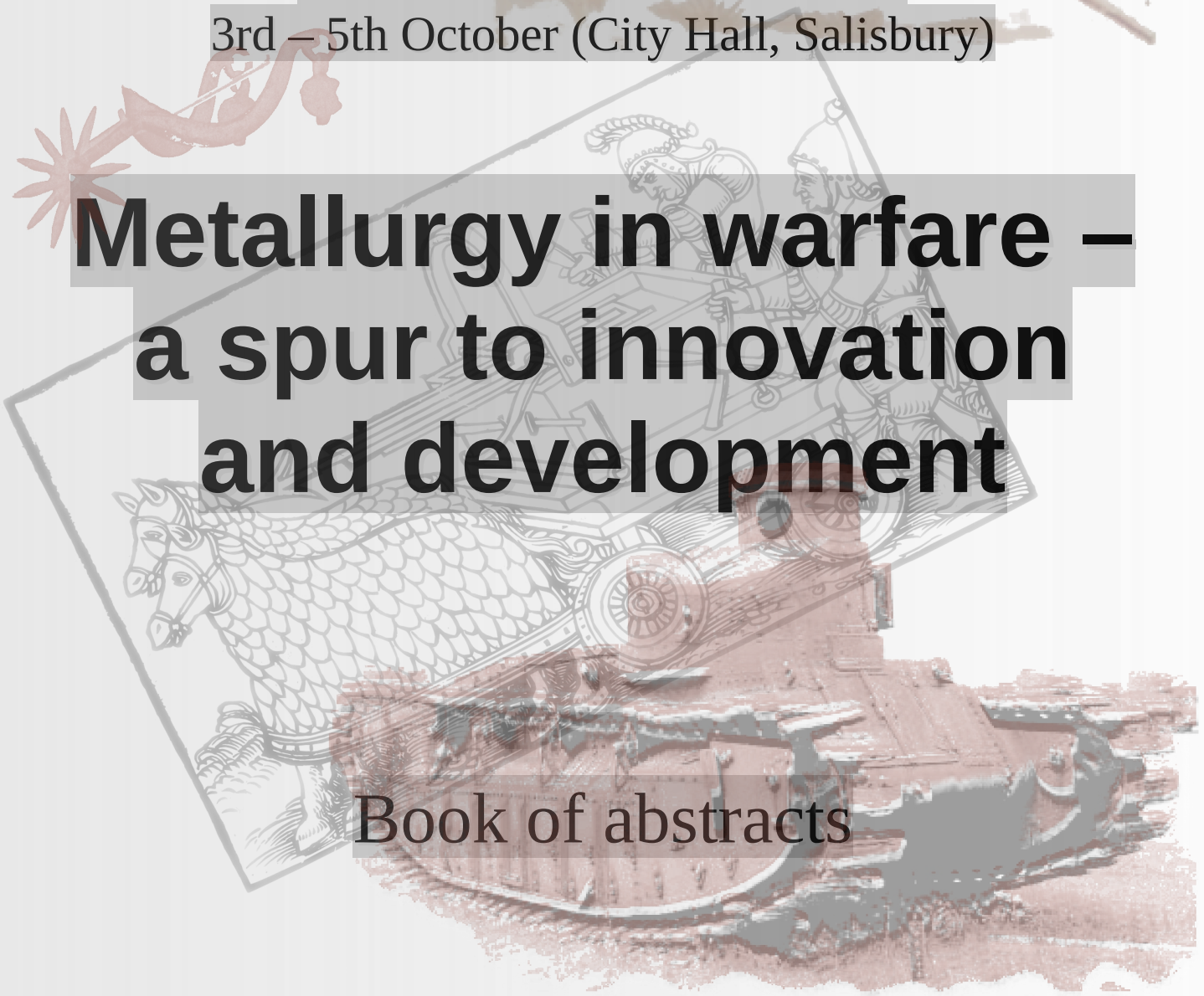
The HISTORICAL METALLURGY Society

HMS Annual Conference 2014
3rd – 5th October (City Hall, Salisbury)

Metallurgy in warfare – a spur to innovation and development



Book of abstracts

Welcome!

The Historical Metallurgy Society wishes you a warm welcome to the 2014 annual conference! It is timed to coincide with the commemorations of the outbreak of the First World War - "The Great War" of its generation. As such, the HMS annual conference title, ***"Metallurgy in warfare – a spur to innovation and development"***, was deemed to be an appropriate theme and focus for presenting research in metallurgy.

Conference Programme

	Friday 3rd October (evening)
16:00 – 17:20 Registration (tea, coffee and biscuits provided)	
17:20	***Introduction***
	Session 1: Ancient warfare and hand-to-hand combat
17:30	***Bronze Age combat: An experimental approach*** **Andrea Dolfini**, Kate Anderson and Rachel Crellin
18:00	***Jousting and metallurgy*** **Alan Williams** and David Edge
18:30	***Avant garde? A techno-social perspective on the birth of the sword in the Bronze Age*** Barry Molloy and Marianne Mödlinger
19:00	***"Två 1800-talsbruk" (film of the Åg blast furnace and Korså ironworks in Sweden)*** **Arkivcentrum Dalarna**
19:30 – 20:30 Catered dinner	
20:30	***Damascus' watered steel: pretty lethal... or just pretty?*** **David Edge** and Alan Williams
21:30 Discussions continue in local Pubs	

