FROM THE DEPTHS OF THE DARK AGE!

A Danish Museum's Reconstruction of a Mediaeval Diving Dress

By David Lazenby
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Right: The Hussite diver circa 1425. Fact or fantasy?

A serious study of little known historical manuscripts and books has revealed a surprising amount of pictorial and literary references to very early underwater activities and apparatus. Most are clearly impractical, others feasible to a degree, and some are downright suicidal! Unfortunately with many of these concepts it is impossible to ascertain whether they were merely the whimsical idea of eccentric inventors or if they were indeed serious proposals which were tried and tested.

During the mediaeval Romanesque period, the works of classical Greek and Roman engineers were at a renewed popularity. One twelfth century scholar describes a submarine descent by Alexander the Great in a glass bathysphere but seems somewhat disappointed by the lack of documentary material, "Alas, he did not leave us his observations"! Roger Bacon, another mediaeval scientist, was convinced that all manner of contrivances had been used in classical times including "machines for walking in the seas and rivers, even on the bottom, without danger to life or limb". The author of a Bohemian poem, *Salman und Morolf*, dated to the 1100s, describes Morolf's dive on a shipwreck with air supplied by a leather hose. Although these accounts are almost certainly works of mediaeval science fiction, the occasional reference, such as an early zoological manuscript that compares an elephant's trunk to the "hose used by divers" is somewhat more tantalising in the search for evidence of the use of early underwater breathing apparatus.

The first known illustration of an autonomous diving suit is that by the German inventor Conrad Kyeser in his military treatise *Bellifortis* circa 1400-1405. The manuscript shows two divers with differing suits, fighting underwater. An accompanying Latin text describes the leather suit and armoured helmet with glass ports of the first diver, and the copper tube, breathing bladder and lead weights of the other. Neither suit has a hose to the surface.

The first depiction of a diver with a snorkel appears in a military engineering treatise (by an unknown author) known as the *Anonymous of the Hussite Wars* of circa 1425 now in the Bavarian State Library. This well executed, coloured drawing shows the diver clearly engaged in the salvage of sunken goods. He wears a helmet, leather tunic, footwear, and a rope lifeline to the surface. The Italian artist Mariano di Jacopo (1382-1453/8) more popularly known as "Taccola" also pondered the possibility of sub-aquatic activity, and in his works *De Ingeneis* and *De Machinis* there are drawings and descriptions of divers as well as ingenious grappling hooks and pincers used to salvage sunken valuables. Like the Hussite dress, one diver is shown with a modified tournament helmet with a long snorkel attached, while another illustration shows a free swimming diver with a breathing bag covering the mouth and nose.

It was not until the early 16th century that we again see attempts at designs for diving dress. The great Florentine artist, scientist and

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David Lazenby descending. Photo: Hannah Rasmussen

