Bronze Collections in the Office of Suaka Peninggalan Sejarah dan Purbakala Jawa Tengah: A Metalographic Observation

by Gunadi

Man learned how to make tools and objects from stone and wood. This was even before he learned how to make tools from metal. In ancient times he knew only native ore and shaped it simply by hammering.

Then he learned how to cast. At first a single metal was casted; later alloy metals were discovered and casted. He learned how to improve the properties of alloy by heat and treatment after casting *(Warangkhana Rajpitak, 1983 : 1)*.

The first bronze foundry was made in 3000 BC in Mesopotamia. This technology spread in Middle Asia, India and China; then in Japan and Southeast Asia *(Tata Surdia dan Kenji Chijiiwa, 1982 : 1)*. The bronze-iron age of Indonesia developed very quickly. The society that emerged as a result were skilled in the technology of mining ores as well as the smelting and casting of the metal. This technology developed until the present.

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It is not easy to find metal. In the mining area many kinds of metals are mixed naturally. For example, an analysis of ore in Blawi revealed that it contains Pb 8.95%, Cu 1.52%, Zn 3.78% and Sn 1.37% *(Van Bemmelen, 1949 : 99)*.

Therefore, once a certain kind of metal is mined, it is necessary to separate the mixed elements. There are quite a few methods of extracting metal grains. One of these is by heating. During the early age, heating was done in the open air, a simple way but without any high temperature. This method could cause volatile impurities to evaporate very quickly. These impurities may, for example in tin concentrates, consist of Fe, S, Pb, Cu, As, Sb and Bi *(Waspodo and Supriyanto, 1979 : 1-5)*.

Bronze is metal mixed with copper *(Cu)* and tin *(Sn). Indonesian bronze objects of prehistoric times were often mixed with black tin (Pb)* aside from copper and tin *(Soejono, 1977 : 241)*. Analysis of bronze objects from the excavation site in Gunungwingko, Yogyakarta, by Timbul Haryono showed that the metal elements in those objects are Cu, Sn, Pb, Fe *(Timbul Haryono, 1984 : 5-6)*.

There is a felt need to develop archaeometallurgy in Indonesia. Timbul Haryono pioneered in this field with his studies and analysis of bronze objects. Until now, however, there are only a few archaeologists interested in this study.

Owing to this, I have tried to study the bronze objects in the Suaka Peninggalan Sejarah dan Purbakala Jawa Tengah collection. This attempt, however, is only a very limited metalographic approach. This approach is based on the elemental analysis of analysed samples.

Aside from the bronze collection of Suaka Peningalan Sejarah dan Purbakala Jawa Tengah, I shall also attempt to discuss the bronze objects in other places for comparison.

Now then, because of my limited samples and ability, the result of this study, using the metalographic approach, would be temporary and will thus require further examination. This metalographic approach and observation is limited in elemental analysis activity. Microstructure analysis, which must be structured in the metalographic analysis activity, cannot be done because of the lack of proper equipment.

Six samples have been analysed. Materials have been studied by Pusat Penelitian Bahan Murni dan Instrumentasi, Badan Tenaga Atom Nasional Yogyakarta. Another study made is revealed in a laboratory report analysis which found a Ganeça image in Playen, Gunung Kidul, from Suaka Peninggalan Sejarah dan Purbakala Daerah Istimewa Yogykarta.

ARCHAEOLOGY AND METALOGRAPHIC DATA

As mentioned above, my objective is to study bronze objects. Archaeological and metalographic data gathered from these objects are:

1. BRONZE AXE

Collection No.	=	75	
whole length	=	6	cm
width of sharp part	=	5	cm
width of handle	=	2	cm
hole of handle	=	1.2	cm.
other characteristics	=	there is no ornament, the colour is reddish.	

Up till now it is not known where this bronze axe came from. Based on the data above, this relatively small axe has a short handle and the blade is chubby. According to a classification made by R.P. Soejono, it belong to the thirth (III) type. Usually this type comes from West Java, East Java, South Sulawesi, Maluku, and Irian *(R.P. Soejono, 1977, 236)*.

The metalographic data is Cu = 63%, Sn = 26.4%, Zn = 8%, Pb = 0.95%

Bronze axe

2. BUDDHIST IMAGE

Collection No.	=	104	
whole height	=	6	cm
width of body	=	3	cm
thickness of body	=	1.5	cm
width of foot	=	5	cm.

This image was found in the east of Sojiwan Temple, Kebondalem Kidul, Prambanan, Klaten. The image's hand position is abhaya mudra. In Borobudur this image is on the rupadatu level. In the north it is called Dhyani Budha Amogasydha *(Soediman, 1974 : 22)*.