Saturday 4th October (day)	
	Session 2: Firearms and artillery
09:45	***"The Art of Gunfounding" by Carel de Beer*** Chris McKay
10:15	***The Keller brothers: gun casters to Louis XIV*** Jean-Marie Welter
10:45 – 11:15 Break with refreshments (tea, coffee and biscuits provided)	
11:15	***What cannonballs can tell us about cast iron production: evidence from mid-18th to early 19th centuries European warships*** **Nicolás Ciarlo**, Horacio M. De Rosa, Ariel N. López and Mercedes Pianetti
11:45	***Breaking the mould*** Kay Smith
	Session 3: Technology, organisation and production
12:15	***Metallurgy and China's First Empire: Bronze weapons for the Qin Terracotta Army*** **Xiuzhen Janice Li**, Marcos Martinón-Torres, Andrew Bevan, Thilo Rehren, Wei Cao, Yin Xia and Kun Zhao
12:45	***Workers Weekend (Video)*** Crown Film Unit (The National Archives, UK Gov.)
13:00 – 14:00 Catered lunch	
14:15	***Persian crucible steel production: Chāhak tradition*** **Rahil Alipour** and Thilo Rehren
14:45	***Iron working and military power in Buganda*** Andrew Reid
15:15	***Supplying the Havor lance: towards standardised war gear in Iron Age Scandinavia*** Thomas Birch
15:45 – 16:15 Break with refreshments (tea, coffee and biscuits provided)	
	Session 4: Modern warfare
16:15	***Army-Industry liason in the Great War – The travels of William Huskisson*** Margaret Birch
16:45	***Liberty Ships: winning the logistics war*** Eddie Birch
17:15	***Closing remarks and formal close to the conference***
17:30	***"Två 1800-talsbruk" (film of the Åg blast furnace and Korså ironworks in Sweden)*** ***(Second chance viewing)*** **Arkivcentrum Dalarna**
19:00 – onwards Conference Dinner at The Red Lion (Milford Street, Salisbury SP1 2AN)	

Sunday 5th October (day)	
09:00	Day excursions to Museum of Army Flying (Middle Wallop) and the Bovington Tank Museum

Every effort will be made during breaks in the formal sessions to ensure that transport is available for all participants wishing to make the suggested Museum visits.

Venue

Salisbury was chosen as the venue because of its rich military history and convenient location for military museums. Two of the museums feature in the Sunday (5th October) excursion, the Museum of Army Flying at Middle Wallop and the Bovington Tank Museum, both of which provide an insight into weapons and military vehicles whose founding would be inconceivable without developments and innovations made in materials and metal technologies. The conference itself takes place here in Salisbury City Hall, a Memorial Hall for the Second World War. We hope that you enjoy your stay in and around Salisbury and have the time to enjoy and appreciate the surrounding military history and material culture.

