A RECONSTRUCTION OF A MAJAPAHIT SHIP*

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INTRODUCTION

In 2009, the Directorate General of History and Anthropology of the Ministry of National Education has launched an initiative to reconstruct a replica of a Majapahit Kingdom era (1300-1400). Together with a few domestic and international NGOs interested in the study of Majapahit, the Directorate General appointed ITS to conduct a study to reconstruct a typical vessel of the iconic Kingdom. During a series of discussion, it was agreed to reconstruct a commercial –not military- vessel of the Kingdom. This has been a rather political decision to avoid developing a perception of an invasive Majapahit.

The assignment of ITS to do the study was not an accident. Toward the end of the 1990s, the Marine Technology Postgraduate programme of ITS has developed a great interest in the study of small craft technology, including traditional wooden boats. Maduranese traditional wooden boats was used as an entry point of study to strengthen the Madura community to prepare itself in the face of incoming industrialization brought about by the planned Suramadu bridge. An international workshop on small craft technology was conducted in 2000 at ITS. Modernizing the traditional wooden boat practices was believed to provide sustainable basis for a later industrialised Madura in which its people play a major role.

The task of reconstructing the Majapahit ship was certainly more challenging than the experience that ITS has accumulated. ITS has the experience of constructing a replica of a 12m Napoleon era boat, called Yole de Bantry in 2002. The boat was a combined 3-sail with 10 rowers, a coxwin, a navigator, and a captain. The replica was named Merdeka and was used to participate in the Atlantic Challenge 2002 of Seamanship Contest and Boatbuilding Festival in Rockland, Maine, the USA. Since then, a second generation of replica, named Garuda was built in 2010 to participate in the 2010 Atlantic Challenge in Midland, Canada. Garuda is presently resident in Rockland to be used as a training boat. The last generation of replica, named Rojo Segoro was built in 2011 to participate in the 2012 Atlantic Challenge in Bantry, Ireland. Rojo Segoro is now borrowed for training in Lithuania.

ITS has started in 1998 an extensive field research and study into traditional wooden boatbuilding practice. This study concentrated on the North and South Coasts of Java and the island of Madura. This study continued until 2008 at which time considerable changes had taken place. These vast coastal areas contain distinctive practices from the two differing ethnic groups of Java and Madura but to a great extent can be considered as mutually complementary and supportive. During this period, great political and economic changes – notably the cost of fuel and the abandonment of sail- took place and had a profound effect on traditional methods and practice.

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*The paper –extended from its original presented in the RINA Conference on Historical Ships in London 2009- is presented at the 1st International Conference of Urban Heritage and Infrastructure Development, the Catholic University of Soegiopranoto, Semarang in 5-6 October 2012.
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It is important to note that an attempt to build a reconstructed replica of a Majapahit ship was carried out in 2010 sponsored by The Japan-Majapahit Society. In a planned journey from Jakarta to Japan the ship was mutinied by the crew due to mismanagement, unsuitable ship condition, and, from our opinion, mistaken "outrigged"design leading to poor seaworthiness.

RECONSTRUCTION APPROACH

Constrained by a serious lacking of any definitive archaeological or documentary evidence from pre Colonial Java, we opted to adopt the following approach. It is obviously a matter for some speculation and a subject of future research as to how much relevance contemporary traditional practice has to the Majapahit period (1300-1400) boatbuilding practices. There is fortunately only one single archaeological evidence showing the most probable form of a Majapahit ship : a stone panel in the Candi (a Hindu temple built in the same period of Majapahit) Penataran in Blitar, South of East Java. Other features of the Majapahit ship can only be traced from historical texts of "major" literatures, i.e. authored by some prominent Majapahit spiritual leaders –such as Mpu Prapanca-, and from texts of "minor" literatures evidenced in written various folklores and community legends.

However, it is strongly believed that over the present to the Majapahit period there is some evidence of a consistent strand of design and building practices. The unique design and practices of traditional construction and the materials and technology currently employed are also assumed to have direct relevance to the design and practices in the Classic period. If this is the case, -and we believe to be the case-, a careful study of the design and expertise of the older generation of Tukang Perahu (the master craftsman) who learnt their trade in the early 20th century before changes imposed by modern economics and technology will have value and relevance.

The design and skills of building a traditional ship is centred around what is defined as "cognitive hull modelling". Where as western ships are built frames first and some cognitive aid such as former lofting mould, half models, scale drawings or ultimately CAD generated computer drawings are used, the ships in the greater part of Indonesia are built hull skin first and the exact hull shape is passed on from generation to generation through apprenticeship. It is also aided by "adat" law and custom for instance relating to the names and numbers of the planks used. Internal framing is added after the hull is defined and planking completed. This all results in a successful vessel to fulfil the original design criteria but innovation in response to technological change, for instance the introduction of auxiliary and, later, full powered diesel engines, is problematical. This process might well mean that links to historical ships are quite likely to exist in current practice, at least among the older generation.

