Sugar manufacturing in the West Indies: A study of innovation and variation

Linda Gail France
College of William & Mary - Arts & Sciences

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SUGAR MANUFACTURING IN THE WEST INDIES:

A STUDY OF INNOVATION AND VARIATION

A Thesis
Presented To
The Faculty of the Department of Anthropology
The College of William and Mary in Virginia

In Partial Fulfillment
Of the Requirements for the Degree of
Master of Arts

by
Linda Gail France
1984
APPROVAL SHEET

This thesis is submitted in partial fulfillment of
the requirements for the degree of

Master of Arts

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Any mistakes are, of course, my own.
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ABSTRACT

Sugar manufacturing in the West Indies from the period of circa 1492 to 1900 C.E. serves as an example of cultural change. Social customs, economics, technologies, politics and general lifestyles were greatly influenced by the industry.

Technologically, methods of production changed over the approximately four hundred year period discussed. Sugar production methods also varied from region to region and island to island. As with any technology, certain similarities in production are also evident in sugar manufacturing.

English Quarter Plantation is discussed in detail. It serves as an example of changes that occurred on one plantation that produced sugar.
English Quarter

1857

St. Eustatius, N.A.
Figure 1. Location Map, Caribbean Region
SUGAR MANUFACTURING IN THE WEST INDIES:

A STUDY OF INNOVATION AND VARIATION
INTRODUCTION

From circa 1492 to 1900 C.E. the Caribbean sugar industry influenced the lifestyles of millions of diverse peoples. It affected colonization policies, economics, politics, diet and social customs. This study of the industry offers an overview of Caribbean sugar manufacturing and some of the myriad elements associated with its development. A Caribbean sugar plantation is described, based on the author's archaeological fieldwork on Saint Eustatius, in the Netherland Antilles. English Quarter Plantation dates from the late eighteenth to early twentieth century. It was inhabited by people of English, Scottish, Irish, Dutch and African descent.

The majority of Caribbean histories that happen to include a discussion of sugar manufacturing lead one to believe that manufacturing techniques were unchanging. Most appear to follow the reasoning of Ward Barrett (1965). In his comparison of the performance standards on individual estates from 1600 to 1800, he concludes, "These standards vary little from place to place or from 1650 to 1800, reflecting not only widespread adoption of a uniform body of techniques but also a lack of technological progress in a century and a half of practice."  

An extensive body of anthropological theory appears to negate a perception of the Caribbean sugar industry as uniform over a widely diverse region and a 150-year period. These theories fall under the
general rubric of cultural change. Anthropological studies of numerous types of cultures have shown that specific elements of a society will change through time. These changes occur due to the influence of many factors, such as the effect of the physical environment, contact between different peoples and the processes of evolution, involution and innovation.²

In particular, Homer Barnett's (1953) theory of innovation is applicable to the study of Caribbean sugar manufacturing. He has defined innovation as "any thought, behavior, or thing that is new because it is qualitatively different from existing forms. Strictly speaking, every innovation is an idea, or a constellation of ideas ..."³ Innovation is a process that is constantly occurring within human minds. The new ideas generated are numerous. Some new ideas are viewed as useful and are accepted by other members of the society. There is a chain reaction to new ideas. Individuals and their cultural traditions, including material culture, are going to be affected in perceived and unconscious ways.

Innovation occurred in sugar manufacturing on many levels. In a basic sense, the effects of sugar production in the Caribbean influenced the diets and general social customs of consumers from the fifteenth through the twentieth centuries. The first taste of sugar by a European had spiraling effects that rippled across a good part of the known world. Perceived wants instigated numerous changes in European culture. In economic terms, demands stimulated innovation pertaining to obtaining increased supplies of sugar. Trade networks
were established, changed and grew over time. These networks and concomitant changing desires continued to spur innovations in other spheres.

For instance, sugar changed from being viewed as a luxury to a staple. The idea of sugar became connected to a drink such as tea, coffee or chocolate. Sugar became connected to a drink, to a particular time to consume (tea time), to things to consume the drinks in (fine ceramics) and so forth until a whole constellation of social habits was derived. These social habits probably differed from region to region and perhaps plantation to plantation over time.

An example of technological and social innovations can be found in the development of rum. Rum is manufactured from sugar's least desirable by-product, termed "scum." Colonial planters discovered how to take the scum and create rum, a viable product. Rum was used in innovative ways. Regional variants of drinks using rum for their base were soon developed. Rum also became a staple on Her Majesty's ships. Innovative uses for rum spread to Europe. Planters soon reaped huge profits from rum sales, further stimulating the sugar industry.

Sugar planters had to be innovators. They faced myriad decisions along each step in manufacturing, from initial planting through curing and shipping their sugars. Planters' decisions would be influenced by many factors. Planters were a diverse group, from different countries and different socio-economic groups. Further, they would have different individual abilities. What technical information
was available to them? How did they use that information? How did they cope with topographic and additional environmental factors?

Environmental variations are a norm within and between the Caribbean islands. What innovations occurred on each plantation, regionally and generally in the Caribbean? Did the diverse ethnic background of the planters play an important role in their lifestyles and decisions? How did Caribbean lifestyles change over time?

Technological changes did occur in sugar manufacturing. Chapter II discusses those changes. Innovative uses for different types of motive power, water, wind, animals and steam can be seen throughout the Caribbean. One major change occurred with the nineteenth century abolition of slavery in the islands. Planters were forced to use a new type of labor, the wage-earner. Some planters were able to adapt to a new type of production, others did not. This resulted in the sale of many estates. Merchant interests from Europe and the United States bought up those large tracts of land. New money stimulated new technological developments, especially in the use of steam in all aspects of sugar extraction and processing. These new owners invested heavily in new production methods and built large, centralized mills.5

A synchronic study would ignore the numerous permutations that were present in the sugar industry and the dynamic aspect of innovation. Temporal and regional variations occurred due to the interplay of technological, managerial, social, economic, ethnic and myriad other factors. These factors combined to influence the growth and development of the Caribbean sugar industry.
This thesis is presented in three basic sections. The first offers a discussion of some of the factors connected to the development of the sugar industry. This provides a context for the second section, a detailed descriptive history of the technology of sugar manufacturing. Last, English Quarter Plantation is described, to serve as an example of a sugar plantation and how it changed over time.
Notes to Introduction


2A culture does not exist in a vacuum. It interacts, in part and as a whole, with the environment and other cultures, with attendant, complex networks of exchanges of information and energy (Moran, 1979). The actions of one portion of the cultural and/or environmental system will register in other portions of the system in a positive or negative manner. Cultures and environments are never in stasis: they are dynamic, ongoing sub-systems constantly changing in relationship to network processes. These processes can constitute historic events, environmental disasters, epidemics and numerous other events.

The interconnected parts of a cultural system must exist in harmony in order to continue long-term existence. Human and environmental sub-systems must continuously adjust, act, and react over time. The process of these adjustments has been termed adaptation (Moran, 1979 and Kroeber, 1947). As stated by Bernard Nietschmann (1973, p. 5), the "constant shifting and reshuffling of variables and self-regulating elements adjust and adapt human populations to an environment." The term "environment" should be extended to include both the physical and social environment. "Social environment" is defined here as intra- and inter-cultural interactions. Many cultural econologists have begun to use the term "social adaption" to emphasize the great effect of social factors, combined with the physical environment, on modern societies. (Bennett, 1969, was a prime instigator of the term.)

According to a study of John Bennett's (1969), adaptive social behavior is the process of utilizing "problem-solving, decision-making, consuming or not consuming, inventing, innovating, migrating, staying" modes of behavior, to enable one to cope with the total environment (Bennett, 1969, p. 11).

A society consciously and unconsciously attempts to maintain a cultural balance, or homeostasis. Two immutable forces appear to affect a society. One force is cultural change, derived from within a culture (invention, innovation) and/or from without (diffusion, trans-culturation/acculturation). The other force is opposing, what is termed cultural conservatism by anthropologists. Cultural conservatism consists of the various elements in a culture that act to hold back change.

The homeostatic nature of culture is dynamic, a shifting, changing oscillation between innovative and conservative elements that work to influence the rate and patterns of cultural change. (Cultural ecologists have offered the example of a gyroscope to help visualization of the above facet of cultural change.)
This dual nature of a culture attempting to maintain its system has its parallel in genetic behavior. For instance, studies of Japanese macaques have shown that innovations are developed by the young, imitated by the innovator's peers and learned in turn by the growing infants of the group (Jolly, 1973, pp. 350-51). Itani and Yamada's research results show that the older generation of macaques did not adopt the younger generation's new, innovated techniques of washing sweet potatoes and rinsing wheat. Two patterns of behavior continued to be present in the same primate group, an innovated, new pattern and the conservative, older pattern. This study seems to indicate that all of the generalized primates do not concomitantly adopt a new adaptation—that the new pattern of behavior is "tested," leaving alternative survival strategies present in the group to ensure group survival—covering the odds, if you will.

I believe that one type of change occurs in a society when the dreamers, philosophers and "general thinkers" become concerned with understanding the broad, basic patterns of existence. They stand back and attempt to see their interests integrated with the whole pattern of their society, looking at the entire metaphorical forest. Thomas Kuhn (1962) has termed this process a "paradigmatic shift"--the process of the emergence of a new, basic abstract perception or model of one's world. For reasons yet unknown, various cultural elements move into a conjunction that "allows" for the acceptance of new ideas.

The atmosphere then seems to shift to a new cultural focus, where the many facts known at the time are then fitted into the new pattern. The "trees" of the time are methodically placed into their proper setting in the new forest. These paradigmatic shifts and their results are often called revolutions, whether consumer, social, industrial or scientific. This seems to be a process of social adaptation.

What are the elements that effect the occurrence of a paradigmatic shift? Evolution theory indicates that the three tiers of culture, ideals, social structure, and technology, are the primary factors to consider. It is not really necessary at present to determine which factor influences the culture most—if any one factor does—and different cultures may have different weightings of the three factors. To use our present paradigm, a systems model, various facets such as the above factors influence each other and other sub-systems in a cultural system. Sometimes these elements combine to generate a new, basic pattern. Other times, they only influence specific segments of a system, leaving the basic cultural pattern, the deep structure of the society, unchanged. As a result, only the surface manifestations of the culture varies.

Technological development is a segment of a cultural system, but one must ask "how much of a given manifestation is predicted by its materials and energy systems and how much by organizational modes, value systems, mythologies, or science?" (Lechtman and Steinberg, 1979, p. 137). This may turn out to be a chicken and egg type of
question, but an examination of technological change in a particular environment, both cultural and physical, should be undertaken. Thomas Kuhn's (1962) premise of scientific revolutions seems to be a good description of some forms of technological change. David Woyick (1979) has offered the environmental movement as an example of the interplay of technological and social forces within a culture. The innovators and traditionalists meet head-to-head over United States environmental issues and compromises have to be initiated. Woyick describes the process of technological change as follows:

The introduction of new technology--new techniques, processes, or information--into an established problem-solving area often requires a great deal more than communication of innovation. Often it requires a revolution, a struggle of ideas. This revolution accompanies the deployment of technology and precedes the social revolution which the deployment may induce (p. 238).

Letchmann and Steinberg (1979) have asked how one can decipher the "manifestation of cultural choice in technology" (p. 139). They believe that a culture's "technological style" is cultural specific, having been stamped by the unique combination of cultural system's components (p. 154). Again, the spectre of environmental (resource and process) determinalism versus cultural determinism arises. To combat this either/or approach, Letchmann and Steinberg are calling for a multi-level study of technological process. Attention to macro-changes in technologies, general historic trends, should be combined with micro-studies of specific cultures. Such a cross-cultural study of technology would hopefully illuminate factors inherent in the technology as opposed to cultural specific innovations or adaptions (1979, pp. 141-42, p. 148).

As stated, change is always at work in a cultural system. The process of homeostasis means that constant adjustments in a system take place--cultural maintenance. From the research results of anthropologists, historians, and others, we know that today's modern society is vastly and basically different from the one that existed one, two, three, four and more hundred years ago. Members of various disciplines discuss the social, consumer, industrial, and scientific revolutions that occurred sometime from the sixteenth through the present century. But no one has attempted to integrate the patterns emerging through their research in any systematic manner. Such a multi-disciplinary approach could offer myriad insights into the processes of cultural change.


4Bennett, 1969 ... Human beings carry culturally derived ideals which seldom exist in "reality" (Leach, 1954, Bennett, 1969). People must constantly adjust to, cope with and choose between alternative solutions to both short- and long-term goals. Human beings must face the fact of limited resources: this means that all may not
possess their ideal, or achieve all desired goals in exactly the planned-for manner (Bennett, 1969, pp. 11-15). Bennett believes that an individual's cost/benefit ratio analysis does not always rest with simple economic or environmental factors. Barnett's (1953) description and discussion of the various mental processes involved with innovation and acceptance of innovations offers an indepth model to the student of cultural change. Barnett, like Bennett, lists all of the mental processes involved with innovation in terms of human choice.

CHAPTER I

THE ORIGIN AND SPREAD OF SUGAR

Sugar (shoog'er)

It can be traced back to the Sanskrit Karkara, which means sand or gravel, thereby suggesting that the crude brown substance made from the cane juice by evaporation was ground into powder in early times. In the Pankrit language, which succeeded Sanskrit, Karkara became Sakkara, and the Arabic form of Sakkara, Sukkur, is the parent of the various words for sugar in modern European languages. The English word "sugar" itself appears as early as the thirteenth century, though its present spelling was not established until several centuries later.

Sugar Cane

Where did the sweet, "long grass" originate? How and why did it spread across many continents, changing the dietary habits of billions of people?

The origin of the cane as a domesticated plant has been debated for centuries. Pere Labat, writing in the late seventeenth century, thought their appearance on Caribbean islands proof that they were indigenous, countering seventeenth century thoughts that Columbus first brought sugar cane to the New World. He wrote, "Mais, pour ma part, je suis persuade qu'elle possait a l'etat naturel dans les iles car jamais les Espagnols n'ont sejourne assez longtemps pour en faire la culture."

After centuries of debate, researchers now agree that the sugar cane first makes its literary appearance with its mention by Nearchus in A.D. 286. Nearchus was part of Alexander's entourage in
the Punjab, Western India, at the time of that writing. The first domestication of the sugar cane plant will probably never be known. Evidence does indicate that sugar cane may have been domesticated in Neolithic Southeast Asia.

The pattern of dispersal of the cane begins in India, spreading to China, Arabia, Nubia, Ethiopia, and Egypt. During the Crusades in Palestine and Syria, Western Europeans "saw and tasted sugar for the first time. Like Pliny, they called it 'honey from reeds.'"

The dispersal pattern of sugar cane included a pattern of trade and manufacture. Merchants first would introduce processed sugar, then carry plants to new areas to expand their supply. This would also entail spreading the knowledge and techniques necessary for cultivating the cane. Western Europeans first tasted sugar when Venetian merchants imported sugar from Moslem producers throughout the thirteenth to fifteenth centuries. The Venetian traders also introduced the cane into Cyprus and Sicily. Christians soon replaced the Moslems on the Iberian Peninsula, displacing them from their sugar fields and absorbing the technology left behind.

During the early fifteenth century, the Portuguese planted Sicilian cane on the island of Madeira, where it flourished. The king of Portugal, Dom Henri, was the instigator of its importation to Madeira in 1425 and to the Canary Islands. It was the Portuguese who carried the cane to Southern Spain, Brazil (early 16th c.) and the island of St. Thomas.
It was Columbus who first brought Canary cane to Hispaniola (Dominican Republic) in 1493. Columbus was interested in the potential of the island for growing cane, as his father was an owner of a profitable sugar estate on the island of Madeira.

The first Caribbean sugar reached Spain in the form of six loaves in 1516. Stubbs writes that in "1518 there were already twenty-eight sucreries on Hispaniola." He claims that sugar canes from Hispaniola were introduced to "Mexico (1520), Martinique (1650), Guadaloupe (1644), Cuba, Guianas, and the rest of South America."

Spanish and Portuguese merchants vied for dominion over their New World possessions throughout the fifteenth and sixteenth centuries. Their competition was further spurred through the introduction and spread of sugar manufacturing. As mentioned, sugar cane was first planted in Brazil in the early sixteenth century (c. 1520). In 1583 the total annual production of sugar from 66 factories in Pernambuco and 36 in Bahia equalled approximately 2,700 tons. Its manufacture soon spread from Brazil to Guayana and Surinam and finally to the Lesser Antilles circa 1630.

Portuguese merchants, like their Venetian predecessors, became the major controllers of the sugar trade in the sixteenth century. They diffused sugar cane and associated production methods throughout the New World. But the Dutch merchant class was rising and learning from the Portuguese; soon the Dutch merchant fleet would eclipse the Portuguese star.
From 1567 onwards, the Dutch began to build refineries for processing foreign crude sugars shipped into Amsterdam. These refineries were relatively short-lived, but the Dutch learned the necessary technological processes for producing sugar during that time. And most importantly, as mentioned by Aykroyd, the Dutch learned about sugar production prior to the English and the French.18

The centers of sugar refining passed from Venice to Antwerp (Belgium) to Amsterdam. By 1587 there were numerous Dutch refineries, as mentioned. These sugar refineries lasted until the seventeenth century Navigation Acts of the British and similar French acts passed under Colbert diminished their production by cutting down supplies of sugar.19 The rise and fall of the Dutch refining industry has been described in detail by Noel Deerr. There were only 20 refineries by 1681, due to the lack of supplies of raw sugar. The Peace of Utrecht in 1713 did lead to a revival of the industry, so that by 1748 this number had risen to 95; in 1770 to 150. Deerr states that by 1770 "12,500 tons came from her own (Dutch) possessions."20 The Napoleonic Wars later influenced the renewed and final decline of the Dutch refineries. Dutch refineries were passe' after 1815.21

The growth of the Dutch merchant fleet was closely allied to the development of the Caribbean sugar colonies. Spain had settled the region first, but the Dutch were a close second, planting small colonies in the Guianas. It was from these areas that the Dutch began to "exploit salt deposits off the South American mainland farther
Salt was a precious commodity in Europe at that date, since it was essential for the preservation of fish and meat. The Dutch trade in salt soon expanded into many other commodities. The Dutch, unlike their Spanish predecessors, were not as interested in settling colonies as in setting up trading posts between Europe and any New World colony. As increasing numbers of Dutch ships plied the Atlantic and the Caribbean Sea, merchants carried raw and semi-processed sugars to Amsterdam refineries. More importantly, the Dutch ships carried techniques of cultivating and processing sugar cane, and actual plants, from island to island. Their interest in sugar was further stimulated by the Dutch takeover of Portuguese sugar colonies in Brazil. The major ethnic group associated with the production of sugar in Brazil was Jewish, and they gladly remained under Dutch rule, escaping the Catholic Inquisition. These Jewish technicians were often brought to other regions by the Dutch, to introduce the manufacture of sugar cane.

The Dutchman Brewer introduced the sugar cane to Barbados in 1637, but the English colonists did not understand the art of making sugar. So in 1641 the Dutch again interceded and taught them how to mill the cane. The first mill and factory was built at that time. The development of the sugar industry on Barbados still took tenacious efforts before planters fully succeeded in making sugar. Ligon, in his History of Barbados, 1657, describes below:

At the time we landed on this island, which was in the beginning of September, 1647, we were informed, partly by those planters we found there, and partly by our own observations, that
the great work of sugar-making, was but newly practised by the inhabitants there. Some of the most industrious men, having gotten plants from Pernambuco, a place in Brazil, and made trial of them at the Barbados; and finding them to grow, they planted more and more, as they grew and multiplied on the place, till they had such a considerable number, as they were worth the while to set up a very small ingenio, and so make trial that sugar could be made upon that soil. But, the secrets of the work being not well understood, the sugars they made were very inconsiderable, and little worth, for two or three years.25

Barbados was well on the way to becoming a monoculture (sugar) society by the late 1640's. Claude Levy26 states three major reasons for the early development of sugar plantations on Barbados. First, the Dutch were afraid of losing their hold on Pernambuco to Portugal. Thus Dutchmen in Brazil wished to expand their influence to other areas. Further, Barbados offered much arable land in combination with a well-established colonial society. As a result of Dutch expertise and investments, Barbadians were able to switch from tobacco to the more profitable production of sugar. At the close of the eighteenth century, the majority of the Caribbean area, including portions of South America, had become devoted to monocropping sugar. Danish, Spanish, French, English and Dutch colonies produced a crude form of sugar to sell to European refineries. The Dutch merchant ships were the inheritors of a grand, four-sided trade between Europe, the Caribbean colonies, mainland North America, and Africa. The Dutch merchant fleets grew, transcending the pattern first set by the Portuguese a century earlier. As described by Richard Sheridan:

The Dutch were said to have imported for manufacture and re-export the sugars of the West Indies, the timber and iron of the Baltic, the hemp of Russia, the lead, tin, and wool of England, the quicksilver and silk of Italy, and the yarns and dyestuffs of Turkey.27
Some of the elements contributing to the rising merchant classes in Europe—consumer demand, increasing supplies and historical events—will be described in later pages. Further, the mentioned trading patterns will be delineated. But first, the final major area that undertook the cultivation of sugar as a major cash crop, on the North American continent, should be mentioned. The eighteenth century saw the full development of the sugar industry throughout the Caribbean. The nineteenth century saw the rise of the last great sugar-producing frontier in Georgia, Louisiana, and Florida.28

Sugar and the Consumer Revolution29

Prior to the introduction of cane sugar, honey was the common sweetener known in Europe. Sir Francis Bacon could list only three sweeteners: honey, manna, and sugar.30 Honey and cane sugar were the two major sources of sweeteners, as they still are today. I do not have the statistics, but the proportion of consumed honey in comparison to sugar has vastly altered. Sugar has come to supersede honey as the favored source of sweetness.

The chemical composition of cane sugar and honey is different. As a result, cane sugar is naturally sweeter than honey. Sugar is more soluble and adds more versatility to cooking. Further, crystallized sugar can be shipped more easily than honey, and spoils less readily.31 The advantages of sugar cane over honey are obvious.

If economic theory does have a sound basis, then one must ask what the cost/benefit ratio of sugar is as opposed to honey. Such a comparison was made in 1905 by Dr. Ellen Ellis at Bryn Mawr. At
first, it appeared that the costs of production were the same, but the utility (benefits) of sugar were much greater than the long-term benefits of producing and consuming sugar.\(^3\) The cost of sugar production was demonstrated to be lower than the costs involved with honey production, after the initial capital investment. Planters making large capital investments tended to produce vaster quantities of sugar to increase sales to cover costs—and they reaped huge profits.\(^3\)

Planters needed a stimulus to invest large amounts of time and money in sugar production. That stimulus lay in a growing consumer demand for cane sugar.\(^3\)

The use of sugar spread from nation to nation, in a repeating pattern of consumer demand. First, sugar would be viewed as an exotic luxury, fit (and affordable) only for the highest strata of society. The upper class or classes would demand sugar in larger and larger amounts, leading to increased production and/or importation of the substance. Over the years, the cost of sugar would decrease and the supplies increase to the point where lower strata could easily purchase the sugar. Finally, the general masses would be able to include the sweetener in their diets. For instance, when sugar was enjoyed by the majority of the inhabitants of China and India, it remained a rare luxury in the Mediterranean and virtually unknown in Europe.\(^3\) By the time sugar became a rare luxury of the upper classes in Northern Europe, it was already available as a general supplement to Mediterranean diets.
One to two shillings per pound was the earliest recorded price of sugar in Europe (1246 A.D.). High prices continued throughout the fourteenth and fifteenth centuries, indicating an increasing consumer demand and short supply. Fourteenth century Europeans viewed sugar as a spice with added medicinal qualities. By the middle of the fifteenth century, sugar was readily available to the nobility, courts, and ecclesiastics of Europe. Richard Sheridan aptly describes the pre-sixteenth century status of European sweeteners below:

Sugar had been classified with such luxuries as spices and silk. For many centuries it was regarded as a superfluity, a rare and costly addition to the ordinary diet and highly regarded for its medicinal properties. Except for the privileged few, honey was the only sweetening in use throughout Europe.

The social stratum of Europe was changing by the sixteenth century. As trade accelerated, the number of monied peoples, especially from the merchant class, increased. The concomitant increase in sugar production outside the Mediterranean; in the Coast of Barbary, Madeira, St. Thomas, and the Canaries, made more sugar available to more people. The relationships between increased sugar production, expanded trade and the rise of the merchant classes continued to accelerate.

Sixteenth century English merchants and landlords prospered in a growing wool industry. Members of this growing class consumed luxuries, including sugar. English currency was debased in the early sixteenth century, causing rising prices in those goods. Nevertheless, the "new nobility" or the landed merchant class continued to enjoy their sweetener. They simply paid higher prices for sugar.
The mercantile class in England continued to expand, deepen and to prosper throughout the seventeenth century. Writers such as young Richard Hakluyt, an English clergyman, with his 1589 and 1600 publications of The Principal Navigations of the English Nation helped to spur the developing overseas expeditions and colonies. Hakluyt's "history" of English explorations and maritime achievements helped sustain a burgeoning English nationalism and belief in individual freedoms. (Greatly influenced by the Tudor succession crises and interlaced with a general wave of anti-Catholocism with roots in Mary Tudor's "Spanish" rule.) English imperialism was felt by the early sixteenth century, with promoters like Hakluyt suggesting that English world domination would benefit mankind—in the guise of freedom from Spanish rule.

This belief in the "natural rights" of all men, in turn, helped the son of a butcher, Oliver Cromwell, ascend to the rulership of England in 1643. The idea of the "rightful" governing status of Parliament, not the old Divine Rights of Kings, led to a brutal civil war. The English King, Charles II, was even beheaded "by the people, for the people" at that time.

The newly settled Caribbean colonies were viewed, akin to the North American colonies, as distribution centers. Europeans were attempting to set a pattern developed by the Spanish and Portuguese in their overseas possessions. The new lands were viewed as military outposts, protecting an important export economy from the other European nations.
The early colonies' function was to acquire raw goods, such as tobacco, silver, gold, and spices, for export to their respective mother countries. There the goods would be processed. The manufactured items would be sold at home, abroad, and back to the colonists. Ideally, the natives of the settlements would become customers of "civilized" goods. When the natives failed to comply with the scheme, often disdaining European goods, the colonists became the primary overseas consumers. Mother countries encouraged their dependency upon their manufactured goods through stiff regulations supporting the existing import/export structure.

Richard Sheridan describes the resulting economic growth process in Europe as "the diversion of capital and labour from domestic agriculture and conspicuous consumption, activities subject to the law of decreasing returns, into the Atlantic empire trade and manufacturing for export, activities which came to yield increasing returns." Earlier luxuries, such as tobacco and sugar, were becoming necessities in the eyes of the seventeenth century consumer.

Consumer habits were changing. The introduction of fine porcelains and the corresponding growth of the tea ceremony in turn influenced the growing demand for sugar. Expanded trade networks meant more money for more people. Demand for luxury items reciprocally increased. This increased consumer demand combined with the merchants' desire for increased trade, helped to instigate the settlement and continued support of the Caribbean colonies. It also helped to choose which products would be exported from the colonies. Thus New World tobacco and sugar industries expanded throughout the entire seventeenth century.
Sugar was well on the way to "becoming a familiar article of domestic use" in the seventeenth century. Increasing consumer demands and the need for new markets joined forces to influence the spread of sugar throughout the Caribbean and parts of Central and South America. Sugar production demanded intensive, periodic labor and Europeans turned to slavery for their labor supply. The slave trade developed side by side with sugar production.

The markets in England and France were flooded by tobacco, the first successful colonial crop, by the 1630's. The various merchant companies working under royal fiat and their colonies began to search for alternative products for export. In the Caribbean, Spanish success with sugar cultivation was well known. Thus, for instance, the directors of the French colonies hired the Dutchman Sieur Trezel to teach sugar cultivation techniques to Martinique colonists in 1639. Other colonies came to emulate that example.

The growing sugar industry proved extremely valuable, especially by mid-century. At that time, molasses and rum, two by-products of the sugar manufacturing process, became valuable commodities, selling for large profits. (See Chapter III for a discussion of the rum industry.) Regulations and company policies prohibited the growth of industrial pursuits in the colonies, protecting the cycle of trade. Crude sugar, muscovado, and rum and molasses would be manufactured and exported to the mother colony for sale and/or refining. As profits increased, so did the number of planters who turned to sugar production.
As more and more planters cultivated and processed sugar, the demand for labor increased tremendously. Estate owners found a solution to their labor problems in using slave labor, first Indian and then African. In Richard Sheridan's words:

Indeed, so much labour and capital was concentrated upon the cultivation and processing of the sweetening substance that the colonies became dependent on imported supplies of labour, manufactures, foodstuffs, draft animals, and building materials. Africa supplied the labor force, North America the foodstuffs, draft animals, and building materials, while Great Britain provided a wide assortment of goods, and most of the shipping, insurance, financial, and mercantile services.48

That pattern was repeated in all of the colonies, with minor variations. On Nevis, some colonists filled a void by becoming merchants. Men like the Pinneys served as factors for the island sugar producers, at the same time producing sugar from their own estates. This was a profitable occupation, and many combined plantership with merchanting. This pattern was also found in seventeenth century Virginia, with tobacco serving as the major agricultural crop.49

Seventeenth and eighteenth century tobacco became a commodity with valuable, monetary worth. Like tobacco, sugar became a valuable currency in the Caribbean. An example is found with the seventeenth century Dominican order on St. Croix. When established, they formed a convention with a Mr. de Sales for their upkeep. Every member of the order was paid a pension of four thousand pounds of either tobacco or sugar, depending on their preference. The pensions could be stopped by St. Croix planters if they donated ten Negro slaves per member of the order. The father superior rated five thousand pounds of either agricultural product.50 The following excerpt was taken from a Barbadian colonist's letter of 9 August 1651:
I could heartily wish you had sent a small cargo for yourself in any of the Dutch ships; it would have been excellent business. The Dutch sell their commodities after the rate at a penny a pound of sugar. Broad and brimmed white or black hats yield here 120 lb. of sugar and 140 lb. and some 160 lb. Brown thread is at 36, or 40 lb. of sugar a pound; thread stockings of 36 pence will yield 40 lb. of sugar a pair.\textsuperscript{51}

Further evidence of the growing intrinsic value of sugar and tobacco as commodities is found, again, on the island of St. Croix. Circa 1663, the Commander de Souvre' wrote a report for the owners of the island, the Knights of Malta. In it he describes the population and finances of the colony. Out of 822 people, 400 were planters by occupation. They were taxed a total of 47,000 lbs. of tobacco, of which one-third became the property of the island commander, in lieu of coined money. The Commander, Sr. DuBois, of the Knights of Malta, not only had a "good size masonry house," he also had control of a sugar factory on the Order's estate. The sugar estate on St. Croix is described as having:

four coppers and with accessory structures such as a vinegar and refining house and a stable with 13 horses or mares, 14 oxen or cows, and four lambs. There are also 30 Negroes, as many young as old ones, among whom 19 were sent from St. Christopher two years and eight months previously. The sugar house was rented to Sr. DuBois for 30,000 lbs. of sugar. However, he was given 20 indentured workers, and to help with necessary expenses of a Commander, his rent was discounted at 50 percent.

One can see that the sugar works must have been considered profitable. Commander de Souvre' mentions further than 20 new sugar works were being built by planters, similar in construction to the arrangement favored by the Jacobin Fathers, mentioned above.\textsuperscript{53}

Sugar became an integral part of the Caribbean monetary system. For instance, eighteenth century Statians (inhabitants of St.
Eustatius) used mostly Spanish coins like the book-peso for exchange, but they also used sugar. Van Soest states that "sugar was widely used as a payment medium (payments in sugar continued to be made until well into the nineteenth century) ..." Sugar was a medium of exchange used on all islands by all nationalities.

The West Indian colonies continued to prosper and grow throughout the seventeenth century. By mid-century, the English, under Cromwell, began restricting foreign trade with the colonies. The English hoped to particularly stymie the Dutch merchant/trading empire and a wave of 'economic nationalism' was sweeping Europe. English regulations included the Navigation Acts (1651, 1660), a tariff (1661), and a Staple Act (1663). Other countries soon emulated England's economic actions.

West Indian planters attempted to bypass the restrictions of the respective mother countries. Duties on goods like sugar led them to seek foreign markets until the eighteenth century. English sugar, for example, was secretly sold through the Dutch West Indian merchants, to the North American colonies, and even Scotland and Ireland. The Dutch, with their brilliant grasp of economic opportunities, began the strategic build-up of Saint Eustatius and Saba, making them freeports. There they traded with planters of all nationalities, serving as a crossroads for illicit and legal trade.

It is surely true that, as stated by Sheridan, sugar was "the most valuable commodity in all of the world's trade of the eighteenth century." Besides the increasing value of sugar as a consumer item, it also became the focal point of a great trade cycle between
Europe, Africa, the West Indies, and the American colonies. The cycle began in the previous century and reached its expanded, successful peak in the eighteenth century. Noel Deerr describes the English cycle of trade below:

Ships left England with trade goods, principally textiles from Lancashire and hardware and toys from Birmingham, which were bartered for slaves as well as for gold-dust, elephants' teeth and pepper. The slaves were in turn exchanged for sugar, which with molasses and rum formed the homeward freight. The profitable and extensive trade networks brought new goods, ideas, and helped to instigate cultural change in England and the other European trading powers. Eighteenth century England was the scene of many cultural developments. The merchant class had its heyday in the eighteenth century. Industry in England slowly changed from individual or cottage industries to the centralized factory. The Caribbean sugar industry influenced the growth of industrialization, as planters needed "quantities of standardized textiles, utensils, tools and heavy equipment" to stock their estates. These estates were like small villages, with planter leaders supplying their retinues of overseers, technicians, and slaves with manufactured as well as raw goods.

English innovators metamorphized two items, water and iron, and helped to stimulate continued industrial growth. Sometime near 1763, James Brindley began the grand canal schemes which transformed the face of the English countryside. Transportation costs dropped and prices of goods soon lowered as a result.

Sugar was finally accessible to all Englishmen at modest prices. It was no longer a luxury for the exalted classes, and was soon viewed as an integral part of everyone's diet. Some Englishmen
resented the social changes occurring in the eighteenth century. They were appalled by the lower class's new preference for sugar over honey. They couldn't understand the lower class's new-found disdain for brown bread, preferring white.62

A typical English grocery list would include tea, coffee, sugar, rice, and pepper. In 1700, two-thirds of their value consisted of brown sugar and molasses.63 Statistically, consumption of sugar products increased in Europe and the New World "from 1700 to 1780 by three times the initial amount."64 This increasing consumer demand is connected to the trading cycles and availability of goods described earlier. Most importantly, coffee and tea were becoming staples in many households, with sugar considered a direct necessity in the eighteenth century art of drinking both beverages.65

The consumption patterns of other Europeans is apparently not known, but Sheridan believes that the English pattern was followed by other nations. In a comparison of French and English retained sugar imports, he found that Great Britain retained 79.3% to France's 37.4% of imported sugars. It appears that England led the rise in home demand for sugar, other nations slowly following with patterns of increased consumption.66

The tabulation below was taken from Sheridan's Sugar and Slavery. He has figured out the increasing frequencies of home consumption in England and Wales circa 1663-1775:
**TABLE 1**

HOME CONSUMPTION OF SUGAR: ENGLAND AND WALES

(Annual Averages in 000 cwt)\(^6\)\(^7\)

<table>
<thead>
<tr>
<th>Years</th>
<th>Imports</th>
<th>Re-exports</th>
<th>Retained Imports</th>
<th>% Retained</th>
</tr>
</thead>
<tbody>
<tr>
<td>1701-05</td>
<td>357.9</td>
<td>95.5</td>
<td>262.4</td>
<td>73.3</td>
</tr>
<tr>
<td>1721-25</td>
<td>671.2</td>
<td>99.3</td>
<td>571.9</td>
<td>85.2</td>
</tr>
<tr>
<td>1746-50</td>
<td>878.2</td>
<td>116.7</td>
<td>761.5</td>
<td>86.7</td>
</tr>
<tr>
<td>1771-75</td>
<td>1811.8</td>
<td>268.9</td>
<td>1542.9</td>
<td>85.2</td>
</tr>
</tbody>
</table>

Although the percentage of retained sugar imports increased by only an average of 12.4%, the total numbers retained, ranging from a mere 262.4 to a staggering 1,542.9, show the marked increase in home consumption. It also reflects the increasing amount of sugar produced by the West Indian colonies. In Barbados, total sugar exports increased from 129.7 during 1745-48 to 813.3 in 1768.\(^6\)\(^8\)

Production rates in Cuba correspondingly increased during the eighteenth century, meeting consumer demands. In 1761, 3,772 arrobas per mill were produced; 5,063 in 1792; and 11,819 in 1804.\(^6\)\(^9\)

These eighteenth century increases reflect numerous cultural factors: developing technology, increased consumer demands, concomitant changes in consumer habits, historic events, and political stances.

