Harry Owen

Simulation in Healthcare Education

An Extensive History

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To the forgotten pioneers of simulation in healthcare education

Preface

I was a medical student from 1972 to 1977 and subsequently specialized in anesthesia. As a student and trainee I learned how to perform procedures on patients. Sometimes I was supervised but often not, and, while I always tried my best, not all my early attempts were successful, and I know I caused complications. I thought this was how modern medicine should be taught, and with practice I became proficient in a wide range of invasive techniques. As a specialist in anesthesia, I also taught on patients but toward the end of the twentieth century discovered that simulation could be a safer alternative. Like most practitioners at the time, I thought that simulation was a relatively recent innovation in healthcare education and that I was an early-adopter of new technology. Searches for early examples of simulators only confirmed this belief. I developed an interest in using simulators for teaching and developed an airway teaching program to improve patient safety [1].

I received some invitations to present on simulation in healthcare education and wanted to provide some history of simulation in education and training. I discovered that the use of the term simulation in this setting was new but the use of what we now call simulation wasn't new at all and had been used hundreds of years ago.

In the nineteenth century in particular, as healthcare professions were established and new medical procedures were developed, simulators were often devised for novices to acquire relevant skills and avoid harming patients. I have included many quotes in this book to make it clear this is not just my interpretation of how simulation was used in earlier times. If this aspect of medical history had been preserved, vast numbers of patients would have received better care and had fewer adverse events. There has been a resurgence of interest in simulation, but it is not universally integrated in entry-level education and training in all health professions and in continuing professional development. Simulation-based training has a cost, but the true cost of training on patients is hidden.

The very early adopters of simulation faced exactly the problems that are being encountered by contemporary users of simulation including lack of funding and indifference of colleagues to new ways of teaching. We should learn from history rather than repeat it.

Adelaide, SA, Australia Harry Owen, MBChB, FANZCA, MD

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Acknowledgments

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Several people made contributions to sections of this book. Neil Handley, curator of the British Optical Association Museum, shared his knowledge of simulators in the collection. Jürgen Schlumbohm at the Max-Planck-Institut für Geschichte in Göttingen, Professor Günter Köhler at the University of Greifswald, and Professor Thomas Schnalke at the Berliner Medizinhistorisches Museum der Charité provided information on obstetric simulation in Germany. Francesca Vannozzi of the University of Siena and president of the Centro Servizi di Ateneo CUTVAP and Alberto Zannatta of the Department of Cardiac, Thoracic and Vascular Sciences in the Medical School at Padua University provided information on some obstetric simulators in Italy. Giulia Rigoni Savioli, rare book and special collections librarian at the University of Padua, provided examples of the development of illustration in medical education. Peter Wilson in Adelaide provided an opinion on the Loomis trial.

Many other contributions have been acknowledged in the book, and I thank all those librarians, historians and curators.

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Part I

Chapter 1
Introduction

The recorded history of simulation in health professional education stretches over 1500 years and around the world and in that time simulators and the professionals who used them have had many names. For most of this time medicine was at best ineffective, surgery was turned to as a last resort and there was little use of simulation. The Enlightenment that started in France in the middle of the seventeenth century and spread widely over the next hundred and fifty years challenged established doctrines, including the prevailing system of medicine. Using careful observation and experiment physicians and surgeons began to develop effective therapeutic measures from interventions during labor that could save the life of the fetus and the mother and vaccination could prevent smallpox.

The demand for knowledge of new medical procedures overwhelmed the traditional apprentice-based training system and gave rise to courses in which simulation was introduced to help students learn the practical skills and when to use them. When such courses were first advertised in the early eighteenth century the pioneers of simulation-based training needed to explain this innovation to prospective students. Manningham's advertisement for a course on midwifery in the London Evening Post in 1740 included an explanation that students taking this course would learn on "a contrivance made on the bones or skeleton of a woman, with an artificial matrix [womb]" [1]. Later in the advertisement this simulator was referred as "the machine". The advertisement also explained why and how simulation was important in obstetrics education. Manningham identified that harm can come from having inexperienced practitioners attend patients and that students on his course would learn how to deliver a baby on the simulator before attending a real labor. A simulator would also be used to show what could go wrong and how such problems were best managed and then practice these interventions on a simulator.