Few bigger sea going vessels have been built in East Java, at least in living memory. Small fishing vessel construction does continue. As for Madura large sea going vessels were built there until very recently as there was a lively long haul trade to Sumatra and Kalimantan in particular. In the 1920's Maduranese vessels were recorded in Singapore and there is a living memory of this. One of the master builders studied serves as an example of this traditional process. We met Haji Solihin of Klampis, Bangkalan, in 1998 after a search for the builder of an exceptionally fine small fishing vessel we surveyed. At that time he was building a large motor sailing cargo vessel, a "Golekan", for the Kalimantan (illegal) timber trade. We kept contact and in 2006 he built a small "Golekan" to go to a museum in Canada under our

patronage. At that time he was in his 80's, two of his sons were independent builders and two grandsons of elementary school age aided him in the work. He has now officially retired. Along the coast of Madura there are many builders with this sort of expertise.

It is held that any artefact produced is a product of custom and knowledge, available technology and materials, and cultural considerations (i.e. what constitutes a "proper ship" in a particular culture). Our initial surveys were of course concerned with how these factors might respond to change and development in the future. However similar field research could still be carried out in the next few years to recover now archaic knowledge and practice. Traces or clues to what might be relevant to anachronistic but historically significant vessels will undoubtedly be revealed.

At the time of our first survey in 1998 things were carried out in very much a time honoured fashion. Engines had been introduced and the necessary changes to construction made to accommodate them, however vessel were largely of traditional form, construction and often still carried sail. This was all about to change irrevocably.

At that time solar (diesel fuel) was heavily subsidized under state policy at around IDR 200 per litre. At that price it made little sense to invest time and labour in a sailing rig. One can only speculate that it might be more attractive if solar costs continue to rise beyond the current IDR 9000 level. Indeed it is noticeable that in the last few years or so sail has begun to reappear of the horizon, often as an auxiliary to the diesel engine that replaced it. One can only speculate that rising fuel costs and environmental concerns might kindle a renaissance of sail. The Maldives, faced with oblivion from rising sea levels has now a goal of phasing out all internal combustion engines from fishing and communication vessels.

Also at the time of the first survey there was a lively long haul trade, mainly for (illegal) timber. Golekan, Leti and non-descript motored vessels from North coast ports traded with Kalimantan, often going far up river to load from a remote sawmills. They also serviced the considerable immigrant Maduranese community. From the South coast and Gili island, Leti – Leti and Janggolan traded up to Sumatra. All this seems to be greatly reduced or finished entirely. No big vessels were under construction, to our knowledge, in 2008 and it seems unlikely that they will be built in the future. As regards the Sumatra trade it is uncertain what factors have finished it. It is likely those years of "get rich quick" indiscriminate felling has decimated forest resources and that remaining stocks are now used for local consumption and rebuilding after the Tsunami. As regards Kalimantan the environmental factors also apply. One former sawmill site visited in 2007 now stands in clear felled sand scrub and peat bog, no tree above a couple of metres remains and no hope of regeneration. In addition to this environmental disaster ethnic tensions had erupted between the Maduranese immigrants and the local Dayak community. This resulted in threats, mass killings and wholesale repatriation of the Maduranese as refugees. The completion of the Suramadu Bridge in the current year will no doubt cause further changes and decline.

For the time being the building of small fishing vessels, many of them of form and construction that is the result of a long tradition, continues to flourish and most builders, at least the more experienced, are quite happy building theses rather than the larger cargo vessels. These small vessels embody many of the features of the larger, or visa versa. It could be conjectured that the current technological retreat might mirror one that may have happened at the collapse of the Majapahit Empire and the suppression of maritime expertise in the following Colonial Period.

TRADITIONAL JAVANESE BOATBUILDING TECHNOLOGY

It is a trait of a European scientific mind set dating back to Linnaeus to order, name and categorise objects natural or man made. Often local terminology, especially in the face of the use of the ethnic language rather than Bahasa Indonesia for marine technical language, does not follow this logic. The name used can refer to a feature of the vessel like rig or fishing method, or be a name in wide usage that is applied to a locally specific type. We have used the terminology used by Horridge in the 1970's in the full knowledge that it might be only partially knowledge. What follows is a digest of our findings and a catalogue of principle traditional types studied during this period. Although interesting from a development point of view modern full powered types and hybrids are omitted. In their case the line of traditional understanding and practice has been largely broken.