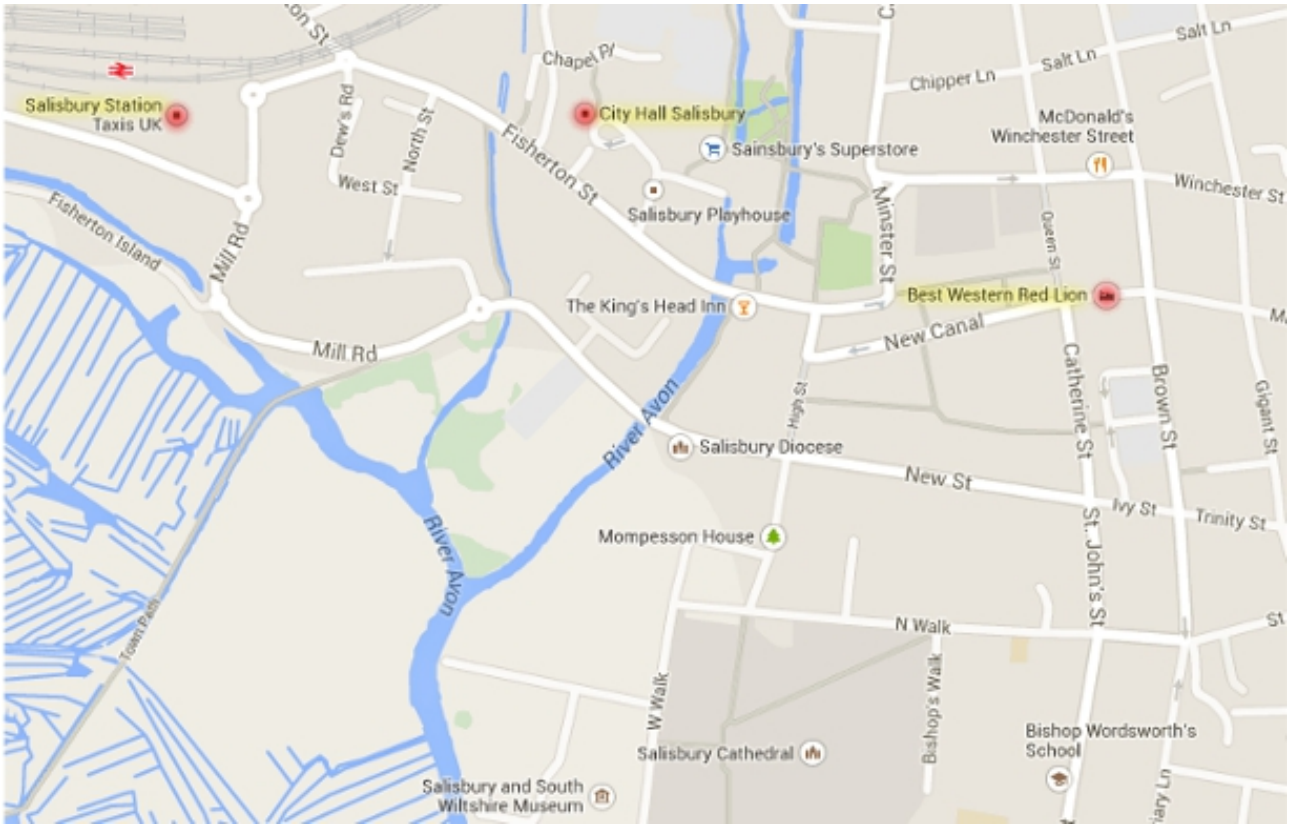
Conference theme

The call for papers made no restrictions on any particular chronological period, which has resulted in a rich and diverse range of presentations. The conference programme has been organised into four thematic sessions, but by no means should these session titles reflect narrowly on the presentations contained within, for most presentations relate to more than one session. The programme has refrained from being overtly academic, encouraging other presentation forms and topics of interest from HMS members. The posters and oral presentations all relate to various themes originally set out for the conference, to facilitate a focus on metallurgy in warfare:

- developments in metallurgy arising from particular military needs;
- developments in weapons or military organisation arising from metallurgical innovation(s);
- developments in the organisation and management of metal/metal artefact production required as a result of urgent military demands.

Conference schedule

Keeping true to HMS custom, the annual conference begins towards the end of the working day (Friday 3rd October), starting with an evening session of papers, where we will break for a catered dinner before our final paper of the evening. We hope to see many of the attendees afterwards at a local public house where conversations and socialising can continue in anticipation for the next day of the conference. The second day of the conference (Saturday 4th October) contains a full programme punctuated by refreshment breaks and a catered lunch, finishing with the conference dinner (optional) at The Red Lion, marking the formal end to the conference. The following morning (Sunday 5th October) commences with an excursion to the Museum of Army Flying at Middle Wallop (where we will lunch), followed by the second excursion to the Bovington Tank Museum.



Information

Please do not hesitate to contact either of the conference organisers at any time, should you have any urgent enquiries or problems:

Eddie Birch (Tel: 07983526110)
Tom Birch (Tel: 07884043081)

Conference Venue:

City Hall
Malthouse Lane
Salisbury
SP2 7TU
Tel: 01722 434726

Conference Dinner Venue:

Best Western Red Lion Hotel
Milford Street
Salisbury
SP1 2AN
Tel: 01722 323334

Car Parking:

Near the venue is the large Central Car Park. Charges apply 08:00 to 18:00 and there is a 10 hour maximum stay, but a judicial change of car park at Saturday lunch time should make this easy enough to cope with. This may not be necessary at other parks, but Central Car Park is very convenient to the City Hall. At the time of writing, it is possible to pay for Saturday morning at any time after 18:00 on Friday.

For more information or for other parks try:

http://en.parkopedia.co.uk/parking/carpark/central_long_stay/sp1/salisbury/

Park and Ride is unlikely to be useful because it is closed on Sundays and the rides stop in the early evening. If you want to consider it, there is information at:

http://www.wiltshire.gov.uk/parkingtransportandstreets/carparking/parkandride.htm

Detailed arrangements for the Sunday Excursions will be made on Saturday during session breaks.

Taxis:

AA-Taxis (Tel: 01722 505011)
Taxi Salisbury (Tel: 01722 505050)
Classic Cabs (Tel: 01722 710111)
Taxi Link (Tel: 01722 325522)

Bronze Age combat: An experimental approach

Andrea Dolfini[1], Kate Anderson[2] and Rachel Crellin[3]

[1] School of History, Classics and Archaeology, Newcastle University (UK)
[2] Independent Researcher
[3] School of Archaeology and Ancient History, University of Leicester (UK)

andrea.dolfini@ncl.ac.uk
website: https://sites.google.com/site/bronzeagecombat/

Abstract

The paper presents preliminary results of an ongoing Newcastle project investigating Bronze Age combat. The last twenty years have seen renewed interest in prehistoric warfare. Wounds and weapon marks visible on ancient skeletons have been examined, and use of prehistoric weapons has been reassessed using modern martial art techniques. This has allowed a reappraisal of the role of warfare and interpersonal violence in Bronze Age Europe, but more research is needed to understand how weaponry was used in combat. Championing a use-wear analysis approach, our project seeks to investigate the macro- and microscopic marks left on bronze swords, spear-heads and axe-heads (as well as leather shields) in Bronze Age combat encounters. The aim is to understand in detail how bronze weapons were used, in what kind of combat situations, and with what weapon strikes and body motions. The paper is mainly concerned with the project design, the field experiments and the preliminary results of use-wear analysis carried out on the experimental weapons.