Its metal composition consists of Cu = 32.7%, Sn = 49%, Zn = 3.8%, Pb = 1.95% and Sb = 12%.

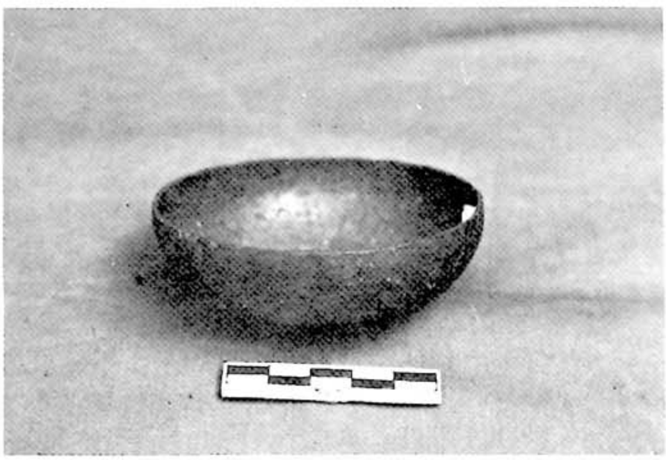
3. BOWL

Collection No.	=	140	
whole body	=	8.3	cm
height	=	2.5	cm
thickness	=	0.2	cm
other characteristics	=	no ornament	

This bowl was found with other materials *(Chinese ceramic)* used by the inhabitants of Karangnongko, Klaten. Similar bowls and salvers were also recently found in Middle Java.

Metalgraphic data are: Cu = 83%, Sn = 3%, Zn = 13.2%, Pb = 1%

Left: Buddhist image
Below: Bowl



4. THREE-HEADED IMAGE

whole height	=	8.5 cm
image's height	=	6.5 cm
width of body	=	2.0 cm
thickness of body	=	1.5 cm
other characteristics	=	sitting on ascena formed padma, has four hands with 2 front hands in dianamudra position and 2 other ones bent up.

Metal composition: Cu = 41%, Sn = 33%, Zn = 21%, Pb = 1.5%

5. GANEÇA IMAGE

whole height	=	12.8 cm
width	=	9.0 cm
width of asana	=	8.5 cm
thickness of body	=	7.7 cm
other characteristics	=	has four hands, i.e. : the back right hand carries an axe, and the left one, a camara.

There is no crescent *(ardha candrakapala)* on the crown, and its two tusks are intact. The front right hand doesn't carry the snout, and the left one with no bowl.

According to the elemental analysis made it consists of Cu = 73.2%, Sn = 9.6%, Zn = 12.55%, Fe = 2.69%. The undetected 3.97% Pb element has not been found because of limited indicator.

DISCUSSION

Before discussing the above materials, I would like to explain the different kinds of metals mixed with the real element of copper.

Bronze is a metal which is mixed with copper *(Cu)* and white tin *(Sn)*. Brass consists of copper *(Cu)* and zinc *(Zn)*. Other metals mixed with copper are phosphorus bronze, alluminium bronze *(Kenji Chijiiwa and Tata Surdia, 1982 = 41 – 42)* and also zinc bronze, i.e., bronze mixed with zinc *(Vohdin Latief and Zeinoeddin, 1982, 52)*.

Mixing copper and zinc can be done with 45% zinc. However, a good mixture should have the proportion of 70/30, i.e., 70% of copper and 30% of zinc. If the added zinc reaches 50%, the mixture will be destroyed easily. It will break into pieces or microstructurally.

Bronze consisting of only copper and white tin has bad liquid. It is therefore not good when pouring *(Tata Surdia and Kenji Chijiiwa, 1982 : 41)*. According to Daryanto there are many metals mixed with Cu, Sn and Zn and which are added to other metals. It is however quite difficult for us to find out if this is bronze or not.

Metal which has more white tin than zinc is called bronze. The zinc element adds strength and hardness *(Daryanto 1983, 48–49)*.

Based on this, the zinc element on the bronze objects in Suaka Peninggalan Sejarah dan Purbakala Jawa Tengah collection is natural. As can be appreciated in the above elemental analysis, the zinc element contained in ancient bronze materials is relatively smaller than the contents of those made in copper.

Imitation metal objects contain about 50% zinc element. But the image of Ganeça from Playen, Gunung Kidul is different; it has two replicas from Purworejo. The comparison between copper and zinc is more like in old objects.

Based on archaeological data, the imitation image was made without iconography. Aside from this, it is known that contrary to genuine ancient objects, imitations usually have bad metal mixtures. But we also have to remember the fact that the imitation image from Playen, Gunung Kidul, has good metal.