Historic events include the numerous wars that took place throughout the periods, the War of 1739-48, the Seven Years' War (1756-63), the War of Jenkins' Ear and the French and American
Revolutions, to name a few. Political factions changed power with reciprocal power changes in the lobbies—with the upper hand switching from refinery to planter lobbies and back again. Also, actual sugar territories were added to or subtracted from various European possessions. All of the wars greatly influenced the markets, the turmoil sometimes increasing, sometimes decreasing the profitability of sugar.70

An addendum was a "new spirit of trade" begun around 1760, when nations began to emulate the Dutch example and to set up colonial free ports.71 This added to the multi-various economic trends occurring throughout the eighteenth century, influencing the production and consumption of sugar—as well as other components of the colonial and European cultural systems.

One facet of the cultural systems influenced by sugar is found in poetry. The English poem, "Sugar Cane," is 2,000 lines in length and was written by James Grainger (1721-1766) on St. Kitts. Practical stanzas appear on methods of producing sugar cane, but romantic or aesthetic pictures are also painted for the reader. Indirectly, the romantic poets like Coleridge and Blake began writing poetry influenced by eighteenth century developments in industry and philosophy.72 British industrialists were generally practical men, Anglican, Unitarian or Methodist in beliefs. They worked and invented for the pleasure of invention and bringing order to their universe. These men were joined by their search for power sources, trying to understand how best to transform Nature's power for their own use.73
The industrial revolution was a continuation of trends in traditional economic sectors like agriculture and textiles, predicated on their initial growth (1783-1802). Agriculture and textiles served as the raw materials for innovators to expand on and helped increased consumption and production. In Harrison's words, we should not tend to forget the "role of textiles, especially cotton, as a pace-setter for the whole of industry in matters of economic organization, industrial relations and technological innovation. In conjunction with coal, iron and engineering, textiles provided the basis of British achievement."^74

A revolution was brewing, a practical paradigmatic shift was taking place. That era of reason, the "age of science," was dawning. Circa 1776, Mathew Boulton and James Watt collaborated to invent the steam engine. The late eighteenth century was the time for such inventions' acceptance. Boulton was truly a man of his time in his statement that "nature had destined him to be an engineer by having him born in the year 1728, because that is the number of cubic inches in a cubic foot."^75

Current philosophical debates influenced this paradigmatic shift in English culture. Philosophers such as the German Fredrich Van Schelling (Naturphilosophie) helped to spread the emerging awareness of men as natural beings. Men were beginning to view themselves as part of nature, as being in control of their destiny. This soon led to a further viewpoint, with man having actual power over nature. Bronowski writes that the feeling was that "nature is the foundation of power, whose different forms are all expressions of the same force, namely energy."^76
As stated previously, a culture is a system with many interconnected parts influencing the whole. The period roughly from the mid-eighteenth to the present century is a case in point, a time of cultural change. The facets of culture shifted and a new perspective of the world was conceived.

For instance, the poet Coleridge visited Germany and Von Schelling, where he was much impressed by his "natural" philosophy. This can be seen in his word choice in his poetry. In turn, the patrons of Coleridge, the Wedgewoods, were influenced greatly. Wedgewood, who deserves a book-length discussion in himself, was a scientist, manufacturer, and inventor. His achievements are still felt today, especially in the ceramic industry. Wedgewood had a particular impact on his grandson, Charles Darwin.

Darwin's 1859 *The Origin of Species* could not have been written without a changing perception of the world—without that practical, paradigmatic shift preparing the way for the development and acceptance of his ideas. The independent development of theories of natural selection by Darwin and Wallace within the same time period supports Kuhn's (1962) belief that a shift in the scientific communities' model of the world paves the way for a scientific revolution. A change in the general atmosphere of society occurs; the culture must be "primed" before major new theories can be accepted.

Darwin helped to support a new perception of the cosmos. Mankind would no longer be locked into the Newtonian and Chain-of-Being world view of foreordained life. The Newtonian model of time itself changed. Time no longer consisted solely of Ancient Times,
Present Never-changing, and the Judgment, far, far in the distant future. Time, history, man, and even nature were no longer immutable, eternal entities. A flow, a continuous change was perceived in the world. Durkheim's protestant ethic and the idea of man controlling nature's forces cannot be separated from any study of eighteenth and nineteenth century cultural change in the Western world. Social, economic, technological, philosophical, religious, political, et al., the facets of European and colonial culture were realigned to form what we call the result of modernization, the present "modern" Western culture.

Harrison believes that Malthusianism and concomitant political radicalism and philosophical radicalism served as extremely strong influences on the late eighteenth, early nineteenth century English culture. He terms Malthusianism "one of the most compelling theories of the modern world" in the overall influence on British society. English population greatly increased in the early nineteenth century due to more births in combination with fewer deaths. As further proof of the philosophic change from man in nature to man over nature, the Malthusian recommendation for saving the world was to have fewer children. As population must equal available food supplies, people were called upon to use "moral restraint" to solve the problem of increasing population. Moral restraint was equated with being a "rational being." The desire and goal of being rational influenced the passage of Poor Law reforms and other political upheavals throughout nineteenth century Britain.
Near mid-century, Malthusian fears of a starving, over-populated world receded with good agricultural harvests and improved agricultural methods which increased production. England had more food, more people, and more industrial growth occurring then ever before. Harrison, in his analysis of George Porter's 1847 *Progress of the Nation, in its Various Social and Economic Relations, from the Beginning of the Nineteenth Century*, has determined that to men like Porter, "progress meant essentially material progress." Progress was measured in "rational" terms of economic growth. England's gross national income increased from 340 millions lbs. in 1831 to 523.3 million lbs. in 1851.

The Industrial Revolution accelerated at a tremendous rate in the early years of the nineteenth century. Harrison believes that this revolution was simply a continuation of growth in traditional sectors—agriculture and textiles—predicated on their initial (1783-1802) growth. But, to reiterate, industrial growth could only have taken place in the correct social milieu, in that practical, rational world of early nineteenth century Britain.

The economic developments occurring in eighteenth century England were affected by the development of the "science of economics" in the late eighteenth century. Economics constitute one major sub-system of a cultural system that is strongly influenced by diffusion, innovation, and re-integration. Writers like Steuart, Hume, and Smith developed the new science.

In Smith's logical world, supply and demand control the market. A product like sugar demands huge investments of time, capi-
tal, and labor, all needing most careful management. Smith writes that sugar production is a worthy enterprise—as long as the supply remains less than the demand—leading to profits to defer overhead. But Smith found it appalling when numerous absentee landlords became involved in sugar-making. He writes that sugar is a crop needing good, direct management. Also, he felt that perhaps the sugar planters desired "unnatural" profits. They expected the sale of rum and molasses to defray the costs of production, leaving the sale of sugar to produce profits. He writes (1776), "It is as if a corn farmer expected to defray the expense of his cultivation with the chaff and the straw, and that the grain should be all clear profit." This seems to have truly been the opinion of many sugar planters. Barrett writes that the planters depended on molasses sales. But, he states, "The expected or actual average yield resulted in a profit if one ignored the interest charge on the capital; but if actual interest charge on a mortgaged plantation had been considered, the expected yields could not have met the costs ... "

Sugar planters were in distress in the beginning of the nineteenth century. Abolitionists were gaining strength and decrying slave labor, the base labor of the sugar industry. The slave revolt in St. Domingo (Haiti) circa 1791 greatly affected the economics of sugar. The war-torn island could not produce sugar, leaving a large gap in the international sugar market. Prices rose and men of many nations invested in sugar production (such as the merchants mentioned above). For example, Louisiana sugar growing began in 1795. De Bore', a local planter, began the first successful crop at that time,
stimulated by the shortened supply of sugar. In those areas already producing sugar, production was increased through multiplying existing techniques, cultivating more fields, adding more labor, and building more sugar works.

The English sugar market soon became glutted with excess supplies. England had added new sugar islands through war and had increased production on existing islands to a point where she produced much more sugar than the gap left by the halt in St. Domingan (Haitian) production. Heated political debates occurred as to whether colonial sugar producers should be protected by the mother nations through regulations.

The Napoleonic Wars silenced the debates to a dull rumble for a short period. By the end of those wars, raw sugar sold for 97s. per cwt, a "fantastic price." The peace of 1814 added more sugar producing areas to British rule, helping to decrease the 1831 price of sugar to a mere 23s. per cwt, as, again, the market flooded. This led to renewed parliamentary debates, and to more abolitionists winning some of those debates.

The Emperor Napoleon had tremendous impact on sugar cane production. This occurred when he became a firm supporter of Franz Achard and Benjamin Delessert's work on extracting sugar from beets. In 1811 he gave financial aid to the project and encouraged Frenchmen to plant fields and fields of sugar beets. The advent of beet sugar, grown in the soils of European nations and tended by freemen gave added impetus to the abolitionist movement. Beet sugar production did not reach 15% of the market until 1850, but began to overtake sugar cane from that period onward.
As mentioned, the advent of beet sugar, produced on home soil and not requiring slave labor for production, surely influenced the growing abolitionist movement. Adam Smith had already shown that "the work done by freemen comes cheaper in the end than that performed by slaves." His argument was that slaves were so directly related to the owners' actions that errors were compounded. The relationship of freemen to employer was less intensive with less feedback. Adam Smith did not care for slave labor, based on both economic and moral grounds. He wrote, "A person who can acquire no property, can have no interest but to eat as much and to labour as little as possible." In his view, slavery was inefficient, possible only under high-profit-generating industries such as sugar, less possible with tobacco, and not possible at all with a product like corn.

The arguments of beet sugar advocates (non-slave made) and economists, such as those of Smith related above, may not have had major impact if the price— and thus the profits— of sugar producers had remained extremely high. But after the Napoleonic Wars, the price of sugar fell and "preferential duties on West Indian sugar were removed between 1848 and 1854, in accordance with the principles of free trade." The "principles of free trade" were supported by the depressed economic state of the West Indian sugar industry and concomitant loss of political influence. An industry in deep depression is hard to defend and expensive to support, and British abolitionism laws began in 1833.

The loss of slave labor tremendously upset the existing system of production. New laborer/planter relationships and wages had
to be designed. Many planters could not adapt or could not hire any wage laborers. They either migrated to other slave colonies or went bankrupt. (Many slaves refused to work in sugar fields after gaining their freedom--due to the hard work and the stigma associated with the idea that agricultural work equals slavery, a feeling perhaps prevalent today in most West Indies.)

Aykroyd writes that British sugar production "between 1839 and 1856 was about two-thirds of that of 1821." In other colonies, the flames of debate between colonial and homeland interests and the added question of slavery led to intensive political struggles. Paul D'Aubree, a supporter of French colonials, wrote a treatise to prove that slave-produced sugar should be supported in France. His argument was that cane sugar should be supported by regulations against beet sugar producers and abolitionists. Using facts and figures, he attempted to show that the French economy and even the French mercantile Navy (with 11,000 sailors) were dependent upon the sugar-producing colonies, and further that without that staple crop the French colonies themselves would simply "cease to exist."

Those wishing to rid their nations of the West Indian colonies and their "distresses" offered counter arguments. Claims of exhausted soil, expensive labour, lack of leadership (talent, organization, and good agricultural practices), and so forth blasted in cross-fire in newspapers, pamphlets and books.

A sugar planter did need great organizational skills. He also needed either engineering skills or to have the money to hire a technical advisor. The planter had to become both an agriculturalist
and an industrialist. Thus managerial abilities did play an important role in sugar production. The planters, as managers, had to adapt to the changing world of beet sugar and wage labor competition.

As mentioned, some planters simply relocated to areas that still allowed slavery. Migration was not an unknown strategy. Planters of various nationalities owned estates in the islands. The Dutch colonies of Berbice, Essequibo, and Demerara in South America needed experienced sugar planters to continue their growth. In the eighteenth century they opened their boundaries to foreign planter-investors. By 1744 there were seven English plantations; by 1769 there were 56. English managers oversaw absentee Dutch-owned estates. Many of the English planters arrived from the British Leewards, especially Barbados. Again, when the Danes opened their mid-18th century boundaries at St. Croix, numerous Dutch, French, English, and so forth planters took advantage of the new lands. The early nineteenth century Puerto Rican lands were cultivated by Santo Domingan, Venequelan, and Louisiana planters. One last example is found in 1834, when a British West Indian, Farquhar Macrae, was "forced" by emancipation acts to migrate to Florida. There, he began sugar production using simplified West Indian techniques.

The nineteenth century cane sugar industry was in a turmoil. Beset by economic problems, lacking a large labor force and political support, the industry began to falter. But consumer demand for sugar maintained a steadily increasing pace from about 1815 to 1964. Kilograms per head per annum in England increased from less than 10 in 1820 to approximately 35 in 1900. The American consumer market
also continued to grow. By 1859 the consumption of sugar "excluding California and Oregon, was estimated at 431,184 tons, of which approximately 130,000 tons were produced in the South."\textsuperscript{110}

Obviously the demand for sugar continued to exist and to increase. Supplies began dropping as British estates went bankrupt. The impetus for manufacturing sugar, high demand, still existed. Many merchants and planters began to reinvest their capital and abilities into sugar production. Their primary problem was that West Indian slave-grown sugars (Spanish and Dutch) were cheaper than wage-grown sugars.\textsuperscript{111} This was due to their use of the same general manufacturing processes. In Barbados, circa 1846, planters were afraid to "adopt new methods because they were not in a position to assume additional risks."\textsuperscript{112} The merchants and more daring planters were ready to invest in new production techniques, however. The technological developments in the early and mid-nineteenth century gave reciprocal impetus to innovations and the adoption of new manufacturing methods. (These developments will be discussed more fully in the following chapter.)

The practical men of the nineteenth century tackled the problem of sugar with methodical care. Writers like William Evans (1848) scientifically approached the industry's problems and suggested step-by-step solutions. I believe it was this welcoming atmosphere that gave the impetus for the many fundamental technological changes that occurred with greater and greater rapidity throughout the nineteenth century.
The price of sugar fluctuated throughout the nineteenth century. Elements such as new free trade regulations (Puerto Rico, for example), sugar bounty debates, drought, exhausted soils, and new developments in the beet sugar industry affected the economic oscillations that took place. The gradual changeover from slave to wage-earned labor sources, at staggered times by nationality, also greatly influenced the sugar industry in the nineteenth century.

The following brief section is a general discussion of the tandem development of sugar and slavery. As mentioned, sugar was dependent upon slave labor for over three centuries, until slavery's abolition in the nineteenth century. This is exemplified by the words of Voltaire's Candide, who describes a scene in Surinam, below:

As they drew nigh to the city, they saw a negro stretched on the ground, more than half naked, having only a pair of drawers of blue cloth; the poor fellow had lost his left leg and his right hand. "Good God!" said Candide to him, in Dutch, "what do you here, in this terrible condition?" "I am waiting for my master, Mynheer Vandervendur, the great merchant," replied the negro. "And was it Mynheer Vandervendur that used you in this manner?" asked Candide. "Yes sir," said the negro, "it is the custom of the country. They give us a pair of linen drawers for our whole clothing twice a year. If we should chance to have one of our fingers caught in the sugar-houses, they cut off our hand; if we offer to run away, they cut off one of our legs; and I have had the misfortune to be found guilty of both these offenses. Such are the conditions on which you eat sugar in Europe!"

**Slavery and Sugar**

One cannot read about Caribbean sugar without discovering that the industry was dependent upon slave labor for many centuries. One writer even believes the industry was so affected by its slave labor base that technological innovations were stymied—that planters
chose inefficient methods purposely just to keep slaves busy. 115 This is often refuted. For a plantation producing sugar needed labor, and had intensive labor as well as calmer periods needing less intense hours of labor. As will be described, producing sugar entailed periodic field labor as well as a six-week period of manufacturing labor. During sugar processing, all hands were needed at all hours. The juice could not wait upon man's needs—it spoiled very quickly. 116

Adaptations to emancipation proved that sugar could be produced by wage-earners; but prior to emancipation it was truly believed that sugar could not be produced without slave labor. The work was simply too arduous, as Henry Coleridge (1825) describes below:

The cane is, no doubt, a noble plant, and perhaps crop time presents a more lively and interesting scene than harvest in England: but there is so much trash, so many ill-odorred negroes, so much scum, and sling, and molasses, that my negroes sometimes sunk under it. "The sweat negotiation of sugar," as old Ligon calls it, is indeed a sweatty affair, and methinks it were not good for that most ancient and most loyal colony, Barbados, that her sons should often visit the sylvan glades, the deep retreats, the quiet and coolness of the cacao plantations in Trinidad. But planters are not poetical. Sugar can surely never be cultivated in the West Indies except by the labor of negroes ... 117

Although Carib, Arawak, and other indigenous Indian peoples were used in the fifteenth and sixteenth centuries by Spanish and even Dutch, English and French planters, their numbers became so decimated through disease, infertility, harsh conditions of labor, and escapes that planters had to search elsewhere for labor. Indentured white servants were an alternative supply of labor in the seventeenth century. But soon the land-intensive sugar industry stripped the islands of available lands to grant indentured servants. As happened in the tobacco-growing Chesapeake region, planters turned to Africa for their laborers. 118
Black African slaves, 235 of them, were first carried to Lagos for sale by Portuguese explorers in 1444. The fifteenth century sugar estates described earlier avidly bought the Negro slaves. Deerr mentions that Las Casas listed the Canaries, Portugal, Italy, Castilla, and Sicily as areas with large early concentrations of Negro slaves.

In the Caribbean, Spanish colonies began augmenting Indian slave labor with Negro slaves as early as 1501. The asiento system of the Spanish granting slave-trading rights began at that time, with German, Dutch, French, and English merchants vying for the privilege.

Deerr believes that the ratio of male to female slave importations was always unequal, and Sheridan feels that the initial ratios were more equal, only changing to more men than women during the tremendous growth in the eighteenth century of the sugar industry.

Deerr devised a tabulation of the numbers of Africans traded as slaves. His final figure is 13,500,000--with an additional number of people lost or killed during the voyages. He states, "It will be no exaggeration to put the tale and toll of the slave trade at 20,000,000 Africans, of which two-thirds are to be charged against sugar."

Deerr has compiled information on white versus black population data and on slave importations to various regions of the Caribbean. Unfortunately, his figures were arrived at in a manner not conducive to statistical manipulation, with differing averaged
segments of time. The overall pattern of slave imports shows significant increases in number of slaves throughout the eighteenth century, with slight or major decreases in the nineteenth century, probably depending upon the economic trends and abolitionist movement's influence in the European nations. The tabulation below of St. Kitts indicates the general trend:

TABLE 2
BLACK AND WHITE POPULATION FREQUENCIES, ST. KITTS

<table>
<thead>
<tr>
<th></th>
<th>1721-1730</th>
<th>1784-1787</th>
<th>1802-1803</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imports</td>
<td>10,358</td>
<td>2,224</td>
<td>847</td>
</tr>
<tr>
<td>White population</td>
<td>1,416</td>
<td>3,881</td>
<td>1,912</td>
</tr>
<tr>
<td>Black population</td>
<td>2,861</td>
<td>17,335</td>
<td>20,435</td>
</tr>
</tbody>
</table>

The simple equation that expansion and growth in the sugar industry equalled increasing numbers of imported slaves is substantiated by trends in Louisiana. The nineteenth century explosion of the sugar industry there included a huge demand for more Negro slaves, "paralleling that of the sugar islands a century earlier."127

The abolitionist movement, with roots as far back as the first 1444 cargo of slaves, began to gain incredible force in the late eighteenth century. Part of the reason for this was the growing
Methodist movement. Connected to this was a general prevailing view that slavery was immoral, unnatural, and uneconomic, which tended to strengthen the political clout of the abolitionists. Lurid descriptions of slave captures and treatment abound in the literature. Too, periodic slave insurrections occurred in many colonies, beginning with Hispaniola in 1522 and ending with one on St. Eustatius in 1848. The worst, and most widely known, occurred on St. Domingue (Haiti) in 1791. English and French armies in 1793 and 1801 respectively tried in vain to retake the island from the successful rebel slaves. All of this, combined with the growth of "free-grown" beet sugar led to first the abolition of the trade and then the apprenticeship and/or emancipation of colonial slaves. England abolished slavery in 1833, although the slavery-like apprenticeship system didn't end in most British colonies until 1838. Sweden abolished slavery on St. Bartholomew in 1847; the following year France and Denmark followed suit in their colonies. The Dutch officially ended slavery in their colonies in 1863, the year of Lincoln's Gettysburg Address and the Emancipation Proclamation. Finally, the Spanish freed their slaves from 1824 to the late nineteenth century. Volumes have been written about slavery and its connection to cultural elements, including technology, politics, the economy, religion, and ceramics.

The following chapter is a discussion of one aspect of the cultural changes and social adaptations inter-connected with West Indian sugar manufacturing—technology. As one shall see, technological innovations were not merely developed in the early fifteenth century and solidified until the mid-nineteenth century, as most
authors would have one believe. Technological development was a con-
tinuous process, but one greatly affected by the cultural reception
granted it. Planters were offered many choices in technology.
Perhaps one day we will know how and why they picked and chose the
methods they used to manufacture sugar. The technological side of
sugar production has been divided into four sections: cultivation
methods; milling the cane; processing the juice; and storage, by-
products, and shipment.
NOTES TO CHAPTER I

1Aykroyd, 1967, p. 7.

2"But, in my opinion, I'm convinced that it was in its natural state in the islands, for the Spanish never stayed there long enough to cultivate it." Radford, 1979, p. 188.


4Sheridan, 1974, p. 98.

5Stubbs, 1897, pp. 3-4.


10Stubbs, 1897, p. 4; Sheridan, 1974, p. 99.

11Stubbs, 1897, p. 4.

12Stubbs, (1897, p. 4) claims that Peter Etienza introduced sugar cane to Hispaniola.


141897, p. 4.

15Ibid.


181967, p. 16.

19Deerr, VII, 1950, p. 453. The majority of raw English sugar was refined by the Dutch until about 1660--ibid., p. 458.

20p. 454.

21Ibid.


The discussion that follows was spurred by many, many conversations with my fellow graduate students, Dept. Anthropology, College of William and Mary, 1981-1982 and by a Spring 1983 history course, The Consumer Revolution, taught by Dr. Cary Carson.


For a good overview of the economics involved in sugar production, see Richard Dunn, 1972 (17th century) and Richard Sheridan, 1974 (18th century).

Unless otherwise noted, the following information was taken from Edmund S. Morgan's 1975 edition of American Slavery, American Freedom, the Ordeal of Colonial Virginia, W.W. Norton and Co., Inc., New York, Chapter 1, especially pp. 14-24, and J. H. Parry, 1966.

Dr. Carson pointed out that the English first adopted this pattern in Ireland, then expanded it by bringing it to the New World.
This also influenced English desires for fine pottery, giving impetus, I believe, to the subsequent development of fine English wares from white saltglaze stonewares to delft to creamware to pearlware to bone china . . .

44 Aykroyd, 1967, p. 57.
46 Ibid.
47 Grouse, 1940, p. 77.
49 Sheridan, 1974, p. 163.
50 Carson and Highfield, 1978, p. 47.
51 As quoted in Augier and Gordon, 1962, p. 33.
53 Ibid., p. 20.
54 Dr. Jaap Van Soest, ND, p. 72.
55 Sheridan, 1974, pp. 38-41.
56 Sheridan, 1974, p. 46; p. 53.
57 1974, p. 11.
59 Sheridan, 1974, p. 476.
62 Aykroyd, p. 57.
63 Sheridan, 1974, p. 20.
64 Aykroyd, 1967, p. 57— from 4 lbs. per capita per year to 13 lbs. per capita per year.
65 Ibid., p. 57.
66 Sheridan, 1974, p. 25, including table 2.2.
Sheridan, 1974, p. 34, tables 2.4 and 2.5, weights of 000 cwt units.

Fraginals, 1976, p. 28.

See Sheridan, 1974, p. 24, for specific information on the fluctuating English market.

Ibid., p. 460.

The following section is based in part on Bronowski's discussion of English industrialization and cultural ramifications, 1973, pp. 274–85.


1971, pp. 10–11.


See Bronowski, 1973, for further details.

The increased consumption of sugar and reciprocal increase in tea and coffee drinking led to Wedgwood and other ceramists' search for a pottery to rival the imported oriental porcelains, so different from the crude, rough wares being made in England. Through many, many experimentations, Wedgwood developed fine earthenwares which eventually led to the production of his creamwares ... the huge expansion of the English ceramic industry ... and his marketing techniques helped to stimulate the consumer revolution even further ... where people demanded more and more goods, using material objects, as never before, to symbolize both achieved and ascribed status ... which led to ...

This practical paradigmatic shift has even led to the development of sociology, anthropology, systems theory, and ...


Ibid., pp. 8–9.

Ibid., p. 9.

Ibid., p. 10.

Ibid., p. 11.

Spence, 1807, pp. 1–2.
891965, p. 153.
90Sitterson, 1953, p. 5.
91Spence, 1807, pp. 4-16.
94Aykroyd, 1967, p. 98. It was a German scientist who discovered a process to derive sugar from beets in the late 18th century—ibid., p. 97.
95Ibid., p. 99.
98Ibid., pp. 488-89. This was echoed in 1848 by Evans, p. 17.
99Ibid., p. 489.
100Aykroyd, 1967, p. 83.
1011967, p. 84.
104Fraginals, 1976, p. 30; Sitterson, 1953, p. 67, p. 70.
105Sheridan, 1974, pp. 442-43.
106Ibid., pp. 444-45.
107Steward, 1956, p. 52.
110Sitterson, 1953, p. 44.
See Beachey, 1978, and Levy, 1980, for extensive discussions on the 19th century economics of the sugar industry.


Fraginals, 1976, p. 20.

See Deerr, VII, 1950, pp. 353-55; or Aykroyd, 1967, p. 56, for examples.

Discussions on slave and indentured laborers may also be found in Deerr, VII, 1950, Chapter 18, and in Parry and Sherlock's 1973 *A Short History of the West Indies*, 3rd Edition, MacMillan Ltd., London; see also Sheridan, 1974, Chapter 11, and Dunn, 1973, Chapter 7.


Ibid.

Ibid., p. 263.

Ibid.


See VII, 1950, pp. 278-80 for figures.

p. 279.

Deerr, VII, 1950, p. 270.


Hiss, 1943, p. 106; Deerr, VII, 1950, p. 300.
CHAPTER II
MANUFACTURING SUGAR

Cultivation of the Cane

Numerous variables entered into the profitable production of sugar cane. Good agricultural lands, climate, available fuel, technological know-how, capital for building sugar works, transportation, and a large work force are the major variables. The primary element needed for the good production of the cane is land hospitable to its growth. Fraginals ranks the four factors most important for the production and growth of cane on Cuban sugar estates as follows:

1. fertile lands adjacent to ports, 2. forests for timber resources, 3. cattle for motive power, transportation, and food, and 4. unsophisticated work implements for the slave laborers.¹

Sugar cane is a relatively hardy, long grass. It is a member of the Monocotyledons and the Genus Saccharum. There are three major species of sugar cane, S. spontaneum (most wild varieties), S. robustum (wild cane found in the Celebes and New Guinea) and S. officinarum (domesticated cane). Officinarum² is believed to have been derived from the crossing of robustum and spontaneum, but may be of independent origin.

The process of making sugar must begin with planting the canes. The two major classes of cane planted in the West Indies are the Creole and Otaheite (Bourbon) canes. Varieties of the Creole
canes diffused from India to Persia, where sixth century Moslems in turn introduced the cane to the Mediterranean. As discussed in the previous chapter, the cane was successively diffused to Madeira, the Canaries, and Hispaniola. The Creole varieties of sugar cane were then dispersed over much of the New World by Portuguese and Spanish explorers and merchants.  

The Otaheite or Bourbon varieties of sugar cane were first brought to Mauritius in 1768 by the French world navigator Bougainville. According to Barrett, Otaheite cane quickly spread throughout the Caribbean, due to its "superior milling qualities" and its high yields. The superior qualities of the Otaheite canes were also recognized in Louisiana, and by 1797 most planters cultivated both the original Creole and the Otaheite varieties.

Both Otaheite and Creole varieties of canes share specific growing needs. These needs include good soils, steady and warm temperatures, and lots of water. Sitterson lists the ideal conditions for their cultivation as follows: (1) average annual temperature of 75°F, (2) annual rainfall of 60 inches (or equivalent), and (3) a quickly draining, fertile soil. The real world generally has less than ideal conditions, but sugar planters learned to adapt the cane through man-made adjustments of temperature, available water and soil types. As a result, cane has been successfully grown in arid lands, poor soils, and colder climes. Man-made adjustments include respectively irrigation, manuring, rotation of crops, and multicropping and staking.
Soils

Sugar cane grew well in the volcanic soils of many of the Caribbean islands. It has been said that sugar cane could be successfully planted in any soil, on steep hillsides or on flat bottoms. The cane is a versatile plant, and sugar planters recognized which soils and cultivation methods would produce the best sugar-producing canes. Ward Barrett writes that "planters in St. Kitts early became accustomed to wide ecological variations within a single plantation, accepting correspondingly wide variations in yields and quality of sugar from fields very near each other." The Agricultural Society of South Carolina (May 1816) published a list of three good soils for growing canes. These three soils were high, dry Sea Island soils ("Live-Oak land"), bottoms adjacent to swampy, "rice" lands (including well-flushed tidal lands), and sandy, high pine-barrens. The Society recognized only two soil types detrimental to growing canes, clays and wet, boggy lands.

Planting

Sugar cane may be planted using two methods, from seeds or through ratooning. Ratoons are portions of cut cane that can be planted lengthwise, generating new canes. Ratoons were usually used only three years in a row, as cane yields tended to drop after that year. Normally a field would be planted with fresh cane one year, then ratooned for two, needing fresh cane only once in every three years. Not all planters ratooned their cane. For example, John Pinney of Nevis preferred to use fresh seedlings for each year's
Most British planters developed field schedules to keep careful track of ratooned and seeded field yields. The cane would grow for about 14 to 18 months, until it reached a height of between 5 1/2 and 6 feet. In Nevis, planting usually occurred during the months of October through January. Pinney preferred to cut his cane the following year, beginning sometime between Christmas Day and New Year's. English planters generally planted in the wet season (August-November) and began grinding in the dry (January to June).

The sugar cane fields would be hoed intermittently and perhaps fertilized with manure. The fields were sometimes multi-cropped and irrigated, too. Ploughs were used by some planters near the end of the eighteenth century, but proved to rather useless on island soils. Ploughs were tried on Antigua, Barbados, Grenada, Nevis, Dominica, and Monserrat, but proved unsuccessful. Factors such as stony, rough soils and the use of small oxen were cited by eighteenth century writers to explain the plough's limited effectiveness. Some nineteenth and twentieth century writers feel that the islanders disdained to use the plough solely to keep their slaves busy with long, hard, manual labor. Deerr refutes this opinion, arguing that the hand-cultivated method of managing cane was continued on emancipated islands well up to the twentieth century. He believes that ploughs were simply less effective than hand-hoed cane pieces.

Planters in the southeastern United States used the plough when possible. Writing in 1816, members of the South Carolina Agricultural Society advised "where the ground is mellow it should be simply furrowed out and the cane deposited."
Through an extensive examination of the writings of Ligon (1657), Labat (1724), Belgrove (1755), and others, Barrett states that seventeenth and eighteenth century field sizes were relatively uniform. Field sizes were generally from ten to twelve square acres, allowing easy checking of yields.  

Planting the cane was usually performed using a system of trenching. In the West Indies, deep trenches were dug by hand, four feet apart and at least 10 inches deep. Four to five cane plants would be placed at "three feet distance in the range of these trenches." The cane plants would then be covered with one to two inches of soil taken from the back-dirt of the trenches.

Thomas Spalding of Georgia believed that the deep trenching mode of planting was fine for the West Indies, but that the U.S. soils and climate were not adaptable to it. He preferred a system of planting developed by himself. He used low ridges located five feet apart with flat tops, 4-5 inches above the ground surface. In his words:

A trench is opened in the center of this ridge, and the Cane Plants cut into lengths of about two feet each, are placed in the trenches, so that they touch each other and make a complete line of cane seed:—They are then covered with about two inches of soil; and the depth of covering is all-sufficient, to preserve them from any degree of cold existing on the sea coast of Georgia or Carolina.

The canes were cut into lengths of about two feet for easy placement on their sides. Spalding's method of planting was generally followed in Georgia, but not in Louisiana. There, the trenches were excavated only two feet apart. As a result, more canes sprouted but were much smaller in size.
The agricultural practice recommended by the Agricultural Society of South Carolina incorporated Spalding's methods. Their methods were more generalized, showing trenches 4-5 feet apart, and cane pieces 14 to 18 inches long being placed "horizontally two feet apart" and covered with two inches of soil. One thousand canes planted in that manner would yield about one acre's worth of canes.24

In Georgia, successive plantings of cane took place. Planters such as Spalding would plant the best lands in the fall, later planting other pieces in winter and spring.25 To preserve cane seed, canes would be cut and "stacked" or "mattrassed" in October. Enough cane would be stacked in the middle of a field to form a rectangle 14 feet wide and five feet high, butts down. They would be placed on a log or smoothed earthen foundation. The cane blades would be used to cover the sides of the stack. Last, earth would be placed over the entire pile. After all danger of fermentation of the cane blades passed, two to three inches of dirt would be spread over the entire stack.26

**Cutting**

When the cane matures, in about 14 months, it must be quickly cut, transported to the mill and processed. Delays could lead to spoiling the harvest. Cutting cane was most often accomplished entirely by hand, using a bill, knife or machete.27 The style of cutting cane by hand has remained constant over time. It is described by Stubbs (1897):

The cutter seizes the cane near the top, with his left hand, strips it of its foliage with the back of his cane knife, tops it, and then severs the stalk at the ground and throws it to the heap,
which is made for the convenience of loading, on every third row. A good cutter in good cane will average about three tons of cane per day ... 28

The first mechanical cutting machine was designed by two Americans, Dollens and Zschech in 1882. Today's cane is cut either by hand or using mechanical methods. 29

In order to save time, money, and labor, a sugar harvest had to be well-planned. Planters had to develop a good organizational plan to transport the canes to the sugar works. Transportation depended on the layout of the plantation lands. Planters used roads with carts, canals with punts, and even railroads and flatbeds. 30 Nineteenth century Louisiana and British planters often used railroads to both transport cane to the mill and carry the processed sugar to harbor for shipment. 31

The cycle of planting, dunging, weeding, and harvesting was often staggered. Fields were often rotated and/or left fallow to revitalize soils. Provision crops were also planted on the plantations to supplement the owner's and the slaves' diets. Indeed, the management of a sugar estate took careful planning and management.