Traditional maritime expertise in the area is largely concentrated on Madura however Javanese practice endures and is to some extent interchangeable. Sometime the difference lies in the detail, rudder arrangements and rig for instance. There is a further influence is from other ethnic groups an example being the Mandar communities on the Eastern islands off Madura. The ethnic origins of a particular vessel can often be unravelled by examining the linguistic basis of the names for these parts.

Throughout the area the basic beach launched fishing vessel is fashioned out of a single log. Sometimes outrigger beams and bamboo floats are utilised especially if ability under sail is required. The English term "dugout canoe" fails to recognise either the sophistication of the design or the skill necessary to produce it. The word "Jukung" is often used to describe this basic craft. There is wide range of forms from the small surf boats used with a double paddle on various South Java beaches, through the Jukungs rigged to sail in the Straights of Bali, the Perahu Putih (meaning White Ship) of North Java and South Madura to the beautifully decorated and archaic Jukung Palongan of North Madura. The latter with its proto-lateen rig may well now be extinct as none have been seen in the past five years. Others of this type of construction provide useful service and some like the Perahu Putih fashioned from a single huge teak log may well have been in service for a number of generations. East Java is also the area where for larger planked fishing vessels various versions of the most ancient of traditional designs, the "Mayang", are predominant (Figure 1). The historic lineage of this type will be dealt with later. During the period of study it was found in large numbers on the North, East and South Coasts of Java and parts of the South Coast of Madura.

Figure 1. Mayang off Surabaya in 1832 drawn by Admiral Paris

Although of Javanese origins it is utilised by Maduranese ethnic groups as well. The hull is a full bodied doubled ended form with high prominent stem and stern posts. As normal in the area it is steered with side rudders. Construction is of heavy planking fastened together edge to edge with wooden pegs, (treenails). Frames are added later and often take the form of heavy partial bulkheads. Sail has to a large extent been discarded but would have been the standard Indo-Pacific lateen, (layar leti). Size ranges from small open fishing vessels, beach launched, some 6 – 7m in length to larger decked versions around 20m used for purse seining in pairs out of Muncar and West Bali.

Fishing vessels on Madura have a complex regional diversity and many distinctive features. Some of these may well be developed from a common Javanese type but ethno specific and Western influence features can also be identified. There are a number of more or less unique vessel types relating to specific areas and coastal communities.

The "Lis alis", a shallow hull with narrow transoms fore and aft and complex decoration is centered in the waters between Surabaya and Madura in communities on both coasts. There is virtually no framing and lateral strength is provided by cross beams / thwarts. Many are still rigged to sail. Principle building is around Sukolilo, Bangkalan.

Considered to be symbiotic with the “Lis alis” is the "Golekan." This is a deeper more powerful hull with pronounced stems suitable for offshore fishing. Sail is now rare but the short masts and rig details have been retained. In living memory these vessels were built without frames and used cross thwarts. More recently framing has been introduced. Interestingly the “Golekan” hull form and detail is retained in very small vessels (Anak Golekan) for use by a boy or as a large working model, through fishing vessels around 8 to 10 m, to moderate to large cargo vessels .The latter traded as far as Singapore in living memory. Principle building is around Klampis.

Along the North coast beaches and small river ports many forms of double ended boats similar to a Mayang exist. These are of finer form and suitable for fishing in the often rough waters of the region. They are referred to by Horridge as “Jaring” or locally maybe as “pursean”. Decoration is distinctive and an auxiliary sail may be retained.

Also in the North coast river ports are a number of “Leti”, as distinct from the Pulau Gili “Leti leti”. These are large open cargo vessels with a single layar leti on a huge composite bamboo spar. They are or perhaps were mainly engaged in medium haul trade to Kalimantan. The “Leti leti” on the other hand carries one or two extra sails of the proto-lateen type. They are considerably large and very able vessels for long haul trade and are fitted with a permanent apex roof over the cargo hold. A second small type of “Leti” with Mandar ethnic origins trades between Eastern Madura and Kangean Island and other islands.

On the South coast, particularly the estuary of the river through Sampang are found possible the most archaic of all planked craft in the area. These are the two classes of “Jangolan”. They have a hull strengthened by cross beams, narrow transoms fore and aft, heavily decorated. They are fitted out with a full or partial Atap (bamboo roof) over the cargo hold. The rig is two proto-lateen sails. The larger were engaged in an annual monsoon voyage to Sumatra. The smaller are still actively engaged in short haul trade between South coast Madura and North coast Java.

