THE GENDER OF THINGS

How Epistemic and Technological Objects Become Gendered

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Phantoms, Radioiodine Uptake Tests, and the IAEA's Standardization Projects

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Maria Rentetzi

During one of my visits to the International Atomic Energy Agency's (IAEA) archives I came across a startling picture (Figure 4.1). Having almost an obsession with boxes and containers (see Rentetzi 2011; Bauer, Schlünder, and Rentetzi 2020) and a long-standing interest in gender studies (e.g., Rentetzi 2007), the female dummy in a suitcase caught my immediate attention. Modelled on a female human torso with prominent breasts and a thin body but without hands, it reminded me of the realistic mannequins that appeared in shop windows throughout the 1950s and 1960s in the United States. As consumerism boomed, mannequins at the time embodied the ideal of female beauty: tiny waistline, high busts, and sloping shoulders (Morris 2015). In the photo, the dummy's neck appears to have a cavity in the location corresponding to the human thyroid gland. Several cylinders and three smaller containers of different sizes were all strapped on the inside of the suitcase's cover. It was obviously a suitcase; a rectangular container with a handle in its long side and two catches, resembling the early cases that held the suits of British and American businessmen before the Second World War (Gross 2014). The photo's caption is detailed and revealing. The "dummy" was part of one of the IAEA's technical assistance programmes, designed to standardize the radioiodine uptake test across its Member States.[1]

Going through archival material and additional photos, it did not take me long to find a few more images that demonstrated the calibration of relevant equipment and the process of standardizing the radioiodine uptake tests. In one of them, Godofredo Gómez Crespo, a member of the IAEA's scientific staff was featured at the Agency's laboratory in Seibersdorf, Austria,

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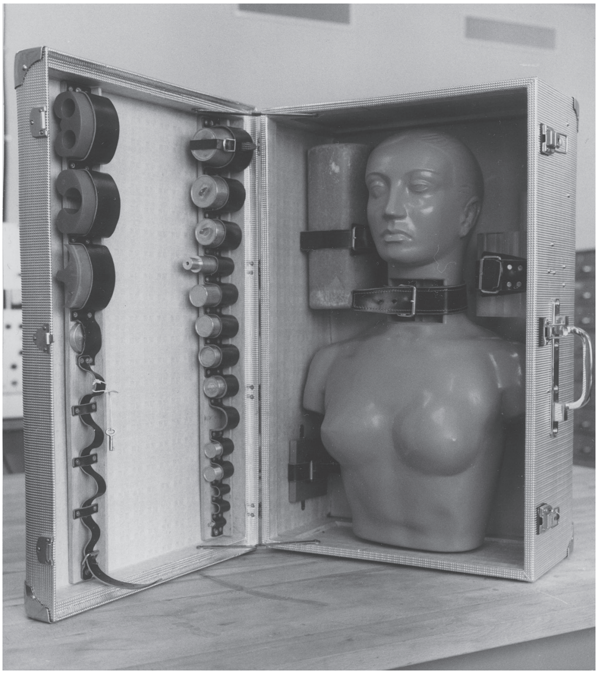

FIGURE 4.1 "In order to demonstrate the accurate measurement of radioiodine uptake by the thyroid gland, a dummy has been especially constructed in the Agency's laboratory. The dummy, which will be taken by a number of the Agency's scientific staff to Member States who have asked for assistance in calibrating and standardizing their measurement techniques and equipment, is carried in a suitcase containing interchangeable mock thyroids and a set of 'standards' of various sizes. 8 December 1961." IAEA's original caption. Courtesy of the IAEA Archives, photo no. E0001-045.

measuring the distance between the mock thyroid of the dummy and the crystal of a scintillation detector placed opposite the mannequin (Figure 4.2). In a second photograph, a close-up of the same setting, Gómez Crespo was captured placing a mock iodine standard in the small container simulating the thyroid gland, which perfectly fitted into the hole in the dummy's neck. A fourth picture was a close shoot of the iodine standards lined up on the laboratory's bench. Taken together, these pictures sum up one of the greatest technocratic endeavours undertaken by one man in the IAEA's early history: the promotion of the medical uses of radioisotopes across the globe. That was the first and only time in the IAEA's history that a man travelled around the world with a radioactive suitcase as part of the Agency's standardization programme. My argument here (as elsewhere; see Rentetzi

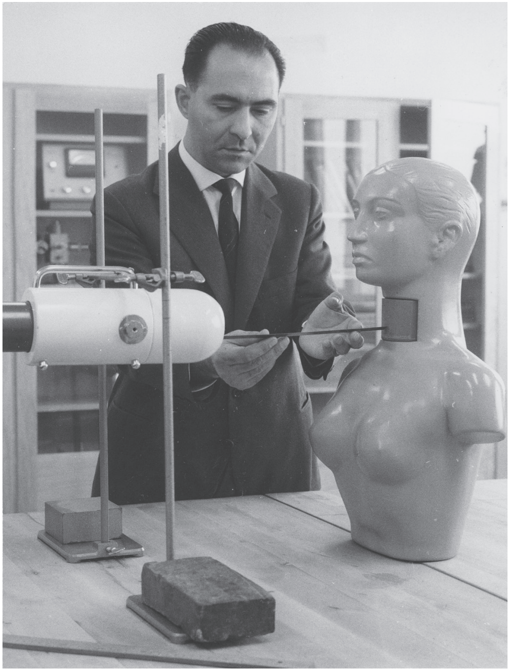

FIGURE 4.2 "A dummy figure has been constructed in the Agency's laboratory to demonstrate the accurate measurement of radioiodine uptake by the thyroid gland. The photo shows the distance being measured between the mock thyroid of the dummy and the crystal of a scintillation detector." IAEA's original caption. Courtesy of the IAEA Archives, photo no. E0001-046.

