology seminar at Leeds, in which undergraduates have been shown Ziegler models and asked to 'consider [their] relations to evidence, theory, medical education and practice … [and] the craft and business of model-making.' It is 'unusual for [such a] course to incorporate the material heritage of science'; at Leeds, 'it had never happened before … it happened … thanks to [Hopwood's] work' **[13, 14]**.

5. Sources to corroborate the impact (indicative maximum of 10 references)

[1] Universitätssammlungen in Deutschland (http://www.universitaetssammlungen.de/), a major new database of German university collections produced by the Helmholtz-Zentrum, Humboldt University, Berlin, with DFG funding, includes within its sub-project on material models (2010–12) 26 series by the Zieglers, for which the entries cite *Embryos in Wax*, http://www.universitaetssammlungen.de/modelle/suche/art/Modelle+von+Lebewesen+und+biologischen+Systemen.

[2] Emails from Person 1 (Collections Manager, Oxford University Museum of Natural History), 14 and 15 Jan. 2013.

[3] Email from Person 2 (Collection Manager, National Museum of Health and Medicine, Washington, D.C.), 11 Dec. 2012.

[4] http://www.wellcomecollection.org/whats-on/exhibitions/exquisite-bodies/credits.aspx and

[5] Emails from Person 3 (Senior Curator, The Wellcome Trust), 17 and 20 Dec. 2012.

[6] For use in an auction catalogue, 17 June 2013: http://www.dorotheum.com/en/auction-detail/auction-10062-antique-scientific-instruments-and-globes/lot-1517519-ffriedrich-ziegler-18601936-and-aurel-v-szily-18801945-two-rare-wax-model-series-three-and-five-models.html?no_cache=1&offset=1&cHash=a0605f69056a885b5607b4c3730dbc20

[7] Google analytics data for *Making Visible Embryos* are available on request.

[8] Impact through *Making Visible Embryos*, e.g., http://jezebel.com/5223102/an-abridged-history-of-the-imagery-of-the-human-embryo.

[9] For use of the *Isis* article in discussion over Haeckel's embryos, see e.g., 'Accuracy in embryo illustrations', 30 Sept. 2008, National Center for Science Education, http://ncse.com/creationism/analysis/exaggerations.

[10] For the Kent teaching: http://resourcelists.kent.ac.uk/lists/C76A8C04-6904-F0E5-1387-F83A82678CDA.html.

[11] http://www.leeds.ac.uk/heritage/hpsmuseum/waxmodels.htm, 2011: 'As a starting point … see N. Hopwood, Embryos in Wax: Models from the Ziegler Studio (2002) and the online exhibition Making Visible Embryos at Cambridge University.'

[12] Email from Person 4 (Director, Museum of the History of Science, Technology and Medicine, University of Leeds), 7 Dec. 2012.

[13] Email from Person 5 (Professor of History and Philosophy of Science, University of Leeds), 6 Dec. 2012.

[14] For student engagement, see the blog at http://hpsmuseumleeds.wordpress.com/ and search, e.g., on 'Ziegler'.