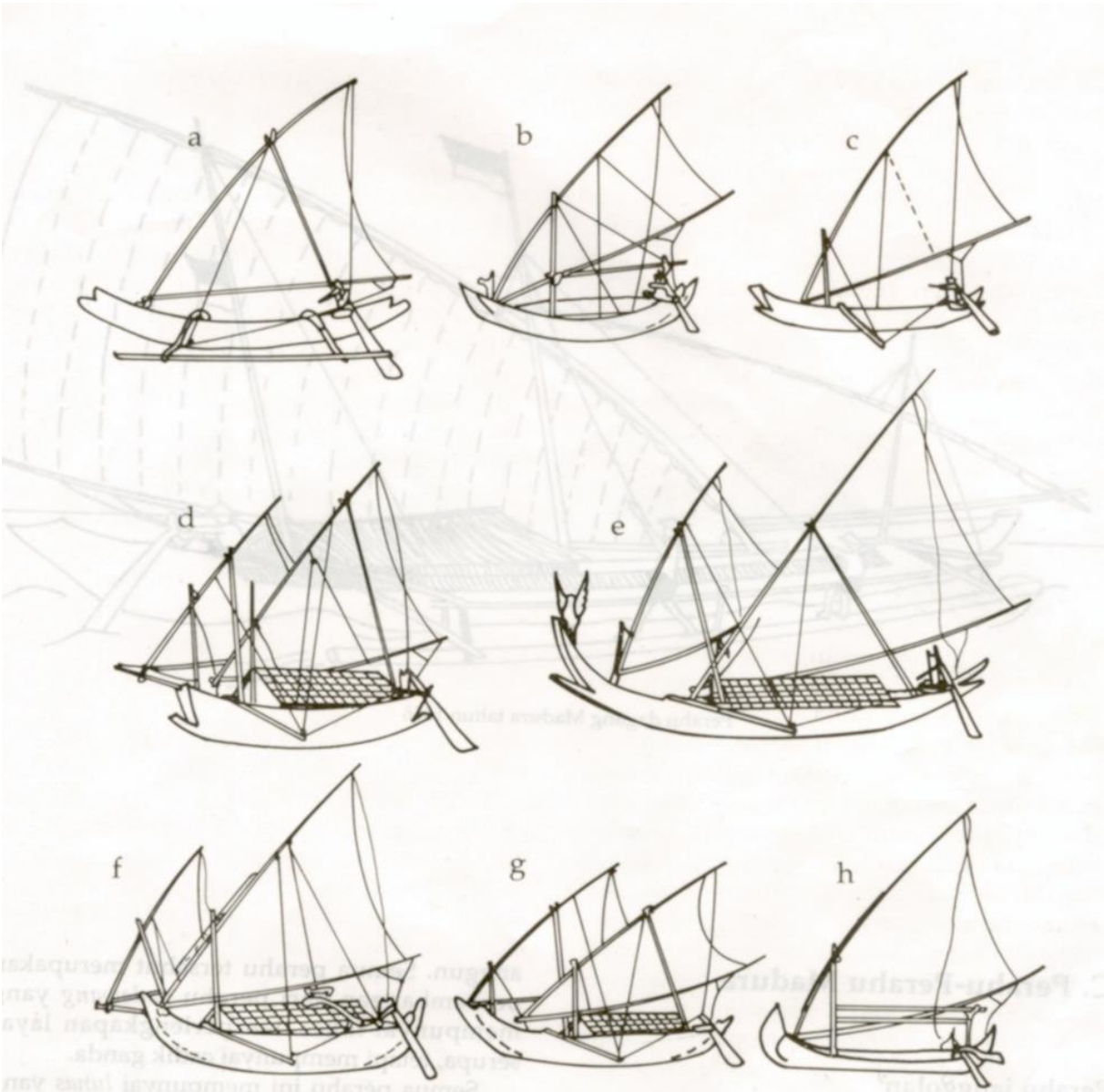

Figure 2. Various Types of Maduranese Traditional Boats

RECONSTRUCTION OF THE PERAHU MAJAPAHIT

This of course is a very brief overview of a complex subject which has a considerable claim to further research or making of an ethnological / technological record. This has merits for both recording considerable ethnic technological achievements before they disappear for ever and because within current practice there is certainly techniques and knowledge that have direct relevance to historically relevant vessels.

To unlock past technological achievements it is necessary to understand the three facets of technology as they relate to any particular period. In this case we examine the possibilities of doing this for the period of arbitrarily 1300 to 1400 which would embrace the years of height of Majapahit influence under Gajah Mada (1336 – 1364) during the Kingship of Hayam Wuruk.