2022) is that this was a highly gendered enterprise reinforced by the material culture of the new organization.

Established in 1957 as the intergovernmental institution that could ensure the international control of atomic energy and the promotion of its peaceful uses (Fischer 1997; Rentetzi 2017; Roehrlich 2022), the IAEA initiated a huge number of technical assistance projects, especially in what was considered at the time the "developing world." The Agency's mission was to promote nuclear industry and medicine and at the same time to safeguard the atom (Creager and Rentetzi 2022; Rentetzi 2021). Functioning as a global regulatory institution, the IAEA set the standards for nuclear equipment and techniques along with the standardization of units of measurement, experimental procedures (Rentetzi 2022), and specialized vocabulary, and even the design of nuclear laboratories as its major and global technocratic venture.

The dummy, named Françoise, was part of the same process. Yet, an obvious question came to my mind as soon as I faced the picture of the naked female dummy manipulated by the male IAEA scientist: Was there any scientific reason for simulating the "standard" human torso by means of a female shop-like mannequin with perky breasts? In short, why was this scientific instrument gendered? In what follows, I focus on Françoise and her "biography" following the process of her construction. I then go back in time to study Françoise's predecessors, almost a dozen mannequins that were produced at the United States' Oak Ridge Institute of Nuclear Studies (ORINS) in the mid-1950s as the first generation of anthropomorphic phantoms—highly specialized objects that mimicked the human body. Keeping in mind that laboratories such as Oak Ridge or the IAEA's Seibersdorf laboratory were gendered spaces including almost exclusively men, I explore the ways instruments were gendered. Eventually, as I argue, through its technical assistance programme, the IAEA actively and constructively gender-shaped the material culture of radiation scientists across the globe, setting standards not only for permissible radiation doses but also for what counts as an "epistemic thing" (Rheinberger 1997).

Françoise and radioiodine uptake tests

One of the most valuable diagnostic applications of radioactive isotopes during the 1950s and 1960s was the determination of the uptake of radioactive iodine-131 by the thyroid gland of patients suffering from thyroid disorders. The thyroid is the gland in the human neck that produces hormones to regulate the body's metabolism. Dysfunctions result in either hyperthyroidism—an overactive gland that produces too much thyroid hormone—or hypothyroidism, an underactive gland. Radioiodine has the characteristic of concentrating in the thyroid. Thus, the radioiodine uptake test was widely used in the diagnosis and examination of thyroid diseases as well as the treatment of thyroid cancers. The diagnostic procedure was straightforward. Patients were orally given radioiodine and 24 hours later, scientists measured the uptake of radioiodine by the thyroid gland. Based on the results they could infer the type of thyroid disorder that was present. Thus, radioiodine thyroid uptake tests constituted one of the first diagnostic applications of radioactive tracers. It was usually the first technique to be adopted by a newly established isotope laboratory in medical settings ("Radioiodine Uptake" 1962). At the time, as did the vast majority of radioisotopes, iodine-131 became widely available, being produced by the reactor of the Oak Ridge National Laboratory (ORNL) (Creager 2013).

According to a recent US study, from 1950 to the mid-1960s, the typical number of thyroid uptake tests per month per institution was in the range of 18–60 patients. A US nation-wide survey conducted in 1966 indicated that the number of patients who went through a thyroid uptake test that year were 301,052 (Drozdovitch et al. 2014, 16, 18). In addition, the development of various imaging devices, especially the rectilinear scanner which visualized human organs, made thyroid scanning one of the most typical clinical practices and most frequently conducted diagnostic procedures.

Besides their medical significance, thyroid uptake tests had political importance due to the radioactive fallout studies of that period. From 1945 to 1963, the US government conducted several ground nuclear weapons tests in Nevada, New Mexico, and in the Pacific. The radioactive substances released by these tests, known as fallout, were carried thousands of miles from the test site by winds, affecting a large number of people who were eventually exposed to varying levels of radiation (Pearce 2018). Among the numerous radioactive substances released in fallout was radioiodine, which collects in the thyroid. As the 1997 National Cancer Institute report made clear, radioiodine was of great concern (NCI 1997). Studies had shown that between 10,000 and 75,000 Americans exposed to radioiodine in their youth could have developed thyroid cancer during their lifetimes. Talking to the *Chicago Tribune*, the director of the NCI, Richard Klausner, tried even then, more than 40 years later, to downplay the results: “These are relevant numbers with a significant amount of uncertainty” (Kirkland 1997).

Back in the 1950s, different laboratories in different parts of the world used a variety of methods and equipment to perform thyroid radioiodine uptake measurements to estimate the exposure. As the Head of the IAEA’s Section of Medicine, Herbert Vetter, admitted then, “the deviation of the measured value from the true value was often depressingly large, even in many European countries one could certainly not consider to be underdeveloped with regard to nuclear medicine” (Feld and De Roo 2003, 114–15). This diverse practice raised concerns about the reproducibility and repeatability of measurements, allowing for uncertainty in the final data. But it also put the United States in great unease on an international level, as the country’s Atomic Energy Commission (AEC) was facing the results of nuclear tests in the Pacific. To address local concerns but also to collect radiation data, American teams of medical doctors and health physicists made annual trips to the Marshall Islands to check on the health, and especially the thyroid glands, of islanders accidentally exposed to radioactive fallout (Simon, Bouville, and Land 2006, 52). At that moment, the subtle shift of responsibility for measuring the effects of fallout to an international regulatory institution such as the IAEA seemed ideal.