Notes

Jousting and metallurgy

Alan Williams[1] and David Edge[1]

[1] The Wallace Collection, London (UK)

Alan.Williams@wallacecollection.org

Abstract

Tournaments started as a practice for mounted warfare and then gradually developed into a sport – apparently very dangerous, but in practice, surprisingly safe.

Jousting armour is improved in design and metallurgy to cope with the demands of not only resisting the impacts of heavy lances with sharp points and but also not overburdening the rider when he was unhorsed. Experimental jousting has shown us that the armour produced was able to withstand the increasing demands placed upon it. Princes who jousted took a keen interest in the metallurgy of their armours and analysis of samples from these have shown that this was indeed reflected in workshop practice.

Notes

Avant garde? A techno-social perspective on the birth of the sword in the Bronze Age

Barry Molloy[1] and Marianne Mödlinger[1]

[1] Independent Researcher

barrymolloy@gmail.com

Abstract

Legendary Victorian swordsman and adventurer Richard Burton claimed the "history of the sword is the history of humanity." As an artefact, swords have long been imbued with profound symbolism and elevated status, even distinct personalities and biographies – Excalibur being of particular fame. There is something ethereal yet deeply pragmatic about them. Their last strategic use in European theatres of war was the First World War, and as transformative as those years were for mankind, so too was the origin of the sword. At the vanguard of Bronze Age military developments, they ushered in the close-quarter ultra-violent melee combat that was to characterise battles for millennia. These social transformations were enmeshed in complex cause-and-effect relationships relating to the context and purpose of sword fighting, which were in turn deeply embedded in the technological developments of production. Swords of the Bronze Age constituted longer, thinner and more complex castings than any preceding type of artefact. The many-stage mechanical and thermal transformations that hardened their edges but retained a tough body were at the forefront of what can fairly be considered a scientific approach to metallurgy. Anthropology reminds us that magic and mystique potentially surrounded early metallurgy and when coupled with the liminal social persona of the warrior, swords are seen to straddle two highly meaningful social arenas characterised by restricted access. In this paper we will explore the entwined technological and social developments in the manufacture and use of swords, and the contributions of these to prehistoric social worlds.

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"Två 1800-talsbruk" (19th century charcoal ironmaking and refining in Sweden)

Arkivcentrum Dalarna (organised by Tim Smith)

tjsmith560@btinternet.com

Conference Media: Video

This remarkable film shows the sequences involved in ironmaking in 1918 at the Åg blast furnace in central Sweden and continues with the refining of the pig iron to bar iron at the nearby Korså Plantation filmed in 1926-27.

The commentary is in Swedish but an English translation by HMS member, Donald Wagner will be read out during the show.

All of the processes illustrated can still be seen in-situ as static exhibits in the Bergslagen district of Sweden. Not only does the film bring these to life but also includes rare footage of the operation of the Lancashire hearth, a technology retained in Sweden long after puddling had replaced it in Britain.

This 25 minute film is in black and white and was edited in 1956 to present these two important stages of bar iron production from preparing the ore to final quality stamping of the refined bar iron largely destined for export to the cementation furnaces of Britain and Europe.

It is on loan to HMS for a 'once only' showing by the Swedish Archive Centre, Arkivcentrum I Dalarna www.arkivcentrumdalarna.se and should not be missed.

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Damascus' watered steel: pretty lethal... or just pretty?

David Edge[1] and Alan Williams[1]

[1] The Wallace Collection, London (UK)

David.Edge@wallacecollection.org

Abstract

The Wallace Collection in London contains nearly one thousand items of Indo-Persian, Ottoman and Far Eastern arms and armour. Many of these are made wholly or partly of so-called ‘Damascus’ watered steel, of which there are many different types, doubtless deriving from differing raw materials and different smelting and forging techniques. What they all have in common is that their surface bears a pattern often resembling ‘watered’ silk. Highly prized by the original makers as well as successive generations of owners, it is likely that this was no mere decorative finish, but also served to indicate a superior metallurgy, giving armour a harder surface and blades a keener edge. It is now known that true ’Damascus’ is a crucible steel, but not all historic crucible steels reveal a pattern. How then could their superior metallurgy be recognized? Was the real purpose of ‘Damascus’ steel military, or decorative, or was it actually both?

Optical microscopy has been carried out in the Metals Conservation Laboratory of the Wallace Collection, and neutron diffraction analysis has been employed both in the UK (at ISIS, near Didcot in Oxfordshire) and at the Budapest Neutron Centre in Hungary, to ascertain the nature of the metallurgy of Eastern steels towards answering this question.

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“The Art of Gunfounding” by Carel de Beer

Chris McKay[1]

[1] Independent Researcher

chris.mckay@tesco.net

Abstract

The book “The Art of Gunfounding” by Carel de Beer is long out of print and commands high prices (£300 - £500) on the second-hand market. Part of the book shows a series of drawings that depict the process of casting of bronze cannon and mortars at the Royal Woolwich Brass Foundry. The period is around 1770-81, Jan Verbruggen was the master of the foundry and his son Pieter is believed to be the artist who executed the drawings.

The series of 50 drawings depict the whole process of casting cannon from start to finish. Some are sketches, some have a coloured wash and others near full colour though this has much faded over the past 200 plus years. In all the depictions give a most fascination insight into gunfounding, buildings, tools and equipment available and period costume.