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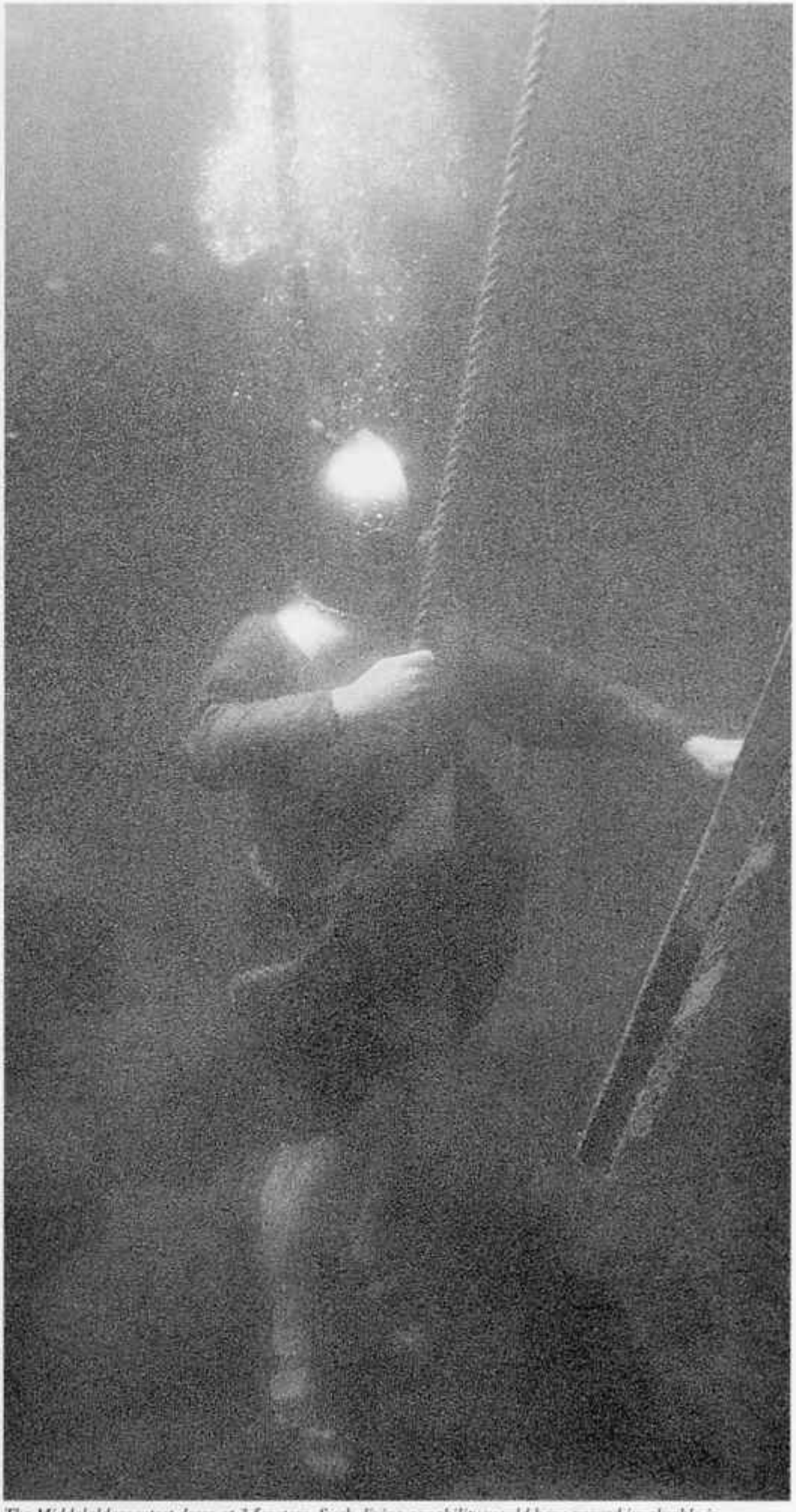
visionary Leonardo da Vinci (1452-1519) drafted a number of underwater contrivances. Like many of his inventions these ideas had military overtones and are included with drawings which depict devices for drilling holes in enemy ships. The da Vinci suits are similar in many respects to the Kyeser's "breathing bag" concept comprising a leather hood with the glass eyeports, but his most detailed design works in conjunction with twin snorkels which are supported on the surface by a float. The hoses are apparently sections of wooden tubing with joints made of leather further strengthened by springlike coils. Some of da Vinci's other designs show definite advances on previous technology. One of his (presumably waterproof) suits shows armoured hoops around the chest and diaphragm to alleviate the effects of compression while another drawing shows froglike, webbed fins, although he depicts them worn on the hands rather than the feet!

Unfortunately none of these drawings show any form of air feed system. The long snorkel would be a physical impossibility and this may be an indication of lack of practical knowledge of the particular inventors. However the concepts of hydraulics and pressure *were* understood at this time and many mediaeval engineers including Taccola had drawn all manner of pumps complete with valves. Written accounts refer to divers undertaking complex underwater salvage work, although the references to their equipment are always vague and ambiguous, and if some form of breathing apparatus was used, it would be apparent that surface air supply would be necessary.

During 1998, Middelaldercentret (The Middle-Ages Centre) a Danish museum specialising in archaeological reconstructions, undertook an experiment to investigate whether a diving dress, with the addition of a simple pump (in the form of blacksmiths bellows) would enable 15th century salvors to work at moderate depth for extended periods. Primarily based on the Hussite manuscript, but using features of the other contemporary depictions, the dress was manufactured to a high standard of historical accuracy in terms of period fashion, materials, constructional techniques and attention to detail. Wherever " educated guesswork" was applied, practical solutions of



The Middelaldercentret dress at 3.5meters. Such diving capability would have proved invaluable in medieval times. Photo: Andreas Jensen

The Middelaldercentret dress was made using Medieval techniques and materials. Photo: D Lazenby

known late mediaeval technology were sought.