On September 24, 1959, Admiral Paul Foster, the US representative to the IAEA’s Board of Governors, addressed Sterling Cole, the Agency’s Director General with a proposal: “The United States believes that the Agency should consider sponsoring a program” in its calibration and standardization activities, he wrote, referring to the thyroid uptake measurements with radioiodine. In mid-December Cole responded rather affirmatively, promising to write a circular letter to all Member States informing them about the project. By January 25, 1960, Herbert Vetter wrote to Foster that "we have started to make preparations for a so-called thyroid phantom project."[2]

Cole's circular letter dated March 21, 1960, informed 70 countries on the details of the project. By early October the Agency had received positive confirmations from 15 countries.[3] An IAEA expert was going to be available to those Member States that agreed to accept his service and share the cost of his two-week stay in the respective country. The expert was going to carry with him the dummy figure with the mock radioiodine standards; his task was to calibrate local apparatus for uptake measurements and suggest the standardized procedure for getting comparable and reproducible results. With an interoffice memorandum, Deputy Director General Henry Seligman informed the Agency's Division of Personnel that Godofredo Gómez Crespo seemed to be "a very suitable candidate" for undertaking the task. A Spanish physician and graduate of the University of Salamanca, Gómez Crespo had moved to the United States to work at Western Reserve University in Ohio as a radiologist in 1955. A polyglot, Gómez Crespo spoke Spanish, French, English, Italian, and Portuguese. His "excellent grasp" of issues related to radioisotopes and scanning techniques made him the perfect candidate for the job. The hiring process went fast. By September 15, 1960, Gómez Crespo had already moved to Vienna with his wife and three children and signed his contract with the IAEA Department of Research and Isotopes.[4] His first assignment was to arrange an experts' meeting at the end of November 1960 in order to extensively discuss the technical details of the calibration and standardization procedure. One of the major issues was the construction of Françoise.

Arriving in Vienna on November 28, the panel of experts—all white men from Western countries—worked hard to achieve a workable plan for a novel, demanding standardization procedure that could be used globally.[5] Although experts attempting to define a feasible technique were caught up in the epistemological and technical thrill of health physics and radiation dosimetry, the committee's recommendation was finally unanimous.[6] At its core was the implementation of a phantom. As the committee argued, the use of a neck phantom was "essential, particularly if results from institutions in various parts of the world are to be compared." According to their recommendation no. 2.2.2,

> This phantom should be a cylinder of 15 cm diameter and of 15 cm in height, made preferably of lucite or perspex. It should have a hole which would accept the standard vessel [...]. The distance from the edge of the phantom to the surface of the hole should be 0.5 cm.
>
> *Comments:* Great care should be taken to avoid contamination of the phantom.
>
> *("Consultants' Meeting" 1962, 206)*

The IAEA's plan was to construct the phantom locally "at a substantially lower price." Because, as Gómez Crespo soon realized, these phantoms were not "readily available" in Austria or anywhere in Europe at the time.[7] The IAEA hired an artist, and a nude model posed for the construction of the mould. This is how Gómez Crespo described the process:

> My boss arrived at the atelier a few minutes later. […] Don't touch her breasts, the artist ventured, they are gorgeous. We acquiesced. A Viennese girl, richly endowed by nature, posed for the artists who made a plastic manikin. / My interesting job involved travel…with the plastic one.
>
> *(Gómez Crespo 1997, 34)*

I want to pause for a moment, go back to Figure 4.1, and juxtapose it with recommendation no. 2.2.2. How did a strictly technical description of a phantom, which precisely defined only sizes and materials, get translated into Françoise with her perky breasts, a female mannequin? How did the linguistic and ontological shift from phantom—a scientific concept—to mannequin—a shopfront window parole—take place? In short, how should one follow the gendered fabrication of an artefact? What immediately comes to mind is Bruno Latour's affirmation that "the construction of facts and machines is a collective process" (Latour 1987). The transformation of a fact into an artefact is always part of what Latour termed science in action, the process of constructing scientific facts through the amalgamation of scientists' day-to-day research. Going back to the IAEA expert panel and Gómez Crespo's colleagues, to understand the construction of Françoise based on the consultants' technical recommendations requires to read closely Paul Foster's letter of September 1959 to Sterling Cole. My focus now shifts to the material culture of Oak Ridge and the history of its female mannequins.

Marshall Brucer's Cohort of mannequins

On July 25, 1956, the Medical Division of the Oak Ridge Institute of Nuclear Studies issued a report on the thyroid uptake calibration. The first phase of that programme, conducted in 1954, had indicated "a considerable variation in the measurement of thyroid uptake throughout the United States and England" (Brucer, Oddie, and Eldridge 1956, 1). A physician and pioneer in nuclear medicine, the report's main author, Marshall Brucer, realized that there was an important issue of precision. Radioiodine measurements at a physics laboratory did not necessarily match those at the clinic. As the ORINS-14 report affirmed, "it is obvious that an exact external measurement of the amount of I 131 in the thyroid gland is a physical impossibility" (6). However, for the intercalibration of instruments a standard was needed. The proposed solution was to create a full-size phantom “closely duplicating the upper part of the human torso” (7).