Since the book is not easily available, Chris will present all the illustrations along with a brief explanation of each part of the process and his personal observations. He is not an expert on cannons, but has a growing interest in that field.

Notes

The Keller brothers: gun casters to Louis XIV

Jean-Marie Welter[1]

[1] Independent Researcher

jean-marie.welter@pt.lu

Abstract

The Zürich born brothers Jean-Jacques Keller (1635-1700) and Jean-Balthazar Keller (1638-1702) were appointed in the 1650 gun casters to Louis XIV. Thanks to their technical and managerial skills, the state secretary of war François-Michel Le Tellier, marquis de Louvois (1641-1691) could produce within the French Kingdom the heavy guns needed for the new strategy, which now favoured siege war. The two brothers reorganised and extended the gun foundries of Pignerol, Besançon, Neuf Brisach and Douai. Their location next to the borders simplified the logistics of moving the guns. Furthermore, the Kellers were innovative in the design and production of guns.

Their achievements were described in 1697 by Pierre Surirey de Saint-Rémy in his Mémoires d'Artillerie. So we find also the recipe of the alloy used by the Kellers: copper, tin and some brass. Therefore it was tempting to analyse some of their guns which are now located at the musée des Invalides in Paris. Sub-surface samples were removed on three places along the barrel of four guns (weighting between 1.5 to 2.2 tons each) and analysed by ICP-OES. The homogeneity of the cast was furthermore checked by eddy current measurements.

The results show that the rather pure alloy contains - with some 9 % of tin - much more tin than guns cast elsewhere at the same period, for which the tin level is more around 7 to 7.5 %. The zinc content is 0.6 %, which means that it acted mainly as a deoxidizer and most of it was slagged in the reverberatory furnace. Lead and other impurities are in the range 1.5 to 2 %.

It should be noted that Jean-Balthazar Keller worked also as a caster of large size statues for Versailles and Paris, using an alloy of the type $CuZn_3$-$7Sn_{1-3}$. This shows his flexibility in handling different alloys, but also that a gun caster did not always use gunmetal to cast statues.

Notes

What cannonballs can tell us about cast iron production: evidence from mid-18th to early 19th centuries European warships

Nicolás Ciarlo[1,2], Horacio M. De Rosa[2,3], Ariel N. López[2,3] and Mercedes Pianetti[4]

[1] National Research Council (CONICET), Buenos Aires (Argentina)

[2] Archeometallurgy Group, University of Buenos Aires (Argentina)

[3] Institute of Technology and Engineering Sciences (INTECIN) "Hilario Fernándes Lond", University of Buenos Aires (Argentina)

[4] Scanning Electron Microscopy Laboratory, National Institute of Industrial Technology, Buenos Aires (Argentina)

nciarlo@yahoo.com.ar

Abstract

The ordnance of early Modern main maritime powers (i.e. Great Britain, France, and Spain) played an important role in conflicts for supremacy of the seas. Within this context, the production of cannons and cannonballs, along with other manufactures destined to naval construction and equipment, demanded much of the iron production of the time. Iron ordnance received special attention and capital investment, and was subjected to diverse innovation processes in manufacturing techniques and materials, aiming to improve their efficiency.

As for cannonballs, their making did not require the same care and attention as cannons, given the function to which they were destined. In turn, the use of poor quality iron - obtained in the first blast furnaces castings - seems to have been common practice for ammunition production in some foundries. It is likely that cannonballs quality was markedly heterogeneous. In this regard, the microstructure in them exhibited can be considered as representative of the metallurgical characteristics of the cast iron production in this period.

This study presents the characterization results of an array of iron projectiles recovered from some mid-18th to early 19th centuries European warships. Based on data obtained using Light Microscopy (LM), Scanning Electron Microscopy (SEM), and Energy Dispersive X-ray Spectrometry (EDXRS), a comparative analysis was performed, in order to clarify the technological differences and similarities present in the projectiles belonging to those ships.

Breaking the mould

Kay Smith[1]

[1] Independent Researcher

member@basiliscoe.fsnet.co.uk

Abstract

By the early decades of the 16th century, artillery had essentially reached its apogee in form and destructive power and changes thereafter were small and incremental. It is probably true to say that the gunners of the Mary Rose would have recognised the guns of Wellington and Napoleon, 250 years later. But how did a relatively weak, somewhat unreliable weapon develop to the extent that it needed little further refinement for nearly three centuries?

Drawing on a range of sources, documentary, artefact and experimental, this paper will show that the vital ingredients came together in the last quarter of the 15th century and that crucial to the development of more effective artillery were changes in casting technology. Using new casting techniques, the cannon maker was able to make use of the full power of gunpowder, as well as use more of it, to propel heavy, cast-iron shot at greater velocities than ever before.

Artillery came of age in the final decades of the 15th century, making it the powerful weapon it was to remain until the development of smokeless propellants and steel in the 19th century.