The plantation managers had to be attuned to the best methods of cultivating their cane pieces, and to coordinate timing and labor needs. Further, they had to fight natural disasters, such as flood, drought, and hurricanes. 32

Cultivating the cane was just the first in a series of steps leading toward the production of sugar. After harvesting, the cane had to be milled and processed, the most vital and risky steps in manufacturing sugar from the cane.
Technology

The sugar cane is a truly remarkable plant. Its extracted juice can be made to yield molasses, treacle, the extremely dark and crude gur, the lighter muscovado sugar, brown sugar, powdered sugar, and the purest white crystals or refined sugar. Even its manufacturing by-product ("scum") can be fermented into a profitable liquor, rum.

As with most technological processes developed by man, myriad methods of sugar manufacturing have been developed over the centuries since its inception. No single factory would ever be the exact duplicate of another. Individual men set their unique prints upon the development of sugar processing; planters had to be innovative engineers to find the best method of manufacturing their sugars.

Technological processes do follow certain basic patterns of manufacturing, due to physical and chemical laws. There are five general steps that were followed by sugar planters to process their sugar. These steps are:

1. Extracting the juice from the cane (milling).
2. Priming the juice with an agent such as lime (clarification).
3. Crystallizing the juice (boiling and/or evaporation).
4. Cooling the crystallized mass.
5. Drying, packing and draining the sugar.

The five steps listed above are all equally important in the manufacturing of sugar from the cane. After the cane was cut, it would be transported to the factory area. The first step in processing was and is milling.
Milling

As mentioned previously, one of the earliest centers of sugar manufacturing was India. The sugar produced was generally a raw form, known as "Gur" or "jaggery." It was produced for countless centuries in the same manner. The cane would be simply crushed using a hand or cattle-motivated press. The juice would then be boiled in one kettle and dried, leaving the thick, crude sugar ready for consumption.33 (See Deerr, VI, 1949, p. 55, figure 2, for an illustration of an early hand press.)

This crude sugar is still being processed today, listed as "non-centrifugal" and called gur, piloncillo, panela, papelon, chan-caca, and rapadura. Total production of crude sugar is only about one-eighth that of refined or centrifugal sugar today.34 Modern Third World farmers still manufacture such crude sugars in some localities. These sugars are primarily used for household and/or local consumption. For instance, a Costa Rican farmer boiling his one vat of sugar may allow passing children to drop in ears of hard corn, to make a sugar-coated candy.35

The hand press method of extracting juice from the cane gave way to the invention of the roller mill. Early roller mills extracted from 50 to 60 percent of the juice from the canes.36 The roller mill comes in two different types, vertical and horizontal. Of course, many variations of the two types have been developed. The first roller mills were usually two-roller mills. Vertical stone rollers with "gear-wheels" at the lower ends were first used in China.37 Two-roller horizontal mills were used in seventeenth century Spain and in Egypt during the early nineteenth century.38
3-Roller Grinding Mills

Figure 2a. vertical

Figure 2b. horizontal
The most common form of roller-mill used in sugar manufacturing was the three-roller mill. Writing in 1848, William Julian Evans describes the three-roller mill as follows:

[The mill consists of] essentially three rollers, which are placed sometimes in a horizontal, and sometimes in a vertical direction. The canes are submitted to the action of these rollers; and, in consequence of the great pressure and squeezing which they undergo, the whole of their tissues are completely broken up and lacerated. The degree of pressure is always so managed, however, that each cane shall, as far as possible, be drawn from between the rollers, preserving its entire length, so that it may better serve the purpose for which it is ultimately destined, namely, that of fuel ... 39

Figure 2 depicts the two types of roller mills. The first, or top roller, was called the canera in Cuba, and it was the primary crusher of the cane. The second roller, or main roller, served as the central roller. The third, the Cuban bagacera, served to crush the cane a second time and was also known as the bagasse roller.40 The second roller was turned by a shaft, and it in turn caused the first and third rollers to rotate. The shaft was turned by a source of power, either animal, water, wind, or steam. Bagasse and megasse are the terms used for the crushed, spent cane stalks. It was usually dried and used for fuel.

The cane was generally hand-fed by two slaves, the first passing the cane to the bite of the rollers G1 and G2, the second receiving the cane and passing it between rollers G2 and G3. This could be extremely dangerous, and caused numerous accidents. Some reports state that "it was customary to keep a cutlass at the mill to chop the arm of any hapless negro who had been caught."41 The biggest danger was to the individual who had to pass the cane the second time
through, between rollers G2 and G3. In 1773, John Flemming mitigated this danger with his invention of the "wallerer wheel." This machine fed the cane through the second bite.42

A mill utilizing rollers to crush cane is called a trapiche, which may also refer solely to the actual grinding machine.43 In the Old World, the first wooden roller-mill was a three-roller vertical mill instigated by the Prefect of Sicily, Pietro Speciale. He named his roller mill a "trapetto for getting sugar from the 'honey canes.'"44 The trapetto could have been driven by three forms of motive power, to be discussed in detail in a later section. These three forms of power are wind, water, and animal.

A three-roller vertical mill was located in Brazil as early as the beginning of the seventeenth century, driven by both cattle and water power. The distribution of cane mill engines in 1852 and from 1813 to 1817 may be found in Table 3. Obviously, cane mill engines (roller mills) were available throughout the Caribbean.

The actual rollers used to crush the canes were manufactured either from wood or from iron. Wooden rollers were used up into the nineteenth century by some planters, but Ligon mentions the use of iron plating over wooden rollers as early as the mid-seventeenth century. Wooden drums were first covered with metal by George Sitwell in England in 1652. Manifold varieties of drums, using differing amounts of wood combined with iron, were used throughout the seventeenth, eighteenth, and even nineteenth centuries.45 Sitterson recounts that a West Indian planter, adviser plant John Couper on St. Simons Island, directed the construction of a mill using rollers manufactured from live-oak as late as 1814.46
TABLE 3
DISTRIBUTION CANE MILL ENGINES

<table>
<thead>
<tr>
<th>Area</th>
<th>1852</th>
<th>1813-1817 Messrs. Fawcett, Preston &amp; Co.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boulton and Watt</td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>British Guiana</td>
<td>54</td>
<td>-</td>
</tr>
<tr>
<td>Cuba</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>Demerara</td>
<td>-</td>
<td>42</td>
</tr>
<tr>
<td>Georgia</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Grenada</td>
<td>5</td>
<td>-</td>
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<td>Jamaica</td>
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<td>-</td>
</tr>
<tr>
<td>Reunion</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>St. Croix</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>St. Lucia</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Surinam</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Tobago</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Trinidad</td>
<td>12</td>
<td>-</td>
</tr>
</tbody>
</table>

*Noel Deerr, History of Sugar VII, pp. 552-54. He derived his information from two order books:


b. Messrs. Fawcett, Preston & Co. for the five-year period 1813-1817.

[Roller Mills - Fawcett, Preston & Co. 1813-1817 orders were "for sixty-three horizontal and for only eleven vertical mills."]

In Puerto Rico, circa 1827, there were 1,547 mills. Of that total only 130 were constructed of metal. By 1830 the beneficial effects of increased foreign trade were felt there and the ratio of metal rollers increased to 275/1,552. Rollers totally manufactured
out of iron were developed first by William Harding in 1721. Deerr describes these rollers as "hollow and cast in one piece with the gudgeon, which was attached to the shell by a spider."\textsuperscript{48}

The horizontal mill designed by Smeaton in 1754 consisted of three rollers set to form a triangle, held in place by a headstock (housing).\textsuperscript{48a} This was a great innovation, as earlier horizontal mills consisted of three parallel rollers, terribly inefficient. Much juice was lost using the parallel three-roller mills, as the cane would absorb pressed juice as it passed between the second or bottom set of rollers.\textsuperscript{49}

Smeaton's design was improved upon by John Collinger. His 1794 design consisted of three "horizontal rollers with their centres at the angles of an isosceles triangle."\textsuperscript{50} The basic horizontal mill design has remained little changed since the late eighteenth century. Deerr writes that after Collinger's designs were accepted "the cane mill had received substantially its present form. The changes in the next fifty years were concerned mainly in the reduction of the form of headstock to a sound engineering model."\textsuperscript{51} Figure 3 depicts the standard form of headstock, circa 1830. A is the central pillar, B the outer pillars. The lower rollers (C) are designed to lie off surfaces in the gaps between the central and outer pillars, the former sustaining the top or driven roller (D). E marks the holding bolts, F the adjusting screws, and G the part that ties the central and outer pillars.\textsuperscript{52}

The open side-gap headstock was developed by Buchanan in 1858. His design enabled the two base rollers to slide, and had
Figure 3. Standard Horizontal Mill Headstock, circa 1830
wrought-iron tie bars covering the rollers. Deerr applauds this development, saying that this prevented the base rollers' horizontal thrust from adversely affecting the cast-iron headstocks.53

The modern three-roller mill took shape in 1871 with the engineering skills of Theophile Rousselot. Below is Deerr's account of Rousselot's design, one still in use today:

He retained the open side-gap of Buchanan and substituted cast-iron side gaps for the wrought-iron bars of that inventor. He strengthened the headstock by fitting two wrought-iron flat tie-bars, on each side of the mill. Each bar was keyed to the headstock and was rounded and screwed at both ends. Links or transverse-bars in horizontal recesses in the outer faces of the side gaps connected the ends of the upper and lower pairs of tie bars.54

Although the three-roller mill was the type favored by the majority of West Indian planters, there were problems with them.55 Evans (1848) states that the cane stalks (bagasse/megasse) re-absorbed some of the juice, resulting in less juice being expressed for sugar production. Further, the oblique direction of the crushing force combined with the extra friction generated meant a total loss of actual crushing power.56 Evans mentions that planters testing the efficiency of their roller mills learned that only from 36 to 68.5 percent of the cane juice was being extracted. Evans believed that both horizontal and vertical mills could be made more effective by following the manufacturer's placement directions more carefully and through keeping the velocity of the rollers uniform. He recommends placing vertical rollers as follows: the bite between the first and second roller should measure 1/4", between the second and third 1/6". For horizontal roller mills, the difference between the top and the bottom rollers should measure either 1/4" or 1/5".57 Evans also suggested
passing the megasse through for a second pressing. He believed that the above improvements could increase extraction by at least 20 percent. His final recommendation was for the planter to invest in a new mill.\textsuperscript{58}

Recognizing the problems inherent in the three-roller mills, inventors developed 4, 5, 6, 9, 11, 14, and 17-roller mills. The six-roller mill was developed in 1849 and used first on Mauritius and Reunion. Five-roller mills were designed by the French in 1848. These mills were horizontal, with two rollers on top and three on the bottom. Five-roller mills were used on Cuba, Bourbon, and Mauritius, and had the successful extraction rate of 70 percent. Unfortunately, the five-roller mill demanded a higher amount of motive power than any other mill type.

The next type of roller mill engineered was the four-roller mill, by a Mon. DeMornay in 1851. His mill was improved upon by Chapman in 1888. This type of mill was found in Brazil, Cuba, and Demerera. The rollers were placed two over two, and as a result the necessary motive power did not exceed that needed for the traditional three-roller mills. The four-roller mill could successfully extract 70 to 75 pounds of juice per 100 pounds of sugar cane.

The nine-roller mill was first produced by the Fulton Iron Works in 1892. The 14-roller mill was in use in Hawaii and Spain by 1906. Modern methods of expressing the juice had their origins in Hawaii. Deerr writes that Ewa Plantation, in 1910, a Mr. Renton "converted two parallel trains of eleven rollers into a single train of seventeen rollers and obtained an extraction of 97.2 percent, which
These large roller mills were used by large, centralized sugar-works.

Noel Deerr calls the development of the modern mill the product of "four hundred years of engineering evolution." A technological evolution in sugar milling took place from the fifteenth through the nineteenth centuries. One of Kuhn's paradigmatic shifts appears finally to have been accepted during the nineteenth century, with invention after complementary invention occurring after centuries of steady, infrequent developments in sugar milling. Deerr describes the modern mill below:

The modern mill embodies the open side-gap headstock of Buchanan, the horizontal throughway bolts of Rousellot, the hydraulic control of Steward and Macdonald [and the] adjustable trash turner of Watson (1871, 1982), the last three devices all appearing within twelve months of each other. Since then improvements have been made in detail, but not in principle.

Improved mills were available throughout the West Indies, but, as Beachey writes, "Apart from British Guiana and Trinidad, only in rare instances were better types of mills introduced in the other colonies." One must ponder the question of why the majority of planters continued to use the traditional three-roller mill throughout the nineteenth century.

One could examine factors such as availability, costs, efficiency, and conservatism to help to determine what factors influenced the prolonged usage of vertical and horizontal three-roller mills. As stated, the knowledge of and accessibility of the new mills is well recorded. The relative costs of the different mill types is presently unavailable, but could be determined from manufacturers' records in
the future. Evans (1848) does indicate that planters preferred to improve existing mills to replacement, due to high costs.

Fraginals (1976) believes that planters preferred to use the older mill types because they were slower and less efficient than the new. This would result in keeping the slaves busy for longer periods of time. Were they inefficient? Yes, the three-roller mills were relatively inefficient. Vertical mills had the problem of uneven distribution of the cane stalks, leaving the tops of the rollers churning air. This was due to gravity and the action of the rollers. Horizontal mills were inflexible, as were vertical ones. Elasticity was not introduced into these mills until the middle of the nineteenth century. This rigidity of the rollers in both systems caused costly breakdowns. This was the planters' nightmare, for the cut cane had to be processed as soon as possible or it would spoil. The use of "slightly over-mature" Otaheite cane added to the possibility of breakdown, due to the hard bagasse of that variety. Planters did attempt to improve their three-roller mill system of pressing the cane. Nineteenth century writers list numerous ways for a planter to increase the efficiency of his mill. Their suggestions are mainly concerned with flexibility, even feeding and using improved, correctly spaced rollers.

Motive Power

Regardless of the type of mill employed in a sugar works, a planter still had to decide what power to employ to drive it. Planters would have to consider factors including availability, topography, costs, technological know-how and the size of their
Motive power usually fell into four distinct types: animal, wind, water, and/or steam. As often is the case, these concomitant technologies appear to follow a general evolutionary sequence of development. The sequence for the West Indies began with animal and hand and/or water-powered mills, then wind, and finally steam.

Animal Mills

After the hand press, animal mills are the earliest form of motivating power to have been used. All animal mills share the basic form depicted in Figure 4, with animals circumscribing the mill itself. The force of the moving, yoked animals in turn rotates a central shaft. This shaft or spindle turns the middle roller in a vertical three-roller mill or the top roller in a horizontal one. This roller then forces the other two rollers to turn, and the cane is crushed. The force of the animals depended upon their type (horses, cattle, oxen, or mules), number employed, and the size of the mill.

The cane would generally be hand-fed. The bagasse would simply drop to the floor, to be picked up later for drying. This could be accomplished by stacking the bagasse at once or drying it in the sun first for several hours. The bagasse would be used as fuel and/or in place of manure for fertilizer. The juice of the cane would flow into a form of trough or gutter (metal or wood) which would carry the juice to the processing region of the factory.

Writing in 1847, Ormachea states that Puerto Rican animal mills run by oxen employed many laborers. His enumeration follows:
Figure 4. Single-level Animal Mill
21 negroes and from 40 to 50 yokes of oxen; 4 negroes with as many ox carts to carry the cane up the mill yard, another 2 negroes to bring the cane up from the mill yard to the mill itself, 1 to put it in between the grinding rollers, 2 to carry the bagasse to the shed ... and 2 boys to coax the oxen to move; all of these, besides the number of persons engaged in actual cutting of sugar cane and in charge of the animals.™

These laborers might have worked in either a one- or two-level animal mill. The one-level animal mill has already been described previously. These mills could be operated solely using one mule, if need be.™ The second type was based on the same principle, but proved to be more efficient due to structural improvements. This was the two-level animal mill as depicted in figure 5. The animals would tread the upper level on a walk, while the bagasse and juice would fall to the second or bottom floor of the mill. Thus the gathering of the spent stalks and the flow of the juice would not interfere with the animal walk.™ The date of its development is unknown.

The two-story structure generally had a conical-shaped roof upheld by beams or pillars.™ The shape of the building was often circumscribed by the need for a circular animal walk. A ramp would have been needed to connect the upper story to the ground. An example of a two-level animal mill has been found in Monserrat on Galways Plantation. This mill is stone, circular in shape, and measures 40 feet in diameter. The upper portion was constructed of earth, stone, and mortar. The raised tract measured 10 feet in width and sloped eastward. The lower aperture was a 10 foot wide by five foot high archway.™

Octagonal animal mills were not unknown on the islands. A stone, octagonal mule mill was located at Harmony Hall, Trelawny, Jamaica.™ This form was an uncommon choice on the islands, but was
Figure 5. Two-level Animal Mill
the common choice in the American southeast. The prevalent construction material used in Georgia and parts of South Carolina was tabby. Tabby consists of a mixture of shell (lime), sand, and water. This formed, when poured, a variety of concrete. It is almost impossible to pour a circular structure using tabby. Spalding, that innovative sugar planter living off the coast of Georgia, designed a two-story tabby animal mill. He was able to do so (1816) by changing the shape to an octagon. Spalding's design is a clear case supporting adaptive regional variations in architectural style and technology. A portion of his letter to Thomas Pinckney describing his tabby mill-house has been reproduced below:

The mill-house that I have erected, is forty-one feet in diameter, of tabby, and octagonal in its form. In Louisiana, they are generally of wood, and square, and this is the form of Major Butler's. The danger of fire, the superior durability, and the better appearance of the buildings, should make us prefer either tabby or brick. The outer walls of this building are sixteen feet high. Upon these walls runs a well connected plate, and over it is erected an octagonal roof, meeting in a point. Within about seven feet distance from the outer wall, is a circular inner wall, which rises ten feet; and from this wall to the outer one is a strong joint work, which is covered with two-inch Planks for a Tread for the Mules, Horses, or Oxen, that work the Mill ... there are two several doors, at opposite sides of Mill-house in the lower story; the one for bringing cane to the Mill, and the other for carrying out the expressed cane; and these doors are six feet wide. There is also a door in the upper story, with an inclined plane leading to it, to carry up the Mules, Horses, or Oxen that work the Mill ... The Mill as represented, is raised within the circular wall, on a strong foundation of masonry, eight feet high, so as to be within two feet of a level with the Horse-way ...

Spalding includes costs, building techniques, and measured drawings of his mill in his letter to Pinckney. Thus detailed, his information concerning alternative mill construction techniques was available to other planters.

The benefits of an animal mill were basically three: they could be built almost anywhere, they could be used at any time and,
further, the animals provided manure for fertilizing the fields. It did take a lot of animals to keep the mill grinding at top speed, over the several weeks necessary to crush all planted canes. The Rev. James Ramsay, visiting St. Kitts in the eighteenth century, mentioned seeing a fixed animal pen measuring about "sixty by eighty feet, in which from thirty to fifty cattle and mules are kept and fed."

Planters would sometimes move their animal pens to help to "naturally" dung their fields, too. All plantation animals did not necessarily pull the mill yoke, but it did take at least several teams of animals to work the mill. As a result, animal mills were rather "expensive in terms both of the cost of animals and of fodder they consumed."

Writing in 1848, Evans states that mule mills were common in the colonies. His belief was that "From their great costs, from the number required to perform the work, from the mortality to which they are subject, and from the additional labour which their care, food, &c., entails, this kind of power is very expensive." Evans caustically replies to the manuring advantages of cattle-mills below:

Manure must, indeed, be much wanted, and its value must be great under circumstances; for the droppings of animals so lean and ill-fed, as those poor creatures too often are, are almost worthless for such a purpose, being scarcely better than the herbs that they have fed upon.

Nonetheless, one of the two types of animal mills can be found on numerous sugar plantations in the West Indies. Animal-powered mills were often built as secondary mills to take over crushing if an adjacent wind-powered mill was becalmed. The early nineteenth century Annaberg sugar works on St. Johns is a case in point. They had a large stone windmill (c. 1810-1830) supplemented by a large, circular stone animal mill. A similar arrangement has been discovered on
Galways Plantation, Montserrat. Archaeologists there have found a cattle mill and a windmill—at the same sugar works. On seventeenth century Montserrat there were from 36 to 40 probable animal mills, two wind- and two water-powered. Windmills were just beginning to become popular (or to be constructed) at that time. Wind-powered mills were to become increasingly evident during the eighteenth century.

A writer in 1655, discussing Barbadian sugar, stated, "This Illand may be improved if they can bring theyer desine of wine mills to perfecktion to grind theyer shugor, for the mills they use now destroy so many horses that it begors the planters, for a good hors for the mill will be worth 50 li starling."84

Windmills

The knowledge of windmills was carried to Europe by the Crusaders, returning from the East. General European millers acclaimed the new invention and quickly built their wind-powered grist mills. Deerr writes that they were extremely popular by the latter part of the twelfth century. As a result, "the Pope, Coelestinus III (died 118), claimed possession of the air and imposed a tithe on all windmills."85

The earliest form of windmill was the wooden post-mill, where the entire mill turned upon a large, central shaft. The sails turned a shaft which rotated gears, the gears rotated the milling stones or a pump. The entire building could be turned using a large pole at its base. These mills were used in England either to pump water or to grind grain.87 It is not presently known if early sugar
mills were powered by post-mills. This is a form of impermanent architecture and its existence can only be deduced from early documents and/or archaeological fieldwork.

The post-mill was later replaced by the tower windmill, the type most prevalent in Europe today. During the latter part of the seventeenth century, post-mills "were increasingly being replaced by tower-mills, in which only the cap of the mill revolved, seated on a very substantial and carefully made stone or brick tower." At times a wooden variety of tower mill, called a smock mill, was used, but they were not common. Wind fed the caps and sails, turning a connected central shaft. This in turn rotated the central vertical rollers on a three-roller mill. Figure 6 demonstrates the tower windmill. The actual mill action was identical to that found in animal mills. Unlike the post-mill, the tower mill could not be bodily turned into the wind. Instead, its sails would be turned by a gallery, using a pulley and chain arrangement.

Windmills were introduced on Barbados by the end of the seventeenth century. In the Virgin Islands, all of the windmills were constructed during the period ranging from the 1740's to the 1840's. St. Croix has approximately 140 ruins still standing. St. John had only five windmills, due to its mountainous terrain.

The comparative costs of animal mills and windmills shows that windmills were more expensive in initial construction, but less expensive to operate. They were able to extract more juice, more quickly. The factors of cost, efficiency, time, manpower, animals, and fodder worked to convince planters to use wind power, instead of solely depending upon animal-powered mills.
Figure 6. Single-level Tower Windmill
Two critical writers on the subject of sugar technology, Levy (1980) and Evans (1848), agree that windmills powered by the steady trade winds were both economical and efficient. Both writers recommend the use of alternative power sources in case the winds turned "fickle." In Barbados, 1892, the winds becalmed and only three or four hogsheads of sugar were produced per week, due to lack of alternative power sources.

Animal- and wind-powered mills share most in common than the mechanical motion of the central pillar. Both mills can be found in two types. Like the animal mills, windmills were built as either one- or two-story structures. Both would be constructed from local stones or brick, and be either conical or octagonal in form.

The single-level windmill has been depicted in figure 6. This drawing, an adaptation of an elevation of the windmill found at Annaberg National Park, St. John's, V.I., shows the windmill action. The sails were attached to a shaft (A) which turned when a good wind filled the sails. This shaft, in turn, rotated the large central shaft (B), which turned the central mill roller (C). Rollers (D) and (E) would be moved by (C), crushing the cane passed in the left and the right bite. The bagasse would drop into a container or simply to the floor. The extracted juice would enter a receptacle such as (F) and be troughed to a waiting holding tank located within the factory. The Annaberg windmill was built of rough-cut stone and measured 38 feet high, with a base diameter of 34 feet. The top conical diameter measured twenty feet.

An interesting single-level windmill was built at Geencastle, Saint Mary, Jamaica. It was constructed of thick, crude masonry with
the "putlog" system of embedding timbers in the walls at each stage." Further examples of what appear to be single-level windmills may be found at Fairplay Plantation, St. Eustatius, and at Galways, Montserrat.

A two-level windmill incorporated the principles of a two-level animal mill. The two-level system was used to allow two different functional areas for ease of operation. The upper story would have a ramp leading to an aperture to allow entrance, carrying cut canes. This level would also house the mill rollers. The lower portion of the mill would also have an opening, to allow slaves passage below to gather the falling bagasse.

An example of a two-level windmill may be found at the mid-eighteenth century plantation Lyssons, St. Thomas, Jamaica. The construction of this windmill also utilized the space under the ramp leading to the top level—it contains a "curious little fortified room." The actual function of this additional room remains unknown.

All windmills had vertical rollers until steam power was used to supplement the wind. By the early nineteenth century, horizontal rollers were common in steam-assisted windmills. Some early steam engines superseding wind were not sufficiently powerful to turn the mills. (Steam-powered mills will be discussed in a following section.)

Concurrent with animal mills and windmills was the third type of drive used in the islands, water power.
Water Power

The first use of water to drive a cane-crushing mechanism may have been prior to 600 A.D. in the Euphrates Valley. Arabs brought knowledge of water power to the Mediterranean area some time after the seventh century. An example of such an early water mill may be found at the site of Jericho. By 1432 the sugar-producing island of Madeira had water-powered mills. In early settled Hispaniola, "Oviedo records that of twenty-four mills twenty were water driven." Water mills may be found in Jamaica, Dominica, and Grenada, in fact, on any island that had good water resources. As the sugar industry expanded, where water was available, water mills were built. In the long run, water mills were the cheapest and simplest form of power available to the colonists.

A water mill utilizes the same basic principles as an animal mill or windmill. An outside power source, water in this case, drives a large, main shaft. This rotating shaft "transmits this power to a vertical gearing, which in turn drives the upright rollers." Again, the turning force of the central roller causes the first and third rollers to rotate. Figure 7 shows examples of the inner workings of a water mill. Figure 7a shows the Speciale three-roller vertical mill, and figure 7b depicts another eighteenth century mill (Bernard 1784). Notice that the two figures display overshot wheels, with the water forced over the wheel, causing it to turn. This is opposed to an undershot wheel, which is set up with the streaming water entering the lower side of the wheel. It is interesting, as Buisseret's examination of water mill ruins on Jamaica indicated that they had employed only undershot wheels.
Figure 7a. 18th c. 3-roller Water Mill.

Figure 7b. 18th c. 3-roller Water Mill.
Evans found that water-powered mills were the best by far. He says, "It is economical as wind, it is more powerful as generally applied; it is very manageable, and its force is easily regulated; and, at the same time, it is unaccompanied with the same uncertainty."

Water mills are dependable, cheap to operate, and efficient. But they are not too common in the West Indies. This is because of a lack of flowing water on many of the islands. A few planters were able to overcome this deficiency by constructing large stone aqueducts. An existing aqueduct stands in Jamaica at Hope, St. Andrew.

Alternative power sources, more costly and less efficient, had to be used in their stead. As a result, wind- and animal-powered mills were much more common than water in the sixteenth, seventeenth, and eighteenth centuries. The nineteenth century was characterized by the use of another alternative, the use of steam.

**Steam Power**

Besides animal, wind and water-powered mills, West Indian planters used the fourth source of power at their sugar works, that of steam. Steam is a water vapor that is simply produced by boiling, but dangerous under uncontrolled circumstances. The first known patent for the application of steam to sugar mills was printed in 1767 by John Stewart. In the title page of his pamphlet, he claims that his "Fire-Engine" could grind more cane more quickly than any other type of power source. He also claimed that a steam-powered mill could be run much cheaper, using less fuel, and saved money in terms of
cattle. Stewart's steam engine was built and tested in 1768 at Greenwich Plantation, St. Andrew, Jamaica. It did not, however, prove as successful as his pamphlet had indicated, nor did the other initial attempts at steam-powered grinding, listed below:

1768 Monsier Bineau, St. Domingue
1769 Dugald Clark, St. Thomas
1773 Wickes Skurray, Jamaica
1793 Josias Robins, Area unknown

The steam engine, as we know it today, was first developed by Mathew Boulton and James Watt. They first collaborated in England in 1776. It was not easily adapted to the known technologies for milling cane. Seibabo, Cuba (1797) was the site of the first steam-powered mill that actually succeeded in milling the cane. As a result, by 1808, Cuba had 25 steam-powered mills in operation. Fraginals has disputed this statement, and believes that the first successful application of steam to a grinding mill occurred in Cuba in 1817. Table 4 gives the dates of introduction of steam-powered mills in 26 areas.

A good example of a steam-powered mill may be found in an article by David Pendergast, describing an English sugar mill located at Indian Church, Belize, circa 1860-1875. The grinding apparatus was situated upon a very fine, detailed foundation of brick. The foundation included a series of arches to alleviate and distribute the weight of the three-roller grinding mill. A "single-cylinder, steam-powered beam engine," located just west of the brick foundation, would have driven the mill.
### TABLE 4

DATES OF INTRODUCTION OF STEAM-POWERED MILLS*

<table>
<thead>
<tr>
<th>Area</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barbados</td>
<td>1846</td>
</tr>
<tr>
<td>Brazil</td>
<td>1813</td>
</tr>
<tr>
<td>British Guiana</td>
<td>1805</td>
</tr>
<tr>
<td>Cayenne</td>
<td>1836 (had 27 steam mills)</td>
</tr>
<tr>
<td>Cuba**</td>
<td>1817</td>
</tr>
<tr>
<td>Grenada</td>
<td>1812</td>
</tr>
<tr>
<td>Guadeloupe</td>
<td>1829 (had 10 steam mills)</td>
</tr>
<tr>
<td>Haiti</td>
<td>1818</td>
</tr>
<tr>
<td>Hawaii</td>
<td>1852</td>
</tr>
<tr>
<td>India</td>
<td>1836-45 Expansion Period (at least &quot;hundred&quot;), p. 554</td>
</tr>
<tr>
<td>Jamaica</td>
<td>1808</td>
</tr>
<tr>
<td>Java</td>
<td>post 1838</td>
</tr>
<tr>
<td>Louisiana</td>
<td>1822</td>
</tr>
<tr>
<td>Martinique</td>
<td>1813</td>
</tr>
<tr>
<td>Mauritius</td>
<td>1822</td>
</tr>
<tr>
<td>Natal</td>
<td>1855</td>
</tr>
<tr>
<td>Puerto Rico</td>
<td>1848 (they had 48 by that date)</td>
</tr>
<tr>
<td>Reunion</td>
<td>1817</td>
</tr>
<tr>
<td>St. Croix</td>
<td>1813 (they had 40 by 1852)</td>
</tr>
<tr>
<td>St. Kitts</td>
<td>1838 (they had 23 by 1848)</td>
</tr>
<tr>
<td>St. Lucia</td>
<td>1813</td>
</tr>
<tr>
<td>San Domingo</td>
<td>1874</td>
</tr>
<tr>
<td>Surinam</td>
<td>1813</td>
</tr>
<tr>
<td>Texas***</td>
<td>1843</td>
</tr>
<tr>
<td>Tobago</td>
<td>1808</td>
</tr>
<tr>
<td>Trinidad</td>
<td>1803</td>
</tr>
</tbody>
</table>

* Taken from Noel Deerr, p. 554-55.

** Fraginals 1976, p. 102.

*** Sitterson 1953, p. 42. A Captain Duncan, Caney Creek Plantation, Texas.
Evidence of two boilers, which would have built up the steam pressure, was discovered at the site. The first boiler was probably located off the northeast corner of the mill. The second, or later, boiler was located on a flagstone platform east of the grinding mill.121

The actual grinding mill was dated 1866, Leeds' Foundry, New Orleans. The author believes that the design of the mill is archaic for the time period. This became understandable when he investigated the history of the foundry. Pendergast discovered that the foundry halted mill production and switched to cannon during the Civil War. After the war they reinstigated manufacturing sugar works, using their pre-war equipment.122

The researchers at Indian Church discovered many "oddities of design" at the site. They believe that these are evidence of modifications to the mill made over time.123 This was the case at many of the sugar estates described in numerous other works, regardless of the type of motive power used. This indicates that planters continued to try to improve their works over time.

Writing in 1848, Evans states that the "advantages" of steam were "indisputable." He recommends using a high-pressure engine in conjunction with milling cane.124 He makes certain to mention that an engine of that type is relatively cheap, "easily managed and kept in repair, and its economy both in fuel and water is considerable." He further states that a planter may have "no fear of accident."125 This leads me to believe that some steam engines had proved costly, hard to manage and repair, and even dangerous. As with the introduction of any new technology, mistakes were bound to have been made.
TABLE 5. FREQUENCY OF MILL TYPESa 1827-1911

<table>
<thead>
<tr>
<th>Area</th>
<th>Date</th>
<th>Steam count</th>
<th>%</th>
<th>Wind count</th>
<th>%</th>
<th>Water count</th>
<th>%</th>
<th>Animal count</th>
<th>%</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barbadosb</td>
<td>1846 (introduced)</td>
<td>506</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>506</td>
</tr>
<tr>
<td></td>
<td>1911 109 33</td>
<td>226</td>
<td>6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>335</td>
</tr>
<tr>
<td>Cayenne</td>
<td>1828 (none)</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>19</td>
<td>17</td>
<td>81</td>
<td>21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guadeloupe</td>
<td>1829 10 2</td>
<td>252</td>
<td>42</td>
<td>143</td>
<td>24</td>
<td>189</td>
<td>32</td>
<td>594</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1865 73 20</td>
<td>164</td>
<td>45</td>
<td>122</td>
<td>33</td>
<td>6</td>
<td>2</td>
<td>365</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1887 87 45</td>
<td>53</td>
<td>27</td>
<td>49</td>
<td>25</td>
<td>5</td>
<td>3</td>
<td>194</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Java^c</td>
<td>1868 11 16</td>
<td>-</td>
<td>-</td>
<td>67</td>
<td>84</td>
<td>-</td>
<td>-</td>
<td>68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Louisiana</td>
<td>1830 100 12</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>727</td>
<td>88</td>
<td>827</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1887 678 85</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>116</td>
<td>15</td>
<td>794</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Martinique</td>
<td>1827 13 3</td>
<td>27</td>
<td>6</td>
<td>184</td>
<td>42</td>
<td>211</td>
<td>49</td>
<td>435</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Philippines</td>
<td>1887 239 4</td>
<td>-</td>
<td>-</td>
<td>35</td>
<td>1</td>
<td>5,920</td>
<td>95</td>
<td>6,194</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reuniond</td>
<td>1836 94 100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surinam</td>
<td>1858 63 64</td>
<td>-</td>
<td>-</td>
<td>35</td>
<td>36</td>
<td>-</td>
<td>-</td>
<td>98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Texase</td>
<td>1852 29 66</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>15</td>
<td>34</td>
<td>44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cuba^f</td>
<td>1860 953 72</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>&lt;1</td>
<td>359</td>
<td>27</td>
<td>1,318</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>2,459 21 1,228</td>
<td>10</td>
<td>645</td>
<td>5</td>
<td>7,565</td>
<td>64</td>
<td>11,887</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

aTaken from data in Noel Deerr, The History of Sugar, 1950, VII, p. 553-54.
bBarbados had 30/500 steam mills in 1862; 90 steam in 1897 (Beachey, 1978, p. 63).
Antigua had 59/71 steam mills in 1894 (Beachey, 1978, p. 69).
cThis excludes 29 water- and steam-driven mills.
dPlus 50 with other, unknown drives.
eTaken from Sitterson, 1953, p. 42.
fFraginals, 1976, p. 84. His categories were of semi- and mechanized combined.
Deciding What Power to Use

Table 5 shows the frequency of mill types in 11 regions, from 1827 to 1911. Data on the distribution of mill types is, at present, fragmentary. Table 5 is a compendium of what data was available to this author. A dash in the table means that the data was not available, and other mill types may or may not have been present in the region. In total, the distribution of the four motive powers was 21 percent steam, 10 percent wind, five percent water, and 64 percent animal-powered mills. It appears that, when available, all types of motive power might be found in any one region.