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From page 4 of the London Evening Post, Tuesday, April 12, 1740

"From the lying-in infirmary in Jermyn Street, St James. On Monday the 5th of May, at five in the evening, will begin lectures in midwifery; wherein the whole theory and practice of the art of midwifery will be fully explain'd and taught, …"

"Also the performance of deliveries of all kinds, with the utmost decency and dexterity, by means of a contrivance made on the bones or skeleton of a woman, with an artificial matrix; whereby all the inconveniences which might otherwise happen to women from pupils practising too early on real objects will be entirely prevented and each pupil become in a great measure proficient in his business before he attempts a real delivery. On this machine will also be showed the natural situation of the child and matrix and all the various preternatural situations of each and the safest and most effective methods of rectifying all these difficulties, and perfecting the delivery; and a further illustration of the best and proficient methods of performing difficult deliveries with all possible ease and safety, a small glass matrix is contriv'd (in which is enclosed an artificial child) to be fix'd on ivory frames, imitating the various shapes of the bones forming the pelvis, in that every position the matrix or child can any way take and the hindrance either may meet from the said bones and the easiest and most effectual ways of performing all difficult deliveries, (as is taught on the great machine) together with the realms of the rules, will hereby in a most instructive manner be beautifully and clearly represented to the eye."

Sir Richard Manningham [1]

The Rise of the Machines

Machines that imitate nature have always been a source of fascination and have a long history. The philosopher Lao Tzŭ (b. 604 BCE) described an automaton made by the "artificer" Yen Shi that could walk, sing, gesture, and wink. The individual parts were made from wood, leather, and glue and painted and inside the body were "all the internal organs complete—liver, gall, heart, lungs, spleen, kidneys, stomach, and intestines—and over these, again, muscles and bones and limbs with their joints, skin and teeth and hair, all of them artificial" [2, pp. 90–92].

Several automata made by mechanicians in the sixteenth and seventeenth century have survived and show remarkable ingenuity in their construction. The modern era of machines in healthcare education began around three hundred years ago and the terms associated with their use in this context evolved as the meaning of terms changed and new ones were invented. The term simulation, derived from the Latin *simulare*, meaning to pretend or imitate, has a short history of use in healthcare professional education.

Machine was a term much used for a simulator in the eighteenth century. Some authors have misunderstood this use of machine in simulation and unfairly derided the pioneers of simulation that used it. William Smellie and Madame du Coudray did not use the term to suggest women were baby factories or birth could be managed like an industrial process. In the eighteenth century any device that had been made for an activity or action was a machine and it did not have connotations of engineering and manufacturing. For example, early in the eighteenth century Pierre Armand a surgeon in Paris invented a "nouvelle machine" for extracting the head of a fetus that had been separated from the body and was still in the uterus. Amand's machine was a net with attached cords that was inserted by hand and passed up over the head which could then be pulled out [3, pp. 243–249]. The umbrella is another example of an eighteenth century machine [4, pp. 123–124].

> *"If you walk with an umbrella, and meet a similar machine, lower yours in time, lest you either break it, or get entangled with the other."*
>
> Advice on walking London's streets from *The London Adviser and Guide* by the Revd. Dr. Trusler (1790) [4]