Earlier attempts to calibrate and standardize radioiodine uptake measurements had involved experimentation on humans. In the early 1950s, physicists in New York, who were associated with the city’s medical institutions and promoted health physics and radiology, had used a patient instead of a phantom. In a letter to Vetter from 1960, Solomon Berson from New York’s Veterans Administration Hospital mentioned that

> Dr. Yalow, former president of the N.Y. Hospital Physicists Association, tells me that about 8–9 years ago the Association carried out an experiment along the lines of the ORINS mannequin experiment by sending around a patient (rather than a mannequin) who had received a dose of I-131 the previous day, to seven different laboratories in New York on the same day.[8]

As this method was considered quite inconvenient and unrealistic (rather than unethical), physicists had to devise a different process. It is interesting that later on, the IAEA panel of experts, too, considered transporting “an actual patient from country to country” as an alternative to creating a phantom but concluded that this “would hardly be economic or practicable.”[9] Using the phantom was indeed a solution.

At Oak Ridge, the idea was to fill a shop-like mannequin with a mixture of longer-lived radioactive isotopes than iodine-131, whose half-life is only 8.1 days. Finally, the mixture was decided to be barium-133 and cesium-137, known as mock radioiodine. Having determined the mixture, Brucer and his Oak Ridge team designed their first dummy, Abigail. “The phantom is the upper torso of a plastic store-mannequin, complete with head and detachable upper halves of each arm” (Brucer, Oddie, and Eldridge 1956, 20). By 1956, eight phantoms were ready and used for calibration purposes.[10] In their report, Brucer et al. mention that two additional ones, “far more complex than the routine mannequins,” were used “for physical tests rather than for calibration” (21).

With plenty of support from the Atomic Energy Commission, the second phase of the Oak Ridge research project in 1956 aimed to calibrate equipment across the United States as well as in England. The group had already “begun on an experimental scale with the distribution of ten calibration kits,” the first systematic attempt to explore the precision of the thyroid uptake measurements and devise a standard. When Foster addressed Cole in September 1959, Oak Ridge had just published its final report on the project, ORINS-19 (Brucer 1959). Foster described it as a manual for students studying thyroid uptake measurements with radioiodine. With this extended programme, the Oak Ridge group did not just calibrate thyroid measurements in the United States. Sources indicate that mannequins were also sent to Japan and Australia (Grigg 1965, 299).

As Foster explained, the United States was expecting to receive requests from foreign countries to borrow their calibration kits and phantoms. But since the IAEA already had calibration and standardization activities in its programme, what could be better than adopt the technique and offer a similar service worldwide? The AEC generously offered to provide an expert on the technique. In his response, Cole agreed to develop the programme along the lines of the ORINS report.[11]

Indeed, before the consultants' group convened in Vienna, they had already received by mail a copy of that report. The key participant was Douglas Ross, head of ORNL's Medical Physics division. Gómez Crespo had already met him in the United States, having spent ten days at his laboratory before his employment by the IAEA began. Ross's group and especially Marshall Brucer, who had designed the programme and co-authored the report, offered Gómez Crespo a fast training to learn about their techniques and equipment. "Blueprints of the simulated thyroids and phantoms were given to me," Gómez Crespo later wrote to Vetter. "In addition, I made photographs of the various components of the mannequins showing some construction details."[12] As Ross was preparing to join the panel of experts in Vienna, Gómez Crespo suggested that he bring along Brucer's "midget exhibit [...] for handy reference" related to the standardization process.[13]

The literal passing on of laboratory equipment from Oak Ridge to Seibersdorf went along with the transfer of practices and experimental styles. Yet this transfer was of a more subtle kind. Things, and especially experimental devices, are loaded with meanings, with assumptions about who has the right to do science, with stereotypical understandings about the role of gender in experimentation. They embody power relations and gender symbolisms (Rentetzi 2007). As an experimental artefact, the phantom portrayed the supposedly universal human body to be used in radiation dosimetry. Oak Ridge's normative range of physiological and cultural functions of a dummy figure came together with a strong statement about the social and gender organization of experimental research at the time. It came with a picture of femininity as well as with a suggestion about masculinities in physics.

The ORINS-14 report (Brucer, Oddie, and Eldridge 1956) was prefaced by a picture of six female dummies. Each of them was placed in a suitcase like the one hosting Françoise. What is striking is that each was different from the others with respect to facial characteristics and their wig. All were white, young females with wigs of different hair styles and colours. I cannot imagine the care that their wigs needed to keep hair straight during experimentation. Although the photo is black and white, it is obvious that their lips were also coloured. Another picture, of the same setting of the six dummies but with Brucer sitting in front of the mannequins, smiling full of confidence, never made it into any of his reports (see Figure 4.3).[14]