What factors would enter into a planter's decision as to which type of power source to use? Again, the caveat of incomplete data must be made. But the discussion following does seem to indicate a pattern. It appears that geographic location (topography and rainfall), efficiency and dependability of mill, availability and costs would be the major factors taken into consideration.

The data on the relative efficiency of the different mills is rather contradictory. From a perusal of the various readings, it appears that elements such as the planters' engineering acumen (or their advisors'), types of rollers used (wooden, metal-plated, or all metal), type of positioning (vertical or horizontal), and number of rollers combined to influence the efficient extraction of the juice. Manifold combinations of the above elements would be possible at any one estate, and probably changed through modifications over time.

Looking at the information available to nineteenth century planters, a table listing the various extraction capabilities of mill
types was discovered. A Frenchman, M. Duprez, conducted an experiment on Guadeloupe. He wanted to find out the average juice furnished by 100 pounds of sugar cane by different mill types and power sources. Unfortunately, it is not known how rigorously he controlled his experiment. Table 6 below lists the results of his experiment:

TABLE 6
FREQUENCY EXTRACTED PER 100 LBS. OF CANE

<table>
<thead>
<tr>
<th>Motive Power</th>
<th>Mill Type</th>
<th>lbs./100 canes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unknown</td>
<td>Horizontal</td>
<td>61.2</td>
</tr>
<tr>
<td>Unknown</td>
<td>Vertical</td>
<td>59.2</td>
</tr>
<tr>
<td>Cattle</td>
<td>Unknown</td>
<td>58.5</td>
</tr>
<tr>
<td>Wind</td>
<td>Unknown</td>
<td>56.4</td>
</tr>
<tr>
<td>Wind/Steam</td>
<td>Unknown</td>
<td>59.3</td>
</tr>
<tr>
<td>Steam</td>
<td>Unknown</td>
<td>60.9</td>
</tr>
</tbody>
</table>

All of the above would be considered inefficient by today's standards. Ward Barrett constructed a table to check the relative extraction efficiency of varying mill and power types. It is reproduced in Table 7. The high extraction rate of the cattle mill was reportedly due to the slow, even, steady pressure of the circumlocating cattle.
TABLE 7

COMPARATIVE EXTRACTION RATES*

<table>
<thead>
<tr>
<th>Experimenter</th>
<th>Region</th>
<th>Mill Type</th>
<th>% Weight Extracted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circa 1840</td>
<td>Martinique, Guadeloupe</td>
<td>Three-roller vertical</td>
<td>50</td>
</tr>
<tr>
<td>Daubree</td>
<td></td>
<td>Cayenne</td>
<td>36-40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Martinique, Guadeloupe</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Steam-driven horizontal</td>
<td>Maximum use</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Potential use</td>
</tr>
<tr>
<td>Circa 1830-1827,</td>
<td>Mantanzas</td>
<td>Cattle</td>
<td>65</td>
</tr>
<tr>
<td>Leon</td>
<td></td>
<td>Horizontal steam</td>
<td>46.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Steam with two crushings</td>
<td>62</td>
</tr>
<tr>
<td>Circa 1866,</td>
<td>Antigua</td>
<td>Wind</td>
<td>49.5</td>
</tr>
<tr>
<td>Reed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circa 1910</td>
<td>Negros, Philippines</td>
<td>8-10 horsepower steam</td>
<td>64.5</td>
</tr>
</tbody>
</table>

*Barrett 1965, p. 156.

From the data in the tables, one might expect that the majority of planters would use horizontal roller mills with steam as their power source. A shift to steam from other sources of power does seem to have taken place over time (see Table 5). Remember, the introduction of steam throughout the Caribbean region occurred intermittently throughout the nineteenth century (see Table 4). On Guadeloupe, bearing the most complete data, the data indicates a good
distribution of mill types over three different time periods, 1829, 1865, and 1887 (see Table 5). In 1829, the four power sources were distributed as follows: steam 2 percent, wind 42 percent, water 24 percent, and animal 32 percent. By 1865 the frequencies had changed only slightly with steam 20 percent, wind 45 percent, water 33%, and, significantly, animal only 2 percent. It would appear as if steam was increasing to the detriment of the animal mills. A significant drop in the percentage of water and wind-powered mills does not occur until 1887, with the following distribution: steam 45 percent, wind 27 percent, water 25 percent, and animal 3 percent. The use of steam increased in direct relationship to a decrease in wind and water powered mills; but, the total number of mills on Guadeloupe decreased over time from 584 (1829) to 365 (1865) to 194 total mills (1887). These frequencies could reflect simply a lessening in the number of mills, disproportionate through time as to power source.

Table 8 was constructed to see if a trend of steam replacing other types of power could be seen. Prior to 1850, the distribution of power was as follows: steam 9 percent, wind 32 percent, water 13 percent, and animal 46 percent. (This data may not include other types of mills on Barbados.) Animal-powered mills were by far the most common, especially if one considers the evidence from St. Johns and Monserratt described earlier. Estates using windmills generally had alternative power sources, such as animal mills. The data in Table 5 from after 1850 forms a different picture. Steam figures predominate, with 62 percent of the total as compared to 14 percent wind, 8 percent water, and 16 percent animal-powered mills. (The data from
the Philippines was left out as it skewed the data and concerns a faraway region.) A trend is indicated of a shift from animal to steam sources of power, with steam, more slowly, later replacing wind and water-powered mills, too.

**TABLE 8**

**MILL FREQUENCIES**

<table>
<thead>
<tr>
<th></th>
<th>Prior to 1850</th>
<th>Post 1850**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>#</td>
<td>%</td>
</tr>
<tr>
<td>Steam</td>
<td>217</td>
<td>9</td>
</tr>
<tr>
<td>Wind</td>
<td>785</td>
<td>32</td>
</tr>
<tr>
<td>Water</td>
<td>331</td>
<td>13</td>
</tr>
<tr>
<td>Animal</td>
<td>1144</td>
<td>46</td>
</tr>
<tr>
<td>Total</td>
<td>2477</td>
<td>100</td>
</tr>
</tbody>
</table>

*Philippine data omitted as it skewed the data; counts read: steam 2242, wind 443, water 304, and animal 6421.

**Data for this table taken from Table 5.

Why did some planters continue to use the non-steam-powered mills to crush their canes? In Puerto Rico in 1852, steam-powered mills were still not standard on the estates. One reason given in explanation was that "the industry had such a favorable market that it did not have to keep pace with the latest technological developments. Further, many factors entered into the decision-making of the planters. Besides efficiency, planters had to consider relative costs.
Near the latter part of the 18th century, the average maximum production life of a mill was forty years. In 1795, a single horse-driven mill may have cost $2,000-$3,000 dollars, $300.00 would go towards erecting the boilers, $1,500.00 to the salary of a skilled technician, and many other expenses would be entailed (slaves, repairs, etc.). The cost of steam in the eighteenth century is presently unknown.

Table 9, developed from Ormachea’s data (Puerto Rico 1847) gives the numbers of men and oxen needed to operate an animal, water (hydraulic), or steam-powered mill. Some of the data on steam is lacking. One can see from the table that a hydraulic mill could grind more canes per day, shortening the gridding season by more than half the number of days. Also, fewer oxen would be needed with concomitant upkeep. More negroes would be necessary, though, but for a shorter period of time. Labor could usually be hired from adjacent plantations, so total slave upkeep need not consist of a full year's service. Steam-powered mills used the same number of oxen and more laborers. Ormachea did not feel numbers were necessary to prove that steam saved much time and was more efficient in extracting the juice. He preferred the steam-powered mills, even if "the working expenses are greater." Bennett’s definition of choice must be applied to the question of power sources used—was the planter considering the short- and/or long-term effects of his decisions? He could save costs and build an animal mill, but extract less juice, more slowly and probably make a lower profit on his sugar crop. He might save money on slave upkeep, but spend more on his livestock, wearing them out more
### Table 9

**Efficiency and Costs: Animal, Water, and Steam**

*(Puerto Rico circa 1847)*

<table>
<thead>
<tr>
<th></th>
<th># Oxen</th>
<th># Negroes</th>
<th>Daily cwts. of cane</th>
<th>Quantity of Sugar</th>
<th>Production Capacity</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal</td>
<td>40 to 50 teams</td>
<td>21</td>
<td>1080</td>
<td>36</td>
<td>360 hogsheads/12 cwts. each</td>
<td>4 months</td>
</tr>
<tr>
<td>Water</td>
<td>25 to 30 teams</td>
<td>37</td>
<td>2520</td>
<td>84</td>
<td>360 hogsheads/12 cwts. each</td>
<td>51 days</td>
</tr>
<tr>
<td>Steam</td>
<td>25 to 30 teams</td>
<td>37, plus additional for obtaining fuel to make steam</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

quickly. Planters more concerned with the long view would invest larger amounts of capital into more efficient power sources and mill types. They would also spend more money on Negroes (or engage in a system of loaning labor at peak periods) and spend less on their livestock. Production time would decrease, allowing the planters to produce more sugar in less time, reaping larger profits.

In his intensive study of John Pinney's estate, Pares writes that speed-grinding and processing was uppermost in a West Indian planter's mind. He states, "They argued that anything which speeded the grinding would enable the gang to cultivate more land altogether, because it would not be distracted from planting and weeding the next crop by the necessity of taking this one off the ground."133

Topographic and hydraulic features of one's estate would greatly influence the range of options open to a planter. An animal mill could be built just about anywhere. Planter needs of water and food sources would have to be expanded to cover extra numbers of livestock. Water mills could be built only in regions containing a good, steady flow of water. Most small streams could be readily adapted to water power. Further, the technical know-how for constructing water mills was centuries old, and easily adapted to grinding sugar. Windmills would mainly be dependent upon a steady source of wind. This is why islands like Barbados and flat Antigua, with their almost constant winds, had many windmills employed to grind the sugar.

At first glance it would appear that steam engines would not carry any special climatic or topographical needs. But steam is generated by heat and water, thus planters who had to catch their
water supply in cisterns would less likely elect to use steam. Heat could be derived from burning bagasse, wood, or coal. Again, planters would need large available supplies of stalks, wood, or coal to heat their sugar for crystallization. Thus a planter using steam would need more fuel, initially, to produce his sugar. Large acres of woodlands, placement near a harbor to receive coal, or plenty of land planted in sugar would be the requirements to meet their fuel needs.

Planters also based their decisions on knowledge, both personal and diffused ideas. As indicated in Chapter II, information about sugar technology was freely given in the seventeenth century. Dutch trading ships brought sugar-canes, technicians, and knowledge to English and French colonies. Industrial secrets were not important to the Dutch, who preferred to expand their area of trade. Further, seventeenth, eighteenth, and nineteenth century travelers throughout the Caribbean, of many nationalities, published travelogues that often included detailed descriptions of sugar making. Information was not always openly exchanged, though. Writing in the late eighteenth century, a Cuban expert on sugar, Francisco de Arango Parreno, proposed a technical voyage of discovery. He wished to visit foreign sugar estates incognito (spying!) to study their manufacturing techniques.

Equipment was obviously manufactured and sold quite indiscriminately as to nation, at least in the nineteenth century. Judging from British sales records (listed in Table 3), British manufacturers sold their wares to any ready buyer. Another example of the diffusion of equipment and ideas can be found in Belize at Indian Church, where English colonists were using an American-made steam engine and grinding mill.
Information was also carried physically in the persons of sugar planters who migrated throughout the West Indies. After the abolition of slavery, numerous British planters resettled in areas that were not under British control (Surinam, United States, for example). People were also constantly displaced by war, most of the islands being taken and retaken by French, English, and Dutch troops throughout the seventeenth, eighteenth, and nineteenth centuries. These wars did not truly end until the final deposition of the colonies after the Napoleonic Wars. All of this movement of peoples would have also disseminated information. In all, information, technicians, slaves, and equipment appear to have flowed easily from one sugar-producing area to another, regardless of nationality. (Of course, further research is needed to see if such was the case equally throughout all colonial times in the Caribbean.)

The Shift to Steam

The preponderance of sugar works utilizing steam in the nineteenth century were large sugar estates. Large estate owners, like John Pinney of Nevis, would have been the most likely to opt for the long view. They would have been able to invest larger sums of money into their works, recouping their investments through the added time to plant and process more sugar. Owners of larger estates could also have the resources necessary to invest in steam. Further, they would probably supplement their steam-powered works with an additional power source, to take over in case of breakdown.

The shift to steam was perhaps hastened along, if not instigated, by the changing labor force available on the estates. Throughout the nineteenth century, slavery was abolished in nation
As the labor force changed from slave-based to wage-earner, the complexion of sugar estates changed too. Many estates went bankrupt, benefit of capital, leadership, or the labor force needed to adapt to the cultural changes occurring during that time. For example, on Cuba, the centralized mills (1840's) were huge mechanized conglomerates that used steam engines and employed only wage-earners. Fraginals writes that with the end of slavery, sugar producers had to totally reconceptualize the manufacturing of sugar, centralizing their factories and using the most efficient power source available—steam.

The abolition of slavery helped to create an environment conducive to the acceptance of new technologies. Many small Puerto Rican operators even attempted to pool their resources and create a communal factory. This would parallel the large, centralized concerns. Although the pattern of letting others grind your crop had been established at least two centuries earlier, the efforts of the small farmers to emulate the larger concerns failed.

Steward describes the changes occurring during the nineteenth century, saying, "This major industry allowing much variation on the scale and techniques of production changed to one in which only one kind of machinery and one level of capital investment could be profitable and efficient." Grinding technology was not the only area of technological improvement. The methods employed in processing nineteenth century sugar were heatedly discussed, with lengthy discourses on the scientific production of sugar.

After cultivating and grinding the cane, the planter still had many decisions and steps to follow before ending up with the
desired, salable sugar. The next step in making sugar was and is termed evaporation and/or crystallization.

**Evaporation, Clarification, and Filtering**

As mentioned previously, the extraction of the juice from the sugar cane is simply the first in a series of processing steps necessary to produce salable sugar. The expressed juice would have to be conveyed from the grinding mill to a boiling house. There the juice would begin to be delicately processed into sugar.

The earliest known arrangement for evaporating sugar is the Eastern method. The juice would be boiled over an open fire in one or two kettles. An agent such as lime, alum, wood ash, egg white, milk, blood, or charcoal would be added to the heated juice to induce crystallization. The modern small farmer manufacturing sugar for local and/or household consumption uses the one- or two-kettle, open-fire process.

The open-fire arrangement was also found in Sicily, Madeira, and Brazil. Deerr has two illustrations of these early open-fire sugar processing areas, one in Sicily and one in Brazil. Both illustrations depict the use of two kettles.

The next major innovation in boiling and evaporating the juice occurred with the enclosure of the fire in a masonry foundation. When describing eighteenth century Cuban sugar works, Fraginals states that the average boiling house contained "a series of smelted copper kettles, each mounted on its own furnace." Bernard has illustrated this method of evaporation in figure 8. This type of arrangement of kettles was often termed a Spanish train. Fraginals describes it below:
Figure 8a. 1784 Boiling House

Figure 8b. 1693-1705 Boiling Equipment
The kettles diminished in size in relation to the lessening volume of the concentrate, which moved continuously onward to the next smaller kettle. . . . [This system] involved a separate furnace for each kettle, a system greatly accelerating concentration but requiring an enormous expenditure of fuel. \textsuperscript{145}

This step in sugar evaporation techniques, dependent upon a change in the construction of the furnace, is known as the closed fire train. Deer indicates that the closed fire train was initially used in Dutch sugar refineries and Brazilian sugar houses circa 1641. A single, masonry furnace would house a fire below a series of from three to six kettles. Enclosing the fires prevented disastrous, spreading conflagrations. This type of system was noted by Ligon in Barbados (1657) and by De Rochefort on St. Kitts (1658). \textsuperscript{146} De Rochefort describes the invention below, leaving little doubt of its joyful acceptance:

The construction of the mill is of wood, more solid, more elegant, more ingenious, better arranged and more convenient than is seen in Madeira or Brazil. There is nothing to fear here, as in those places, where the fire may reach the boiling cauldrons and start an appalling conflagration, which often causes the death of those working nearby. \textsuperscript{147}

Ligon writes that the extracted juice would be transmitted to a cistern in the sugar-house. \textsuperscript{148} Lead pipes or lead-lined troughs would convey the juice, by gravity, to a waiting stone or wooden-planked holding tank (cistern). \textsuperscript{149} Slaves would be set to cleaning the flowing juice of unctuous matter if the trough was open to the air. The juice would then be ladled into a copper kettle which would be heated. The impurities would be "skimmed" out of the kettle. Next, the pure juice would be transferred to the next copper and the process repeated down the line of kettles. When the sugar reached its last kettle, an agent such as lime would be added. When the sugar
appeared well granulated, the boiler would "strike" the sugar. The sugar would be taken from the last and smallest kettle, the teach, tatch, or teache, for the next processing step. This was accomplished by dampening the fire and removing the cooling juice to an additional cistern. In this manner one gallon of raw juice would generally yield one pound of muscovado, or dark brown sugar.

The most common form of train found in the Islands was one described by Pere Labat (Voyages Aux Iles De L'Amerique 1693-1705). It came to be called the French train (tren) or the Equipage du Pere Labat. Labat describes his method of boiling below:

Les chaudieres au nombre de cinq ou six sont en cuivre rouge et sont chauffees avec le bois ou avec les feuilles des cannes abattues. Chacune d'elles a son nom suivant sa fonction. Il y a la grande, la propre, la lessive, le flambeau, le sirop et la batterie. A chaque passage, le suc, grace a la chaux, la lessive et la cendre, s'epure peu a peu et blanchit. Il y a egalement d'autres utensiles, par exemple le rafraichissoire, le bec de Corbin, l'ecumoire, les couteaux a sucre, les loucher. Mais pour faire un bon sucre il ne suffit pas de les avoir tous. Il faut surtout toute la science du raffineus qui doit savoir arreter la derniere cuisson en fonction de la qualite et la maturite des cannes ... La sucrerie proprement dite est une grande salle situee a cote du moulin, c'est la ou sont attachees les chaudieres dans lesquelles on recoit, on purifie et on reduit en sucre le suc des cannes.

Skimmers were used in Cuba until the 1860's to remove scum. They consisted of a long ladle or paddle, often with a two or more yard long metal handle, and had a lever-like action. They were called bombo, bomba or bombons. In Louisiana the skimmers were usually shallow copper scoops (D = from 10-12") attached to handles which were usually long and wooden. The French train was not commonly adopted on Cuba until about 1780. The train was often called reverbero (reverberator) on Spanish islands. The great innovation described
by Lafat, later varied but little with the Jamaican or Jimaquan train, was the use of one long furnace under a line of kettles. The actual fire was placed under the initial copper, and the heat was diffused along the furnace foundation to heat the other kettles.\textsuperscript{159}

On English islands, the above arrangement of kettles over a single fire closed furnace was simply called a "copper wall" or Jamaica train. In Mauritius it was called a \textit{batterie} and the teache was a \textit{cuite}. In Louisiana "sets" usually consisted of four size-graduated kettles, named for their sizes. They were from largest to small, the \textit{grande}, \textit{flambeau}, \textit{syrup}, and \textit{battery}. These kettles were cast iron, ranging from 52/72" in diameter to 33/54". Sitterson writes that "their capacity was increased considerably by the sloping rise of the masonry several inches above their rims."\textsuperscript{161}

Sitterson describes the nineteenth century sugarhouse as follows:

\begin{quote}
A set of kettles, usually four in number, required a space about thirty feet long by seven or eight feet wide. The tops of the kettles were usually two and a half to three feet above the floor. The kettles were set with the utmost precision in a solid body of masonry, within which were found the arches that supported the kettles . . . the furnace was under the \textit{battery}, with the door and ashpit on the outside of the building. The flue from the furnace passed under the kettles and at the end of the set turned at right angles and went outside, where it rose in an independent chimney to a height of at least equal to the horizontal circuit of the flue.\textsuperscript{162}
\end{quote}

English Quarter, the sugar estate on St. Eustatius described later, had a flue and train arrangement similar to that described above. Spalding, our Georgian sugar expert, also recommended using a single, closed flue system to evaporate the juice. He writes, "When all the boilers are full, and \textit{not before}, the fire is kindled under the
smallest, and is communicated through the medium of arches from one to
the other, until it passes to the last boiler, and enters the chimney
which is placed without the house."163

In Thomas Spalding's letter of March 25, 1816, to Thomas
Pinckney, he describes the necessary spatial arrangement of the
grounding mill or trapiche to the boiling house. In the following
paragraph, Spalding compares the West Indian layout to that found in
Georgia:

In a flat country like this, we are compelled to raise our
Mill-Houses higher than they do in the West-Indies, where they
have often little else to do than to place their Mill-House on the
side of a hill, which gives elevation enough to the Mill to allow
the juice from the bed, which is covered by sheet-lead, and
receives it as the Mill expresses it, to run by means of a gutter,
covered also with sheet-lead, into a clarifier, containing three
hundred gallons, which stands in the boiling-house. The boiling-
house is placed as near as possible to the Mill-House, as well to
save the trouble and expense of a lengthy gutter, as to prevent
the risk of the cane-juice souring by passing far, before it is
cleared of its impurities by the operation of lime upon it.164

As one will see, English Quarter was arranged along similar
lines, with the trapiche being situated at a slightly higher elevation
than the adjacent boiling house.

Spalding used four copper kettles to boil his juice. The
dimensions of the kettles he used are reproduced below:165

<table>
<thead>
<tr>
<th>Gallons/Capacity</th>
<th>Diameter/Inches</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>320</td>
<td>62</td>
<td>30</td>
</tr>
<tr>
<td>300</td>
<td>60</td>
<td>28</td>
</tr>
<tr>
<td>200</td>
<td>52</td>
<td>24</td>
</tr>
<tr>
<td>100</td>
<td>42</td>
<td>22</td>
</tr>
</tbody>
</table>
Spalding mentions that he adds a thin copper rim at a 45° angle to the coppers to prevent them from boiling over. He adds, "Lead is used for this purpose in the West-Indies, but it burns away so soon as to cost more than copper." Louisiana sugar planters could not use metal rims, as only brick or wood would attach to their iron kettles.

There was no scientific trade secret involved with the earlier centuries' striking of the last copper. Knowledge of when to add the crystallizing agent and when to cease the boil was intuitive, learned through much trial and error. Processing time for the syrup once it reached the final copper ranged from one to two hours. Good "boilers" were hard to come by and considered true artists. Spalding recommended using one's Negroes, as they seemed to have a "special knack" for judging the condition of the juice. Janet Schaw writes that the boilers "are always the best slaves on the plantation." Two testing methods were often employed, similar to our "throw the noodle at the refrigerator" style of judging the doneness of spaghetti.

Sitterson writes that one could employ a wooden-handled copper spoon for testing striking readiness. Only simply dipped it into the final copper, withdrew it and if "the syrup had a grained appearance and was so thick that it covered the spoon in a film and drained from it slowly, it had been cooked sufficiently." The other tried and true method was to drop some syrup on one's thumb, pulling it into a thin thread. If the thread "broke dry" and formed a "spiral," the sugar was ready for the strike.

On Cuba, lime was introduced in 1798 to induce granulation. Prior to the use of lime, an alkaline compound derived from "rural
alchemistic techniques from the ashes of certain trees—preferably the
jobo (silk cotton tree), ceiba or almaaige—mixed with quicklime and a
herb called 'vixen's tail.'" Coconut shells were used for measurement
and smell to judge the doneness of the sugar.173

Dunn writes that up into the eighteenth century the boiling
house was a dangerous hell-hole of "Suffocating heat and stench."174
Such was not the case on all eighteenth century plantations.
Remember, boilers were expensive and planters did not wish to lose
their most valued technicians. Janet Schaw, visiting an estate of St.
Kitts in 1774, has left a descriptive account of the boiling house.
In her words:

The boiling houses are very high and lofty, covered with shelving
boards that admit the air freely as well as give vent to the
steam. When one considers the heat that must be produced by four
or five kettles which contain not less than a Hogshead apiece, and
which requires a strong clef fire to boil the sugar to its proper
consistence, it is very wonderful how they contrive to render them
so sufferable as they are. Lady Isabella, Miss Ruterfurd and
myself were very little incommoded by the heat and much enter­
tained by being shown the process of this great work from the
first throwing of the canes into the mill to the casking the sugar
and rum.175

In 1816, Spalding, too, recommended good ventilation. He writes that
the illumination of the boiling house with many windows was necessary.
Further, he writes that "the roof should have rising from its top, a
latticed Cubola, to allow the steam to pass freely off" to avoid poor
vision during the manufacturing of the sugar.176

As mentioned, once the grinding season was under way the
juice had to be quickly processed. Depending on the size of the crop,
the boiling season could last from one to six weeks. One of many
logistical problems that planters had to consider was obtaining enough fuel to fire the boilers.

Recall, the use of multiple furnaces for evaporation systems such as that of the Spanish train predominated in the West Indies until about the turn of the seventeenth century. Stretching from the mid-seventeenth to the early eighteenth century, various technological improvements finally resulted in the development of the single, closed-fire system of boiling. The use of multiple fires under the multiple furnace system would have used up three, four, or even five times the fuel needed for that of the single furnace. Wood would also be needed for construction material for mills, out-buildings, and within the main house.

In Cuba, Fraginals states that an incredible amount of wood was cut down. He has determined that the amount of wooded acres cut increased by at least eight times from 1800 to 1844.177

Wood was sought from sources on other islands, as many islands ran out of their own forested acres.178 Therefore wood became a precious resource on many islands.

The depreciation of the forests led planters to experiment with other sources of fuel. Coal burned well, but it was an undependable resource. This was because coal had to be shipped in from a mother country. Further, the island would have need of a good, safe harbor closely situated to the plantation to make the importation of coal worthwhile. The third fuel source experimented with and used was the megasse/bagasse—the spent stalks of the ground sugar cane.

It appears that if the bagasse became the primary source of fuel on all of the islands. It was a natural by-product of sugar-
making, and thus an abundant supply was assured. It was also a renewable resource. After grinding, the bagasse would be laid out to dry, then stored away until needed for fuel during the next grinding season. Traveling Cubans in 1794 brought back the idea of the French and Jamaican trains to Cuba. They had observed these single-fired furnaces on English islands. They also brought to Cuba the idea of using bagasse as fuel, a convention first attributed to the British islanders. Bagasse did not burn as well as coal or wood, but its advantages well offset its slight inefficiency as fuel.

Before describing nineteenth century innovations in sugar evaporating techniques, the clarification and filtering methods used in processing sugar should be discussed.

**Clarification**

Freshly extracted juice is "opaque, frothy, and a yellowish green or sometimes grayish color. It has an aromatic and sweet taste, and balsamic smell, and produces a slightly acid reaction on litmus paper," so says Evans. Many pragmatic new scientists of the nineteenth century directed their efforts to discovering the chemical composition of sugar. Part of the impetus for experiments with cane sugar came from the scientific developments occurring on mainland Europe in the sugar beet industry. Another impetus was the pragmatic, rational man's disdain for the seventeenth and eighteenth century planters' use of intuition to process their sugar. This was especially the case when they had to determine when to add lime, evaporate, and to strike the juice. Evans called their results using the old muscovado process, described earlier, as "semi-crystallized
concrete." Beachy adds that the "most prominent characteristics of the muscovado sugar industry, were wastefulness and slovenliness"—thus speaks pragmatic man. Finally, many planters were going under with the abolition of their slave labor forces. Spurred by great necessity, technological developments were seen as the industry's savior, to overcome the depression in the industry partially brought about by the end of slavery.

The long, dry report of Evans on sugar making is a perfect example of a rational, methodical inquiry into improving sugar manufacturing and the actual sugar. For example, he writes that cane juice can be separated into two portions: a transparent, pale yellow fluid and a dark green "fecula." The expressed juice was passed through a filter, and that was when he noticed the "fecula."

Clarification is a process developed to remove this fecula, leaving a purer juice for evaporation. The removed fecula would constitute the scum of the clarifiers. Clarke is simply the process of removing the scum or fecula from the expressed juice. The process took place in a vessel or vessels called clarifiers (clarifyers), racking coppers or simmers. With additional process of clarification of the juice, the earlier method of adding lime directly to the evaporating mass was discontinued. Instead, the agent added to induce granulation was added prior to boiling, during clarification.

The earliest mentioned use of a clarifier is from Jamaica, in 1778. This seems not to have been taken advantage of on Cuba until the mid-nineteenth century; but later eighteenth century inventions, such as the aerometer saccharimeter and Baume hydrometer were employed
These devices measured the granulation or "doneness" of the juice or determined the quantity of lime needed to ensure good granulation. One inventor was Dutrone la Couture, circa 1785, who wrote a history of the cane of St. Dominque. He developed a copper hydrometer "the bowl of which could be filled by way of the hollow stem with lead shot, and adjusted so that the exact submergence of the bowl in the hot liquor corresponded to a density of 24° Baume." This device accurately predicted when the evaporation process should be stopped. The addition of lime to induce granulation is a separate process from clarification, as one can see below.

The addition of lime to the expressed juice prior to heating is clarification. Too little lime resulted in a juice that would not crystallize—doughy, moist, and with false grain. Adding too much lime resulted in a dark, "stinking" mass with much too much molasses in the final product.

There were two general methods used to clarify the juice, one cold and one hot. "Clarifiers" is the general term used to describe the copper vessels used in the heating method, "cold receivers" for those used during the cold method of clarification.

For the cold method, the juice would flow into a cistern, a 500-600 gallon holding tank of wooden, lead-sheet lined boxes. Evans writes this method was least used on British islands. In Louisiana, however, this method appears to have been preferred. Planters there used at least two shallow, large, copper or lead-lined cypress boxes as cold receivers. Various filters were used to separate the scum from the "pure" juice. Wire screens, sieves, gauze cloths, or simple gravity settlement were used as filters.
Clarification would continue during the normal evaporation procedure on the "set," with intermittent skimming off the scum. Lime was also, at times, added to the grande during evaporation to help the juice crystallize.193

The heated method of clarification was often used on English islands. Further, it seems to have been preferred on Cuba. Clarifiers on Cuba were usually copper pans, 70-80" in diameter. The fresh cane juice would be troughed or piped to the clarifiers, lime would be added and the whole mass heated near to boiling. The juice would then be allowed to "stand" in the clarifiers for an unknown amount of time. When deemed ready for evaporation, the mass would be sent into the first copper, via an aperture located approximately three inches from the bottom of the clarifier. The location of the drain above the actual bottom of the clarifier would ensure further separation of the unwanted particles from the juice.194

Evans' description of the clarifiers on British Islands indicated that they preferred a more complex procedure of clarification of the juice. The expressed juice would be piped directly to the clarifiers, "shallow copper pans of a circular form, almost flat, or rather arched slightly upwards at bottom, and capable of holding from 250 to 500 gallons each.195 The clarifiers were placed over separate, closed furnaces that could be dampened easily to regulate heat flow.196

The steps in the British clarification procedure have been outlined below:197

1. Fill clarifier until almost full
2. Heat juice to approximately 140°F
3. Add lime (caustic or hydrate)
4. "Slake lime action with water or clarified cane juice—the quantity of lime added is dependent upon the quantity of juice

5. Stir the slaked mass

6. Test the need for additional lime by dipping a series of wine glasses in the juice—add successive amounts to each

7. Increase heat to almost boiling

8. Heat "until a thick scum forms upon the surface, which cracks and separates into two or three pieces, allowing the clear liquor to be seen"

9. Dampen the fire, let juice sit until evidence of scum has disappeared

10. Turn cock or spigot on the clarifier, allowing the juice to drain into the first copper on the evaporation train

**Filtration**

Evans incorporates filtering with the process of clarification. The simplest form of filtering has already been described. This was accomplished by having either very young or old slaves clean the gutters with strainers and a stick. Evans recommends straining the juice through 1/12" or 1/30" wire mesh as it pours into the clarifiers. He also stresses the importance of cleaning the sieves after each use.

Thomas Spalding concurs with the need for cleanliness in making sugar. He writes that sugar-making can be accomplished only "provided your Mill, your Gutters, your Clarifyers, your Kettles, and your Skimmers are kept washed, scoured, and scalded: for no Mahometan, with his seven daily Ablutions, is a greater enemy to dirt than sugar is."

Further filtering of the juice was advisable, using the "common bag" or charcoal methods of filtration. Evans believes that
Figure 9. Evans' 1848 Filter Designs

a.) Common Bag

b.) Charcoal

A. Wall of clarifier.
B. Clarifier, with cock.
C. Uppercistern of filters.
D. Filters inclosed in their case.
E. Lower cistern and discharging cock.
the common bag method was fast, simple, and inexpensive. Figure 9a portrays his design. The bag system incorporates calico bags, 18" wide and 3 to 5 feet long. These bags would be placed into a strong, canvas bag 6" wide and long. A metal tube would be placed in the neck of the sacks, "to which the sack is tied, and by which it is fixed to the bottom of a cistern adapted to receive the cane juice as it comes from the clarifier."201

For the charcoal filtration method, one needs charcoal grains, flannel, and a touch of water. One builds a wooden receptacle as shown in figure 9b. A false perforated metal or basket bottom is laid over the wooden base. A thin, even layer of moistened charcoal is spread on top of a piece of flannel which overlies the false bottom. Next, another sieve is placed over the top. A metal tube and cook system is placed between the real and false bottoms, and then the filter would be ready.202

Dutrone la Coutre preferred to stop clarification when the juice density read 24° Baume (43° Brix). The syrup would be passed through filters of wire-gauze covered with wool.203 For evaporation, he recommends striking the juice at 95°R (260°F) with a resulting solution of 88% sugar. The normal striking methods, prior to the late eighteenth century, produced only a 75 percent solution, a greatly inferior sugar "saturated with molasses" and forming unwanted "small crystals (false grain)."204 Evans, writing about half a century later, was quite content with the syrup produced using charcoal filters, with a density of 27 to 28° Baume, a boiling point ranging from 219-220°F. This resulted, upon cooling, in 3 pounds solid crystallized sugar and the same amount of molasses.205 ("Mother
liquid" is the term used for molasses, consisting of 2 pounds dissolved sugar and 1 pound of water.)