Notes

Metallurgy and China's First Empire: bronze weapons for the Qin Terracotta Army

Xiuzhen Janice Li[1,2], Marcos Martinón-Torres[2], Andrew Bevan[2], Thilo Rehren[2,3], Wei Cao[1], Yin Xia[1], Kun Zhao[1]

[1] Emperor Qin Shihuang's Mausoleum Site Museum, Lintong, Xi'an (China)
[2] UCL Institute of Archaeology, London (UK)
[3] UCL Qatar, Doha (Qatar)

xiuzhen.li@ucl.ac.uk

Abstract

The Qin Dynasty, the First Empire of China, was established in 221BC after a long term constant state of war fought for land and power. The imagining of the warfares, the Qin troops and their weapons was very vague, based on incomplete historical records, until one day in 1974 the fully equipped Qin Terracotta Army was discovered. A study of the functional and lethal weapons for these terracotta warriors suggested special metallurgical technologies were employed and a labour organisation model was in place to enable quantity production: the alloy optimisation balanced the hardness and toughness of the weapons; the filing, grinding and polishing procedures enhanced their penetrating power; and the organisation of craftspeople secured the efficiency and quality of the weapons production. Without doubt, in competing with other contemporary states, the metallurgical techniques and organisation for making weapons should be considered as one of the crucial factors for the Qin's military success.

Notes

Workers Weekend

Production: Crown Film Unit

Commentary by: Flying Officer J. Peach, Royal Canadian Air Force

The National Archives (UK Government)

Conference Media: Video

‘A tribute to the workers of the British Aircraft Industry'. Men and women in a factory in the North-West of England set themselves the task of building a Wellington bomber in the record time of 30 hours. Constructing in their own time, the workers donated the bonus they got to the Red Cross ‘Aid to Russia Fund'.

The cameras capture the whole process of the construction in record time through to the test pilot taking off in the plane, ahead of schedule.

Notes

Persian crucible steel production: Chāhak tradition

Rahil Alipour[1], Thilo Rehren[1]

[1] UCL Qatar, Doha (Qatar)

rahil.alipour.09@ucl.ac.uk

Abstract

Since the crusades crucible steel weaponry has been a matter of admiration and speculations. The highly specialized production of crucible steel weaponry was a break-through in arms and armour industry. This competitive metallurgical innovation, meeting the military demands of the time, was to be kept untold in the West. Now the archaeometallurgical study of crucible steel production, despite being a relatively new field of research, is revealing new horizons in the understanding of this technology in Central Asia (9th-12th centuries CE), India and Sri-Lanka (mostly 17th century CE onwards).

A number of historical manuscripts relate this industry to several production centres in Persia. They highlight the military purpose of this industry by determining the ingot quality based on evaluating their produced blade properties. This research reports initial results of the archaeometallurgical study of historical and archaeological data of an on-going project on Persian crucible steel production, based on the medieval site of Chāhak in Central Iran.

Microstructure and elemental composition of different crucible fragments and slags were determined with metallographic optical microscope and SEM-EDX, providing information on crucible fabric, slag composition and the metal which was produced by this process. This research attempts to open a new chapter in the study of crucible steel production by introducing the Chāhak process, which may pave the way to track and study the origins of crucible steel production in the broader context of Central and Western Asia.

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Iron working and military power in Buganda

Andrew Reid[1]

[1] UCL Institute of Archaeology, London (UK)

a.reid@ucl.ac.uk

Abstract

Recent work has identified a significant quantity and diversity of iron production within the borders of Buganda, the major power in the Great Lakes region of Africa in the eighteenth and nineteenth centuries. Unusually, this iron production was not a core element within the state, but rather it was regarded as an exotic and greatly needed commodity. Traditions even suggest early episodes where Buganda defended itself from invasion using wooden stakes, lacking iron for spears. A significant factor behind the expansion of Buganda in the last centuries before the arrival of Europeans must in part have been the desire to control areas of iron production. This iron production also then supplied the weaponry used by Buganda's armies. In contrast with its neighbours, Buganda enjoyed overwhelming superiority in numbers, and state-instigated raids were sent out to acquire booty. In response, neighbours had to develop innovative tactics in order to withstand Buganda's attacks. Notwithstanding Buganda's need of iron and, increasingly in the nineteenth century, of smiths making rudimentary repairs to imported firearms, iron production was never symbolically incorporated within the iconography of the state.

Notes

Supplying the Havor lance: towards standardised war gear in Iron Age Scandinavia

Thomas Birch[1]

[1] Institute of Archaeological Sciences, Goethe University, Frankfurt am Main (Germany)
birch@em.uni-frankfurt.de

Abstract

Across southern Scandinavia are some 30 known weapon depositions made in former lakes from the Roman Iron Age (0-375 CE), seven of which are large-scale war booty sacrifices entailing material culture from whole defeated armies. The major weapon deposits contain spears, lances, shields, swords, knives and other *militaria*, representing a colossal sum of iron – at one site, some 6000 objects totalling 500kg of iron metal.

As part of an enquiry into the provenance of the iron used to make these weapons, the research also studied in detail a group of lances identified as the 'Havor' type. Thirteen Havor lances were sampled for metallurgical analyses to understand how the lance type was made and which materials were used. Further to this, a metric analysis and geometric morphometric analysis (shape analysis) was conducted on all Havor lances (over 120) known from the three major weapon deposits, using scaled drawings and photographs.

The results portray the Havor lance type as a highly standardised weapon produced in a single workshop, using iron sourced from across wider Scandinavia. The combined results reveal a dynamic movement and trade in iron to supply weapon workshops, such as the case for the Havor lance, which was a standardised weapon that could be used by a war bands or organised armies for military offensives.