An issue in this book was how to refer the health professionals who used simulation. Until the seventeenth century a midwife was a woman who was more or less experienced in comforting a woman giving birth but often knew very little about the process. The first surgeons or physicians such as William Harvey who acquired additional skills to intervene in childbirth were also called midwives. Professional midwives learnt their craft through a lengthy apprenticeship but the demand for training for the new discipline that would become obstetrics created a need for a different education model. The training courses that began to appear in the eighteenth century led to increased numbers of these practitioners and the term man-midwife was introduced to better explain their role in childbirth. This differentiation was important in justifying their fee which was more than that of a midwife. Some adopted the more fashionable title of *accoucheur* that originated in France. In France midwives were called *sages-femme* an in Germany they were called *Hebamme* or *Geburtshelfer*. Widespread use of the terms obstetrics and obstetrician developed in the nineteenth century and the word for obstetrics German started as *Geburtshülfliche* and later became *Geburtshilfliche*. A challenge in narrating the development of simulation has been the way boundaries changed in Europe in the last three hundred years particularly those associated with what is now Germany. The biggest problem has been with names used for simulators, which have changed a lot over the years in all languages.

The first doctoral thesis on simulation was written by Langsdorf who was studying in Göttingen at the end of the eighteenth century [5]. The title he gave the work was *Phantasmatum Sive Machinarum Ad Artis Obstetriciae Exercitia Fascientium Vulgo Fantome Dictarum Brevis Historia* which can be rendered as "A short account of likenesses or devices for practicing obstetric skills also called phantoms."

In the nineteenth century the terms most used were manikin, mannequin, and phantom (fantom). Phantom seems to have been least used in articles written in English although in 1876 when he referred to a machine used by Smellie for teaching obstetrics, McClintock noted it was now called a phantom [6]. In 1835, an article in the Lancet on medical education reported that in Paris the positions of the fetus and the mechanism of labor are demonstrated "upon what are called 'mannequins,' i.e., a stuffed pelvis with an artificial fetus" [7]. The London Medical Record of September 15th 1881 outlined the examinations required to graduate in medicine from midwifery the University of Brussels including that the examination in midwifery consisted of "obstetrical operations on the mannequin (model of pelvis)" [8, p. 375]. Manikin and mannequin have been spelt in many ways including mannikin, maniken, manakin, manequin, and even maunequin.

In "A Dictionary of Medical Science" published in the United States in 1860, the entry for "Manikin" referred readers to "Fantom" but the entry for "Fantom" noted that a "Mannequin" was used by surgeons to practice bandaging or the accoucheur for the manual part of midwifery and there were alternative spellings for manikin such as mannikin, manakin, and manikin [9]. The Italian equivalent of mannequin is *manichino* [10]. The many different ways of spelling manikin and phantom, e.g., phantome, phantoma, fantom, fantoom, etc.) particularly before the twentieth century can be a barrier to finding articles on historical simulators.

A body that was used as a simulator was sometimes called a natural manikin. In obstetric simulation the terms mannequin/manikin and phantom generally referred to the maternal part of an obstetric simulators The same term was used in other countries including, *macchina ostetricia* (obstetric machine) and *macchina da parto* (birthing machine) in Italy, *Entibindungsmaschine* (maternity machine) and *Gebährmaschine* (birth machine) in Germany and *Machina babiena* in Poland. There were separate names for the artificial fetus such as Puppe (German), poupee (French), and fantoccio (Italian). In the eighteenth and nineteenth centuries there was much debate over the merits of using a stillborn or cadaver fetus over an artificial one.

In German nouns can be run together and "Maschine" and "Phantom" were prefixed with the part of the body or process being simulated to make a name for the simulator. Examples include Augenphantom (eye simulator), Entbindungsmaschine (birth, delivery simulator), Gerburtshilflichemaschine (obstetric simulator), and Dammschutzphantom (perineum simulator). Two terms were added to the German obstetric simulation lexicon at the beginning of the nineteenth century, *pelvarium* and *hysteroplasmen*. The *pelvarium* was a model pelvis specifically designed for students to learn the names and measurements of the diameters of the pelvis used in pelvimetry [11]. The *hysteroplasmen* was a replica of the vagina, cervix, and uterus used to practice "touching", vaginal examination during labor or procedures such as packing the uterus to stop post-partum hemorrhage [12–14].