First any artefact is controlled by available technology and materials. From a look at a contemporary boat building sites we conjecture that the principle technique would have been the hewing of logs using a hand axe or adze. It's not certain at what period hand saws became available; there of course would be no log mills! Planks then would be formed out of the two halves of a split log allowing for the inclusion of integral lugs if the frames were lashed into place. Iron certainly existed but its use for fastenings is likely to be limited or non existent. Construction would be plank first, how or even if frames were added is problematical. As for materials there would be plentiful supplies of virgin teak and other useful timbers available in impressive length and girth. That such timber no longer exists is of course a major limiting factor in any project to build a convincing replica.

To unlock the extent of maritime knowledge at such a remote period let alone the supporting cultural concept is a formidable task. Links or traces may well survive in current practice but how well they survived the great cultural upheavals of the Muslim expansion; Colonial control independence and modernisation can only be explored in future specific research. There remain two other possible sources of information.

The most relevant source is of course contemporary archaeological sites giving first hand information, as with land and civic structures this is patchy an inconclusive. Civic structure seems to have been largely of wood and unlike the stone of the Central Java empires have not endured. What we can assume is a high degree of craftsmanship and availability of superb materials. Ships are much more vulnerable and difficult to excavate. For a start the present day sea coast is a long way to seaward of its position in that period. Any surviving harbour wrecks may well be under modern city developments. Offshore wrecks are even more difficult to locate and record. At the present time a report is being prepared of the excavation of a cargo vessel on a voyage from China in around 900AD. This vessel sunk off the North coast of Java. The Makassar based marine historian Horst Liebner is involved in publishing a full report. Another wreck was excavated at Zaytun in China in the early 70's. This vessel is dated at around 1271 and about 200 tons burden and because of construction may well be of Javanese origin. What is significant that Java had at that period the capability of building deep water vessels and engaging in long haul cross ocean trade. Two generic names appear "Jonque" and "Mayang".

Contemporary Javanese second hand evidence in literature, illustration, or carvings is scarce. Most famous of course are the Borobudur ship carvings of around the 9th Century. These however seem to be of a type that is neither a "Jonque" or a "Mayang" but more related to the Molucan "Kora kora". They would also be unsuitable for long distant trade or imperial aspirations that were a feature of Majapahit. Also at some 5 Centuries earlier and from a completely lost Budhist civiliasation in Central Java the cultural links are very tenuous.