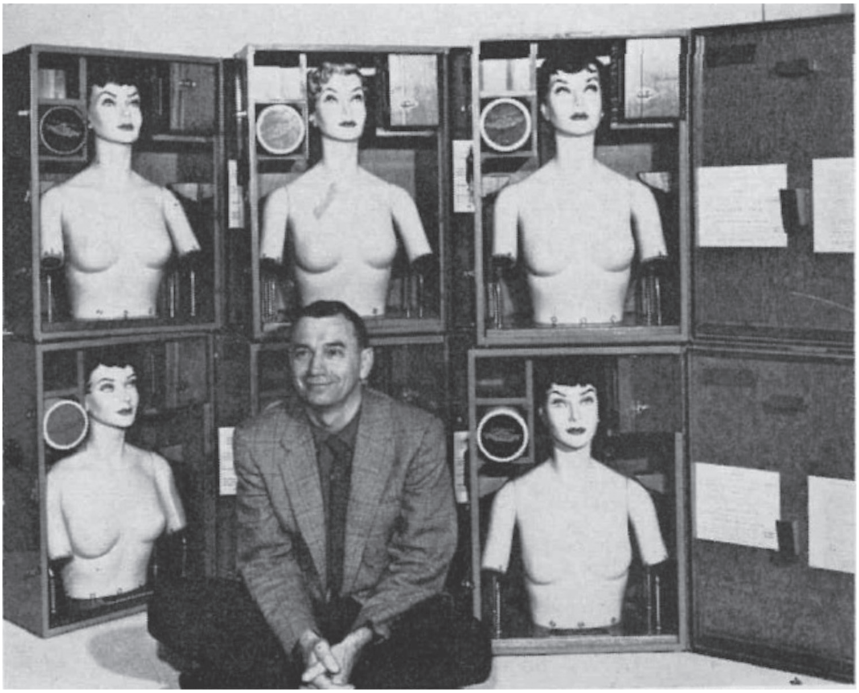

FIGURE 4.3 Marshall Brucer amidst his mannequins at the Oak Ridge Institute of Nuclear Studies (Grigg 1965, 299).

Instead, in ORINS-19—Brucer's final report on the mannequins' project—all drawings of the generic patient on whom the phantoms are based are male figures (Brucer 1959). Ironically, Brucer's photo surrounded by his inanimate creatures immediately reminded me of Hugh Hefner, the founder of Playboy in 1953, and his usual photoshoots with him surrounded by his equally "standardized" playmates (e.g., Figure 4.4). There is something very similar about Figures 4.3 and 4.4: they were both taken at a time in US history when women were strongly objectified.[15]

The Oak Ridge mannequins definitely looked more "real," "attractive," and "feminine" than Françoise. "*Our girls* (emphasis mine) are made of a 'plastic' shell," explained Ross to Gómez Crespo. Advising him on the experimental setting and procedure, Ross underlined the important question at hand: "Does the I-131 spectrum coming from my manikin resemble, sufficiently closely that coming from a human patient? I should warn you that this question is not gratifyingly simple."[16]

Not incidentally, then, the recommendations of the IAEA panel experts were heavily based on Brucer's experimental settings, including the description of the phantom. As Vetter explained to Warren Sinclair, a prominent member

FIGURE 4.4 "Millionaire publisher of Playboy magazine Hugh Hefner poses with a bevy of bunny girls at one of [the] Playboy clubs" (photo by Helmut Kretz/Getty Images).

of the International Commission on Radiological Protection (ICRP), "in practice this could be a continuation and expansion of Marshall Brucer's mannequins project."[17]

Objects and power

In the face of dealing with a worldwide calibration and standardization programme, the IAEA's experimental settings and devices were eventually adapted to meet certain constraints. In scale, purpose, and use, the Agency's standardization kit differed from Brucer's chorus of mannequins. It had to be easily transportable and adjustable to both advanced and developing countries in respect to the scanning equipment used for the calibration process. Reminiscent of the Bauhaus's "form follows function" ideal, the IAEA turned a highly ornamented laboratory instrument into a functional tool. That was a matter of style and international constraints for easy transfer. The overall aim was "to establish a relatively simple but reasonably accurate standard method which could be used even under rather primitive conditions" ("Radioiodine Uptake" 1962). Thus, in 1961, the IAEA team constructed only one mannequin, Françoise, precisely following the panel's technical recommendations. In a note to Vetter, Gómez Crespo ensured him that the suitcase, given its radioactive content, would be designed in such a way as to meet the IAEA Regulations for the Safe Transport of Radioactive Materials. The suitcase had a lock and a folding handle. In line with the regulations, it bore a white label with the IAEA's logo and a sign warning that its content was radioactive.[18]

Over three years, from the spring of 1962 to the end of 1965, Gómez Crespo travelled the world together with Françoise to test and calibrate the local equipment in a network of 199 laboratory and medical settings in 41 IAEA Member States. In terms of its magnitude but also of the personal sacrifices Gómez Crespo made by being constantly on the go, this project of standardizing radioiodine uptake was a unique endeavour. Gómez Crespo and Vetter (1966) emphasized this in their published description of the project. Operating at the intersection of science and politics, the IAEA had designed this highly ambitious project on the recommendation of the United States. It invited early on a group of experts from Western countries, strongly reflecting the Cold War tensions. It depended heavily on diplomatic negotiations with Member States to arrange Gómez Crespo's visits. It relied on the 1961 Vienna Convention on Diplomatic Relations established by the United Nations in order for the radioactive suitcase to cross national borders. As David Fischer, the IAEA's internal historian eloquently put it, "the fact that Françoise was slightly radioactive caused numerous difficulties with suspicious customs officers and aircrews; difficulties that Françoise's magnificent torso helped to resolve!" (1997, 449). It was indeed the first time that an organization could support—both economically and logistically—such a large-scale project, involve international experts, have an in-house production of the required equipment, ensure accessibility to such a large number of laboratories worldwide, and guard its implementation from the beginning to its end.