The greased leather suit, reconstructed from an original example of a woollen coat features handstitching styles copied from other archaeological leatherwork finds. The footwear are "patterns" a kind of mediaeval wood clog with the addition of lead soles. Further lead ballast (a total of 18 kilograms) is provided in leather pouches tied to the waist. A nose clip to enable the diver to equalise is a bronze paperclip of the type used by monks to hold manuscript pages together! The lifeline and other ropework was hand spun and laid using hemp and shredded lime bark fibre.

The pump system comprises three independent bellows of around five litre capacity each, connected by wrought iron pipes to a hand-hewn wooden chest which acts as a pressure reservoir. Each pipe inlet has a simple non-return "clack" valve in the form of a leather flap nailed to the inside of the box. The chest is reinforced with wrought iron straps and is sealed within with beeswax (it was found that the pressurised air would actually escape through tiny irregularities in the wood grain!). The lid is fitted with a greased leather gasket and is secured by wooden wedges against the iron bands.

It should be pointed out at this time, that the above description refers to the second pump system that was built for the experiment. The first featured a much larger pair of bellows, around eighty litres each which (as in many early drawings) were linked to each other by the draw rod. This proved entirely useless since it was impossible to compress the bellows with the helmet in water deeper than fifty centimetres.

The hose was constructed from hollowed out wooden sections (thirty millimetres inside diameter) reinforced and joined by a tubular leather sheath (sewn in the same edge to edge manner as mediaeval sword scabbards), further strengthened with rawhide and linen strips soaked in natural tar.

The helmet is perhaps the most controversial part of the equipment since many academics are firm in the belief that it should be a leather hood. Both Kyeser and Taccola however vividly depict modified military helms and the fact that the 15th century saw the craft of metal beating and shaping approaching its zenith, producing the diving helmet would have been no problem whatsoever to the highly skilled armourers of the day. It is important to understand that fashion played a substantial part in the ever changing appearance of mediaeval armour and it would be appropriate for the diving helmet to be greatly influenced by the so called "Great Bascinet" style that was vogue around 1420-1430. The reconstructed helmet features a hose-

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Bellows technology proved more than capable of supplying the diver at moderate depth. Photo: D Lazenby

The Middelaldercentret helmet. Made in the style of a "Great Bascinet" of 1420-30. Photo: D Lazenby

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connection flange with a simple leather flap to act as a valve, and the eye ports are fitted with riveted lead frames set with hand made glass around three to four millimetres thick. Straps and buckles are used to fasten the helmet to an inner leather doublet both at the front and rear.

The first tests were undertaken in a training tank at the Royal Danish Navy Diving School in Copenhagen, in the presence of several members of the Danish Historical Diving Society, the media, Naval officers and divers. Each dive required a five man surface crew to operate the pumps and to tend the hose and lifeline. The first few descents were somewhat uncomfortable and claustrophobic due to the irregular pumping rhythm, the helmet flooded regularly up to eye level and short periods of breath holding were necessary while waiting for the air to vent the water! The system is of the "open dress" type which means that the helmet and dress are not sealed, the helmet acts as an air bell (the water level just below the mouth) and therefore it is also vital that an upright posture is maintained. The air flow within the helmet kept the eye ports free of condensation and the exhaust air vented from the sides and rear. There did not appear to be any sign of carbon dioxide build up. Once the pump tenders became more practised, the air flow became relatively constant (it was also found that wetting the leather valves improved performance) and the last dive of the day lasted around fifteen minutes, the diver returning to the surface only in sympathy for the exhausted crew!

A series of other dives have been undertaken in the Middelaldercentret's own harbour and while the extremely cold water was a definite disadvantage it was reasonably easy to climb down a wooden ladder, walk on the flat seabed and to kneel down and undertake simple tasks. On two occasions there have been pump failures in the form of punctured bellows whilst diving at around 3.5 meters, and interestingly this had little effect on the air supply, only a slight pulse in the water level was noticeable.

With the current configuration, the system has been tested to a depth of 5.5 meters before it became difficult to pump air against the ambient water pressure. However this could easily be extended with additional (and smaller) bellows. Although the equipment is inherently dangerous, with practice and due care it would be certainly possible to perform more ambitious tasks such as the recovery of cannons as mentioned in early shipwreck salvage accounts.

Sadly, the fact still remains that we may never know for sure whether breathing apparatus *was* used over five hundred years ago. However the experiment shows that within the realms of known technology and available materials, the aquatic dreams of Kyeser, Taccola and an inventor whose name has been lost to history, were indeed a possibility.

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