Despite the fact that measuring devices greatly aided evaporation processing, there were still problems for a planter to contend with. The largest was regulating the heat in the teache, or last copper. Evans calculated that the uncontrolled temperature of the teache caused a 10 percent loss in the quality and quantity of the sugar. Sitterson agrees, stating the Louisiana planters had the same problems. Further problems during the clarification process could affect the quality of the juice, too. The difficulties planters encounter with regulating heat arose from the design of their furnaces. Evans explains below:

. . . its [teache] upper rim is surrounded by a lip or flanche, by which it is suspended over the furnace below. The mason work into which this flanche is inserted, is constantly in a glowing heat, so that damping or even withdrawing the fire is insufficient to extinguish the intensity of the temperature to which the syrup in the vessel is always exposed.

Evans uncovered three solutions to the problem. The first was to make the teache smaller, increasing the number of skips or strike needed. As a result, the syrup would stay in the teache for a shorter time. This method was common in Barbados. The second method was to remove the teache from the furnace, building a separate brick or stone furance for the teache. The heat would not be cumulative, and thus would be easier to control.

The third method was the most desired, in Evans' opinion. Planters would use vacuum pans to process the sugar, instead of copperers. The use of vacuum pans would assure the most rapid processing of the juice, and at a lower temperature. Unfortunately, the vacuum
pan was still too risky to use in 1848--too expensive, too often broken and too hard to repair.210

The predecessor of the vacuum pan was the method using steam coils to heat up the syrup. The first attempt to use steam to evaporate liquids was in England, in 1692.211 Philip Taylor developed a method using high-pressure steam and tubes in the period of 1816-1818. His process used a "series of double concentric straight tubes connected to a common header, which could be rotated about its long axis, thus rinsing the tubes and allowing the pan to be cleaned."212 The header was divided in half, one side for incoming steam, the other for outgoing condensation.

Taylor's method was quickly adopted by the beet sugar manufacturers in Europe. For reasons as yet unknown, it was not adopted, commonly, in the West Indies sugar cane works.

Wyatt (1817) and Cleland (1827) introduced the use of a steam-heated coil in heating the syrup. Deerr writes that Reunion was the site of the first successful use of these evaporators, sometime prior to 1845.213

It appears that most sugar planters were slow to adopt the coil-heated method of evaporating the juice. One reason may be that they needed to use steam as the motive force. Those using steam to power their grinding mills would have been more apt to add the additional apparatus needed for steam-coiled evaporation. Deerr writes that by 1880 in Mauritius only four-fifths of the sugar works used the steam heating procedure. He believes that the continued use in the late nineteenth and early twentieth centuries of the closed-fire train
on Barbados, Mauritius, and other islands resulted from a steady demand for unrefined ("flavored"—Muscovado) sugars.214

An English chemist, Edward Howard, developed the theory of the vacuum pan, how to evaporate liquids in a vacuum, in 1813. Howard preferred using a pump and condenser to create steam to heat the enclosed liquids.215 The vacuum pan was first used in European refineries. It was not actually adopted by the beet industry until sometime prior to 1835. The Dutch in Demerara were the first to use the vacuum pan system to crystallize sugar from the cane, in 1832.216 Vacuum pans were introduced in Louisiana in 1831, Mauritius in 1844, Brazil in 1847, Guadeloupe and Martinique in 1842, and on Jamaica in 1846.217

In Louisiana, the first site of the vacuum pan system was on the Morgan Plantation. The pan system was only used in place of the teache, and cost $6,000 to install. The sugar produced was greatly superior in quality to the previous sugars manufactured there, using the teache.218 Other Louisiana planters did not copy Morgan’s methods. Sitterson attributes the delay in the vacuum pan's acceptance to Louisiana planters' general discontent with steam. It appears that an 1830 experiment in using steam clarification and boiling had failed, at great cost.219

Evans believes that the reluctance of the planters to adopt improved evaporation techniques was due to ignorance combined with the costs of having to build entirely new facilities. His treatise constantly refers to methods easily adapted to the train method of processing—so the planters could improve upon existing buildings.220
Beachy writes that the vacuum pan method of evaporation was superior to the train method in many ways. Primarily, the actual extraction and crystallization processes were much more efficient. Further, fuel was saved, as only a small amount of bagasse would be needed to process the juice. He writes that the use of the pan in the cane sugar industry was not entirely successful until the invention of the "modern" three-pan vacuum pan in 1880.

Clarification and evaporation of the juice were extremely important procedures that determined granulation of the syrup. But sugar manufacturers could still lose a great quantity of sugar through the incorrect cooling, draining, and storage of the sugar. Again, planters dealt with those next steps in making sugar in various ways. The next section contains a discussion of some of the alternative manufacturing methods used.

Cooling

In Louisiana, the cooling process generally lasted from about six to fourteen hours. The teache syrup, after striking, was ladled, troughed or poured into holding tanks. These cypress tanks measured from 6-7 feet long, 4-5 feet wide, and from 12-14 inches deep. The first strike would fill the tank only two or three inches deep. This mass would be stirred and allowed to stand until a thick crust appeared. Next, the mass would be stirred again and then allowed to stand until almost hard. The next three strikes would be poured on top successively, following the same procedure.

In the West Indies, coolers were made of wood or copper, measuring 5 to 10 feet long, 3 to 5 feet wide, and from 12 to 16
inches deep. Each cooler held two or more skips, charges, or strikes. This would amount to approximately one-half to one hogshead of sugar. Once the syrup in the teache reached the desired consistency, it would be placed into a cooler. The syrup could be ladled, which could be dangerous, removed with a bucket/yoke contraption, or removed by using a copper skipper. A copper skipper could scoop up the mass in one swoop. The hot syrup would be poured from this skipper into the cooler, through a valve on the instrument.

Beachey condemns the habitual placement of the coolers in the most ventilated portion of the boiling house, adjacent to the train. Evans agrees, stating that crystallization would occur unevenly, leading to false grains. He states their placement in way of "strong gusts of wind which are admitted on all sides into the building, and the shallowness of these vessels causes the heated syrup which they contain to present a very large surface to the cooling influence of the atmosphere." Additionally, Beachey claims that the stirring of the cooling mass, or "oscillation," especially prevalent in Barbados, caused granulation to be uneven, deteriorating the sugar's quality.

After cooling, the sugar was cut and shoveled into buckets, then carried and poured into hogsheads "regardless of temperature." This usually led to a loss of sugar during the next step, draining. Evans supports Beachey's condemnation of the usual method of cooking the sugar and placement into hogsheads. He writes, "It is dug out of the cooler, shovelled into a bucket or some other vessel, carried into
the curing house, and then thrown into the hogshead as if it were so much manure . . . ."231

The discriminating planter could place the coolers in an area with more restricted air flow. Further, he or she could refrain from having the cooling sugar stirred; and instead of using large coolers, one could follow Evans' recommendations and use a mold or form of wood with a one-hogshead capacity for cooling. These coolers would be placed in the actual curing house, with its even temperature and protection from the wind. This would also ensure faster cooling per cooler.232

Evidence does indicate that the "dump and stir" method of cooling was more common on the Islands, and over an extended period of time. One does not expect the more sophisticated methods of cooling to have become common until the abolition of slavery necessitated changing sugar-making procedures, and concomitant investments.

Rum

The manufacture of rum, alias kill-devil, grog, Barbados water, or Rumbullion (translated as tumult in Devon), was discovered accidentally on Barbados sometime in the early seventeenth century, circa 1630. The by-product of sugar manufacturing, molasses, could be sold as it stood, slightly purified into treacle or manufactured into rum. At the turn of the seventeenth century, new markets for the by-products of sugar were developed. Molasses and treacle became important parts of slaves' and poor whites' diets. Rum was enjoyed by planters in their punches and traded to Europe, North America, and Africa. The British Navy even adopted rum rations as a staple condiment to work on ship.233
Rum is basically fermented molasses. The scum of clarification and evaporation was gathered from the pots and placed in a rum-making area on the plantation. Fermentation would be induced with added water, sulphuric acid, or ammonia and the mass allowed to stand in stone or wooden cisterns. There were two methods of fermenting the molasses. The Demerara method used a wash of sulphuric acid and a touch of ammonium sulphate, which speeded up the growth of the yeast. The cistern full mass would be fermented in a mere 48 hours. The second method was the Jamaica process. No wash is added to the liquid, only "dinder" or by-products scraped from the still are used. This begins fermentation. This method took from 10 to 12 days before fruition.

After fermentation, the liquid would be conveyed to a copper still sitting over a fire. Next, the liquid would be boiled to separate the wash from the liquor. Finally, "after being rectified in a vessel containing vertical tubes surrounded with water, [it] is condensed in a spiral tube cooled with running water." Sometimes a vertical still, a "Coffey," would be used. This would produce a white liquor to which coolants would be added.

Aspinall describes the process of this type of still below:

This is a vertical still consisting of two columns of considerable height, with an internal arrangement of alternate shelves. The wash is introduced at the tope of the first, and drops from shelf to shelf until it reaches the bottom, meeting on its way down a current of steam, while the vapour from it passes to the bottom of the second column, where it is rectified by the cold wash passing through it in tubes, and condensed in the upper part. The process is continuous, and the separation is so complete, that the hot spirit constantly passes off to the cooler from near the top of the second, while the waste liquor runs off at the bottom of the first.
Figure 10. 18th c. Drying House
darker top and bottom areas of the loaves would be cut for reboiling on the train. The central two-thirds would be packed into hogsheads for transportation to a European refinery.241

The clayed method of processing sugar took about four months, producing a semi-refined whitish sugar. This method, less common in the Islands, was basically the same as that described above for the muscovado method. (This method cost more in terms of time and expense, with the additional disadvantage of higher tariffs in Europe.)

A thin layer of good, white clay would be poured over the sugar in its clay sugar mold. The clay would be moistened with water. The water would percolate down through the sugar, carrying much of the uncrystallized sugar and/or molasses with it. The pot would be unplugged and the molasses drained out for storage, reboiling, or for making rum. A relatively refined white sugar would be the final result.242

In Cuba, the clay sugar pots were called hormas, but they were simply known as "pots" elsewhere. The draining process was called curing or purging.243 The color of sugar was extremely important, as it was graded and priced according to its hue. Until the mid-nineteenth century, sugar samples were simply held against a group of "glass jars containing sands of different and accepted shades of color," a procedure first developed by the Dutch.244 The gradients spanned 1 (darkest) through 18 (lightest). Sugars found to match 16 and less were graded as muscovado. Chemical analysis led to a four-color scale used by France, Netherlands, England, and Belgium in 1867. The four classes of sugars sent to refineries were: muscovado (raw),
sucré passe (cassonade gris), sucre terre (clayed, caissonade blanche), and sucre raffine (refined).  

During the late eighteenth century, the use of clay pots for drainage gave way to two alternative methods. One was the use of metal molds, often cone-shaped. The metal molds used in Cuba were either iron or tinplate. A planter could forego the expense of having to build or buy any separate drainage container by using the second alternative— the hogshead. Often the sugar was directly placed into the hogshead with the drainage hole left open until processing was completed. Then the aperture would be plugged and the sugar shipped. Curing methods did change over the centuries. Early nineteenth century curing houses were generally built on the windward side of the factory, keeping the place cooled by breezes. Evans was appalled at this practice, and writes, "Had the planter intended to convert the cane-juice into dough or bird-lime, he could scarcely have invented a more successful method of accomplishing his purpose, but to obtain sugar a more ill-judged method, or one more defective in principle, could not be employed." Sugar needed a secure, warm, dry atmosphere to continue separation through drainage.

The curing house would be built in two levels, the top holding the draining hogsheads or molds on beams. (See figure 11.) A cistern would be located underneath, "lined with cement" and "seldom in a perfect state of repair." The molasses would drip into the cistern, there to sit awaiting distillation as rum or storage for shipment to the U.S.A. or Europe. Roaches, rats, and "vermin" would also fall into these cisterns, aiding fermentation. Unfortunately, fermentation was not desired at that point in the process.
Figure 11. 19th c. Drying House
In the hogsheads, the sugar would chemically combine with lime and "the deliquescent matter of Hervey" a (hygroscopic organic substance) and melted away "like ice in warm weather." The hogsheads would, as a result, be covered with seepage consisting of molasses and melting, processed sugar. This occurred both during curing and throughout transportation to Europe. Normally, one could expect from 2860 pounds of juice 2000 pounds of good sugar and 860 pounds of molasses. Through use of hogsheads, 2860 pounds yielded only 1680 pounds of passable sugar and 660 pounds of molasses. The remainder would have leaked down the sides of the casks. The 1680 pounds would be formed of 75 percent crystallized sugar, found as "loaves, lumps, pieces, and bastards; there being 20 percent of uncrystallisable treacle and 5 percent loss." (Evans' improvement plans will be discussed in the following section.)

An example of a boiling house and adjacent curing area can be found in Spalding's letter to Thomas Pinckney. The curing room is placed perpendicularly to the boiling area and easily accessible from the coolers. (See figure 12.) Spalding recommends using few windows in combination with a terrace roof. This would help to retain heat. He further mentions that the use of stoves in the curing house would help to purge the sugars. The text of Spalding's description of his curing house is reproduced below:

In the curing house, strong joists cross from side to side, at fifteen inches apart, resting at the end upon an abutment wall. The bottom of the house, is two inclined planes, of two feet descent, that discharges the molasses into a gutter in the middle. This gutter also inclines a little to one end, where it empties itself into a close cistern containing two thousand gallons—The cistern may be made of cypress plank, rammed at the bottom and sides with clay. For preserving the molasses clear, the cistern
Figure 12. Spalding's 1816 Sugar-works
should be covered over with plank, and have only a scuttle to take the molasses out. For the convenience of moving your casks, there should be a planked tread-way over the joists from one end to the other. 253

Using inclined floors and a series of gutters appears to be a system that was unique to Georgia and perhaps South Carolina. Planters in that region generally drained their casks for sixty days, after the initial 24' to 36' hour curing period prior to draining. 254

Louisiana planters apparently designed their curing houses more along the lines of the West Indian planters'. The sugar was removed from the coolers and poured into hogsheads, then placed on top of joists (scantlings). The joists would measure about one foot apart. The curing, or draining room or rooms would measure individually 40-60 feet in the length and would adjoin the boiling house. The hogsheads, resting on their joists, would drip the molasses or uncrystallized sugar down into molasses cisterns. These cisterns were manufactured from brick and cement or, more often, pitched and caulked cypress boards. They measured 20 square feet over all and from 16-20 inches in depth. 255

The drainage procedure would begin by leaving open the hogsheads' joints. Three or four apertures would be drilled into the cask bottoms, plugged by a sugar cane stalk. After the one or two days of initial curing, the holes would be unplugged. This procedure of draining out the molasses would generally last from 20 to 30 days. Sitterson writes that from 40 to 45 gallons of molasses would be drained from each hogshead. The molasses cisterns wold eventually be drained, to ship out and be sold. "Cistern bottoms" of the scum left in the cisterns (3% processed sugar) was reboiled, used for rum manu-facturing or sold as is. After drainage, the hogsheads would be
packed fully with sugar, ready for shipment to Europe or elsewhere.\textsuperscript{256}

The curing house or room would be kept very warm, and planters sometimes used "stoves to maintain a constant temperature of about 80°F."\textsuperscript{257} Figure 13 demonstrates a curing area dating to the eighteenth century. Notice the use of sugar pots for draining. The stove at left would have helped to keep the building both warm and dry.

In his 1848 treatise on sugar, Evans carefully describes the best methods he can design for curing sugars. In doing so, he offers a glimpse of how the average planter cured his sugars, already described, and how planters may have improved their methods.\textsuperscript{258}

To begin, the curing house would be kept at a constant temperature of 90°, with no air currents allowed. Lots of light, due to glazed windows, would be allowed in. The cold receivers, placed in the curing house, would be water-tight boxes of wood, measuring from 3 to 4½ feet. These coolers would be placed on the joists, leaving an aisle after every two rows. Evans' cold receivers would have a false bottom with wooden plugs. Each strike of the teache would be poured and blended until a box was full. After three days of cooling, the sugar would have set, having reached the temperature of the curing house. Then the plug could be removed and the molasses drained from the cold receiver.\textsuperscript{259}

Evans states that planters wishing to maintain the older drainage containers, molds (expensive), or hogsheads (leak), should at least refrain from using molasses cisterns. He recommends draining into jars placed on the floor of the house or setting up the vessels on tables with gutters. The vessels' apertures would be directly
Figure 13. 18th c. Drying House
placed over the gutters. After 24 to 36 hours, the vessels would reach the temperature of the curing room and could be unplugged. Their apertures could even be fitted with strainers to catch any crystals flowing out with the molasses.\textsuperscript{260}

In regard to making clayed, or refined sugar, Evans states that he prefers to replace the "magma" or clay slip with sugar. The upper 1 to 2 inches of sugar crust would be smoothly removed, crushed, and mixed with cold water to form a smooth paste. This paste of pure syrup would be poured over the vessel to 2 inches in depth. After a new, thin crust formed, a wet cloth would be placed over top, bleaching the sugar. The vessel would be dried in a warm, dry area heated by a stove for a few days. Finally, the sugar could be removed from the molds and placed into bags or hogsheads for shipment.\textsuperscript{261}

Refineries in Europe followed similar procedures for metamorphosing their imported muscovado sugars into white, refined. The resulting sugar would be cone- or loaf-shaped, as apparently refineries preferred to use clay and/or metal molds.

After separating the imported sugars by quality, they would be processed in two clarifiers, one "skimming vessel" and one copper. They were located in that respective order, from left to right, and placed over a masonry flue system. The fire was usually fueled by coal.\textsuperscript{262}

The first major improvement in refining came with a combination of an air-pumped and partial vacuum system developed by a Mr. Vaughan in 1809. His system drained the molasses form the sugar while still in the molds. But the greatest change in refining technology
occurred with the development of the centrifuge in 1849. The centrifuge machine simply separates the molasses from the crystallized sugars through motion, and the molasses would be sent through a mesh.\textsuperscript{263} The resulting sugar would still be packaged in the form of paper-wrapped loaves. The last English-made loaf of sugar was produced in 1893, when the Martineau refinery burned to the ground.\textsuperscript{264}

Aykroyd writes that "until about 100 years ago, it was customary to press sugar into molds from which cones of sugar weighing perhaps five pounds emerged. These were sold by grocers and confectioners and the housewife broke them up as she needed the sugar for different purposes."\textsuperscript{265} Housewives must have been used to creating and/or choosing different types of sugar for their cooking needs. "Miss Paloa's New Cookbook" of 1880 mentions boiling sugar to different degrees, to obtain different stages of sugar for a specific dessert, from purchased "granulated" sugar or from the "loaf."\textsuperscript{266}

Beachey writes that in Jamaica 48 out of 140 estates used the centrifugal. This was due to investments and improvements made by many new merchant owners of the plantations. The vacuum pan and centrifugal could be effectively combined to produce a drier sugar in just a few hours. Further, the sugar could be packed into inexpensive bags for shipment.\textsuperscript{267}

**Shipment**

Prior to the use of bags, costing "pennies," hogsheads were used to ship the sugars. They generally cost a pound a piece to buy.\textsuperscript{268} Planters could have had slaves manufacture the casks directly from plantation woods, if available.
The hogsheads of sugar would "weep," seeping molasses down the sides, in the hot ship holds. Beachey estimates that Tobagonians lost 16 percent of their sugar in this manner, 320 tons per 2,000 tons, in 1877. In 1969 Barbados, a refinery was built to process the molasses leaked on board ships, scraped from the holds.

Evans lists five factors leading to loss of product (and profits) on nineteenth century British sugar estates:

1. Injudicious cultivation of cane
2. Commencement and continuation of an unsuitable crop
3. Imperfect expression of the juice (grinding)
4. Unskilled manufacture
5. Leakage on shipboard

He estimates that 10 to 15 percent of the total sugar shipped was lost on board, with a mean loss of 12.5 percent. Evans could offer no solutions to the problem of leakage on shipboard, except to ship drier, centrifugal sugars in bags.

Writers like Evans offered advice available to any reader. Specific production improvements, agricultural experiments, and calls for agricultural societies abound in the nineteenth century literature. It remains to be seen through archaeological and archival research whether anyone followed through with the improvements. A 1907 traveler to the West Indies does mention observing two distinct manufacturing methods occurring on the same island: the "old muscovado process," making brown sugars, and the "vacuum-pan process." This should not have been a surprise. Technologies tend to flow concomitantly.
The art of making sugar has really changed over the centuries. Modern refineries stress cleanliness and efficiency, and are based on modern sources of power. Akroyd describes the modern refinery below:

The raw sugar goes in at one end and after passing through various stages (affination, recovery, melting, carbonation, filtration, charring, crystallization and granulation), emerges at the other end as sucrose packed in suitable containers—"untouched by hand." Minor modifications of the process can produce granulated sugar, "ordinary" and "fine," cube sugar, castor sugar, icing sugar, coffee crystals and other products.274

The growth of large, centrifugal refineries in combination with the end of the large plantation period on the Islands has led to the abandonment of many sugar factories. Buisseret writes that the only standing remains of the large island sugar works on Jamaica is the furnace and its characteristic stoke-holes. He adds, "Inside, the coppers have nearly always been removed, but may often be seen as decorative features in gardens, or as drinking troughs for animals."275 The ruins on Statia generally confirm to those on Jamaica, except at the site of English Quarter. There, large standing ruins give testimony to the tremendous planning, energy, and general vitality of a once flourishing island industry, sugar. Archaeology may serve as a forum for the industry to be acknowledged once again.

The following section is a description of English Quarter, one site among countless numbers on the West Indian Islands. It is presented in the form of a standard archaeological site report, beginning with a geologic description of the Island, St. Eustatius, the location of English Quarter.
NOTES TO CHAPTER II

1Fraginals, 1976, p. 16.

2S. officinarum means "of the apothecaries' shops," says Deerr, VI, 1949, footnote p. 12. No wild examples of officinarum have been discovered, Ibid., pp. 3,13.

3Deerr, VI, 1949, p. 19.


5Sitterson, 1953, p. 10.

6Sitterson, 1953, p. 13


81965, p. 151.

9Coulter, 1937, p. 259

10Pares, 1968, p. 16.


13Pares, 1968, p. 15.

14Ibid., p. 114.


16Pares, 1968, p. 15.


21Letter from Thomas Spalding to Thomas Pinckney March 25, 1816--in (ed.) Coulter, 1937, p. 233. Noell Deerr lists the trench sizes as 4' by 4' by 9" or 12 cubic feet.

23Ibid., pp. 233-34.
24Ibid., pp. 259-60.
25Ibid., p. 231.
26Ibid., pp. 321.32.
27Pares, 1968, p. 15.
28Stubbs, 1897, pp. 159-60.
29Deer, VII, 1950, p. 584.
30Fraginals, 1976, and Sheridan, 1974, discuss transportation of the cane.
31Levy, 1980; Sitterson, 1953, pp. 133-34.

32For a detailed account of cultivation methods used by early sugar planters, see the following: Sheridan, 1974, p. 105; Pares, 1968, pp. 105-15; Barrett, 1965 and 1970, pp. 46-49; and Stubbs, 1897; and Samuel Martin's 18th century essays on plantership. Further, the planters in Louisiana, at least, had to learn to deal with widely fluctuating crop years. In New Orleans, yields varied as below:

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<th>Year</th>
<th>Hogsheads</th>
</tr>
</thead>
<tbody>
<tr>
<td>1860</td>
<td>228,753</td>
</tr>
<tr>
<td>1856</td>
<td>73,976</td>
</tr>
<tr>
<td>1855</td>
<td>231,427</td>
</tr>
<tr>
<td>1850</td>
<td>211,201</td>
</tr>
<tr>
<td>1846</td>
<td>140,000</td>
</tr>
<tr>
<td>1845</td>
<td>186,000</td>
</tr>
<tr>
<td>1840</td>
<td>87,000</td>
</tr>
</tbody>
</table>
Deerr, VII, 1950, p. 541.

Ibid.

Fraginals, 1976, footnote p. 15.

Deerr, VII, 1950, p. 536.

Deerr, VII, 1950, p. 537.

Sitterson, 1953, p. 32.

Steward, 1956, p. 53.

gudgeon—a trunnion, support for machinery; spider—a "part having a
number of radiating spokes or arms, usually not connected at their
outer ends."

See illustration, figure 1, p. 538; Deerr, VII, 1950, p. 537.


Deerr, VII, 1950, p. 537.

Ibid.


Deerr, VII, p. 540.

Information concerning the development of roller mills that
follows was derived from Deerr, VII, 1950, pp. 544-46, and Evans,
1848, pp. 96-104.

Evans, 1848, p. 103.

Evans, 1848, p. 101.

Evans, 1848, pp. 102-03.


Ibid, p. 543.

Deerr, VII, 1950, p. 543.


64 Deerr, VII, 1950, p. 541
66 See Evans, 1948, as aforementioned, and Beachey, 1978, p. 62.
68 Ibid.
69 Evans, 1848, pp. 106-07.
70 As quoted in Steward, 1956, p. 53.
71 Buisseret, 1980, p. 29.
72 Ibid., p. 30.
77 Sheridan, 1974, p. 159.
78 Buisseret, 1980, p. 31.
79 Evans, 1848, pp. 109-10.
80 Evans, 1848, p. 110.
81 VINP, NPS ND
82 Pulsipher and Goodwin, 1981.
83 Ibid., p. 67.
84 Whistler, as quoted in Deerr, VII, 1950, p. 549.
85 Deerr, VII, 1950.
86 Examples of the post-mill can be viewed at Williamsburg and Flowerdew Hundred, Virginia.
87 Brunskill, 1980, pp. 69-70.
89 Brunskill, 1982, p. 70
90 Brunskill, 1982, p. 70.
91 U.S. Virgin Islands National Park Service
92 Ibid.
93 Levy, 1980, p. 110; Evans, 1848, p. 110.
94 Beachey, 1978, p. 64.
96 VINPS, NPS ND
97 Buisseret, 1980, pp. 31-32.
98 See Pulsipher and Goodwin, 1981, pp. 62, 65, for their examples on Monserrat.
99 D. Buisseret, 1980, p. 33, figure 3, depicts a cutaway elevation of a two-level windmill.
100 Buisseret, 1980, p. 32.
101 Ibid.
103 Beachey, 1978, p. 64.
104 Deerr, VII, 1950, pp. 548-49
105 Ibid., p. 459.
106 Ibid.
107 Buisseret, 1980, p. 35.
109 Buisseret, 1980, p. 35.
110 Ibid., p. 35. A Spanish sugar mill using water as the motivating force has been located in Ponce de Leon Springs, Florida, and dates to about 1570. The site is presently being transferred from private restaurant owners to the State Historical Commission. Thus no information could be had concerning the site, even if their brochure claims that portions of the machinery and wheel still stand.
111 1848, p. 111.
112 Buisseret, 1980, p. 35, see plate 73.


114 Ibid., p. 549.

115 Ibid., pp. 551-52.


117 Deerr, VII, 1950, p. 552.

118 See Fraginals, 1976, p. 159, footnote.

119 Journal of the Society for Industrial Archaeology (JSIA), vol. 8 no. 1, 1982, pp. 57-66—for detailed elevations and plans, see this article.

120 Ibid., p. 57.

121 Ibid., p. 60.

122 Ibid., p. 61.

123 Ibid., p. 57.

124 1948, p. 111.

125 Evans, 1848, p. 111.

126 Evans, 1848, p. 96—the weight trials varied from 200-12,000 lbs. and the cane varieties and number of rollers used is unknown.

127 Barrett, 1965, p. 156.

128 Steward, 1956, p. 53.

129 Fraginals, 1976, p. 20.

130 Sitterson, 1953, p. 10.

131 1974, p. 176.

132 Steward, 1976, p. 53.

133 Pares, 1968, p. 115.

134 Fraginals, 1976, p. 31.

135 Pares, 1968, p. 115.

136 See Chapter 2—discussion on slavery.
See Fraginals, 1976; Sheridan, 1974; Beachey, 1978; Steward, 1956; and Deerr, VII, 1950.

Fraginals, 1976, p. 41.

Fraginals, 1976, p. 83.

Steward, 1956, p. 54.

Steward, 1956, p. 54.


Deerr, VII, 1950.

1976, p. 106.

1976, p. 38.

Deerr, VII, 1950, p. 556.

Ibid.

Dunn, 1972, p. 194.

Sheridan, 1974, p. 114.

Sheridan, 1974, p. 115; Fraginals, 1976, p. 38; Dunn, 1972, p. 194.

Dunn, 1972, p. 194.

Ibid.

Fraginals, 1976, p. 106.

Radford, 1979, p. 190.


Fraginals, 1976, p. 106.

Ibid.

Fraginals, 1976, p. 38.


Sitterson, 1953, p. 141.

Sitterson, 1953, p. 141.
165 Ibid., p. 240.
166 Ibid., p. 241.
167 Ibid.
168 Sitterson, 1953, p. 143.
170 Schaw in Andrew, 1923, p. 128.
171 Sitterson, 1953, pp. 142-43.
172 Ibid., p. 143.
174 1972, p. 194.
175 Schaw in Andrew, 1923, p. 129.
177 Fraginals, 1976, p. 74.
178 Sheridan, 1974, p. 115.
179 Fraginals, 1976, p. 32.
180 Sheridan, 1974, p. 115.
181 1848, p. 67.
182 Evans, 1848, p. 22.
183 Evans, 1848, p. 134.
185 Evans, 1848, p. 67. This scum was analyzed by M. Averquin, who states it consists of cerosie or wax 7.5% albumin and wood 3.4; greenmatter 1-3; biphosphate of lime 0.5; silica 2.1; and water. Evans, 1848, p. 68. Sitterson states that the amount of water was dependent upon the ripeness of the cane. 1953, p. 142.

188Ibid., p. 39.

18924° Baume = 43° Brix; Deerr, VII, 1950, p. 585.


191Evans, 1848, p. 112.

192Sitterson, 1953, p. 140.

193Ibid., pp. 141-42.


195Evans, 1848, p. 112.

196Evans, 1848, p. 112.

197Evans, 1848, pp. 113-14.


1991848, pp. 115-16.


201Evans, 1848, pp. 130-31.

202Ibid., p. 154.


204Ibid. Dutrone determines that most boilers struck at 87-87.5% R (228-229°F).

205Evans, 1848, p. 157.

206Evans, 1848, p. 161.

207Sitterson, 1953, p. 146.

208Evans, 1848, p. 161.

209Evans, 1848, pp. 161-63.

210Ibid., pp. 166-69.

211Deerr, VII, 1950, p. 556.

212Ibid., p. 557.
213 Ibid., p. 557.
214 Ibid., p. 557.
216 Ibid., p. 561.
217 Ibid., pp. 561-62—Deerr, pp. 561-72, contains a detailed account of the research and development of the vacuum pan.
218 Sitterson, 1953, p. 146.
219 Ibid., p. 147.
220 Evans, 1848.
222 Sitterson, 1953, p. 143.
223 Evans, 1848, p. 184.
224 Beachey, 1978, p. 70.
225 Evans, 1848, p. 184; Sitterson, 1953, p. 142.
226 Evans, 1848, p. 184.
227 1978, p. 70.
228 Evans, 1848, p. 184.
229 1978, p. 71.
231 Evans, 1848, p. 186.
232 Evans, 1848, p. 192.
233 Akroyd, 1967, pp. 6-7, p. 88; Sheridan, 1974, p. 358—Akroyd, pp. 89-90, tells the tale of British Admiral in Chief Vernon of the West Indies, who in 1740 helped to promulgate the use of rum in Her Majesty's Navy. Vernon habitually wore a grogram (wool and silk) cloak, thus the nickname "Old Grog" arose for both Vernon and in reference to the rum.
235 Detroit has a fine illustration of a 17th century rum still in the section on sugar manufacturing.
The sugar was "purged" of molasses. The color gradations in Cuba ranged from white, quebrado (yellow) to brown (cucurucho, cogucho, culo, or puntas)—"tips." Fraginals, 1976, pp. 34-35.

263 Deerr, VII, 1950, pp. 573-77—contains a complete discussion of the development and improvements made upon the centrifugal. Beachey 1978, p. 72, also describes the centrifugal.


265 1967, p. 8

266 Re-published by General Mills, 1974, p. 70.


268 Ibid., p. 73.

269 Ibid., p. 71.

270 Ibid., p. 72.

271 Evans, 1848, p. 234.

272 Ibid., pp. 233-34.

273 Aspinal1, 1907, p. 287.


Figure 14. Location Map, Caribbean Region
CHAPTER III
SITE REPORT, ENGLISH QUARTER

Geology

The Dutch Caribbean possessions extended over a wide area (see figure 14). They can be divided into three major regions, the Dutch Windwards (Bovenwindse Eilanden), Dutch Leewards (Benedenwindse Eilanden), and the portion of mainland South America known as Netherlands Guiana (Surinam, about 50,000 square miles). The Dutch Windwards and Leewards are located in the crescent-shaped arc of islands known as the Lesser Antilles (see figure 14). All islands were formed as the direct or indirect result of volcanic action, although at two different geologic periods. These two periods were the Holocene and the Pleistocene.

The Dutch Leewards consist of Curacao (170 square miles, highest elevation 1220 feet), Aruba (170 square miles, highest point 617 feet), and Bonaire (108 square miles, 787 feet). Collectively, they are called the "ABC islands." These islands were formed through the actions of geologically old volcanoes. Through immersion in the sea, limestones were laid upon a base of volcanic, then sedimentary rocks. Uparchings of these materials (tending northwest/southeast) formed the present ABC islands.

The Dutch Windwards (British Leewards) consist of the islands of Saba, St. Eustatius and a portion of St. Martin. The Lesser
Antilles Island Arc, the Carib Bow, stretches from Saba through Grenada and lies west of two other arcs, running respectively northwest and southeast. The northwest arc includes Saba and St. Eustatius (Statia). These islands are the remnants of either dormant or extinct volcanoes. They are located about 220 miles east of Puerto Rico (352 kilometers). This brings them into the tropical zone, as they are located about five degrees south of the Tropic of Cancer. The island of St. Martin's center lies at 18°3'40"N, 63°6'40"W. Its highest elevation measures 1278 feet, and its total area is approximately 31 square miles. St. Martin, unlike the islands of Saba and St. Eustatius, is only indirectly of volcanic origin. It is part of the craterless, Tertiary-aged arc of islands formed by sedimentary action. The oldest formation found on St. Martin is known as the Pointe Blanche Formation. A combination of marine and volcanic episodes has formed chalks, pebbles, tufts, tuff-breccia, and old and crystalline limestones.

The smallest island located in the Dutch Windwards is Saba, measuring approximately 5 square miles. It is located between 63°12'W, 17°37'N. Saba owes its existence to direct volcanic action. The entire island is a dissected volcanic cone, elevation at the highest point 2887 ft. Saba is characterized by agglomerates and tuffs, with magmatic rocks of hornblende-andesites, lamprobolite-andesites, Basaltic hornblende-andesites and Basaltic lamprobolite-andesites.

The island of St. Eustatius is also a part of the Carib Bow. It is located between 17°30'N, 62°50'W and measurements ranging from
7.5 to 12 square miles have been given for its area. Statia measures approximately 2.4 miles at its greatest width and about 5 miles at greatest length. (See figure 15.) Statia is characterized by three distinctive topographic features, the Quill, the Little Mountains, and the Cultuurvlakte (cultivation plain).

The Quill is the name of the large volcanic cone located on the southern end of Statia. Its name is a derivative of the Dutch word "Kuil" which means pit or hole. British seamen also named the Quill the "punchbowl." The Quill is an extinct volcanic cone 1975 ft. high with a fine crater. The Quill has been lyrically described as found below:

It is perhaps the finest example of its kind in the Antilles, with a beautiful, truncated cone, regular concave sides, and a wide, deep crater, almost circular in shape, with exceedingly steep inner slopes.