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Army-Industry liason in the Great War – The travels of William Huskisson

Margaret Birch[1]

[1] Independent Researcher

margaretcbirch@btinternet.com

Abstract

Having reluctantly been retired from the Royal Engineers in November 1917 Major General William Huskisson was appointed Assistant Inspector of Steel under the aegis of the Chief Inspector, Naval Ordnance. On taking up his appointment in Sheffield he was put in the section that inspected Bombs and Mines. In February 1919 he was asked to take charge of the Manchester office of the Inspection of Steel in order to close it down, which was where he operated from until the establishment of the peacetime operation in Openshaw and the termination of his appointment in June 1919.

While WH's background was in military engineering, his family connections around Birmingham and Wolverhampton meant that he was well acquainted with the realities of non-military manufacturing and construction.

His diaries, and those of this wife, describe a fairly relentless timetable of visits, testing, and inspections.

The munitions factories inspected by WH were of 3 distinct types:

- factories converted to munitions for the duration, eg. The Linotype & Machinery Co. Ltd, Altrincham
- companies already involved in arms manufacture, eg. Vickers at Crayford in Kent
- munitions facilities created specifically for the war effort, eg. the National Filling Factory at Banbury.

Although based in Sheffield, and there were offices of the Inspectorate in London, Birmingham and Manchester, inspections appear to have been made not on a geographical basis, but on the nature of the inspection. In a typical week WH would be out on inspections Monday to Thursday, and be in the office on a Friday. For instance, in one week of February 1918, WH was on Monday inspecting at Huddersfield, on Tuesday in the office, at Banbury to inspect mine filling on Wednesday, at the

Thames Ammunition Works in Erith to inspect the filling of detonators, as well as the casting of containers at Woolwich on Thursday, mine filling again at Harding and Ware in Edmonton on Friday before returning to Sheffield that evening, arriving home around 9.30. pm

As well as inspecting the quality of castings, WH was also involved in inspecting the processes – for instance at Gainsborough he distinguishes between the "inspection of 65lb bombs" and the "manufacture of 250 lb bombs". He was also concerned with the storage of bombs, and also with actual testing, deciding which tests should be carried out.

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Liberty Ships: winning the logistics war

Eddie Birch[1]

[1] Independent Researcher

Mejbirch@aol.com

Abstract

When the Liberty Ship SS Robert E. Peary was launched 4 days, 15 hours and 29 minutes after the keel was laid down this was of course a morale boosting, but unsustainable, propaganda record.

Nevertheless, the Liberty Ship program, which applied the techniques of mass production to ship building was innovative in a number of ways. The operation involved building many new shipyards and training tens of thousands of workers.

This presentation will attempt to review not only the military and political situation in which the ships were built, and their contribution to the war effort, but will also deal with some of the operational and metallurgical problems met by the shipyards, and by the ships in service.

Notes

Lead bullets: A Case study, La Verde Battle (Buenos Aires province, Argentina 1874)

Carlos G. Landa[1,2], Emanuel Montanari[2,3], Mercedes Franco[2], Florencia Cantargi[4] and Horacio De Rosa[2,5]

[1] National Research Council (CONICET), Buenos Aires (Argentina)
[2] Archeometallurgy Group, University of Buenos Aires (Argentina)
[3] Philosophy and Letters School, University of Buenos Aires (Argentina)
[4] National Atomic Energy Commission, Bariloche Atomic Center, Bariloche (Argentina)
[5] Institute of Technology and Engineering Sciences (INTECIN) “Hilario Fernándes Lond”, University of Buenos Aires (Argentina)

hormader@gmail.com

Abstract

On November 26, 1874, near to "Estancia La Verde" (currently 25 de Mayo, Buenos Aires province, Argentina Republic) took place a battle between loyal government forces, leaded by Lieutenant Colonel Inocencio Arias, and the revolutionary forces, under General Bartolomé Mitre command. This event lasted at least three hours, and resulted in great casualties, sealing the fate of the revolutionary movement. From the technological and historical point of view this is one of the first events in which breech block rifles were massively used in this country.

Archaeological works performed in the site have permitted recover a variety of metallic artefacts and fragments related to this war event. By means of microstructural studies information about warfare technology of that time, its actual use, as well as the way that the environment has affected these remains were obtained.

The majority of the artefacts consists in lead bullets and brass cartridges primarily identified as belonging to Remington and Martini-Henry rifles. This work aims to analyse the chemical composition, sizes, shape and microstructure of lead projectiles, in order to put light on the technological aspects such us mechanical properties and alloy quality and other ones relates to the battle development. The basic analytical techniques applied were: optical microscopy, scanning electron microscopy, energy dispersive X ray spectrometry and neutron activation analysis.

Notes

Challenging the times of technical innovation: the traditional production of musket balls after the introduction of shot towers

Nicolás Ciarlo[1,2] and Ana Castelli[2]

[1] National Research Council (CONICET), Buenos Aires (Argentina)
[2] Archeometallurgy Group, University of Buenos Aires (Argentina)

nciarlo@yahoo.com.ar

Abstract

Lead shot production experienced a radical change during the last quarter of the 18th century with the introduction of shot towers, for which William Watts from Bristol received a patent in 1782. They were developed to replace the preceding method, which consisted in pouring molten lead into moulds, a traditional but laborious process that usually left undesirable seams and other imperfections on the shots' surface. Nonetheless, despite the success and expanding use of Watts' invention in England and the rest of Europe, the previous practice withstood in some manufacturing centres for decades.