Now then, what if we find a bronze object such as a bronze image with iconography and a rational composition of metal elements.

The kettle drum, bronze axe and bronze vessel have been analysed and their elemental composition are as follows: *(R.P. Soejono, 1977 : 241)*.

Kettle Drum *(Pejeng type)* has Cu = 75.5%, Sn = 14.51%, Pb = 6.09% composition.

Bronze Axe from Pasir Angin, Bogor consists of Cu = 26.93% Sn = 37.22%, and Pb = 0.55%

Bronze Vessel from Madura has Cu = 64.40%, Sn = 15.20% and Pb = 2.83%.

There is still about 4-36% of the total composition which is not yet detected from these three ancient objects. This cannot as yet be classified as dirt or impure element. It may be zinc.

No zinc element was found in the elemental analysis of the bronze object at the excavation site in Gunung wingko, by Timbul Haryono. And the Fe and Pb elements found were dirts *(Timbul Haryono, 1984, 6-13)*. Based on this it can be concluded that the metal composition of bronze rings consist of Cu and Sn. It is pure bronze; free from zinc.

Bronze objects with Cu and Sn composition were also found by Bayard in Non-Nok Tha, Thailand. The analysis, using x-ray fluorescence, revealed that its metal is composed of Cu 94 - 96% and Sn 4 - 6%. *(Pisit Charoenwongsa and Subhadradis Diskul, 1978 : 43)*.

From the foregoing metalographic data, we now know that good technique was used in the metal works. So, if we extract a certain metal, a complicated working process ensues.

For example, to get copper, first we have to find sulphate copper *(Cu Fe S2)*, with 34% Cu. It should be heated repeatedly until it is melted together with *kokas* on fire. To get copper with 90% Cu, we have to find copper stone which must be heated until melted. We have to change it in a converter to get copper with 98% Cu, then we put it on the fire. If we need copper with 100% Cu, we must do it electrolytically. The same goes for Zn, Sn and Pb.

It has been previously mentioned that to extract a certain metal, first we must prepare it in the open air. The metal grains are warmed repeatedly. Because metals often mix naturally with each other and if this is done without proper equipment, the metal extracted will not be as pure as it shoud be.

How did our forefathers then extract metal grains? Perhaps the ore consisting of metal grains was heated in a kowi *(bowl)* on fire. After the metal grain became liquid, it was poured on a wood or clay cast. *(Francis Celonia, 1973 : 78-83)*. This technique of pouring is known as the lost wax process.

Three-headed image

Left: Ganeça image

CONCLUSION

1. Cu, Sn, Pb, Zn and dirt or impurities are elemental composition of bronze objects from the Suaka Peninggalan Sejarah dan Purbakala Jawa Tengah collection. This applies to both originals and imitations.

   The percentage of zinc in ancient objects is smaller than in the replicas. The Buddhist image in collection no. 104 however has a different composition; it has 12% antimony element.

2. Bronze mixed with zinc is a natural metal mixture especially in pouring work. Aside from adding hardness against corrosion and oxidation, the zinc element also adds power.

   But zinc alone is a bad metal. In other words, it can be concluded that the zinc element is an indicator; it fixes the quality of the bronze object.

3. The Ganeça image from Playen, Gunung Kidul deviates from the iconography structure. But its elemental composition is rational *(like ancient objects)* and its metal quality is good.

   What is important is that if we encounter imitation objects like this image, we must consider the reason connected with the copy making of this archaeological object.

Another method of distinguishing a genuine archaeological object from an imitation is what I have seen in Thailand. Before selling archaeological objects, owners submit their artifacts to museum officials for observation. Once verified, a special mark is then put on the objects to distinguish the genuine from the imitation.

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Deciding to computerize your museum?

> Computerization is not a cure-all remedy. It is only part of the treatment

A number of museums cannot easily ascertain what they have, what they are supposed to have, or where each object is located. The pressure to do something about the state of their collection documentation and the major innovations in data processing lead many museums to undertake computerization projects with the belief that automation could control and improve documen tation.

Computers are wonderful machines. They assist in the performance of tasks that are normally difficult and time consuming to do manually. They do not only simplify and improve the efficiency of collection registration but also assist in facilitating better research and reports, exhibits, budget planning, labelling, administration, and other museum functions.

Nevertheless, computerization is not a cure-all remedy. It is only part of the treatment. Therefore, before plunging into the computer age, it is important to fully understand the museum's existing manual systems and take steps to correct erratic structures. Only then will information be easily fed and maintained in computer formats.