The second distinctive topographic feature on Statia is the collective remains of an extinct volcano or volcanoes called the Little Mountains. The Little Mountains have the appearance of a folded mountain range, but one can see the partial remains of the crater near Signal Hill, known as the Horshoe crater. The Little Mountains are located on the northern end of the island. They were formed by a dissected cone, and their highest elevation is 965 feet. The third distinctive feature is the cultivation plain (Cultuurvlakte). It lies between the Quill and the Little Mountains. This elevated plain is composed of slightly rolling terrain with an average height of approximately 120 ft. Its highest point lies 900 ft. above sea level.
Figure 15: Topographic Map of St. Eustatius, N.A.
The island of Statia also has high bluffs, deep guts (washes) and numerous small bays. Its black volcanic beaches on the leeward side of the island are very distinctive.

Both Statia and its sister island Saba were "built of relatively young volcanic materials: lavas, loose ash, stones and boulders." Various types of volcanic rocks can be found on Statia. Beach rocks consist of Augite-andesite. At Signal Hill, one finds Hornblende-pyrosine-andesite, Hornblende-andesite and augite-andesite. At Whitewall, Augite-andesite. The Quill contains Hypersthene-Augite-andesite and Augite-andesite with tridymite. Finally, at Sugar Loaf, one may find Dacite-pumice. The soil in the Quill is a rich humus built up from thick vegetation in the crater. Agglomerates, tuffs, andesites and lapilli are found there. The thick lava flows have helped create rich soils on Statia. Soil layers contain lava, pumice, and humus. The north to east volcanic eruptions left lapilli and pumice and the western portion of the Cultivation Plain has, as a result, rich, thick soils. The Keurs have described the soils of the Cultivation Plain as being 100-150 ft. thick volcanic ash. Further, they state that the plain, lying 100 to 250 ft. above sea level, measures approximately 1400 acres in area.

Soils on Statia are fertile volcanic ash. They are permeable, except in the Quill, where thick humus slows down the process. Rain falls into temporary pools and then evaporates or runs off down one of the many guts.
The Dutch Windwards have temperatures ranging from 56 F to 90 F, but variations in temperature tend to occur more between day and night than from season to season. The warmest months are generally August and September. The coolest temperatures occur in January and February. The chart below demonstrates the constancy of temperature:

Temperatures, St. Martin: Philipsburg

<table>
<thead>
<tr>
<th></th>
<th>1920-1933</th>
<th>1920-1942</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean annual</td>
<td>79.7</td>
<td>80.4</td>
</tr>
<tr>
<td>Mean warmest</td>
<td>82.2</td>
<td>82.2</td>
</tr>
<tr>
<td>Mean coolest</td>
<td>76.5</td>
<td>76.5</td>
</tr>
</tbody>
</table>

The tradewinds remain constant, keeping the climate pleasantly cool. The Dutch Windwards do lie in the path of hurricanes, occurring from about June through September.

The Keurs describe the environment on Statia as "intermediate between savannah and monsoon forest, characterized by a tropical rainfall and several dry months." Rainfall on the Windward Islands is scanty but somewhat dependable. The Windwards average about twice that of the Leeward Isles, which only receive about 22 inches per year. Data on rainfall is scarce, but the chart below demonstrates the relative dryness of the Windward Islands:

Rainfall, St. Martin: Philipsburg

<table>
<thead>
<tr>
<th></th>
<th>1892-1933</th>
<th>1892-1942</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean annual</td>
<td>42.6</td>
<td>42.9</td>
</tr>
<tr>
<td>Rainiest</td>
<td>5.8</td>
<td>5.8</td>
</tr>
<tr>
<td>Driest</td>
<td>1.6</td>
<td>1.6</td>
</tr>
</tbody>
</table>
The Keurs state that monthly rainfall averages are more indicative of the relative dryness or wetness of the islands. They write that Statia, with an annual precipitation of +42 inches, has extremely variable rainfall patterns. For instance, 15.8 inches fell in September of 1949, 4.5 inches fell in September of 1950. The wettest month on Statia is usually November, with 5 or 6 inches of rain, the driest is usually March with 2 or 3 inches falling. The recognized dry period on Statia is from December through July and a monthly average during the dry period can be as low as \( \frac{1}{2} \) inch/month.\(^{30}\) (See the MA thesis in progress of Ms. Christine Grebey on the use of cisterns and other water-resource management skills employed on Statia through time for further information.)

**Statia: Agriculture and Trade**

The Dutch, as mentioned in Chapter I, were the hired carriers of the Spanish and the Portuguese throughout the sixteenth century. By the early 1600's, Dutch shipment turned to the more lucrative plundering of Spanish and Portuguese colonies and ships. These pirates continued their plundering as privateers under the auspices of the Dutch West India Company, chartered in 1621.\(^{31}\) This pattern of sanctioned piracy simply followed the English pattern laid down by Elizabeth and cohorts such as Sir Francis Drake.

The Dutch area of interest was soon too extensive, through expansion by war, to hold easily. By 1623, the Dutch West India Company's proprietors decided to enlist outside help in maintaining their area of control. This was accomplished through a policy of colonization.\(^{32}\) The Keurs write that "in 1628 a group of merchants
TABLE 10

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Rainfall (mm)</th>
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<tbody>
<tr>
<td>1962</td>
<td>1</td>
<td>156.8</td>
</tr>
<tr>
<td></td>
<td>2</td>
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<td></td>
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<td>101.4</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>113.4</td>
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<tr>
<td></td>
<td>6</td>
<td>68.3</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>52.8</td>
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<tr>
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<td>40.0</td>
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<td></td>
<td>12</td>
<td>111.2</td>
</tr>
<tr>
<td>1961</td>
<td>1</td>
<td>120.9</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>125.8</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>128.1</td>
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<td>128.5</td>
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<td></td>
<td>11</td>
<td>128.23</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>128.24</td>
</tr>
</tbody>
</table>

Average Yearly and Monthly Rainfall
from Zeeland [Holland] obtained a charter from the Company which led to the establishment of settlements on St. Maarten (1632), Saba (1640), and St. Eustatius (1636) . . .33

The islands of St. Eustatius (Statia) and Saba were perhaps first viewed by a Dutch ship in 1626, when Admiral Piet Hein, a pirate, sailed by.34 French and English colonists first attempted to settle Statia in 1625, and again in 1629, but were forced to leave, due to inadequate supplies of water.35 The first successful settlement was placed on Statia circa 1632 by the Dutch West India Company. The colonists were probably of diverse national origins, and under the command of a Dutchman from the province of Zeeland. (Jam Snouck has been named as the first commander on Statia.)36 The Keurs write that the Dutch Windwards were "populated by evacuated sugar planters from Brazil, seamen and soldiers left behind by ships, adventurers and privateers, as well as French and English from neighboring islands."37 By 1636, the Dutch West India Co. considered the colony as permanently settled. Their success has been attributed to their knowledge of cisterns, and the successful application of that technology on Statia.38

The Dutch West India Co. owned the land on Statia. Statia's rich, volcanic soils offered good potential for agricultural development. The period rainfall, combined with irrigation and efficient catchment systems, led to a full utilization of the land. Statia's physical location, adjacent to French and English colonies, allowed for a further exploitation of the island, as a trading center. The dual potential of Statia was recognized by the Company from the beginning and encouraged.
The Company sold various grants of settlement rights to people in Europe. The grantees rented out parcels of land to the colonists, who were often recruited by them. Further, certain parcels of land were set aside as a form of payment to the soldiers and the governors of the island. The Company granted rights of land use to private individuals, the grantees described above, who had to "settle a certain number of colonizers within four years in order to have his grant recognized. His duty was to develop the land, his aim 'to plant tobacco and make good profits.'" The grantees financed the colonists and bought their tobacco, cotton and sugar cane when it was shipped to Europe.

The colonists first planted tobacco on small plots of land in 1636. Tobacco from Statia was first sent to Holland in 1638, and again in 1639. Hartog writes that tobacco plantations were "even to be found on the slopes of the hills" by 1650. Statian tobacco continued to be grown and shipped to Holland until approximately 1680.

During the seventeenth century, Statian farmers planted tobacco, indigo, coffee, cotton, and sugar. They also herded cattle. It appears that the colonists concentrated their efforts more on tobacco production than on sugar, as there were only 5 sugar mills located on the island in 1688.

The vicissitudes of wars—forced migrations, burned crops, steep taxes, and general disruption of the agricultural cycle—plagued the Statian farmers throughout the entire seventeenth century. The island planters had to practically defend themselves, partially because the trading aspect of Statia was of more interest to some of
the Dutch West India Company officials than agriculture. In fact, "their High mightiness of the States-General of Holland were still not particularly interested in the Dutch-American settlements, except as trading centres . . . the local planters had no say in the policy of the colonies and only a nominal part to play in their administration." By the early eighteenth century, the Company had sold large acres of land to private individuals, which was the beginning of a "small and limited plantocracy."^49

At the turn of the century, many small farmers were going broke, and their lands were repossessed. The disinterest in Holland, combined with the numerous small skirmishes between Dutch, French, and English had taken its toll. Further, there was a real labor problem on Statia. This labor problem was typical of most early colonial settlements which stressed agricultural development. The Dutch, unlike the English and French, had never developed an indentured servant policy.

The respossessed lands of the small farmers was added to the growing estate holdings of the larger planters. It was used for cattle or sheep grazing or growing sugar cane, or was left abandoned.

The labor problems on Statia were solved by the importation of African slaves. This took capital on the part of the planters, which the small farmers lacked. The Dutch West India Company monopolized the region's slave trade with an asiento that it held from 1662 to 1722. (After 1722 the trade was opened to all and sundry.) The population on Statia in 1665 was about 1600 persons, "half of them slaves."
Statia soon became a major slave depot. The nearby British planters bought Dutch slaves, two to three thousand per year, as they were cheaper than those sold by the British merchants. (Generally the planters were from St. Kitts and Barbados.) The Keurs write that "slaves were also needed for the local plantations and their numbers in the population increased steadily . . . ." Population figures for white/African inhabitants on Statia show a tremendous increase. The table below shows that in 1715 the ratio was 524/750, in 1742 860/1586.

<table>
<thead>
<tr>
<th>Date</th>
<th>Slave*</th>
<th>White</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1705</td>
<td>303</td>
<td>303</td>
<td>606</td>
</tr>
<tr>
<td>1715</td>
<td>750</td>
<td>524</td>
<td>1274</td>
</tr>
<tr>
<td>1742</td>
<td>1586</td>
<td>860</td>
<td>2446</td>
</tr>
<tr>
<td>1750</td>
<td>1513</td>
<td>802</td>
<td>2315</td>
</tr>
</tbody>
</table>

*The first slaves in Statia were Indians, mostly from Dominica. It is not known when African slaves replaced those Indians. Further, the number of Indian slaves or African slaves living on seventeenth century Statia is undetermined at this time. See Hartog 1976, p. 19, p. 21. No mention of the use of Indian slaves during the eighteenth or nineteenth centuries has been found.

Dr. Jaap van Soest writes that the Dutch Windwards "were not so overwhelmingly dependent on trade as was Curacao." Nevertheless, the trading aspect of Statia became increasingly important, completely overshadowing agricultural development in the late eighteenth century. As early as 1671, much of Nevis's and Antigua's agricultural products were shipped from Statia by Dutch merchants. By
1690, "some 1,500 hogsheads of Leeward Island sugar annually went out the 'Back door for Holland, under the name of St. Eustace sugar.'"\textsuperscript{58}

This growth in trade, stimulated in part by the slave trade, fostered the apathetic attitude in Holland towards seventeenth century Statian farmers.

The growing importance of Statia's trading port was not unnoticed by other nations. The flaunting of British and French navigation acts instigated reprisals. On April 3, 1689, Statia was taken by the French Admiral Blenac with 1,200 men and 17 sail. The French justification for this act was that Statia was "well stocked with slaves, sugar and European merchandise to be sold to all comers, particularly to French colonists, this in the face of all efforts to suppress them."\textsuperscript{61} All Dutch inhabitants were resettled to Nevis and the colony was destroyed. 345,656 Livres profit from the sale of plunder was realized by the French on the markets of Martinique.\textsuperscript{62}

The Dutch had regained control of the island by 1701. At that time the Company Commander was one Isaac Lamont, a man despised by both the Dutch colonists and their French enemies. Lamont was accused of gross negligence of Company sugar and cattle estates "in favor of his own."\textsuperscript{63} But the Commander did successfully retake St. Martin in 1702-03 and later became Commander of all the Dutch Windwards.\textsuperscript{64} Lamont's lackadaisical defense of Statia led to an easy French victory in 1709. The French commander, Du Plessis, was appalled at the ease of success of his night raid. A Captain Heyliger, not Lamont, led the colonists to escape in the hills, accompanied by planters and their slaves. The French set "first to churches, sugar-mills and private property."\textsuperscript{65}
Statia was thus taken and retaken, settled, disrupted, and resettled. The international character of the inhabitants continued from initial settlement in 1632 through the nineteenth century, and even continues today.

Many diverse ethnic groups have settled on Statia. The use of the island as a slave depot led to the use of English as the language of trade. As mentioned previously, the West Indies saw frequent migrations of diverse population groups. During the eighteenth century, British planters, especially from Barbados, resettled and/or invested in Dutch colonies. They especially concentrated on Essequibo, Berbie and Demerara, located in South America. Sheridan writes that in 1744 Essequibo held seven British plantations. That number increased to at least 56 by 1769. These planters would christen their new homes with names like "Irish Hope," "York," "Glasgow," "Richmond," "Dundee," and "Tweedside." The existence on Statia of plantations bearing the appellation "English Quarter" or "Scottish Quarter" (Schoestinhoek) indicates that descendants of planters from the British Isles settled on Statia. This group would have come as sugar planters.

That sugar was produced on Statia has already been indicated. Further proof is found concerning the introduction of the Javanese purple and striped variety of cane introduced by the Dutch to Statia, Guiana, and Curacao in the 1750's. This variety, Otaheite Ribbon Cane, was in turn introduced from Statia to Savannah, Georgia, in 1814. By 1781, Statian sugar planters produced approximately 600 hogsheads of sugar annually. The loss of records through war and
neglect, combined with the falsification of documents to hide foreign-produced sugars, under the name of Statian sugars, makes it hard to determine the annual sugar production of solely the Statian planters.

Historians seldom mention the sugar production and attendant agricultural development of Statia. The monotonous routine of the planters has been overshadowed by her notorious trading activities. An example is found in Spinney's remark that "there were a few sugar plantations, it is true, but what made St. Eustatius famous—or infamous—were the great stone warehouses..."70 In 1778 those "few" plantations were populated by 120 whites and 1200 blacks.71

Statia's continued status as a neutral port allowed for international trade, despite wars and European trading regulations. Jameson states that, in fact, "St. Eustatius flourished still more, and drew in a far larger population than that of peaceful days."72 Merchants appear to have flocked to Statia's only town and port, Oranjesta, from the period spanning the late seventeenth to late eighteenth centuries. Merchants of any nationality could attain classification as a burger after only 18 months' residency on the island. This status enabled them to "enjoy various commercial advantages."73 An example of a group of foreigners migrating to Statia for trade is found in the Jews. In 1721 a group of Jews left Brazil and migrated to Statia. There they were quickly absorbed by the Oranjestad business community.74

In 1774, Janet Schaw took ship from Scotland for the American colonies. Fortunately, she kept a colorful, detailed account of the trip (1774-1776). En route to North Carolina, she stopped briefly at
Statia. She wrote that "the Island itself [is] the only ugly one I have seen." Miss Schaw did not like the disorderly conduct of the tobacco smokers, but did enjoy the diversity of people on Statia. She writes, "But never did I meet with such variety; here was a merchant vending his goods in Dutch, another in French, a third in Spanish, etc. etc. they all wear the habit of their country, and the diversity is really amusing." Her description of the merchants and their goods portrays a lively, disorganized scene in the lower town. She writes, "But it were endless to enumerate the variety of merchandise in such a place, for in every store you find every thing be their qualities ever so opposite."

Many of the merchants were Englishmen who resided on Statia as Burgers. By 1780, England was at war with France, the United States, and Spain. All of the merchants continued to trade with shipowners of any nationality. England was increasingly enraged by the "illicit" trading on Statia. For instance, in 1776 the American rebels began to buy armaments on Statia, sometimes from British merchants. Also, Franklin sent secret letters and envoys to Paris via Statia. The final, damning act in British eyes was the November 16, 1776, salute that occurred between the Armed Continental ship, the Andrea Doria, and Ft. Oranje. The salute was instigated by the Americans, but responded to by order of Statia's governor, Johannes de Graffe. This was the first official recognition of the United States by a foreign power. Political maneuverings raged on the continent between Holland and England over the account. Finally, England declared war on Holland, on December 20, 1780. That same day orders
were dispatched to Sr. Georges Rodney, Admiral of the British Caribbean Fleet, to take St. Eustatius. 81

Rodney had personally hated the island merchants on Statia for a long time. He considered them traitors to England, calling them a "nest of vipers." Rodney was able to take the island in one hour, when the island surrendered without one shot being fired. The Americans on Statia did offer their services to fight, but were turned down. One can understand their desire to fight when one realizes that over two thousand Americans were eventually captured on Statia. 82

Rodney's handling of the captured island has been debated in the literature. He has been viewed as everything from a sickly old man to the meanest nip-cheese and despot. 83 Personally, Rodney was proud of his work. In a letter to his wife he writes, "The Dutch have been drubbed in such a manner as not only the City of Amsterdam, but all Holland, will feel the blow, as well as many of our own people in London. I will teach them for the future not to supply the enemies of our country with the sinews of war; they suffer justly." 84 All of the property on Statia was counted, weighed, and shipped to England. This was a huge undertaking, as Rodney writes, "All the magazines and storehouses are filled, and even the beach covered with tobacco and sugar ... " 85 All French, Americans, Jews, Dutch merchants, "guilty Bermudian and British" were removed from Statia. The Lower Town was demolished, warehouses de-roofed and the breakwater destroyed. This allowed the sea to finish the devastation of the warehouse district in Oranjestad. 86
The planters on Statia were the only inhabitants allowed to retain their estates. Rodney admired the members of the small plan-tocracy. In a letter to Philip Stephens, Esq., from Statia, dated March 6, 1781, Rodney states:

The very few respectable men in this island were those who owned the sugar plantations. Few of them were concerned in the per-nicious commerce which proved so detrimental to Great Britain. The above indicates that perhaps a few planters had trading interests. The extent of their merchant activities is unknown at this time. Rodney did have detailed lists of the contents of the warehouses and their account books, as all records were confiscated and sent to England; but Rodney's rough handling of Englishmen on Statia led to a great political debate spurred by the relatives of the merchants. Rodney was taken to court, a number of times. A change in the admin-istration in England led to a mysterious "loss" of all Rodney's evidence--the incriminating warehouse accounts.

Rodney occupied Statia for three months. After that period, the records are mute as to who was in charge of the island. There is a letter from one Zimmerman the Elder, who states that by 1790 Statia was once again prosperous. He calls it a "little Amsterdam" with its 600 warehouses in use in the lower town. By 1792-93 the French took over the island, taxing her new-found prosperity to oblivion. Hiss writes that the island was taken over by the French in 1795, taxing the population 8,000 Spanish florins. He says, "The latter soon proved to be an impossibility, for the population was by this time totally impoverished, and many thousands of people left the island, in spite of laws enacted to prevent their departure."
By 1800, the entire southeastern portion of Statia was reportedly being cultivated. Rodney had not devastated the planters' estates, and they probably continued to grow their sugar cane and other agricultural products. The French takeover and subsequent taxation may or may not have affected those particular planters. Nevertheless, sugar was planted on Statia, producing approximately 500 tons of sugar in the year 1816. The planters of this sugar could have been new immigrants to Statia, buying estates during the late eighteenth century decades of upheaval, and/or the original plantocracy. I do know that the first owner of English Quarter, John Williams, died in 1809. The estate probably dates its beginnings to that post-1781 period on the island. John Williams was English, and would have had good opportunities on the island after the English takeover. As Rodney was suspicious of all Englishmen living on the island at the time of his capture of it, I seriously doubt if Williams would have been on the island prior to that time. Rodney would probably have taken away his estate, thinking him a traitor, especially if Williams had any connections to trade.

The market demand for sugar was fluctuating madly throughout the early years of the nineteenth century. Remember, Napoleonic wars, slave rebellions, the growing influence of the abolitionists' movement, the increased production and development of beet sugar, and the Dutch concentration of growing East Indian sugar all greatly affected the price and the demand for West Indian sugars. By 1828 the production of Statian sugar began to stabilize "at 200–250 tons per year." Sugar production on St. Martin was about 300 (1825) to 450 (1826) tons
per year, until approximately 1848. At that time the Dutch slaves on St. Martin fled to the French side of the island to freedom. Van Soest writes that "the same downward trend was evident on St. Eustatius, although it began somewhat later but then was faster." It appears that Statians continued to produce sugar successfully until the official abolition of slavery on Dutch islands in 1863. For instance, the Keurs viewed an 1830 map of Statia, Carte Topographique de L'Ile Saint Eustache par Samuel Falsberg, that showed thirty-eight plantations. The Quill, Cultuvrylakte, and even Little Mountains were cultivated. Hartog mentions that most of the island was still cultivated circa 1850. In 1855 Statia exported £65,790 worth of goods, including sugar, rum, and vegetables.

The English Caribbean production of sugar from 1839 to 1856 was only "about two-thirds of that in 1821." Slave-produced Dutch (and Spanish) sugars could have been in great demand during the acclimatizing periods resulting from the French and British abolition of slavery. Their abolition of slavery greatly disrupted their island cultures, including sugar production. Evans' treatise on improving sugar production mentions that British free-grown sugar could possibly be made cheaper than slave-grown, through technological improvements. Obviously, he viewed the slave-grown sugars as stiff competition.

Evidence of the prosperity of Statian sugar planters can be found in the 1857 refurbishing of English Quarter. At least three additions were apparently built at that time, including the stone arch depicted in the beginning of this thesis. The arch, with its pink marble keystone (EQ, 1857) symbolizes prosperity, and an investment in the estate.
With the abolition of slavery on July 1, 1863, that prosperity declined. From 1819 to 1862, Statian sugar works produced 400,000 to 500,000 pounds of sugar per year; 10,000 gallons of rum; and 1,000 gallons of molasses. After abolition, the Keurs believe that the stigma of slavery was attached to agricultural labor. At that time the slaves had the "choice of becoming agricultural laborers or buying or renting (for money or 1/3 the crop) a piece of land." Many planters refused to sell any of their land. Further, most freed slaves were not financially able to buy property. The majority of freed slaves seem to have left their plantation quarters and moved into the town of Oranjestad. In the Keurs' opinion, "The plantation owners could not obtain people to work the land, fields reverted to brush, homes were abandoned, and exports stopped completely."

By 1871, St. Eustatius could meet only 11 percent of her expenditures, not getting "out of the red until 1882." Various adaptive strategies were employed by the nineteenth century Statians to revive their economy. In five rough categories, these schemes concerned (1) animal husbandry, (2) agricultural diversification, (3) reviving trade, (4) periodic off-island work, and (5) migration off-island.

Statia has never forgotten her golden years as a major trading center (late 18th century population about 37,000). In March of 1828, Commissioner General Vanden Bosch toured the Dutch islands. He recognized the economic plight of the island and ordered three changes to revive trade. First, Statia was again opened up as a free,
neutral port. Secondly, he revised the fiscal system to encourage investment. Last, Vanden Bosch ordered the construction of a small quay. As often happens, financing for the new developments was not obtained. Dr. van Soest writes that "the quay was only half-finished and did not weather the first storm, and the commerce of St. Eustatius did not revive." Only two major nineteenth century exports appear to have successfully left the island, labor and agricultural products.

After abolition, Statian planters apparently re-invested capital, time, land, and energy into diversified agricultural crops. These crops, such as sweet potatoes and yams, were less labor-intensive and grew extremely well on Statia's volcanic soils. Exports near the turn of this century have been estimated at "millions of pounds" of the vegetables. These vegetables also served as a principle island staple. By 1824, Statians exported f. 1,073 of sweet potatoes and f. 5,888 of sweet potatoes to Curacao, which continued yearly until about 1940.

Some Statian farmers did continue to plant sugar cane, but in much smaller amounts. In the early 1900's, "cheap" rum was produced at Fair Play estate, from about 50 acres of cane. The Keurs mention that a 1900 tiny sugar factory on Statia was "run so inefficiently that only 50% of the sap was utilized, and it was soon abandoned." A muscovado factory was built in 1917, but also proved to be inefficient. Farmers did ship cane to a factory on St. Kitts (in Basseterre) up until about 1933, for processing. The government experimental farmers grow some cane today, but with no
apparent method of processing the juice. The years of Statia's cash-
cropping only sugar ended in 1863. Even sugar for home consumption
had to be imported to Statia after about 1923.112

Various attempts at monocropping have continued on Statia
since the early 1900's. In particular, Dutch and British firms
attempted cotton and sisal production. Sea Island cotton from the
U.S. Atlantic coast was transplanted in 1909, growing very well. A
small gin was built in the Lower Town. The industry peaked between
1913 and 1915, influenced by the First World War. The majority of the
cleaned and packed cotton was exported to Belgium, and the war effec-
tively halted the industry by the end of 1915.113

In 1909, a British and Dutch company planted sisal on over
1,000 acres on Statia. The downfall of that project has been attri-
buted to poor management.114 Sisal was again planted in 1914 by Dutch
investors. Dr. van Soest believes that "the sisal cultivation of St.
Eustatius flourished for a few years between 1915 and 1923, before
disappearing for ever [sic]."115 No explanation for the discon-
tinuation of the industry has been given. The ruins of the sisal mill
may still be seen on the road to Whitehall, with much of the machinery
left intact.

Besides yams, peanuts, sweet potatoes, sugar cane, cotton,
and tobacco, Statian farmers probably planted many diverse vegetables.
Present farmers grow, usually in small, multi-cropped plots, bananas,
sweet peas, yams, sweet potatoes, and numerous other vegetables.
Coconut trees were planted successfully circa 1930, but are not common
on the island.116 Fruits such as soursop, mangoes, and star apples
are also grown.117
Some nineteenth and twentieth century estate owners hedged their survival with a combination of agriculture and stockbreeding. The abandoned bush makes fine grazing for cattle, goats, and sheep. Lack of water serves as the primary limitation to stockbreeding today. It would be wonderful to discover how the earlier farmers handled the problem of watering their stock. Perhaps they utilized water systems developed previously for running a large sugar plantation—cisterns, irrigation pools, and ditches. (One modern irrigation pool was observed at Venus Bay.)

Kruythoff writes that both St. Martin and Statia are located in the "cattle belt" region, where cattle tend to thrive. He also states that both islands ran "quite a cattle industry" until about 1914. The majority of their stock was imported to Curacao, where a high demand existed in the early 1900's. Stockbreeding was apparently cheap, simple, and profitable during that period.

Various Dutch farmers have attempted (1930's, '40's, '50's) to cultivate about 1,000 acres on Statia in combination with cattle breeding. Failures, due to poor management, droughts, and insects occurred each time.

Some Statians still raise a few cattle and numerous goats. Poaching appears to be common, and many animals are lost during periodic droughts. Owners state that their most pressing need is the construction of water catchment systems to water their stock. At present, their stock is dependent upon them to come and water them at least once a day. At present, there does not seem to be a high market demand for their meat animals, either locally or off-island, except from Sabans.
As labor-intensive agriculture production declined on Statia (sisal, sugar, cotton), there was an overabundance of labor on the island. From the decades of the early twentieth century, Statians have either permanently or periodically migrated off-island to find work. Holland, the U.S.A., and the other Dutch possessions in the Caribbean are the areas most often chosen for resettlement and/or employment. The table below depicts the population of Statia from 1816 to 1974.

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<thead>
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<tr>
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<td>?</td>
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<td>?</td>
<td>?</td>
<td>921</td>
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<tr>
<td>1960</td>
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<td>?</td>
<td>1014</td>
</tr>
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<td>1974</td>
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<td>1421</td>
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</tbody>
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As the oil industry developed on Aruba and Curacao, circa 1925, migrant Statians moved to the Leewards for employment. They generally sent part of their pay home to Statia for their families. By 1950 the majority of the oil refineries had become automated, and the unemployed Statians returned to their island. The table shows this slight increase in population by 1960. Dr. van Soest states that most Statians, unlike some other migrant worker groups, preferred to return to their island when their work ended or if they wished to retire. He believes that they were able to retire or return and subsist due to a combination of stockbreeding and agricultural strategies.
such as mentioned previously. A dwindling number of Statians do still follow that survival strategy.

Of the five adaptive strategies employed by Statians, the combination of stockbreeding and agriculture has been the most successful. The present survival strategy for many Statians appears to be obtaining government employment and subsidies.

The inhabitants of English Quarter have followed the same changes in economic emphasis as the majority of the Statians. Through 1857, and probably 1863, they produced sugar, based on slave labor. During the latter part of the nineteenth century, the owners bred stock, horses and cattle on the estate.

The following section gives a specific account of the history of English Quarter, demonstrating the pattern of planter to cattle breeder to final abandonment of the estate.

**Family History/English Quarter**

A doctor from Galway, Ireland, O'Flaherty by name, married one Maria Solomons (?). They had one daughter, at least, by the name of Maria Arabella O'Flaherty. Maria Arabella (later known and loved on Statia as "Mammy") was born 23 October, 1786, and died 21 September, 1830, at the age of forty-three years. In that relatively short lifetime she outlived two husbands, and was happily married to a third when she died.

Maria Arabella's first husband was a Mr. John Williams. He is thought to have been the first owner of English Quarter, deriving its name from his homeland. Williams' estate included 45 adult slaves
with 13 children. The duration of their marriage is not presently known, as no known marriage record exists.

Maria Arabella's first known child is one David Young Campbell, born on Trinidad on 8 February, 1815. Maria Arabella must have been remarried to a member of the Campbell family. It is not known whether her husband was given any control or ownership rights over English Quarter at that time. I do not know if they lived on Statia. Mr. Campbell died sometime in the early nineteenth century, leaving Maria Arabella a widow once again.

The third and final man in Maria Arabella's life was a man of Dutch extraction, Theodore Godet Heyliger. He was born 4 November, 1790, and died on 8 May, 1845. The date of 1831 has been given for his marriage to Maria Arabella. "Papadorey," as he was affectionately called, owned Broadview Plantation (Ruinsicht) on Statia as the time of their marriage. He acquired English Quarter by the marriage, and later added the estates of Willemstad, Fairplay, and Roots to his proprietorship. Theodore Godet Heyliger did not like to call his enlarged estate English Quarter; he preferred the Dutch name "Willemstad en Ruinsicht."

In 1831 Willemstad en Ruinsicht had 78 slaves on it and was worth F 160,965.25. The plantations of Fairplay and Roots had a contingent of 23 slaves, their combined value was F 54,240.

Although he owned valued estates, in 1839 a depression of sorts seems to have affected all planters on Statia. At that time, Theodore and his brother, Engle Heyliger, carried a petition to the King in the Netherlands stating that the colony of Statia was "reduced to the last extreme of poverty." (Calmeyer, as translated to me by
Mr. Lampe.) I could find no other supporting evidence or explanation of hard economic times on the island at that time. I do know that the economy must have picked up soon after. (See previous chapter discussion of sugar production on Statia after 1800.)

Theodore Godet Heyliger and Maria Arabella (alias O'Flaherty, Williams, Campbell, Heyliger) willed their estate to her son, David Campbell and their three own children. (Engel/Engle Heyliger, born Statia 23-4-1820, died 11-4-1872 (?); John William Heyliger, born Statia 10-10-1822, died Curacao 19-7-1840; Maria Arabella Heyliger (II) born Statia 19-10-1823, died 28-1-1870.) David Young Campbell was the executor of the estate. This half-sister, Maria Arabella (II) inherited English Quarter. (John Williams, of course, didn't live to come of age.)

David Campbell married Alleta DeGraaff Godet on 30-11-1839. They had no issue. Campbell must be credited with the 1857 refurbishing of English Quarter. He also must have preferred the English name for the estate, as the entranceway keystone is inscribed with English Quarter, not Willemstad on Ruinsicht. Campbell is also credited with the building of a second house on the plantation, adjacent to the old.

David Campbell's half-sister Maria Arabella Heyliger (II) is said to have been a real beauty. English Quarter was the site of many balls, with carriages and men on horseback crowding the gateway. The English officers stationed at Brimstone Hill, St. Kitts, often attended the balls at English Quarter. The "island beauty," Maria Arabella (II) met and married one of those officers, a Lieutenant Peter John Macdonald. Lieutenant Macdonald was born in Kent in 1822.
He later fought in the Crimean War as a Lieutenant Colonel in Br. 4th West Indian Regiment. He died sometime in 1862.

It appears that the Macdonalds lived in England at least for part of the duration of their marriage. The Lieutenant's military career probably dictated their movements. They had two daughters, Maria Arabella Heyliger Macdonald (III) and Marina Eliza Heyliger Macdonald.

David Young Campbell's will is dated 19 November, 1866. He left one-third of English Quarter to Marina Eliza and two-thirds to Thomas Nelson Cockfield Pandt.

Marina Eliza was also said to have been a great beauty. She was a renowned horsewoman on Statia, too. Possibly, she and her mother and sister returned to Statia after her father Peter John Macdonald's death. Marina Eliza is said to have been the real favorite, the darling of the entire family. In fact, an addition located in the northeast corner of the main house structure at English Quarter is said to have been her own special room. The second and late Thomas Nelson Cockfield Pandt (II) told stories of how he and the other Pandt children would play in the upper story, wooden, of the room, calling it Bluebeard's Castle.

Marina Eliza never married. She left her share of English Quarter to her sister Maria Arabella (III)'s children.

The story of the inheritance of English Quarter gets somewhat more complicated at this point. Remember, Campbell left two-thirds of his estate to one Thomas Nelson Cockfield Pandt. This Thomas Nelson, his nephew, is the first with the name Pandt to be associated with the
site. He was the son of Jane Barley Hill and Henry Herman Pandt, who were married in 1829. Now Engle was the name of Papadorey's brother who helped to petition the Queen in 1839. Further, the family name of David Young Campbell (II) appears as another brother (see list following). Thus the Hill-Pandts must have been closely related to the Heyliger-Campbell group. The connection deepens when one learns that his brother, Engle Heyliger Pandt, married Maria Arabella (III) in 1874.

Engle and Maria had ten children (see list following). For reasons unknown, Maria Arabella (III) did not inherit directly through David Campbell as her sister Marina did; but her children inherited a portion of English Quarter through her sister Marina's one-third share. Only seven of Maria and Engle's ten children outlived Marina Eliza's 1942 death.

Thomas Nelson Cockfield Pandt married Domingas Angelista Bitoria. They had two daughters. Upon his death, Peter John Macdonald Pandt bought Thomas Nelson's share of English Quarter (two-thirds of the estate). The deed of sale is dated August 1927. Peter John Macdonald Pandt (1877-1938) was one of the seven surviving children of Maria Arabella (III). From 1927 to 1938 he was the major owner of the estate. He followed the major island pattern mentioned earlier, raising stock on the plantation.

Mr. Lampe writes that "they are all dead now. The last one, Thomas Nelson Cockfield Pandt [Peter John's brother] died this year in Orlando, Florida." The death of Thomas Nelson (II) has left a welter
of legal battles over the inheritance of English Quarter. All pertinent documents are being held by a legal firm in Miami at present, and are unavailable for research.

