Unlike the Harappan and post-Harappan Chalcolithic studies in Gujarat, the Early Historic period of this region has not been subjected to the same vigorous and modern treatment. As focussed in the introduction chapter, a large number of Early Historic sites have been excavated and several iron objects reported, but their contribution to our understanding of early historic society, technology and economy is limited. This was because these excavations were conducted nearly two decades ago, when archaeological concerns were limited to simple correlation and scientific methods available for artefact analysis were not being fully explored. The conclusions drawn were thus simplistic and a deeper understanding of the nature and character of iron technology in Early Historic period of Gujarat remained in an embrionic stage.

The present work has been an attempt to overcome some of the above mentioned discrepancies by adopting a material science approach to gain an understanding of metallurgical processes and relating them to socio-economic aspects in the limited context of Early Historic period of Gujarat.

The inferences are drawn on the basis of the typological, chemical and metallographical study of unearthed stratified iron objects belonged to Early Historic Period. Analytical and metallographic aspects of these excavated iron objects are dealt with an emphasis on technology and socio-
economic significance of the metal. Ethnographic survey has been carried out to understand the practices of contemporary traditional blacksmith. The artefacts used for the study represent various types of iron objects which has been excavated from Nagara, Shamalaji, Timbarva and Devnimori from Early Historic context.

The study carried out on these objects revealed that the objects belonging to Nagara, Timbarva and Shamalaji were corroded and showed a coating of iron oxide on the surface. Samples belonging to the early layers of Nagara and Shamalaji were heavily corroded with hardly any core part left in it.

The typological analysis of the iron objects comprised various tool types namely, hunting tools, agricultural tools, house-hold objects, tools for building activity, craft activity and ornaments. The earlier phase (400 BC to 200 BC) begins with lesser amount of tools and types. Towards the end of this period (200 BC to 100 AD), there is a change that is an increase in the number and variety of tools and objects. Simultaneously, the beginning of craft diversification is also noticed. The beginning of Phase II (100 AD) showed an increase in number of iron tool types and craft diversification became very significant at this stage. The middle and later layers of this period showed profuse use of iron and diverse craft activity.

The chemical and metallographic analyses indicated that the extraction of wrought iron was known to the smith around 400 BC in this region. It is revealed from the microstructural examination that during earlier levels of Nagara and Timbarva, the smith was aware of rudimentary smelting practices only. The high amount of slag inclusions in early samples implies
the process of direct smelting. The uniform distribution of slag inclusions, which is the characteristic feature of wrought iron, is seen in the microstructures. The iron thus produced by direct process is given heat treatment, which is followed by its hammering in open forging areas. Presence of slag in most of the sites indicates local production of iron objects. The microstructures of the specimens from the lower most layers indicated that the technique of improving mechanical properties of the object through heat treatment (through quenching and tempering) and lamination was not yet known in the early phase. It can be inferred that the metal technology was in its incipient stage and was undergoing experimentation.

Due to heavy corrosion, few specimen from early layers of Nagara revealed only relic carbide and pseudomorphs of carbide embedded within the corrosion products. The last stage of Phase I, Nagara II and Shamalaji III showed the improvement in technology by application of carburisation. The percentage of carbon in the iron objects of this phase showed an increase in its amount, indicating that the smith became aware of the fact that introduction of carbon into wrought iron could convert it into steel. The mechanical property of the objects was thus increased by carburising it or by case hardening. The microstructures showing high carbon and low carbon content clearly indicates the carburisation technique. The end of Phase I and beginning of Phase II showed application of lamination technique. It can be established that by 100 AD the smith was equipped with an advanced technology of lamination to increase the mechanical property of the objects.
The second phase of Early Historic Period represented by Nagara III, Shamalaji II, Prabhas Patan V, that is from 100 AD – 400 AD showed development in technology. The result of chemical analysis of two nails from Shamalaji is interesting due to their similarity in impurity pattern. The substantial similarity of the impurities in these specimens suggests that they may have been produced from the same bloom. The blacksmith was able to produce mild steel, low carbon steel and medium steel.

To conclude, it may be stated that the iron technology in this region showed a slow but definite advancement. The blacksmiths were able to produce from wrought iron to mild, low carbon and medium steels. The techniques of cold working, hot working, carburisation and lamination were prevalent in Early Historic Gujarat. Quenching and tempering was also observed in the late phase specimens. Evidence of hardening the surface by quenching and tempering to martensitic feature are visible from few iron specimens from Nagara and Shamalaji. Since iron could not be melted and casted easily, carburisation of thin sheets of iron in charcoal fire and subsequent lamination and forge welding of alternate layers of carburised and uncarburised sheets are found to be a significant achievement of the period under consideration. The uniform structure of pearlite and ferrite in the Devnimori samples indicate slow cooling after forging. The ethnographic survey further enabled an understanding of the methods and processes which could have been used by the early workers by observing the working practice of contemporary and tribal blacksmiths in this region and comparing the microstructure of the final product with the ancient samples.
This work has helped to identify further scope of such studies pertaining to iron technology. This approach can be extended to the subsequent periods of the history of Gujarat to ascertain the entire course of development of iron technology. Further, it can be made more substantiative by undertaking ore-artefact correlation studies to identify the source of the raw material and the techniques which were adopted for ore-extraction can be subsequently looked at from that viewpoint to provide a regional insight into the development of iron technology.