Illustrative to the effects of the IAEA's radioiodine uptake project was the fact that the specifications of the phantom were "adopted by the ICRU [International Commission on Radiation Units and Measurements] in handbook 87, without modification or citation of a data or research basis for such recommendations." By the late 1960s, both the ORINS and the IAEA phantoms became commercially available through Abbot and Nuclear Associates respectively.[19] Several commercial manufacturers begun to produce other parts of the experimental setup. Unsurprisingly, the IAEA's radioiodine uptake measurement set-up became a global standard. In the Agency's photographic archive one can find photos of measurements performed on patients in countries all over the world; from Indian indigenous peasants in an isolated village of the Chilean Andes to school children in Baghdad. In the hands of Gómez Crespo, Françoise was able to transform clinical and laboratory procedures on a global scale and to redirect and instigate what physicists and physicians did in laboratories worldwide. But when it came time defining who had control over Françoise—or Abigail and each of Brucer's other "girls," for that matter—it was men in nuclear and medical laboratories that did so. The intimate connection between objects and power is manifest in the fact that technical specifications of things were translated into imaginary, sexualized female figures, which, in turn, became canonical experimental devices offered in the nuclear market as commodities. And in the case of Brucer's mannequins, the story is even more fascinating.

Brucer made history not only as the first chairman of ORINS's Medical Division and president of the Society of Nuclear Medicine. He also left his mark as one of the most outspoken supporters of nuclear energy, to the extent of claiming that fallout had no significant effects on human health. As late as the late 1980s, Brucer argued that "Low-dose radiation is not only good for you, it is also essential to life" (Ketchum 1987, 1645). Without question he was indeed a pioneer in medical physics. The AEC recognized his outstanding achievements by awarding him a gold medal in 1965, and during his Oak Ridge years he received several awards and prizes for his exceptional clinical research in radiation (Harris 1994). But he was also a controversial figure, having his "personal charms." As Sinclair explained to Vetter, "Brucer's somewhat jocular way of setting about scientific matters does not meet with approval in all quarters."[20] In one of his interviews, musing on the fact that the majority of his colleagues insisted on alerting the public about the effects of radiation, he noted: "I am not against health physicists. I just think that 75% of them ought to get shot" (Ketchum 1987, 1645). And yet, his masculine, provocative character never got in the way of his professional recognition. The "family of clothing-store mannequins" (Harris 1994, 46A) that Brucer devised eventually led, by way of the IAEA, to a "universal adoption," in Gómez Crespo's words, of his technique for assessing radiation risk.[21]

My point here is that things, experimental artefacts in our case, have stories to tell. They preserve "historical events" that might seem unrelated but, as one unravels social and cultural histories, they make connections materially present. During a period when the first Barbie doll—a kind of miniature mannequin launched by American toy company Mattel, Inc. in 1959—sold at three pieces per second, the ORINS and the IAEA were fashioning calibration phantoms that resembled her.[22] Abigail and the entire line of Brucer's dummies mimicking white, petite, American women—such as Hefner's playmates—acted as agents of facts and universal standards in medical physics in locations where they were definitely not the norm. The materiality of these phantoms, not just their shape and their symbolic function, entangled them in the IAEA's global politics. The transcript of the 1960 experts' meeting documents how this novel nuclear regulatory institution shaped the materiality of laboratories across the globe. The IAEA had the unique power to mobilize a gigantic network of actors to make it possible for Gómez Crespo to travel with Françoise. The aim was to bring order to the nuclear landscape. But while Françoise seems helpless and dependent throughout the trip, she is actually the one that allows us to start unravelling the complex, gendered, and thus power relations that shaped the nuclear order.

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Notes

1 On the importance of IAEA's technical assistance programme, see, for example, Creager and Rentetzi (2022); Rentetzi (2022); Hamblin (2021); Mateos and Suárez-Díaz (2019, 2020); Webster (2011).

2 Paul Foster to Sterling Cole, September 24, 1959; Sterling Cole to Paul Foster, December 14, 1959; Herbert Vetter to Paul Foster, January 20, 1960; all in SC/461-1 (1959–62), Box 35840, IAEA Archives.

3 Sterling Cole, Circular Letter, March 21, 1960; Herbert Vetter to Solomon Berson, October 8, 1960; both in SC/461-1 (1959–62), Box 35840, IAEA Archives.

4 Henry Seligman to Karol Kraszkiewicz, interoffice memorandum, May 4, 1960; Hymer Friedell to Herbert Vetter, May 25, 1960; Karol Kraszkiewicz to Gómez Crespo, July 5, 1960; Gómez Crespo to Karol Kraszkiewicz, July 10, 1960; Gómez Crespo to Division of Personnel, October 26, 1960; all in Godofredo Gómez Crespo Personal File, IAEA Archives.

5 The experts were radiation physicist Frank Barnaby and Nigel Trott from the Royal Cancer Hospital, both from England; physician Rudolf Höfer from Austria; Wolfgang Horst from Germany, the Swedish Lars-Gunnar Larsson from the Radiumhemmet in Stockholm; Douglas Ross from Oak Ridge and Werner Sinclair from the Argonne National Laboratory, both from the United States; Cristiaan Sybesma from the Netherlands; and physician Maurice Tubiana from France ("Consultants' Meeting" 1962).

6 The full transcript of the three-day expert meeting reveals not only the epistemological and technical challenges that the panel faced but also the unique and novel diplomatic and political demands of such a grandiose international scientific project. See Consultants Meeting of Thyroid Radioiodine-131 Uptake Measurement, Calibration and Standardization, Transcript from the tape, SC/461-1 (1959–62), Box 35840, IAEA Archives.