A newspaper article written 25 June, 1908, on Statia recounts that a gale occurred on March 7, destroying many places on Statia. Structures on English Quarter were listed among those destroyed. The author of the article called English Quarter "Ruimzicht en Curacao," Broadview and Curacao. Thomas Nelson and Mrs. M. Macdonald (Maria Arabella) were listed as the owners and as residents of Statia.

This same article mentions that restoration of the structures had begun after the storm:

[A] completely new building of two stories had been put up, standing apart from the old one. Scarcely had all the work been finished when everything was reduced to ashes. On Saturday, 6th of June, the carpenters had just put the finishing touches to it, and the night of June 7 to 8 everything was burnt to the ground.128

Children of Jane Bailey Hill and Henry Herman Pandt (married 1829)

1. Ann Hill Pandt
2. Henry James Pandt
3. Maria Pandt
4. John Heyliger Hill Pandt
5. Engle Heyliger Pandt (married Maria Arabella Heyliger Macdonald)
6. David Young Campbell Pandt
7. Thomas Nelson Cockfield Pandt (I)

Children of Maria Arabella Heyliger Macdonald (III) and Engle Heyliger Pandt (married in 1874)

1. Maria Arabella Macdonald Pandt (IV)
2. Mariana Henrietta Jane Pandt
3. Peter John Macdonald Pandt
4. Aletta Campbell Pandt
5. Ida Eliza Pandt
6. Henry Herman Pandt
7. Ann Hill Cockfield Pandt
8. Maude Aileen Pandt
9. Theodore Alfred Macdonald Pandt
10. Thomas Nelson Cockfield Pandt (II)
It is not known if English Quarter was inhabited until storm destruction forced Marina and/or Thomas Nelson to move into town during repairs. Perhaps it had already been abandoned, and one or both owners had decided to repair the structures and re-inhabit the plantation. Nevertheless, the plantation was never lived in after that fire. Islanders say that two "no good" men were quickly apprehended and jailed for the arson. All islanders knew who those "jealous" men were and why they fired the plantation. But no one today remembers why or who—only that there was an envious reason for the arson.

English Quarter was transformed through the years from a sugar plantation of intense energy and many inhabitants, perhaps peaking sometime shortly after 1857, to being a cattle station. Either after the fire in 1908, or even sometime before that date, the empty walls of English Quarter were used to house cattle. Windows and doors show evidence that the walls were used as animal pens. (Many were found to have been blocked up with rubble and dry-laid walls, especially at the sugar factory site.)

The Royal Dutch Marines have used the site for maneuvers in the past, until some of their members stole the pink marble keystone over the arch. This was noticed by Mr. Lampe and friends passing by, who quickly contacted the government on Statia. The Marines were contacted and returned the keystone. Mr. Lampe now retains the stone in his safe possession, as guardian. Evidence of the Royal Dutch Marines' maneuvers may be found at the site, in charred remains of fires in arched openings and by the empty bullet cases scattered across the site.
Since the early 1970's, Cyrill Teer has been renting the land for grazing his goats (probably through Wesley Pandt). English Quarter is now the home of the accacia, Jack Spanier (wasps), goats, and the occasional bovine visitor. The wooden upper stories of the structures are gone, and the island vegetation is slowly pulling apart the stone foundations at the site. In the summer of 1982 the site was cleared of thick brush, and for the first time in years the strong stone walls were seen once again. The section that follows contains a brief description of the field methodology used during that summer of intensive archaeological survey at English Quarter.

Research Design

Plantations have been studied intermittently by historians, cultural geographers, and historical archaeologists at least since the early twentieth century. Until very recently (Pulsipher and Goodwin 1981), these studies have been undertaken in practically a vacuum, the only interdisciplinary approach being that of historical archaeology. Historical archaeology inherently combines historical and archaeological research. The majority of reports have been descriptive, selective, and/or synchronic. There is nothing wrong with such reports, they generate needed information; but I sincerely hope that some researchers will begin to synthesize their results with those stemming from other disciplines researching the same fields. I hope that a larger picture of human adaptations will emerge from such combined studies. It is time for a paradigmatic change in our approach to plantation studies. It is time for a multi-disciplinary approach within a coalescing framework, such as is found in systems theory.
Plantation studies should address a central question or series of questions, such as ethnicity, evolutionary process, or cultural change.

Archaeologists, historians, and scholars of other disciplines are becoming increasingly interested in researching the lifestyles of diverse groups, ranging from the poorest to the highest on the socioeconomic scale. Systems theory development has affected the approaches of various disciplines and concomitant hardware like computer technology has led to new methodologies. New methodologies have led to the discovery of "new" information and theories. (An example, from social history, is found in Philip D. Morgan's 1982 "Work and Culture: the task system and the world of lowcountry blacks, 1700 to 1800." ) Many scholars would agree that a culture constitutes a system formed by the interaction of various components. Thus cultures are perceived as dynamic, never static, and inter-related further with the physical and social environments. The process of interaction is conceived as two-way, or multiple, and never as singular. The various disciplines concerned with the study of the early developmental history of the American and Caribbean colonies are now beginning to realize that understanding of that early development will best be derived by research into the interaction of all of the involved subgroups. The emerging focus on the poor and the "ordinary," versus extraordinary people and events, is still in its infancy—particularly research directed toward emic and etic understanding of the institution of American and Caribbean slavery.
Prior to the 1960's, knowledge of Afro-American slave culture had to be gleaned from plantation records, the travelogues of biased observers, and disjointed oral accounts compiled under the WPA. Beginning with the work of Fairbanks in the late 1960's, and continuing sporadically to the present, museum personnel, archaeologists, social historians, and anthropologists have re-examined old evidence with new questions and techniques. The combination of results has revolutionized our conceptions of Afro-American slave life.

Prior to these types of investigations, it was believed that slaves were so degraded and traumatized that they carried no remnant of their own cultural identities with them to their "homes." Further, slaves were given no credit in their own cultural development spanning the approximately 400 odd years of their existence in connection to European powers. When viewed in total, the new investigations into slavery and Afro-American survivals create a mutually reinforcing picture. Plantation, slave-based economies are pictured as economically sound, with the slaves playing an active part in plantation developments. Slavery appears as an institution containing both spatial and temporal differences. Exploration of the regional and temporal similarities and differences is just beginning, and it seems as if no single causative factor such as climate or major agricultural crop will be uncovered to explain these differences. Slavery and all its myriad ramifications for all early colonies still needs to be fully researched.

Mac Goodwin (1983) would like to see plantations studied under the framework of evolutionary theory. He plans to study a sugar
plantation on Montserrat, Galways, with Lydia Pulsipher, with that question in mind. It is hoped that his results will be comparable to the works of anthropologists studying nineteenth and twentieth century plantation life on the islands.132

Another possible approach to plantation studies would center around the question of ethnic identity. The work of Moerman (1965), Barth (1957 and 1972), Leach (1954), and Sankoff (1980), stemming from a combination of interests in linguistics and social structure, raise numerous interesting questions about the identification of an ethnic group: through language, territory inhabited, and material culture. Their work with living peoples should stimulate research questions that could be combined with archaeological methods to enable us to better understand the process of ethnicity. At present, archaeological investigations into ethnicity have been devoid of anthropological theorizing. Purely descriptive accounts are fine, but a combination of research questions arising from two different research methods should enhance our understanding of the problems and actions concerned with ethnicity.133

I approached my work at English Quarter with hopes of not simply emulating Otto, Drucker, and Deetz. I wanted to discover ethnic symbols of slaves and masters, through material expressions of cultural self-awareness and exclusiveness, perhaps to also discover physical evidence of anomalies. Here was a plantation once owned and/or inhabited by at least three separate groups, English, Dutch, and African! Status differentiation on the part of masters and slaves could be both spatially and temporally explored through artifactual study at the plantation. As documentary research was only a future
possibility, I knew I would have to depend upon evidence of material culture to understand the surface lifestyles on the plantation. Further, I hoped that multi-variate analysis of various attributes would lead to patterns with meaningful connections to ethnicity versus simply reflecting economic differences.

My artifacts never left Statia. Due to a series of unmitigable circumstances, I realized I would not be able to analyze the artifacts from English Quarter. Research questions concerning ethnic identification must await future funding.

The following discussion of my fieldwork and results on English Quarter will necessarily be purely descriptive. I hope that the information given will still stimulate research questions in the minds of the readers and prove comparable to information from other plantation sites.

Field Methodology

On June 29, 1982, I received permission from Melville Pandt to clear, map and surface collect at the site of English Quarter. At 10:00 a.m., Robbie Canwood drove me and one student to the site for an initial reconnaissance. Our first sight of English Quarter was framed by an approximately fifteen-foot-high ashlar stone entranceway, flanked by dry-laid uncoursed rubble walls. Underneath, a brief cobbled pavement abruptly ended, leading to a dirt track about 70 feet wide, that bisected the site. To our right, or east, was a series of stone foundations. To the left, west, tall factory gables and an ashlar stack could be seen. The ruins appeared extensive and complex, overgrown with small trees (acacia, manchioneel) and thick brush.
During a quick survey along the dirt track whiteware, creamware and glass fragments were observed. The artifacts had apparently eroded out and been washed northwards down a slight slope, towards the Atlantic (Windward) coast.

The area of English Quarter proved to be about two acres in size, packed with brush, buildings, and artifact scatters. I knew that the plantation was much, much larger in size, but decided to concentrate on the main structures for the first field season.

Field methodology had to be tailored to fit two limiting factors, time and labor. We had only about four weeks of field time available, and the field crew size varied daily from two to six people. The field research design was very simple. I wanted to clear the area containing standing ruins, map and photograph them and to surface collect the area in controlled units. Further, the remaining plantation lands needed to be surveyed for artifact scatters and/or structural remains.

The entire area was cleared to a point about three feet outside the ruins' outer walls. The field crew used machetes and small and large root clippers to clear the site. Although periodic clearing occurred throughout the entire field season, the major portion of the site was cleared in about one and a half weeks. (I wish to sincerely thank my students, Charlie Lopes and the Barka twins, for their hard work clearing the site.)

On Monday, July eighth, we arrived at English Quarter to discover that someone had bulldozed an approximately 55-foot-wide swath around the perimeter of the site. I soon discovered that Cyrill Teer, who pastures his goats at the plantation, had noticed our
clearing efforts and decided to help. He simply pushed the brush along and outside the site area. The damage due to bulldozing appears to have been minimal, and our archaeological efforts were accelerated.

Throughout the entire period of fieldwork at English Quarter, we maintained a photographic record of our work in both black and white prints and color slides (35 mm film). Further, a two-person team began photogrammetric recordings of the standing structures. The recording procedure used was as follows: a 2¼ format camera (black and white) would be set upon a tripod and vertically and horizontally leveled. As a result, the camera would be at right angles to the wall being photographed. Next, the distance between the camera lens and the structure would be measured in engineering feet and recorded. Finally, a scale demarcated in one-foot intervals would be placed against the structure, and the picture taken. This procedure was used to enable me to measure structural features directly from the photos. Existing conditions plans were either sketched or drawn to scale to provide a check against the measurements derived from the photos. Further, additional general photographs in both black and white and color were taken using 35 mm film.

Figure 16 depicts the portion of English Quarter that was intensively surveyed. As one can see, a basic 50 x 50 foot grid was laid out across the site, using an arbitrary North/South axis running parallel to the eastern wall of cistern A of the factory (SE45-2-A). Additional stakes were placed where needed for mapping and collecting references. The map shown here is a composite map derived from using two methods of mapping, with a transit and an aledade. Again, a
cross-check was assured through the use of two methods, as each instrument carries certain advantages and disadvantages. (Also, the students were able to learn two mapping techniques.) A topographic map was also rendered, using the transit. Topo lines can be viewed on figure 16.

The site was divided into three basic operations, as shown in figure 16. Operation 1 designates the domestic or owner's housing complex. Operation 2 designates the factory area, and 3, what seems to have been the location of the slave quarters. Each structure within each operation received a letter and each wall an additional number. For example, the northern wall of the eastern cistern adjacent to the factory would be called SE45 (St. Eustatius site #45)--2 (Operation 2 or the factory)--A (Building A)--2 (wall 2). The last two digits, always a letter followed by a number, could also be used to designate a surface collection area.

After completion of the basic grid, 25 x 25 ft. collection units were either shot in with the transit or triangulated in and pinned. The size units chosen were the result of a compromise between time limitations and the need for a good control. If a structure was located within one of the 25 by 25 foot collection units, it was collected separately with a different bag number. Thus the size of the collection units was not always uniform. In operation 1, letters A-D designate structures. Letter E depicts surface collections from outside of the structures and across the area. In operation 2, letters A-F designate structures, letter M being the only one reserved for exterior surface collections.
The method employed for surface collecting was one hundred percent walk-over and collection. Any unusual scatters or concentrations were recorded within each square. Odd-shaped units, and disturbed units such as the road, were recorded and collected as separate units. The interiors of all structures were collected in the same manner. In addition, 2 x 2 ft. scrapbacks were placed in each structure (trowel scrapping to a depth of less than one inch). This was to determine if any artifacts lay immediately beneath the brush and structural debris in the structures' interiors. Figure 16 shows the locations of the scrapbacks.

Additional surveys were made to the west, east, and north of the immediate site area to search for additional structures, and/or artifact concentrations. The field crew would walk in transects approximately ten feet apart. The brush was extremely thick (and painful), limiting the amount of area covered. These surveys were undertaken as a reconnaissance, to help plan for future work at the site. Also, Chris Grebey's survey crew measured and recorded the cisterns at the site.

Operation 3 was the result of such a survey. Located approximately 400 feet west of structure Q and 100 feet north of the main paved road was a series of large stone rubble piles. These piles contained large fragments of domestic refuse. This area was mapped and recorded photographically. The piles were 100 percent sampled, surface collection only. (These piles were tested, summer 1983, and proved to be probably slave occupations sites. See notes on file, Anthropology Department, College of William and Mary.)
The entire area of standing structures was thus cleared, recorded, and collected. Limiting factors in the field consisted of numerous wasps, thorns, and having unskilled students having to learn how to carefully and effectively use machetes. All these were quickly ignored or overcome. Two limiting factors arose back in the United States. The first was that our large-format camera took only seven out of 15 photographs successfully. Fortunately, needed information was generally found in the notes, sketches and/or other photos. The second problem has already been mentioned. The washed and bagged artifacts never left Statia for analysis in the States. Thus statements concerning artifact distributions, domestic versus industrial and ethnic and temporal patterns of artifact usage and disposal cannot be included in this report. Results of the artifact analysis should be available in the near future.

The section following contains an architectural description of the standing structures located at English Quarter. The first part consists of a general discussion of the site. The latter portion contains descriptions of the structures, with detailed measurements.

**Site**

English Quarter Plantation is located approximately two miles southeast of the town of Oranjestad, along the only paved road that partially circumlocutes the island, Windward side. (See figure 15 for boundaries, as of 1927 deed of sale.) Local informants believe that the Heyligers and Pandts once owned a good part of the cultivation plain on Statia. The present owners' plantation consists of about 336 acres.
During the field season of 1982, only about two acres of the site were intensively surveyed. These acres contain the standing structures known at the site, including the sugar works and the main housing area.

The topography at English Quarter in the vicinity of the housing and factory complexes is fairly simple. The land gently slopes north by northeast from the main paved road, at the entrance gate, towards the Atlantic coast. Figure 16 is a map of the site, which includes a topographic representation. To construct the map, an arbitrary benchmark was placed just north of the site's entrance gate, at the edge of the cobbled drive. It was given an elevation of 100 ft. One can see from the topo lines on figure 16 that the greatest slope occurs in the southern portion of the site. There is approximately an 8 foot gradual drop between the reference benchmark and stake North 50. The slope becomes increasingly gradual, demonstrated by the approximately 5.3 ft. drop between stakes N50 and N125.

It is interesting to note that the inhabitants of English Quarter utilized the site's natural stratigraphy to their advantage. For example, the animal mill (SE45-2-L) was built on a high portion of the site, built into the slope. As a result, the construction crews had only to build a partial circular wall, able to exclude the northern portion of the trapiche. Their construction of the boiling house south and down slope allowed for gravity troughing of the expressed juice into a waiting receptacle (near SE45-2-J1) in the sugar house below. (Spalding, recall, had mentioned that West Indians
Plate 1a. Housing Complex, View to South

Plate 1b. Factory Complex, View to West
were known for effectively using the topography of their plantations in constructing their works, to aid their sugar production.

Another example is found in the housing complex. A small arched opening was excavated southward into the slope adjoining SE45-1-C, at the time of construction. Brick and flat, red tiles were used to build stairs, placed just north and east and up over the arched structural feature. This allowed entrance to the house above the stone foundations.

As indicated previously, the architectural features at English Quarter are impressive. Regard Plate 1. This is a view to the south, toward the Quill. It depicts, from left to right, structures SE45-1-B, SE45-1-C (see arch mid-center?) and the northeastern addition to structure SE45-1-A (SE45-1-A10). Below, view 1b, is a view to the west of the factory complex. The structure in immediate front is a large, expanded cistern (wall SE45-2-A1). Notice the dirt road in front dividing the two complexes; also, the large, ashlar chimney stack at left and coursed rough-cut gable end at right.

The two photographs in Plate 1 exemplify the quote below:

Since life revolved around the king of crops, it should not be surprising that sugar-works buildings were often magnificent architectural achievements. Except for fortresses, a few public buildings and churches, more care was put into their design and construction than anything else in the islands. Even the treasured great house was less impressive or was sometimes simply a wing of the factory.\textsuperscript{135}

Such was the case discovered when Pulsipher and Goodwin recorded the boiling house ruins at Galways, Montserrat.\textsuperscript{136} The 7.28 x 27.0 ft. stone ruin was substantially constructed. Their description of one facade was particularly illuminating. They recorded six arched, false
apertures that were "included in the design of the building solely to present a more aesthetically pleasing facade," as far as they could ascertain.\textsuperscript{137}

The harmonious boiling house at Galways is indicative of the great care and planning involved in constructing sugar works. It is also not uncommon to find beautiful sugar works in the islands.\textsuperscript{138}

These structures were not simply viewed as functional edifices. In a manner similar to late nineteenth and early twentieth century American public buildings, mills, and other industrial structures, sugar works were at times a great work of art.\textsuperscript{139} Surely these structures carried great symbolic meaning, whether implicit or explicit or both. To my knowledge, research concerning the symbolic, structural and aesthetic values of industrial architecture has yet to be undertaken. Such a study could be richly rewarding in terms of information concerning the ideals and the architectural symbolic significance to the industrial architects, builders, owners, and even the general public.

I also wonder when the aesthetic aspect of sugar works became emphasized. How did the plans and layouts, the conception of factory, change through time? There is not enough comparative material available at present to make any definitive statements. If sugar works' architectural evolution (or involution!?) parallels developments in British and American architectural history, one would expect a general, broad scheme such as found below:

17th century - mills more organic, individualistic
18th century - mills become symmetrical, almost standardized
Plate 2. Coursed Rubble Construction, View to Southwest of Factory
19th century - mills become more "logical" and efficient in terms of their interiors, more ornate as to their exteriors.

It would also be interesting to correlate technological innovations with architectural renovations and changes in basic designs. How did the planters choose the designs, building materials, and locations of their factories and homes? Investigation of such questions necessitates research into factors such as time, availability (information, expertise, materials), ethnicity, and personal taste and money. Hopefully, a combination of future architectural, archaeological, historical, and ethnographic research on Statia will help to illuminate some of those factors, at least in regard to English Quarter.

Construction Methods/English Quarter

All structures at English Quarter share at least two characteristics. They are constructed of gray, granite-like stone (andesite and fire rock) and white mortar. But there are three distinctive construction methods present at the site. These three methods denote different temporal episodes, and a rough correlation has been made between construction techniques and specific dates.

The first method of building can be seen in Plate 2. This view of the sugar works, looking southwest, shows the entrance to the boiling house at left, the largest cistern (SE45-2-A) at front, and the chimney stack in the background. A close inspection of Plate 2 reveals coursed rubble walls, with the local andesite stones rough-cut and faced on only one side. The walls have been laid with a lime mortar. This coursed rubble technique is most common at the site.
I have assigned a tenuous date range of 1809 to 1857 to this first method of construction. The first owner of English Quarter, John Williams, died in 1809, giving a rough beginning date. The latter date, 1857, coincides with the date on the keystone of the entrance gate, built using the second method of construction found at the site.

The arched entrance gate (see cover page), the chimney stack (Plate 2), the flue system (Plate 16), and the addition to structure SE45-1-A (SE45-1-A9, A10)--all are constructed using a distinctly different construction method. The stone (local "fire rock") is smoothly cut, not rough, on at least three sides. These stone blocks are fitted closely together. This type of wall is called ashlar and/or cut stone. Again, lime mortar holds the blocks in place. Plate 3 exemplifies the ashlar construction at the site. It is a view to the south of the north wall (SE45-1-A9) of structure A, in the housing complex. Notice the cantered plaster on top of the foundation; one can also see from the evidence mid-center that the window aperture once housed a doorframe.

The third prevalent type of construction found at English Quarter is evident in Plate 4. The west wall of structure C in the housing area (SE45-1-C2) shows a definitely different type of coursed rubble stone wall. Here the mortar is much harder, whiter, and perhaps made from a cement. Small stones have been fitted into the mortar, rather like a non-traditional exposed rubble wall found elsewhere on the islands, or the flint chips on the facades of some English vernacular homes. The use of small rubble in modern repairs is evident
Plate 4. Coursed Rubble with Pushed Rubble Morter, View to East Wall SE 45-1-C2
on Statia, at Godet plantation house (SE95) and also at Ft. DeWinte, recently reconstructed. When asking local builders the reason for the rubble bits, all answered that they did not know why they were necessary. (They may have slight structural advantages, but I believe they serve an aesthetic function more than a structural one.)

As English Quarter was renovated in 1908, I am using that date for the known earliest use of small rubble pieces in the mortar. Rubble-pushed mortar is prevalent at structure C, which seems to be the "second house" built in 1908, mentioned earlier. Repair patches of this type may be seen on most of the coursed rubble walls at English Quarter. The end date for the third method of wall construction must be simply called the present for now.

When asked if the islanders used to use volcanic rocks in construction, the answer was always no. Most islanders believe that the stone used in construction of structures on Statia in the "Old Days" and "Ancient Times" originated as ballast from merchant ships. No documentary evidence has been found to refute or support their belief. The 1983 geologic research of Rebecca Spraggens of William and Mary indicates a local source for all stone used at English Quarter.

Additional architectural details at the site are numerous. Unmortared dry-laid walls of rubble are found in some areas of the site. For example, such walls are found flanking the entrance gate of the site, joining the similarly constructed walls that parallel the paved road, down most of the Windward side. These parallel walls have been called slave-made by various locals, and it is said that it has
been kept up for well over one hundred years. (Recall, slavery ended on Statia in 1863.)

Arches are used for structural strength (as under the single-flighted stairs of SE45-1-C, mentioned earlier), flues and in SE45-11A, what may have been a kitchen oven.\textsuperscript{142}

Additional features include the use of red and yellow bricks for small repair patches. Brick was also used to cap off cistern SE45-2-A. (An example of a repair is found on wall SE45-1-A10.)

Cantered plaster, as already seen in Plate 3, was found also. It can be seen along factory gables and the gate to structure SE45-2-P (animal pen). Most windows at the site are cantered, too, but not plastered. Some apertures contain rounded hollows, indicative of wooden jambs and frames. Plaster was also found within all cisterns, for lining, and along the train. A plaster-lined trough was observed joining two cisterns at the factory, SE45-2-D and E.

The final, general feature at English Quarter is the technique of using a continuous stone foundation. These foundations contain corner and/or interior hollows, indicating that wooden beams tied into the stone walls. Plate 5a depicts this method, an interior and westward view of SE45-1-C7. The wooden beam in the photo is squared at top, tapering to the bottom placement within the interior wall. It is located 7.8 ft. north of the southwest corner of the structure. Other apertures placed along the interior west and east walls indicate similar "studs" or upper story supports were once in place. A post was found in place in the exterior northwest corner of the same structure (C), measuring 1.3 ft. east of the southwest corner. This indicates that structure C had a wooden upper story, not an uncommon
Plate 5a. Inset Wooden Beam, View to West Wall SE45-1-C7
Plates 5b, 5c. Ceramic Fragment, View to South, North Interior Wall Structure SE45-1-C
arrangement in Oranjestad. (Examples can be seen in the house
directly across the alley from the synagog, in some of the warehouses
near the public water cistern, and in some of the homes on the
island.)

Structure SE45-2-Q also had clearly seen spaced apertures
along its interior, northern wall. (Five apertures, average width 0.9
ft., average spacing 6.6 ft., with range of 2.0 to 14.0 ft. apart.)
This construction technique may indicate that both structures C and Q
date to the 1908 rebuilding period, as no other structures were found
with this arrangement for posts. Further, examples of this construc­
tion technique on the island are reportedly early twentieth century.
The other alternative is that this type of construction dates also to
the previous century. (The posts are definitely a deliberate part of
the structures and not simply repair posts.)

Before beginning a more detailed description of the site, I
should mention that all walls were constructed of stone, and most were
mortared. (See Plates 3, 4, 5a.) Typical wall thickness was approxi­
mately 1.9 ft. (engineering scale), ranging from 1.2 to 2.9 ft.
Plates 5b and 5c show a fascinating ceramic fragment mortared into the
north interior wall of structure C. This "jester face" is yellow ston­
neware, perhaps a jug fragment, date unknown as yet. No other cera­
mics of this type were observed at the site, and no other mortared
ceramics were observed in the walls. (This may be connected to spirit
bottles in function.)
Fragments of red tile and red brick were also observed in the rubble and mortar interiors of structure C's walls, but only structure C's.

The arched entranceway to English Quarter is semi-elliptical (3-centered). Construction is ashlar, as mentioned. The keystone, once facing the paved road, is pink marble and reads "EQ--1857." It is currently in the possession of Mr. Lampe, resident of Statia.

As one faces north of the arch, the housing complex is located east (to the right). The first "structure" viewed is an isolated post, amidst a small rubble pile. The post, of unknown purpose, measures 1.75 ft. high and 1.1 ft. thick. Plate 6, view to the south/southeast, shows the post (SE45-1-D) and its relationship to the southwestern corner of the interior of SE45-1-C. Plate 6 also demonstrates the use of most structures at English Quarter in the early to mid-twentieth century as animal pens. The southern wall of structure C is gone, replaced with a low, dry-laid stone rubble wall. This wall can be seen at bottom left of the photograph. (Notice again the wooden post behind the tree to the right.) Dry-laid rubble walls were also found in SE45-2-K (with blocked window apertures), SE45-2-Q, and SE45-2-P. All are indicative of use as temporary animal pens, after the plantation ceased to be inhabited, at the beginning of this century.

Structure C is rectangular, with an arched single stair adjoining. The arched feature measures 6.0-8.7 ft. deep (N/S along east and west, respectively) and 4.55 ft. east to west. The arch measures 5.4 ft. at its highest point above ground surface. Stone
Plate 6. Structure SE45-1-C, View to South/Southeast
stairs faced with flat red tiles are located east and up over the arched aperture. They measure 1.4 ft. high and from 1.33 to 1.55 ft. wide. This would have served as the entrance to C. A possible doorway with south to west cantered edges is located along the northern wall of the structure. No other apertures are apparent. (See Appendix A for more detailed measurements.)

The arched opening carried signs of burning and ash lay thickly within its interior. Mr. Lampe believes that the Royal Marines, when on maneuvers across the site, used the feature as a hearth. Discarded twentieth century rifle shells support his view. Mr. Lampe also was asked the function of the arched aperture when visiting the site in July of 1982. He believes that coal may have been kept in the feature. Dr. Julia Crane at the University of North Carolina, Chapel Hill, stated when asked that on Saba one finds a small, trap-door leading to the basement of many homes. This opening is called a "scuttle" on Saba. Again, coal storage under the home, in the foundation area, is indicated.

As already mentioned, structure C probably had a wooden upper story. To recapitulate, there are stairs leading above the stone foundation and wooden posts embedded within the foundation's walls. Further, the news article mentioned earlier (Amigoe di Curacao, 11 July, 1908) mentions that the houses burned to the ground.

The next two structures in the housing complex, SE45-1-B and A, may actually be parts of the same structure. David Campbell is said to have built a second house at the site, and a third house may have been constructed in 1908. (See previous section on family history.) Structural evidence does presently indicate that C was a
separate structure. The interior walls of A and B are fragmentary and covered with earth. Positive delineation will have to await further archaeological fieldwork results. For the present, A and B are being treated as two separate structures.

Structures SE45-1-A and B appear to date to 1857 and earlier, based on the construction techniques used. Structure B, shown in Plate 7, is located just north and eastward of structure C. It consists of a rectangular foundation of coursed rubble and has a rectangular-shaped single-stair porch attached. (See Plate 8.) Plate 7 is a view looking southeast across the structure. The eroded interior at left indicated the location of a doorway. One window aperture is located on the southern wall, with cantered sides (SE45-1-B3). The southern interior wall contains two window openings, again with cantered sides.

Plate 8 is a photograph looking south, along the eastern side of exterior wall SE45-1-B3. This portrays the stone single staircase leading to the solid rectangular porch section of the structure. Flat red tiles and rough-cut gray chart-like material tiles were found laid on the floor of the porch. Again, a second story is indicated by the raised porch. There was little rubble in the vicinity of structure B, which leads to the assumption that the upper story was wooden, not stone. (Further details of this structure may be found in Appendix A.)

Immediately north of structure C and north by northwest of B is the final structure at the housing complex, structure SE45-1-A. Plate 9a, a view to the south by southeast, shows the structure, adjacent to the dirt road running through the site. Structure A is very
Plate 7. Structure SE45-1-B, View to Southeast
interesting, as it displays all three wall construction techniques described previously. Ashlar can be seen to the left, coursed rubble with plain mortar elsewhere except for the coursed rubble with pushed rubble mortar at right. When regarding the southern exterior, SE45-1-A9, one can see that the ashlar portion of A is obviously an addition to SE45-1-A7. The ashlar portion of this structure is constructed differently from all other rooms.

The southern window of the ashlar portion of A was once a doorway. The eastern exterior wall (see Plate 9b) has two openings, the window at left and doorway at right. Both have wooden jambs still in place. The doorframe even has an iron, circular attachment for a hook and a metal pintel (see right side doorframe). Notice the small patch of red and yellow brick bottom right of the window. The rubble line left of the window indicates a stone single-stair, which tentatively ended at the southeastern corner of this addition to A. The whole foundation of this section was built into a south to north slope. The southern wall only measures 4.5 ft. above the ground. It too has a single-stair located near the southwestern corner of the ashlar structure. This is 5.5 ft. "lower" then the northwestern corner. The entire top of the foundation is capped by a cantered, plaster collar.

I believe that this room was built in 1857, as it is constructed exactly like the arched entrance gate so dated. This room post-dates the construction of the room to its right (see Plate 9a), as its western wall adjoins tightly against it. Further, the adjacent room is the only kitchen located on the housing complex side of the site. Evidence in the kitchen (arched oven and yellow brick flue)
Plate 9a. Structure SE45-1-A, View to South/Southeast

Plate 9b. Structure SE45-1-A, Ashlar Section, View to West
indicates it was built prior to the ashlar room. Also, Mr. Lampe, during his July visit to the site, said that the ashlar room was specially used by Marina Eliza Heyliger Macdonald. Her room was perhaps even built especially for her. The later generation of Pandts called her room "Bluebeard's" or "Blackbeard's Castle" and played in the "tall, high" room. (As told to Mr. Lampe by Thomas Nelson Cockfield Pandt II.) This hints that this room also had a wooden upper story. Again, two staircases leading to a point above the foundation support this assumption. (Marina was one of the two owners mentioned when the 1908 disaster was recorded. Perhaps the changes noted in this room were constructed at that time so the older Marina could still live in her special room.)

Plates 10a and 10b display the kitchen area of structure SE45-1-A. Plate 10a is a view to the east, showing the western exterior wall and interior eastern wall of the room. Plate 10b is a closer view of the chimney and small arched flue at bottom. The larger arch, left, Plate 10a, may have been a dutch oven or some form of hearth. The upper stones of this arch were blackened by fire. (For additional measurements, see Appendix A.)

The kitchen and adjoining small, square rooms—storage and/or pantries—appear to have been located in the basement of the structure. This arrangement was not uncommon in the American or West Indian colonies, although the use of a separate structure for the kitchen may have been more common on Statia.

If one regards figure 16, it becomes obvious that the southern portion of structure A has only tenuous structural remains.
Plate 10a. Kitchen, Structure SE45-1-A, View to East

Plate 10b. Chimney of Kitchen, View to East
Rubble piles and fragmentary walls do indicate that this area was extensively used as an animal pen or pens. Future excavations will hopefully clarify the plan of structure A and its relationship to SE45-1-B.

Crossing the dirt road, one arrives at the sugar factory ruins. Operation 2, the sugar works, has survived the vicissitudes of time better than the housing complex (operation 1). Apparently, the owners of English Quarter followed general tradition and invested more money and time in constructing the factory.

The discussion following will generally follow the procedures used for manufacturing sugar in order of description. Therefore the first structure discussed will be the trapiche, or mill area (SE45-2-L).

The motive power used at English Quarter was the basic animal mill. (Refer to figure 16 as needed.) The animal mill at the site is circular and partially built of stone. It measures approximately 60 ft. north-south and 70 ft. east-west. It is a single-level animal mill, built on a slight rise into the slope. This is interesting, as most animal mills were built on raised, flattened surfaces, circumscribed by low stone walls. The circumlocuting wall at this mill exists only partially around the mill area, in the northern half. The dry-laid rubble wall adjoins the northern wall of the train just outside the boiling house (wall SE45-2-K4). At that point the dry-wall measures 3.0 ft. high and 1.9 ft. thick. A 2.4 ft. space, now rubble-filled, existed between the two structures. Plate 11 demonstrates this, looking west toward interior wall SE45-2-K4. The northern boundary of the mill is curving at left, the rubble-filled space is
Plate 12. Feature and Wall SE45-2-L1, View to Southeast
center, and the coursed rubble factory wall can be seen at left. (The scale, recall, denotes one-foot increments.)

Plate 12 is a view to the southeast of the western boundary of the animal mill. A feature attached to wall SE45-2-L1 may be seen below the scale in the photo. It consists of two parallel short (2.1 ft.) stone walls (measuring 3.1 ft. high, 3.8 ft. thick--each wall is 1.8 ft. thick) of unknown function. Above, plaster fragments can be seen. Perhaps this area functioned as a place to dry the squeezed bagasse.

The animals (mules, oxen, or horses) would have trod around the limits of the circular mill area, up on top. They would have been yoked to a shaft to turn what probably was first a three-roller vertical and later a three-roller horizontal trapiche. No physical remnants of the mill have been located on the surface of the site. (This interpretation is presently based on negative evidence. There is no platform for a steam mill present, very substantial platforms, and there is no room for the larger number of rollers sometimes employed in mills.) Plate 13a gives an example of one of the rollers used to crush sugar somewhere on the island of Statia, probably very similar to one of three used at English Quarter. (Taken near the Jewish Micvah in Oranjestad, lying loose in a field.)