In *Three Hundred Consultations in Midwifery* Lee reported a conversation with a young accoucheur who said he had only practised applying forceps on "the Dombey". Lee was then told this was the name students gave "to the stuffed machine called a mannequin or phantom, usually imported from France" for teaching operative midwifery [15, pp. 69–71]. The term "dummy" appears only became common in

twentieth century. A short review of simulators in dentistry published in the Journal of the British Dental Association in 1898 had the title *The "dummy patient," or student's practising ground*. Cunningham, the author of the article and editor of the journal wrote,

> One word, re the term "phantom" I don't like it, it sounds unenglish. I know that it has been used to mean a model, manikin, or effigy upon or by which to illustrate bandaging, surgical, obstetric, and other operations This is so far from the original meaning of the word, which is defined as "an illusive perception of an object that does not exist" that it is not surprising that it has never got into common use.

The term android for a functional humanoid model is from an 1886 novel *L'Ève future* (translated as Future or Tomorrow's Eve) by Villiers de l'Isle-Adam. The term robot was derived from the Czech word robota, meaning servitude or forced labor. It was first used by K. Čapek in 1920 in the play "R.U.R. Rossum's Universal Robots". Robots became celebrities and it wasn't long before a robot patient was developed. The terms manikin, mannequin, and phantom were the terms most usually used in the nineteenth century and continue to be those most often used.

In this narrative of the development of simulation in health professional education it has been necessary to accommodate all these different terms. The convention adopted for this book was to use the term for a simulator and associated items that was used in the time and place being written about and the English equivalent at that time (see Table 1.1). The modern term simulator has also been used for them to emphasize the connection and similarity between the use of simulation then and its use now.

Table 1.1 Summary of terms used for simulators at different times and in different places

	English	French	German	Italian	Latin
Sixteenth century	Automaton	Automate	Automat		
Seventeenth century	Statue				Statua
Eighteenth century	Contrivance				
	Apparatus	Appareil	Gerät	Apparecchio	
	Artificial man	l'homme artificiel			
	Machine	Machine	Maschine	Macchina	Machina
	Phantom	Phantom	Phantom	Fantasma	Phantasma
		Fantôme			Simulacrum
	Doll	Poupée	Puppe		
	Puppet	Fantoche		Fantoccio	
Nineteenth century	Mannequin	Mannequin		Mannequin	
	Manikin	Manequin		Manichino	
	Replica		Nachbildung		
	Android	Andréïde			
Twentieth century	Dummy				
	Robot	Robot	Roboter	Robot	
	Simulator	Simulateur	Simulator	Simulatore	

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Chapter 2
Early Examples of Simulation in Training and Healthcare

"The art is long, life is short; the crisis fleeting; experience perilous, and decision difficult". Hippocrates

Everyone about to undergo a healthcare procedure wants the health professional to be knowledgeable, well-trained, and experienced so that a complication would be unlikely but if one did occur it would be managed quickly and effectively. Practical experience is essential for learning a skill and it may take hours or days to develop competence and learning all the skills of a craft or a profession may take several years. The Greek philosopher Aristotle (384–322 BCE) taught in his *Nichomachean Ethics* that we learn skills and behaviors through repetitive actions (habituation) and development of expertise, like virtuous behaviors, requires guidance and feedback:

> For we learn a craft by producing the same product that we must produce when we learned it; we become builders, for instance, by building, and we become harpists by playing the harp. Similarly, then, we become just by doing just actions, temperate by doing temperate actions, brave by doing brave actions. [1]

There are two parts to learning a skill; learning what to do when everything is normal and working as it should and learning what to do when there is an abnormal condition. Hippocrates (c. 460—c. 367 BCE), known as the father of medicine, summed this up in the *Aphorismi*, which starts with the phrase, *Ars longa, vita brevis*. The English rendering of the complete aphorism explains exactly why simulation has to be at the core of practical training of health professionals.

> Life is short, the Art is long; the crisis fleeting; experience perilous, and decision difficult. The physician must not only be prepared to do what is right himself, but also to make the patient, the attendants, and externals cooperate. [2]

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