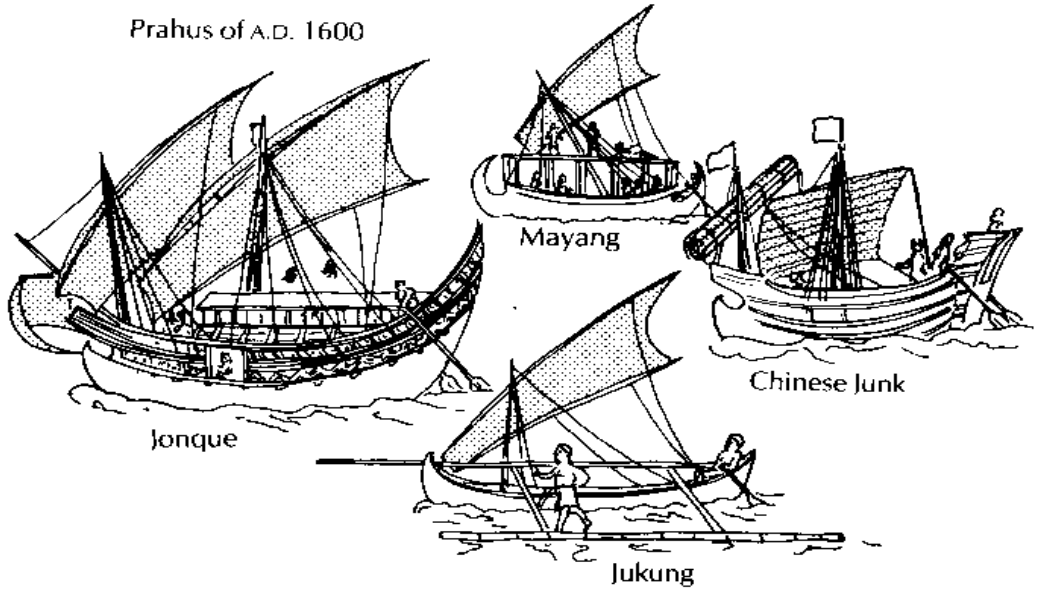

Figure 3. Ships of AD 1600, Possible Candidates of the Majapahit Ships

The last source of data are the third hand reports and drawings from Western observers. The earliest are drawings of a "Jonque" and a "Mayang" dating from 1595 – 1597 in Lodewycksz; *D'Eerst Boeck.* They show double ended vessels with lateral rudders and tilted rectangular sails. In a side note it is worth observing that such sails, constructed of palm frond 'cloth' are in current use in the whale boats of Lamalera. Mayangs again are depicted in 1771 by Parkinson on on Cook's first voyage. Finally the to be Admiral Paris recorded them in 1832 off Surabaya during his circumnavigation in "Favourite". As there are considerable similarities between these depictions themselves and with modern versions it seems reasonable to speculate they were unlikely to have changed much in the previous 200 years to bring us back Majapahit. We hold that there is high degree of certainty the « mayang » were a Majapahit ship. How close they were to The Majapahit Ship is of course a matter of further research and speculation. A more likely candidate is perhaps the "Jonque". These were certainly both large and powerful enough to impress early Western observers, indeed larger than Western ships that had crossed three oceans to search the wealth and power of the Indies. Such ships could well be the basis of the considerable Majapahit sea power.

Our thesis in trying to establish a credible replica of this distant but significant period of Javanese / Indonesia history is that it should be based on those factors that dictate any technology ancient or modern. First is that it should fulfil its design criteria. That is to say that the replica has to work at sea, be able to navigate under sail, be sufficiently seaworthy and carry enough cargo and people to be politically and commercially successful. Next it has to be capable of being built from materials and with skills and technologies available at the time. Both these are straightforward enough to achieve but need a careful research and definition. Lastly and most difficult is the establishing of the cultural context in which the ships were created and operated. Basically this would affect choices in layout and design and more importantly the decoration and "look" of the vessel.

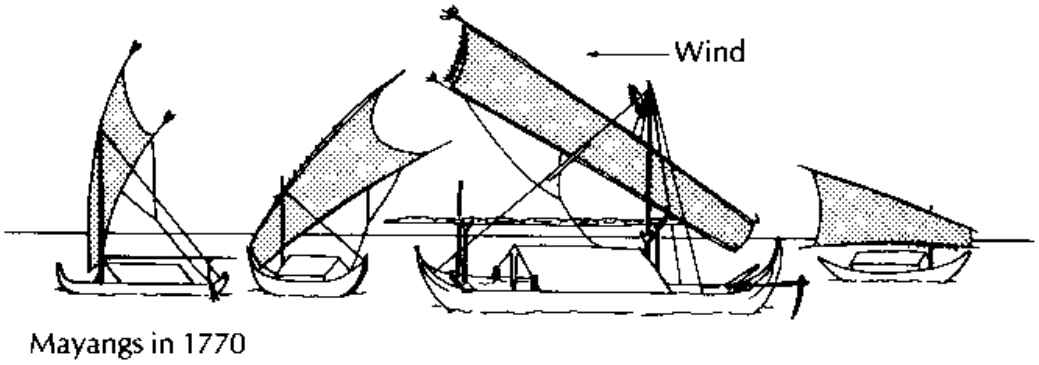

Figure 4. The Mayang in 1770 (Parkinson)

Majapahit influence seemed to extend over much of what is now Indonesia and certainly there was more distant trade with China. The commodities would be of low volume, high value items such as porcelain, spice, and so forth. A large crew would also be necessary both to work the ship and to form the armed guard necessary to ensure safety before firearms. Such a crew needs food and more significantly water. The design solution is a heavy displacement, high freeboard vessel, just what the first European observers recorded in the "jonque" and similar vessels;

Technologically ship building has changed little over the 5 Centuries of Western influence, at least until the advent of motor power. The links lie firmly in the tradition of coastal communities, at least until the inevitable deaths of the older generation of tukang perahu. Most vessels have a variant of a basic "pajala" hull, double ended, built plank first and steered with side rudders. In defining a replica it will be necessary however to make choices. For instance is it possible to build a vessel of the right size without frames and rely on "lashed lug" and cross beams? How far can modern machinery be used in the construction? How much steel used in fastening the structure? And so on. However if the illustrated "jonque" is a credible departure point items of Western influence should be eliminated as much as possible. Two examples are in the rig. First the bowsprit and square "spritsail" are clearly a Western addition. Second a single pole mast may also be such. It seems much more probable that a bipod or tripod mast system would be used, and with the absence of a flat deck structure this would be a better design solution. Whatever the decisions made it should be clear from the outset if it is aimed to produce a "full replica" or a "visual replica". Should it be intended to actually build a vessel, then a full assessment of it modern day design criteria needs to be made, as well as key decisions of how the vessel is going to be used and maintained.