7 Godofredo Gómez Crespo to Douglas Ross, October 3, 1960, SC/461-1 (1959–62), Box 35840, IAEA Archives.

8 Solomon Berson to Herbert Vetter, October 17, 1960, SC/461-1 (1959–62), Box 35840, IAEA Archives. Berson refers here to Rosalyn Yalow, one of the few women Nobel Prize laureates in the sciences (Nobel Prize in Physiology of Medicine, 1977). The two of them had teamed up in the early 1950s, working on the radioactive labelling on insulin molecules with radioiodine (Straus 1998). See also the website created by Nobel Media on her: www.nobelprize.org/womenwhochangedscience/stories/rosalyn-yalow?keyword=physics. The history of radiation experiments on humans has not yet been adequately researched.

9 Formula for Calculate Thyroid Uptake, Tuesday November 29, 1960, Fourth Meeting, SC/461-1 (1959–62), Box 35840, IAEA Archives.

10 According to Paul Frame, Brucer constructed six mannequins in 1955:

> Abigail (euthyroid), Bridget (euthyroid), Chloe (euthyroid), Drusilla (hyperthyroid), Euphemia (hyperthyroid), and Felicia (hypothyroid). By 1956, the following manikins had been added: Grenadine (hypothyroid), Hortense (hyperthyroid), Ibis (hyperthyroid), Jezebel (euthyroid), Katrinka (hypothyroid), Lulu (hyperthyroid), Moira (euthyroid), Nabby (hypothyroid), Ophelia (euthyroid), Pandora (well-type), Queenie (well-type), Rhoda (well-type), and Terry Toma (euthyroid). Abigail, Felicia and Lulu were available for one month loans while Bridg[e]t, Drusilla, Jezebel, and Nabby could be loaned out for six months.
>
> *(See www.orau.org/health-physics-museum/collection/nuclear-medicine/orins/felicia-manikin.html)*

11 Paul Foster to Sterling Cole, September 24, 1959; Sterling Cole to Paul Foster, December 14, 1959; both in SC/461-1 (1959–62), Box 35840, IAEA Archives.

12 Godofredo Gómez Crespo to Herbert Vetter, July 21, 1960, Godofredo Gómez Crespo Personal File, IAEA Archives.

13 Godofredo Gómez Crespo to Douglas Ross, November 8, 1960, SC/461-1 (1959–62), Box 35840, IAEA Archives.

14 The picture is reproduced on Paul Frame's website (see note 11 above), together with the Felicia mannequin. Take also note of their hair colours.

15 The recently produced documentary *Secrets of Playboy* (2022) unravel *Playboy*'s toxic environment for women as well as the entire gender culture of this time period; see www.imdb.com/title/tt15250706/

16 Douglas Ross to Godofredo Gómez Crespo, October 18, 1960, SC/461-1 (1959–62), Box 35840, IAEA Archives.

17 Herbert Vetter to Warren Sinclair, January 25, 1960, SC/461-1 (1959–62), Box 35840, IAEA Archives.

18 Godofredo Gómez Crespo to Herbert Vetter, January 12, 1962, SC/461-1 (1959–62), Box 35840, IAEA Archives.
19 Richard Riley to Herbert Vetter, April 14, 1970, SC/461-1 (1959–62), Box 35840, IAEA Archives.
20 Herbert Vetter to Warren Sinclair, January 25, 1960; Warren Sinclair to Herbert Vetter, March 3, 1960; both in SC/461-1 (1959–62), Box 35840, IAEA Archives.
21 Godofredo Gómez Crespo to Nigel Trott, October 8, 1960, SC/461-1 (1959–62), Box 35840, IAEA Archives.
22 For an advertisement of the first Barbie doll by Mattel, see www.youtube.com/watch?v=0puJKqHoR3s&cbrd=1

References

Bauer, Susanne, Martina Schlünder, and Maria Rentetzi, eds. 2020. *Boxes: A Field Guide*. Manchester: Mattering Press.

Brucer, Marshall. 1959. *Thyroid Radioiodine Uptake Measurement: A Standard System for Universal Intercalibration*. ORINS-19. Oak Ridge: U.S. Atomic Energy Commission.

Brucer, Marshall, Thomas. Harold. Oddie, and James S. Eldridge. 1956. *Thyroid Uptake Calibration: I. Mock-Iodine, a Radioactive Iodine Gamma-Ray Standard*. ORINS-14. Oak Ridge: Oak Ridge Institute of Nuclear Studies. www.osti.gov/servlets/purl/4351534

"Consultants' Meeting on the Calibration and Standardisation of Thyroid Radioiodine Uptake Measurements, November 28–30, 1960." 1962. *British Journal of Radiology* 35 (411): 205–10.

Creager, Angela N. H. 2013. *Life Atomic: A History of Radioisotopes in Science and Medicine*. Chicago: University of Chicago Press.

Creager, Angela N. H., and Maria Rentetzi. 2022. "Sharing the 'Safe' Atom? The International Atomic Energy Agency and Nuclear Regulation through Standardization." In *Living in a Nuclear World: From Fukushima to Hiroshima*, edited by Bernadette Bensaude-Vincent, Soraya Boudia, and Kyoko Sato, 111–31. New York: Routledge.

Drozdovitch, Vladimir, et al. 2014. "Nuclear Medicine Practices in the 1950s through the Mid-1970s and Occupational Radiation Doses to Technologists from Diagnostic Radioisotope Procedures." *Health Physics* 107 (4): 300–10.