As non-profit entities, museums have formidable constraints on their budgets. But with the help of grants, a computerization plan could easily become a reality. It would however be wise to first take a hard look at the existing situation. The following process could also help in deciding whether or not automation should be set to motion.

1. Read about computers in general and investigate methods

used to computerize museum records. Examine computer projects in various disciplines and museum environments. Know the pitfalls encountered and how other museums have avoided them. Talk to colleagues in other museums about how they use computers.

2. Analyze the museum's manual operations. Identify the various existing files, forms, and procedures. Know how they interact to produce information and documentation. A sound knowledge of the manual system is necessary for the provision of a solid data to those designing and implementing the automated system.

3. Determine the problems and difficulties of the manual system. Know the roots of the problems and decide if automation could really help solve them.

4. Make a list of priorities for activities to be computerized.

5. Seek the help of a computer consultant experienced in several types of systems and who does not represent a particular manufacturer. Ask him to evaluate your assessment of the problems and needs and to recommend the level of equipment (hardwares) and programmes (softwares) most suitable for the museum. Let him list applicable hardwares and softwares.

6. Decide whether or not to use computers. Because of the usually small museum budget and the high costs involved, it may be unfair to automate if there is no pressing need. It may even be better to postpone. Wait and see, softwares for museums may soon be available commercially. Hardwares are also getting cheaper. "If it works – it's obsolete" is a saying that sums up the computer industry and its high speed technological

development.

7. If computerization is solely the answer to your difficulties then start setting your short-term and long-term project goals. Develop a master plan for implementation and list steps to be followed to accomplish each goals. Create a timetable.

8. Begin with a small project. After the computer has been purchased, aim for a project that could be completed in a month or two. Use the project to help the staff learn how to use the equipment. Errors in a small project are not as serious as those in larger ones. And the satisfaction of successfully completing a small project soon after the computer is installed could create a positive impact on the attitudes of the staff and the administration towards automation.

CHIN- Linking Canadian museums through computers

Museum collections in most developed countries are increasingly getting more readily available to scholars and others at home and around the world. In these countries, museums with computer terminals or microcomputers are even able to communicate with one another through electronic telecommunications networks.

In Canada this works under a programme known as the Canadian Heritage Information Network (CHIN). Initially conceived as a central computer-based inventory of Canada's major museum collections, CHIN is presently managed by the National Programme's Branch of the Department of Communications (National Museums of Canada).

CHIN was primarily designed to increase public access to museum collections and to preserve these collections as a national resource through their care and documentation. Hence, it maintains a national inventory and encourages information-sharing. The programme also provides member institutions with the means to improve their collections management systems by the use of suitable modern technology. For this purpose, CHIN has created an advisory service, on the use of new technology, to the Canadian Museum Community. State-of-the-art computer technology, sophisticated computer programmes, and a national telecommunications network linking museums to one another were all combined to make up this unique national programme.

Through CHIN's computer system, better known as PARIS (Pictorial and Artifact Retrieval and Information System), museum professionals are allowed to store, retrieve, manipulate, and exchange large amounts of detailed information quickly and efficiently. As a result, the computer system now contains over 2.5 million records, representing some 5 million objects. Over 150 institutions all over Canada are presently associated with the CHIN/PARIS network.

Member museums all over Canada can directly enter data, from their premises, into the mainframe computer in Ottawa and perform their own searches. Each member has its own institutional data base in the central system. And this could either be in the humanities, the natural sciences, or both. As terminals on museum premises are directly connected with CHIN's mainframe computer, users can ask questions, get immediate answers on their terminal screen, and add or delete information as often as required. The CHIN staff could also be requested for guidance and to produce formatted reports.

CHIN is building two national data bases: one for the humanities and the other for natural sciences. These are based on the institutional data bases. Among the various reasons for searching the national data bases are: to assist in collecting by listing the types of material already held in public collections, to assist in cataloguing like objects, to support loans or exchanges, to plan in-house and travelling exhibitions, to identify the distribution of specific materials, and to locate particular artifacts. In other words, the national data bases are intended to make information on Canadian collections more widely available.

The general public are given access to these data bases through the CHIN office in Ottawa or through participating institutions.

The PARIS computer system accepts data in the natural language and responds to commands in English or French. Nevertheless, to assist users, CHIN has published data dictionaries for the humanities and natural sciences. These dictionaries list and define all the data fields or categories of information available in institutional data bases. And because each definition explains how information could be entered and retrieved, the records are clear and consistent. This makes PARIS relatively easy to use and quickly understood by all users.

The CHIN staff are actively researching questions of museum documentation and automation. For example, their work on data dictionaries is an on-going task. And, as the needs of museums change, they will continue to keep pace with the help of computer technology and their new applications.