Lastly, a careful study needs to be made of surviving Majapahit artefacts, particularly those from wood, to establish as much as possible the cultural context of their technology and styles of design and decoration. We are confident that enough traces remain to produce a credible replica to tests this thesis and deepen our understanding of the period. The preliminary sketch that follows attempts to define some of the feature of a vessel to satisfy this complex challenge (Figure 5).

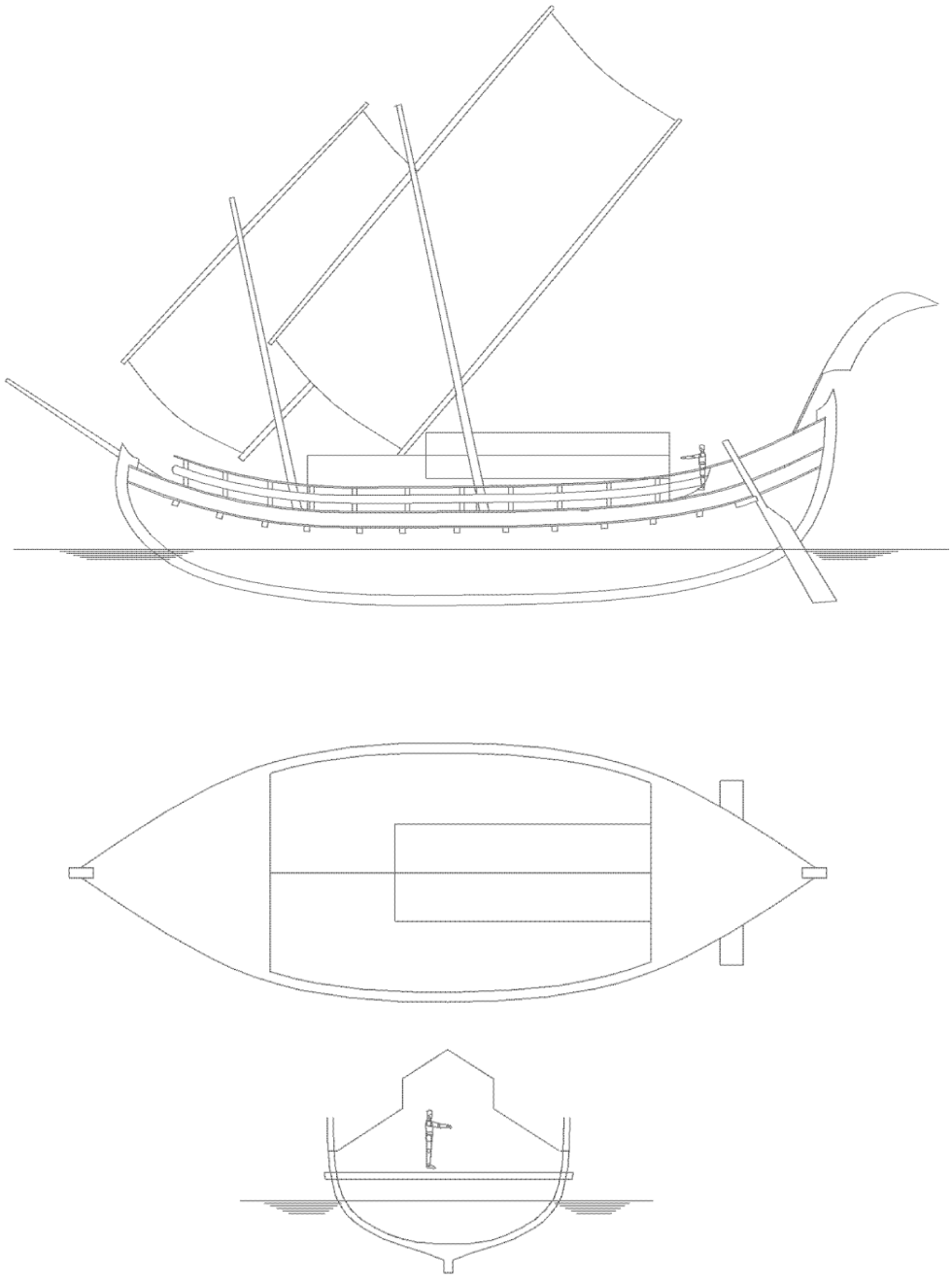

Figure 5. An Artist Impression of a Javanese Ship of the Majapahit Period

PROPOSED FEATURES OF THE REPLICA

The following features are suggested to be adopted in the replica of a Majapahit Ship :