Feld, Michael, and Michel De Roo. 2003. *History of Nuclear Medicine in Europe*. Stuttgart: Schattauer.

Fischer, David. 1997. *History of the International Atomic Energy Agency: The First Forty Years*. Vienna: International Atomic Energy Agency.

Gómez Crespo, Godofredo. 1997. "Birth and Adventurous Life of Françoise: The Mezza Dona Morta. Tragicomic Aspects of an International Scientific Mission." *Interciencia* 22 (1): 34–36.

Gómez Crespo, Godofredo, and Herbert Vetter. 1966. "The Calibration and Standardization of Thyroid Radioiodine Uptake Measurements." *International Journal of Applied Radiation and Isotopes* 17: 531–49.

Grigg, E. R. N. 1965. *The Trail of the Invisible Light: From X-Strahlen to Radio(bio)logy*. Springfield: Thomas.

Gross, Daniel A. 2014. "The History of the Humble Suitcase." *Smithsonian Magazine*, May 9. www.smithsonianmag.com/history/history-humble-suitcase-180951376/

Hamblin, Jacob. 2021. *The Wretched Atom: America's Global Gamble with Peaceful Nuclear Technology*. New York: Oxford University Press.
Harris, C. Craig. 1994. "In Memoriam: Marshall Brucer, MD (1913–1994)." *Journal of Nuclear Medicine* 35 (5): 45A–46A.
Ketchum, Linda. 1987. "Marshall Brucer Still Full of Acerb Wit 30 Years after Serving as SNM President." *Journal of Nuclear Medicine* 28 (11): 1645–1650.
Kirkland, Joel. 1997. "Fallout from 1950s Nuclear Tests Touched All 48 Contiguous States." *Chicago Tribune*, August 2. www.chicagotribune.com/news/ct-xpm-1997-08-02-9708020100-story.html
Latour, Bruno. 1987. *Science in Action: How to Follow Scientists and Engineers through Society*. Cambridge: Harvard University Press.
Mateos, Gisela, and Edna Suárez-Diáz. 2019. "Technical Assistance in Movement: Nuclear Knowledge Crosses Latina American Borders." In *How Knowledge Moves: Writing the Transnational History of Science and Technology*, edited by John Krige, 345–67. Chicago: University of Chicago Press.
Mateos, Gisela, and Edna Suárez-Díaz, eds. 2020. *Development Interventions: Science, Technology and Technical Assistance*. Special Issue of *History and Technology* 36 (3–4): 293–309.
Morris, Leighann. 2015. "The Complete History of Mannequins: Garbos, Twiggies, Barbies and Beyond." *Hopes&Fears*, November 20. www.hopesandfears.com/hopes/city/fashion/213389-history-of-mannequins
National Cancer Institute (NCI). 1997. *Estimated Exposures and Thyroid Doses Received by the American People from Iodine-113 in Fallout Following Nevada Atmospheric Nuclear Bomb Tests*. Bethesda, MD: National Cancer Institute. www.cancer.gov/about-cancer/causes-prevention/risk/radiation/i131-report-and-appendix
Pearce, Fred. 2018. *Fallout: Disasters, Lies, and the Legacy of the Nuclear Age*. Boston: Beacon Press.
"Radioiodine Uptake by the Thyroid Gland." 1962. *IAEA Bulletin* 4 (1): 7–9.
Rentetzi, Maria. 2007. *Trafficking Materials and Gender Experimental Practices: Radium Research in Early Twentieth Century Vienna*. New York: Columbia University Press.
Rentetzi, Maria. 2011. "Packaging Radium, Selling Science: Boxes, Bottles, and Other Mundane Things in the World of Science." *Annals of Science* 68 (3): 375–99.
Rentetzi, Maria. 2017. "Determining Nuclear Fingerprints: Glove Boxes, Radiation Protection and the International Atomic Energy Agency." *Endeavor* 41 (2): 39–50. https://doi.org/10.1016/j.endeavour.2017.02.001
Rentetzi, Maria. 2021. "With Strings Attached: Gift-Giving to the International Atomic Energy Agency and US Foreign Policy." *Endeavor* 45 (1–2): 1–10.
Rentetzi, Maria. 2022. "Setting up a Global Experiment: The IAEA and its Dosimetry Programs in the Early 1960s." In *The Politics of Radiation Protection*, edited by Maria Rentetzi, spec. issue of *NTM: International Journal of History and Ethics of Natural Sciences, Technology and Medicine* 30 (2): 167–95.
Rheinberger, Hans-Jörg. 1997. *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube*. Stanford: Stanford University Press.
Roehrlich, Elisabeth. 2022. *Inspectors for Peace: A History of the International Atomic Energy Agency*. Baltimore: Johns Hopkins University Press.

Simon, Steven L., André Bouville, and Charles E. Land. 2006. "Fallout from Nuclear Weapons Tests and Cancer Risks: Exposures 50 Years Ago Still Have Health Implications Today That Will Continue into the Future." *American Scientist* 94 (1). https://doi.org/10.1511/2006.57.48

Straus, Eugene. 1998. *Rosalyn Yalow, Nobel Laureate: Her Life and Work in Medicine. A Biographical Memoir*. New York: Plenum Trade.

Webster, David. 2011. "Development Advisors in a Time of Cold War and Decolonization: The United Nations Technical Assistance Administration 1950–59." *Journal of Global History* 6 (2): 249–72.