Studying archaeological materials allows enriching the available knowledge related to mass-produced artefacts, particularly where traditional means persisted within a context of industrial growth and innovation. In this work, the analyses were conducted on a sample of musket balls recovered from the cargo of a British ship that sunk in the Ebro delta (Catalonia, Spain) in 1813. The macroscopic and microstructural characteristics of these artefacts, combined with data from other archaeological sites, provided additional information about the production methods used in the period.

Based on historical and archaeological research, the underlying drivers of innovation process were explored. Confluent factors such as the economic and technical advantages that one way had over the other, certain conservatism associated with traditional craft, and the increasing military demand of ammunition in times of war, were in this respect taken into consideration. The analysis performed provided a more accurate picture of the technological changes associated with weaponry during late 18th to early 19th centuries.

Roman military equipment from Britain and Lower Germany in the first and second centuries AD

Pablo Antonion Fernández[1]

[1] Department of Archaeology, University of Liverpool (UK)

Pablo.Fernandez-Reyes@liverpool.ac.uk

Abstract

In the past, military equipment from the Roman Empire has been studied through typological and stylistic analysis that suggested a 'logical' evolution and presenting quite clearly differentiated stages. A simple mono-linear explanation (in the tradition of Graham Webster, Peter Connolly, or Henry Russell Robinson) for change and/or production is insufficient to explain the enormous variation observed in the archaeological record. Whilst this problem has been noticed and addressed in recent years, technological aspects have been neglected. Microstructural and chemical analysis on copper alloy objects down to trace elements can reflect different metallurgical traditions amongst military units or workshops. When alloy-type is considered across an extended period of time, however, a continuous change in alloy type from brass to leaded gunmetals can be observed across Northwestern Europe.

Notes

Lead – the ideal material for ammunition since ancient times

Regine Müller[1]

[1] Institute of Geosciences, Goethe University, Frankfurt am Main (Germany)

regines.knie@gmx.de

Abstract

The sling as a weapon has been in use since neolithic times. The first ammunition by than consisted of suitable stones or spheres of clay. The oldest lead bullets found derive from Aegean late bronze age sites, though the first written source mentioning lead ammunition is Xenophons Anabasis, dating into the 5th century BC. From the 5./4. century BC lead ammunition became more frequent and from the 3rd century BC on was also used within the Roman army.

In general the shape of the bullets is either ovoid or bipyramidal in varying extents, though a number of other, less frequent shapes is known as well. The production was the same in Greek and Roman times. The bullets were cast in a mould and afterwards – if necessary – worked over, in order to improve their aerodynamic properties. During late Roman republican times other ways of production appeared: casting bullets in an open mould and mechanically forming lead chunks into the right shape. A kind of production, that also seems to be restricted to the Iberian/Balearic area. Another notable way of casting lead bullets was reconstructed on a 1st century AD site, where during battle ammunition was cast by merely producing a hole in the ground with a finger and then using it as a mould.

These different production examples show, that lead, due to its properties – low melting temperature, quick cooling out and high specific weight - could be easily turned into ammunition, even without moulds and that the bullets could be as easy accommodated to the individual slingers needs.

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Shipbuilding Production for the Austro-Hungarian Navy by the Vítkovice Ironworks (1891-1914)

Aleš Materna[1]

[1] Faculty of Arts, Department of History, Centre for Economic and Social History (Czech Republic)

ales.materna@seznam.cz

Abstract

This study analyzes shipbuilding production by the Vítkovice Ironworks, which ranked among the most important manufacturing sectors for the company in the period 1891–1914. Vítkovice shifted its focus to the production of military hardware in response to increasingly tense international relations and new trends in warfare. For Vítkovice Ironworks Corporation was easiest to enter competition in the manufacture of armor plates for the construction of naval forces. This production fully met the business objectives of enterprise management, which was led from 1876 - 1893 by one of the best metallurgical experts of Austria, Paul Kupelwieser. He constantly acquainted with technological innovations in steel production in the European steel industry centers (Sheffield, Middlesborough, Essen) and the most important inventions applied in Vitkovice Ironworks. Through the transfer of information and monitoring of technological development, that were obtained by Vítkovice ironworks in the period 1891-1914, Vitkovice succeeded to get a monopoly on the production of marine armored plates and marine armored turrets for the entire area of the Habsburg monarchy. Vitkovice Ironworks were also involved in the construction of dozens of battleships, cruisers and 4 dreadnought (the most famous of them was Viribus Unitis), which fought in the World War I. The study outlines the processes of shipbuilding production: the initial plans to make special armour plating for military purposes, the acquisition of the necessary expertise and know-how, the construction of manufacturing facilities, negotiations with the naval authorities, the production itself, and ultimately the commercial success generated from this sector. The author points out the importance of naval contracts for the Vítkovice Ironworks, both in commercial terms (military production was an exceptionally profitable line of business) and as a means of raising the company's profile and prestige.

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