- Pajala-type hull, similar to Pulau Gili type Leti2. LOA 25m X 7m X 3M.
- Crew of 20 – 30. Cargo 200 – 300 tons.
- Range / endurance. Max 100nm per day with fair Monsoon wind. Food and water for two weeks. Works out at max range of 1000nm.
- Treenail or Lashed lug construction with additional cross beams

- Pronounced sheer and stern higher than bow, moderate deadrise.
- Distinctive and substantial bulwark structure.
- Considerable decoration to hull.
- Lateral rudders, probably hung off post Madura style.
- Pitched roof deck house, atap and bamboo, with raised "skylight.
- Accommodation deck on top of structural cross beams, cargo below.
- Two bipod masts, one amidships one forward.
- Titled rectangular sails from woven palm, bamboo spars.
- Details and working much like a Lamalera whaleboat.

For operation in the 21st century, the following departure is contemplated :

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- Addition of auxiliary engines. Perhaps using electric rather than internal combustion type.
- Two, one on each quarter should be used, with folding propellers to maintain performance under sail. No alteration to underwater profile or centre rudder and propeller.
- Retain the cross beams but use conventional frames with treenail (pasak) fastenings.
- Design watertight integrity into hull and deck house structure.
- Facilities for pumping and producing minimal electrical power. Solar panels?
- Look at rig carefully to see if it can be strengthened without compromising its essential features.
- Safety and security for ship, passengers and crew.
- Establish minimal levels of comfort in accommodation.
- Tanks for water and fuel
- A useful case study would be the Brendan replica, and other replicas from Tim Sevrin.

REFERENCES

Johnson, R.M, and Rosyid, D.M**.-** *Its All In The Mind : Cognative Aspects of Design and Contstruction of Traditional / Historic Vessels. Proceedings of* Historic Ships Conference, The Royal Institute of Naval Architects, London, 2007.

Johnson, R.M**.,** *A Ballad of East and West. Building a Replica of the 1796 Bantry Bay Gig in Indonesia.* Maritime Life and Tradition ; No 29, 2005

Rosyid, D.M, and Johnson. R. M**,** *Developing Sustainable Fishing Vessels for a Developing Country in the 21st Century.* The Royal Institute of Naval Architects Conference on Fishing Vessels, Newcastle, UK., 2005

Johnson , R.M**.** *Les Chasseurs de Baleines de Lamalera.* Le Chasse-Marée, No 165, 2004

Rosyid, D.M., and Johnson, R.M**.** *Lokakarya Perencanaan Program Kemitraan Bahari Jawa Timur,* (Workshop on Sea Partnership Consortium) 2003

Johnson, R.M**.-** *A la recherche du sandeéq - Les pirogues à double balancier des Célèbes du Sud.* Le Chasse-Marée; No 156, 2002.

Rosyid, D.M., and Johnson, R.M**.** *An Alternative View of the Development of Small Craft*

Design, with particular reference to fishing vessels for sustainable development in the Republic of Indonesia. Proceedings of Workshop Small Craft Technology, ITS Surabaya, 2001

Rosyid, D.M, Johnson, R.M, and Birmingham, R.W. *Boatbuilding Training Centre; an industrial transformation initiative for Madura.* Proceedings of Workshop on Small Craft Technology, ITS, Surabaya, 2001.

Johnson, R.M**.** *The Last Whale Hunters,* (Lamalera, Indonesia.) Maritime Life and Traditions, No 8, 2000

Rosyid, D.M., and Johnson, R.M. *The Improved Design and Construction of Wooden Vessels for Sustainable Maritime Development in the Archipeligo.* Proceedings of Second Regional Conference on Marine Technology for Sustainable Development, MARTEC2000, ITS, Surabaya, 2000.

The Tragedy of the Commons in Indonesian Waters. The Jakarta Post. June 23rd and 24th, 2000.

Kusumaatmaja, K. *Boat Building Practice and Prospects in the New Indonesia*, Proceedings of Workshop on Small Craft Technology, ITS, Surabaya, 2001

Johnson, R.M. *In Search of the Sandéq; The Double Outrigger Canoes of South Sulawesi,* (Including full photo reportage), Maritime Life and Traditions, No 5., 1999

Rosyid, D.M., and Johnson, R.M. *Development of Rational Design and Production Methods for Maduranese Traditional Ships, A model of society-centered industrial transformation.* ITS, Surabaya.

Djuhairi, A. et al. 1999. *Survey Report of Traditional Maduranese Boatbuilding Developments.* PT. PAL Indonesia Training Centre, Surabaya