Plate 13b is a westward-looking view of one of two definite pillars found on top of the animal mill. Fragments of a possible third were located just above the paralleled wall feature described earlier, on top of area SE45-2-L1. The two pillars have squared bases with plaster-scooped hollows near the intersection of their bases and the rounded top columns. The location of the pillars (see figure 16),
Plate 13a. Example of Metal Roller

Plate 13b. Pillars, SE45-2-L, Looking West
combined with documentary evidence, indicates these plaster hollows once held railings. Further, an impermanent roof, probably with a peaked gable, covered the mill area. The pillars measure about 5.35 ft. high, 2.8 ft. wide at base, and have an average diameter of about 2.2 ft.

The animals used at the mill, and possibly all animals located on the plantation, were quartered in an impressive stone corral. SE45-2-P, the animal pen, consists of only two standing mortared rubble walls at present. A broken line of rubble, since disturbed by a bulldozer, gave the impression that the walls were once continuous. Further, the structure would have been rectangular in form. Plate 14a is a picture looking south toward the northwestern corner of the approximately 110 x 40 ft. pen. The chimney stack is located left foreground, the curving animal mill behind (SE45-2-L1), and the pen center and right. The mountain in the background is the Quill.

Plate 14b depicts a scene looking west/southwest along the longest wall of the pen. The Little Mountains can be seen to the right. The walls are constructed of coursed rubble and mortar. Repair-pushed rubble mortar patches can be seen where the mortar looks thicker in the photo. Notice the cantered, south to north sloping plastered top portion of the walls. This would have protected the underlying wall from erosion, besides adding height to the structure. The space in the middle of the photo denotes the entrance gate to the pen. Two columns, squared, jut perpendicularly from the wall. They serve as the frame for the gate. Plate 15 is included to demonstrate
Plate 14a. Animal Pen SE45-2-P, View to South

Plate 14b. Animal Pen SE45-2-P, View to West, Southwest
the type of gate system used at the site. This picture is a view to
the south/southeast of the easternmost column. Four apertures,
averaging 0.6 ft. high, 0.6 ft. wide, and 1.2 ft. deep, denote where
metal or wooden bars would have fitted to close off the pen. The
second column has corresponding apertures.

No actual stable area has been located. The fact that women
in the Heyliger family were known for their fine horsemanship argues
to my American mind that separate stables would have been constructed
on the plantation. Perhaps Statian planters did not utilize separate
structures for their horses. All animals may have been housed in
structure SE45-2-P.

After grinding, the juice at English Quarter was piped or
troughed through wall SE45-2-J1 of the boiling house. The juice would
then be in the southern portion of the single-fired, closed furnace/
train. The northern wall of the boiling house, at the point of inter­
section with the train, proved to be very interesting.

When examining the interior wall (SE45-2-J1), two apertures
can be seen. The top is ellipsoid, 0.75 ft. high and 1.5 ft. wide.
1.8 below is a flue-like lintel of stone laid over a squared, approxi­
mately 1.0 x 1.0 ft. aperture. The first opening has plaster
fragments attached. The second aperture serves as the southern cen­
terpoint of a circular feature, constructed of mortared coursed
rubble. This feature (diameter 5.5 ft., depth to south of 1.5 ft., to
north of 0.3 ft.), appears to have been the first receiver for the
juice. It may also have had a red tile floor, as such fragments were
noticed at the bottom, with its interior depth of 4.7 ft.\textsuperscript{144} This
ring of fitted stones was probably the holder for or the actual clarifier at the sugar works.

Above and left of the two apertures mentioned above was one additional feature. This consists of a plaster-lined rectangular hollow, for, possibly, post placement. It begins right at the top of the wall (SE45-2-J1) and measures 0.35 x 0.35 and is 1.0 ft. deep. This feature is unique at the site. The function of the post is unknown.

The train at English Quarter runs parallel to the westernmost wall of the boiling house, SE45-2-H1. The train is a raised platform, long and rectangular, measuring about 8.9 ft. east to west and 32.3 ft. north to south. The train is defined by two semi-parallel rows of mortared stones. The eastern boundary wall (0.6 ft. west of SE45-2-J3) is straight, parallel to the outer boiling house wall (SE45-2-H1). It rises less than a foot above the present floor of the boiling house and is covered with white plaster. The western wall is constructed of stone and mortar, too, but lacks any plaster surfacing. This wall sits about 0.8 ft. east of the top edge of the flue wall, and it is slightly curved. The northern third of this side of the train curves from west to east.

The curvature of the western train wall became apparent while measuring the distance to the edge of the boiling house wall, using the flues below as a reference. At the clarifier (5th flue), the distance was 1.2 ft. At the first flue, farthest north, the distance is 2.6 ft. (See Appendix A.)

Plate 16 is a picture of the western wall of the sugar works, looking east (SE45-2-H1). Six apertures can be seen along this wall,
Plate 16a. Flue System, Wall SE45-2-H1, View to East

Plate 16b. Factory Cisterns SE45-2-D, E, View to East
which is an exterior wall of the boiling house. These apertures are the flues of the closed furnace. Temperatures could be controlled through the use of separate wooden dampers where and whenever deemed appropriate. The smoke would be drawn from north to south along the flue system and up the chimney stack, located far right. Far left in Plate 16a one sees an oval cistern (SE45-2-E), with door or window opening above. Notice, too, the use of red and yellow brick for structural repair, center-right.

The chimney stack is connected perpendicularly to the furnace with a 3.7 ft. long, rounded "tunnel" of mortared rough stone. The stack is ashlar, as are the flues. Brick and possible plaster capping can be seen on top of the approximately 33.5 ft. high stack. The brick is yellow and consists of three courses of stretchers of smaller horizontal increments. The base of the stack is widest, measuring 2.0 ft. high and 6.15 ft. long (e/w) at the top of the shouldered base. The column then tapers for 39 courses of stone before ending at the brick cap. The flue of the stack is constructed of cut purple-to-grey stones, the eastern measuring 1.3 ft. high and 0.45 thick, the western 1.8 ft. high, 0.5 ft. thick. The aperture measures 1.75 ft. east to west and 1.8 ft. high.

One cast iron bar with tapered ends can be observed just west of the first flue on the surface. It measures 4.1 ft. long and is 0.4 ft. thick. The function of the bar is specifically unknown, but generally it would have been part of the grinding machinery at the works.

Moving north along the flue wall, one sees two cisterns built of coursed rubble and mortar. Both are still partially plastered in
their interiors. They do differ in form. Plate 16b depicts the two cisterns in relationship to the boiling house. (See left side of photo and figure 16.) Cistern SE45-2-D is roughly rectangular, measuring 0.85 ft. x 6.0 ft. and 0.85 ft. deep, built on top of a curving cobbled wall, connecting cisterns D and E. Below the cobbled wall rubble indicated that a stone stair may have given easy access to both cisterns. Cistern E is oval and much more shallow than its companion, cistern D. The placement of E, lower in elevation than D, hints of its function as an overflow catchment.

What was overflowing from cistern D to E? The positioning of the two suggests two strong possibilities. Most probable is that excess molasses drained from hogsheads in the curing room (SE45-2-C and F) was troughed or piped through the aperture above the cisterns mentioned previously. On the other hand, but less likely, is that the cisterns were used as fermentation vats for rum manufacturing. (No structural or documentary evidence of rum manufacturing at English Quarter has been uncovered.) The cisterns would not have functioned as cooling vats, as their placement lies outside of the sugar works, and they would not have held water. Cistern SE45-2-A would have been adequate for the water supply at the site. Further, their placement suggests a connection with the manufacture of sugar.

Plate 17a is an illustration of the northwestern corner of the sugar works. To key to figure 16, the curving wall right, behind the tree, is the cistern wall SE45-2-D1. The wall at middle is a buttress to the gabled wall at left, SE45-2-C1. This is the northern exterior wall of the drying curing structure at the site, containing rooms C, F, and G. Notice the coursed rubble and mortar construction
and the window, center gable. The gable pitch is less than 30°, the height about 13.0 ft. It is plastered on top. Further, a "ghost image" is apparent on the wall, directly below the window. This suggests that an impermanent structure (bagasse drying or storage shed?) may have been attached. The buttress could have served two functions. The secondary function could have been providing a western wall for the wooden addition. The primary function of the buttress, which is about 10.0 ft. high, can be seen clearly in Plate 18. It serves as a support to the tall gable end of the drying house. Upon examination, it appears as if the buttress was built at the time of initial construction of the northern drying house wall. It is odd that only one support was built, here on the western corner. There must not have been any perceived need for support to the eastern side of the structure.

Turning to Plate 17b, a view to the southwest, one sees the curing house portion of the sugar works. (Figure 16 should be consulted as needed.) There are three distinctive areas in this lower portion of the sugar works. G is to the far left, F next, and C the major rectangular area in the middle right. (Notice the repetition of the use of the rectangle as a major construction device?) Joist apertures mid-way up the back or western interior wall of C can be seen. The short (5.2 ft.) wall running perpendicularly below and the entrance front and center can also be seen in the picture. Again, the plaster on the gable end is apparent.

Plate 19 is a view to the west of the entrance to the drying room. The wooden lintel of the gate can be seen, as well as the hollow at the side for placement of a wooden door frame. The entrance
Plate 17a. Northwest Corner, Sugar-house, View to South

Plate 17b. Lower Sugar-works, View to Southwest
Plate 18. Lower Sugar-works, View to Southwest
Plate 19. Entrance to Curing Area, View to West
measures 5.0 ft. long (n/s) and 5.0 ft. tall. The wall is 12.0 ft. high. An aperture can be seen right of the doorway. This is located 2.7 ft. north of the doorway and 9.0 ft. south of the northeastern corner of the structure. This opening is narrow on the exterior of wall SE45-2-C5 and widens to the interior. This could have served as a defensive aperture, except the angle of vision from within is blocked partially by cistern SE45-2-A. More likely it served as a source of ventilation and/or illumination.

Plate 20a is a view of the southwestern corner of the curing house, the intersection of walls SE45-2-F1 and F2. A probable doorway can be seen mid-left leading down to this structure. The doorway is at the ground level of the upper factory, and an approximately 3.9 ft. drop occurs down into room F. To the right of the doorway, near the corner, is a single flue. Like the flues located along wall SE45-2-H1, this flue was full of fine ash. It sits 2.9 ft. above present ground surface and its opening measures 0.7 ft. high and 0.9 ft. wide. A 0.2 x 0.4 ft. wooden lintel rests above.

Referring to figure 13, one sees that many drying rooms had stoves to keep the room temperature warm and dry and steady. The position of the flue just mentioned indicates that the English Quarter sugars were dried with a stove placed against the wall, and connected to the flue. The flue leads directly to the first flue of the main furnace, sitting just across the wall from the beginning of the train.

Sugar at English Quarter was apparently dried using hogsheads or casks instead of molds. This is inferred by the lack of pot shards in any of the rooms and by the presence of joist holes along the interior east and west walls of room C. Plate 20b shows two of these
Plate 20a. Stove Flue, Room SE45-2-F, View to Southwest

Plate 20b. Joist Apertures, Room SE45-2-C, View to Southwest
squarish holes. It is a view of the southwestern corner of room C. Average space between the joists is 1.98 ft., but ranges from 1.1 to 2.1 ft. on the western interior wall. Average placement of openings above the ground is 5.8 ft. Average openings are 1.0 ft. tall by 1.2 ft. high. On the eastern wall of C. the joist holes average 2.2 ft. apart and range from 2.15 to 2.3 ft. Distance above present ground surface averages to 5.6 ft. Average openings are 1.06 ft. tall by 0.95 ft. On F's western wall, a 0.1 ft. thick line of plaster can be seen. It rests 5.7 ft. above the present ground surface and 5.6 ft. below the top of the wall. This is added support to the idea of a grated floor of joists in the rooms.

To reiterate the flow of the sugar-making process, sugar at English Quarter was ground in an animal-mill-powered three-roller trapiche. It was piped or troughed to a clarifier on the southern end of the train. A doorway located just east of the clarifier would have given access between the mill and the boiling house. The sugar would be scooped from kettle to kettle along the train. The surface of the train is presently fragmented, but scattered white curving tiles hint that this train probably had four kettles in place.

The heated sugar would be scooped into cooling boxes, probably placed against the northern wall of room K in the boiling house. After the crystallized mass cooled, the sugar would be shoveled into hogsheads. The doorway located just east of the train gave access between K and F. The hogsheads of sugar would be placed up on the joists for draining and drying. (Refer to Chapter II, figure 11.) The molasses would be collected and either stored for shipment, reprocessed into more sugar, or fermented into rum. Molasses collection at
English Quarter could have occurred in three different ways. First, a cistern presently filled by dirt and rubble might be located in the floor of rooms C and F. Or, the molasses could have been piped or troughed to cistern E and D. There is, recall, an aperture between room F and cistern E. One would expect the aperture to have been located over cistern D, as E is an overflow cistern, not the main cistern. The third alternative is that the molasses would have been hand carried in casks through the gate and poured into cistern D for reprocessing.

The function of room C has not been ascertained. There is a shelf, or jutting foundation along the eastern and southern walls, 1.05-1.15 ft. wide. This area appears to be a later addition. (See Appendix A for wall key.) The eastern wall has a small, pitched gable just south and over cistern SE45-2-A. This gable lies about 5.5 ft. above the ground surface of room G and about 4.0 ft. above the edge of cistern A. Single flight stairs 4.0 ft. high lead to the cistern, and are located just below and south of the gable.

Cistern SE45-2-A is large and rectangular. It measures about 23.0 ft. long and 11.0 ft. high. It is plaster-lined. Cistern A sits about 9.0 ft. above the ground surface, and follows the natural slope south to north. It is flat-topped, with a yellow and then red brick course of stretchers capping it. (The red brick begins about 14.0 ft. northward.) Plate 21 is a view to the west of wall SE45-2-A1, the cistern's eastern wall. The stairs can be seen at left, behind lies the exterior wall SE45-2-K7, and above is the beginning of the small gable.
Plate 21.
Cistern, Wall SE45-2-A1, View to West
Plate 22a has been included to show the northern cistern wall and the relationship of the cistern to the arched entrance gate and the factory. The western wall of A is 11.5 ft. high at the northern end, about 7.2 ft. on the southern. A 7.0 ft. long "ghost" staircase can be seen, beginning 2.2 ft. south of cistern A's northwest corner. It is topped for a 1.65 ft. long red and yellow brick repair, sitting 5.7 ft. above present ground surface. The western exterior wall of the cistern is only about 9.0 ft. long. This does not really correspond with the change in brick capping mentioned along the top of the eastern wall. This partially negates a theory that this part of the cistern was a later expansion.

Cistern A is large and deep. It probably served as the major source of water for all of the inhabitants of the plantation. The only other cistern at the site that may have been used for water procurement was located the last day of fieldwork, when Cyrill Teer kindly showed us its location. This cistern was not even mapped, due to lack of time. It is located at least 100 yards east and slightly north of the housing complex. It was probably a vaulted cistern over its rectangular base. It will be interesting to compare the two cisterns next field season, as they are two different types of catchment systems. A is built above the ground. The second cistern is resting well below the ground surface. (I am sure there are functional and temporal differences between the two cisterns.)

Plate 22b is a northwestern view of the final standing ruin to be discussed at the main site area. Structure SE45-2-Q has only the southern wall left intact. It measures 5.5 ft. high and 33.0 ft. long (e/w). A small, dry-laid rubble wall, 2.5 ft. thick, was placed
Plate 22a. Cistern SE45-2-A, View to Southeast

Plate 22b. Structure SE45-2-Q, View to Northwest
perpendicularly to this wall. It begins 3.7 ft. west of the structure's eastern end. This was probably an early twentieth century modification enabling the use of it as an animal pen.

The interior of Q contained a series of five vertical openings for post placement. These openings ranged from 0.4 to 1.4 ft. wide. This indicates that structure Q also had a wooden upper story. Q probably functioned as a storage shed. Finished hogsheads of sugar and rum would have needed a storage building prior to shipment. Portions of these hogsheads could have been stored in room SE45-2-G, but it seems to be much too small to have held all of the casks. The location and probable size of structure Q suggests it was used for storage. Further, no domestic artifacts were found in the structure. Further work at Q, along with artifact analysis, is needed before a definite statement of its function at the plantation can be made.

During a brief survey west of the factory area, two rubble piles (Operation 3) were located. The first, shown in Plate 23a, is located about 100 ft. north of the main paved road and 300 ft. from the animal pen SE45-2-Q. The second pile was seen 375 ft. farther north and 400 ft. to the southeast. (See Plate 23b.) These concentrations of rubble, large standing stones, and large artifact fragments will most likely prove to have been derived from slave occupation. The artifacts found were largely domestic. Interpretation of Operation 3 must await artifact analysis and mapping.

A description of English Quarter would not be complete without mentioning the well located down the coast, about 28,000 ft. north of the ruins. Plates 24a and b are two views to the south and north, respectively. The well is believed locally to date to "old
Plate 23a. Rubble Pile, Operation 3, View to Southeast

Plate 23b. Rubble Pile, Operation 3, View to South
Plate 24a. English Quarter Well, View to South

Plate 24b. English Quarter Well, View to North
times." The copper in the photograph is an old sugar kettle, probably from English Quarter, that is currently adapted for use as a drinking vessel for animals. The trough is a mid-twentieth century addition. This well is located far from the main ruins, and may have served to provide water for irrigation and/or animals. The water from wells on Statia is usually too salty for pleasant drinking by human beings. The well site was only briefly investigated. Again, it must await next year's field season.

All of the structures located at English Quarter during the 1982 field season have been described. Tentative interpretations as to function and temporal distinctions have been made. More detailed analysis must await further research in the lab, field, archives, and through ethnographic work.
NOTES TO CHAPTER III

1Platt, et al., 1941, p. 70.
2Platt, et al., 1941, pp. 70-71.
4Keurs, 1960, p. 11.
5Kruythoff, 1964, p. 56; Platt, 1941, p. 70.
7Ibid., p. 62.
8Ibid., p. 90.
9Platt, 1941, p. 70.
10Kruythoff, 1964, p. 95-96.
11Kruythoff, 1964, p. 103; Platt, 1941, p. 70.
12Kruythoff, 1964, p. 103.
14Platt, 1941, p. 70.


17Platt, 1941, p. 103.
18Kruythoff, 1964, p. 103.
19Platt, 1941, p. 70.
221960, pp. 13-14.
231960, p. 31.
The data in the first column comes from Platt, 1941, p. 71, in the second from Hiss, 1943, p. 194.

1960, p. 11.

U.S. Government; Platt, 1941, pp. 71-72.

The data in the first column comes from Platt, 1941, p. 72, in the second from Hiss, 1943, p. 194.

Keurs, 1960, pp. 11-12.

Keurs, 1960, p. 38.

Ibid., p. 37.

Ibid.


Keurs, 1960, p. 36; Hiss, 1943, p. 67. It appears that there were no native inhabitants on Statia by the time of first settlement.

Hiss, 1943, p. 67.

Keurs, 1960, p. 38.

Hiss, 1943, p. 67.


Ibid., pp. 19, 21.

Keurs, 1960, p. 77.

Hartog, 1976, p. 33.

Kruythoff, 1964, p. 38.


Keurs, 1960, p. 77.
Crouse, 1943, p. 14—describes how Lt. General Edward Morgan and one-half of his 650 pirates took Statia in the 17th century. Kruythoff, 1964, pp. 15-16, states that Robert Holmes (1664) and Morgan (1665) plundered, taxed, and "governed" Statia until its recapture in 1667. When Morgan took the island in 1665, he looted at least 50,000 pounds of cotton, according to Hartog, 1976, p. 33. Statia became English in 1672, French in 1674, and traded hands until it finally, officially remained under Dutch rule after the Treaty of Breda in 1802.


Keurs, 1960, p. 38.

Keurs, 1960, p. 38.

Keurs, 1960, p. 38.


Keurs, 1960, p. 39.

Keurs, 1960, p. 39; Hartog, 1976, pp. 34, 43.

Keurs, 1960, p. 71.

Keurs, 1960, p. 78.

Sir Dalby Thomas, as quoted in Sheridan, 1974, p. 46.

1964, p. 38.


Crouse, 1943, pp. 149-50.

Ibid., pp. 151-52.

Kruythoff, 1964, p. 17.

Ibid., p. 15.

Ibid., pp. 17-18.

Hiss, 1943, p. 15.

Sheridan, 1974, pp. 442-43.

Stubbs, 1897, pp. 9, 74—he writes, "Mr. King, of Savannah, Ga., brought a schooner load of it from the Island of St. Eustatius and planted in on St. Simmond's Island, near the mouth of the Savannah River, in 1814," p. 77.
69 Jameson, 1903, p. 683.

70 1969, p. 360.

71 Jameson, 1903, p. 684, footnote 1.

72 1903, p. 684.


74 Kruythoff, 1964, p. 33.

75 1923, p. 136.

76 Ibid.

77 Ibid., p. 137.

78 Jameson, 1903, p. 702; Spinney, 1969, p. 163.

79 Jameson, 1903, p. 696.

80 See Jameson, 1903; Spinney, 1969, for descriptions of the political debates.

81 Jameson, 1903, pp. 697-98.

82 Jameson, 1903, pp. 700-01.

83 See Mundy, 1833; Spinney, 1969; Jameson, 1903.

84 Sandwich, St. Eustatius, Feb. 12, 1791 in Mundy, 1833, VII, p. 25.

85 Letter to Philip Stephens, Esq., Sandwich, St. Eustatius, Feb. 4, 1781 in Mundy, 1833, p. 11.

86 Jameson, 1903, p. 703; letter of Rodney to Philip Stephens, Esq., St. Eustatius, March 6, 1781 in Mundy, VII, 1833, pp. 44-45.

87 Spinney, 1969, p. 360.

88 In Mundy, VII, 1833, p. 45.

89 Mundy, VI, 1830, p. 5; Hart, 1922, p. 182—if those documents were ever unearthed, a wealth of information could be discovered concerning Statia's free port activities.

90 Mr. Franz S. Lampe, interview in July, 1982 on Statia.

91 Hiss, 1943, p. 103.
Eustatius had a total number of 1,087 slaves at that time. The government paid a total indemnity of 217,400 F1. to the slave owners. See Hiss, 1943, appendix xx, p. 207.
For more information, see Dr. Eric Ayisi's unpublished ethnographic account of Statian farmers, on file at the Department of Anthropology, College of William and Mary.

H^For those interested in the present lifestyle of the Statians, there are two ethnographies available. Contact the Dept. of Anthropology at William and Mary for further information.

Sources: The following discussion of the specific history of ownership of English Quarter stems from two discussions with Mr. Franz Siegfried Lampe in July of 1982. The discussions took place on Statia, one at the home of Mr. Lampe and the other on the site of English Quarter. Mr. Lampe is a wonderfully knowledgeable man who resides on Statia. He had had a long-term interest in the history of English Quarter, as Thomas Nelson Cockfield Pandt (II) was a close personal friend. Further, Mr. Lampe is related to Gov. Johannes DeGraaff, whose great-granddaughter Alleta married David Young Campbell, one-time owner of English Quarter. (I believe Alleta was the great, great-aunt of Mr. Lampe.) Further clarifications on family relationships were provided by Mr. Lampe over the course of the fall of 1982, by mail. (Especially in a letter to me dated November 25, 1982 from Mr. Lampe on Statia, to Williamsburg, Va.) Mr. Lampe has my heartfelt thanks for all of his aid. Any errors, of course, are mine.

Three other sources were discovered on Statia concerning the history of English Quarter. The first is a Deed of Sale, dated September 16, 1927, that may be found reproduced in Appendix A. My thanks to Lois Taylor for diligently searching on Statia for any documents related to English Quarter, and for obtaining a copy of the one above. The second source was a newspaper clipping in the possession of Mr. Lampe. The newspaper was the Amigoe di Curacao, dated Saturday, 11 July 1908. It is a report written on St. Eustatius, 25 June 1908. Mr. Lampe had the clipping at his home, along with an early 20th century postcard of Ft. Oranje, depicting a bearded gentleman, "Top," who was the head builder at English Quarter during a 1907-1908 reconstruction period.
The third source is by Calmeyer, N.R.H. Het Geslacht Heyliger (The family Heyliger): Planters, rendus en regenten op de Bouvenwindse Antillen (Planters, shipowners and regents of Windward Antilles). In Jaarboek Van Het Centraal Bureau Voor Genealogie en Het Iconografisch Bureau. Deel 27 Den Haag 1973. This source contained an essay by Mr. Lampe's cousin, Mr. Calmeyer, on the Heyliger family, one-time owners of English Quarter. He kindly typed a copy for me, in Dutch.

128 Amigoe di Curacao, 11 July 1908.

129 See previous discussion, Notes to Introduction, footnote 2.


131 See Fogel and Engerman, 1974, for a complete discussion.

132 Examples: Blaut, Glaut, Harmon, and Moerman, 1973; Eisenberg, 1974; Knight, 1970; Mintz, 1964; Ortiz Fernandez, 1947; Guerra y Sanchez, 1964; and Steward, 1956.

133 Examples of archaeological investigations into ethnicity can be found in the works following: South, 1977 (ed.); and Schyluer, 1980.

134 My thanks to Atwood Barwick for synthesizing our field maps into a rough of the present figure.

135 Radcliffe, 1976, p. 110.

136 1981, see pp. 41-58.

137 Ibid., p. 46.

138 See Buisseret, 1981; Sitterson, 1952; Hatch, 197; Radcliffe, 1976--further examples are found at Annaberg on St. John's and at English Quarter.

139 I would like to thank a fellow graduate student, Susan Winter-Frye for first pointing out the commonality of the non-functional aspects of American industrial architecture, circa 1880-1930.
To standardize, all architectural terms were taken from Chapman, 1981.

During an interview with Dr. Crane, 4-26-83 at U.N.C., Chapel Hill, she described the mortar-making techniques used once on Saba, according to her informants there. Coral, usually white, would be gathered by the sea. The pile of coral would be covered with wood and the whole burned. Water would be thrown on the burned mass, disintegrating it all. Red earth, called torus on Saba (meaning unknown), would be mixed with the lime.

Williamsburg, Va. contains numerous examples of the use of arches beneath stairs, especially at front entrances, for structural support.

Personal communication, 4-26-83.

Goodwin and Pulsipher, 1981, mentions a cistern with a red tile floor located at Galways Plantation.
CONCLUSION

The Caribbean is a unique cultural area. The combination of expansive trade, agricultural development and subsequent production of sugar helped to direct the region's development.

Focusing on the Caribbean sugar industry circa 1492 to 1900 C.E. allows one to see how cultural change results from the interplay of numerous factors; economics, politics, social elements, technological developments, ideals and aesthetics. Cultural change in the Caribbean is especially evident in an examination of the technological changes that occurred.

Major and minor technological innovations can be seen in the Caribbean sugar industry over time. The industry was not technologically static as heretofore indicated by historians such as Barrett (1965), Dunn (1972) and Sheridan (1974). Innovation and variation in the sugar industry is evident in the changing use of resources, architectural styles and in all stages of sugar manufacturing.

Changes in sugar manufacturing techniques were influenced by factors such as ethnicity, chronology and additional elements associated with intra- and inter-island development. The high variance of sugar yields throughout the entire developmental period, including the nineteenth century, suggests that diverse methods were adopted by individual planters. Their adaptive strategies were not identical or
based on one rigid pattern. Each planter had to cope with diverse environmental resources, problems, individuals and different levels of manufacturing acumen.

The results of the fieldwork at English Quarter plantation have been offered as a microcosm of cultural change. Initial results indicate that innovation, seen both spatially and temporally, occurred at the site. Future analysis of the artifacts should help to illuminate the reasons behind these changes, in particular reference to the inhabitants of English Quarter.

It remains to be seen if chronological and ethnic differences were the major contributors to the formation of broad cross-cultural patterns in the material remains of the sugar industry in the Caribbean. Present archaeological theory indicates that such a pattern should emerge from a careful comparison study of the physical evidence left on sugar plantations. (See Stan South, 1977.) Nascent investigations of the remaining historical documents in the Caribbean and Europe will help to develop and refine our understanding of specific and general patterns uncovered in the region. A cross-cultural study, reaching across time and space, could offer invaluable insights into the process of cultural change. More questions remain: How does technology interact with the social and idealistic features of a culture? with the environment? with ethnicity? symbolism? with individual choice?

Through focusing research on the Caribbean sugar industry and its ramifications, we should discover answers pertaining to some of the specific and general questions of cultural change. A synthesis of the research efforts from many disciplines' results would lead to a deeper understanding of cultural change in the Caribbean.
APPENDIX A

ENGLISH QUARTER

ADDITIONAL MEASUREMENTS

Operation 1 (Housing Complex)

SE45-1-C

Wall key:  
<table>
<thead>
<tr>
<th>Corner</th>
<th>Wall into</th>
<th>Wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE</td>
<td>E</td>
<td>N</td>
</tr>
<tr>
<td>NW</td>
<td>N</td>
<td>W</td>
</tr>
<tr>
<td>SE</td>
<td>S</td>
<td>E</td>
</tr>
<tr>
<td>SW</td>
<td>Finished, i.e., doorway?</td>
<td></td>
</tr>
</tbody>
</table>

Construction: Coursed rubble and mortar, includes yellow, red brick fill and patches of pushed rubble mortar stone-rubble fill-stone

Wall thickness:  
<table>
<thead>
<tr>
<th>Wall</th>
<th>Ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>East</td>
<td>1.9</td>
</tr>
<tr>
<td>West</td>
<td>1.9</td>
</tr>
<tr>
<td>North</td>
<td>1.9</td>
</tr>
<tr>
<td>South</td>
<td>(rubble)</td>
</tr>
</tbody>
</table>

Elevations:  
<table>
<thead>
<tr>
<th>Corner</th>
<th>Ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE</td>
<td>6.65 (6.1 at arch)</td>
</tr>
<tr>
<td>NW</td>
<td>7.30 (0.6 plaster cap)</td>
</tr>
<tr>
<td>SW</td>
<td>6.30</td>
</tr>
<tr>
<td>SE</td>
<td>?</td>
</tr>
</tbody>
</table>
Wall key: Corner Wall into Wall
NE E N
NW N W
SE S E
SW S W
(Stairs key into east wall)

Construction: Coursed rubble and mortar
Stone-rubble fill-stone

Wall thickness: Wall Ft.
East (trees and rubble) 2.0
West 2.0
North 1.8-2.2
South

Stairs: 9 stairs measuring 0.9, 0.95, 1.0 ft. E/W and
5.1 ft. N/S. Stairs av. about 0.65 ft. high.
Thick mortar upper surface. Porch has red tile
over yellow brick headers over cut field stone
and/or 2 rows chert-like stones. Lowest stair
is 0.9 ft. high, highest is 5.3 ft. high, total
height of porch is 6.5 ft. except south side,
only 3.9 ft. high due to slope.

Elevations: Wall Interior (ft.) Exterior (ft.)
S 5.7 2.5
E 5.7 stairs
W 5.25 0-0.65
N 5.35 4.7

Additional information:

There are two apertures, window (?) in south
wall located 2.25 ft. west of SE corner and
doorway, just 0.0-0.5 ft. west of NE corner
north wall (adjacent to porch block).
Marina's room

Wall key:

<table>
<thead>
<tr>
<th>Corner</th>
<th>Wall</th>
<th>into</th>
<th>Wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>NW</td>
<td>W</td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>NE</td>
<td>E</td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>SW</td>
<td>W</td>
<td></td>
<td>S</td>
</tr>
<tr>
<td>SE</td>
<td>E</td>
<td></td>
<td>S</td>
</tr>
</tbody>
</table>


Wall thickness:

<table>
<thead>
<tr>
<th>Wall</th>
<th>Ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>2.2</td>
</tr>
<tr>
<td>South</td>
<td>2.1</td>
</tr>
<tr>
<td>East</td>
<td>2.1</td>
</tr>
<tr>
<td>West</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Additional comments:

Windows measure about 3.0 ft. wide and 1.9 ft. tall, with 2.2-2.5 ft. wide jambs. Embrasures measure 1.8 ft. deep, wider outside than inside.
SE45-1-A

Pantry

Wall key: Corner Wall into Wall
NE E N
SE S E
(no NW or SW (stairs?))

Construction: Coursed rubble and mortar with some pushed rubble repairs. North wall of pantry built against south wall of kitchen. West wall has fragments of stairs in SW corner.

Wall thickness:

<table>
<thead>
<tr>
<th>Wall</th>
<th>Pantry -</th>
<th>Kitchen -</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>1.15</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>0.9 (hard to ascertain)</td>
<td>1.5</td>
</tr>
<tr>
<td>E</td>
<td>at least 3.3 (stairs?)</td>
<td>1.0</td>
</tr>
</tbody>
</table>

(no West)

Elevations:

<table>
<thead>
<tr>
<th>Wall</th>
<th>Interior (ft.)</th>
<th>Exterior (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>1.85</td>
<td>None</td>
</tr>
<tr>
<td>S</td>
<td>3.5</td>
<td>Level w/ground</td>
</tr>
<tr>
<td>E</td>
<td>3.5</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Additional comments:

One aperture 3.1-3.4 ft. wide in SW corner (cants SW to NE). Eastern wall of kitchen contains arched feature 4.5 ft. N/S, 4.3 ft. coursed stone and yellow brick wall, then 2.0 ft. wide yellow brick chimney, 17 rows yellow brick high with stone lintels. Small arched flue bottom measures 1.0 ft. N/W, 0.8 ft. high and 1.2 ft. to top of arch. Elevation top of arched feature is 5.2 ft., at flue is 5.6 ft., at bottom flue is 3.35 ft., at intersection with pantry 2.2 ft. high.
# Operation 2 (Factory Complex)

<table>
<thead>
<tr>
<th>Room</th>
<th>Wall</th>
<th>Ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>N</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>S</td>
<td>1.9-2.0</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>W</td>
<td>?</td>
</tr>
<tr>
<td>G</td>
<td>N</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>S</td>
<td>1.15</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>1.05</td>
</tr>
<tr>
<td></td>
<td>W</td>
<td>2.0</td>
</tr>
<tr>
<td>F</td>
<td>N</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td>S</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>2.0 (same wall as GW)</td>
</tr>
<tr>
<td></td>
<td>W</td>
<td>?</td>
</tr>
<tr>
<td>C</td>
<td>N</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td>S</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>about 2.0</td>
</tr>
<tr>
<td></td>
<td>W</td>
<td>?</td>
</tr>
</tbody>
</table>

Wall key: Corner Wall into Wall

- **G**
  - NE: N (both walls) E
  - SE: E S
  - SW: W S
  - NW: cantered N

- **F**
  - NE: cantered E
  - SE: E S
  - SW: W S
  - NW: C south F west

- **C**
  - SW: W S
  - NE: N E
  - NW: N W

(C interior wall keys to outer W, W walls.)
Lower Factory

SE45-2-C, F, G

Comments: A ledge runs the perimeter interior of room G, thus G has "double" walls except for wall joining room F. May be entrance along southern wall of G into K, but wall is deteriorated. Room F has aperture along southern wall leading to train vicinity in upper factory. Room C is partitioned, partially, into wider southern area as opposed to narrow northern. Entrance through gateway in eastern wall of C. Aperture located north of gate along same wall either gave entrance to narrow section or is simply eroded wall.

Upper Factory

SE45-2-K, J

Comments: The northern wall of the boiling house is elevated and fits snugly against the southern wall of the lower factory. This portion of the sugar works appears oldest. The northern wall measures 34.6 ft. E/W. 7.2 east of the NW corner is a 3.6 ft. wide doorway. 8.1 ft. further east is a 6.2 ft. wide space (window? door? eroded wall?). The 22 ft. long eastern wall gives access 9.0 ft. S of the NE corner, in a space measuring 4.9 ft. wide. The southern wall has a door or window, now blocked with rubble, located 5.85 ft. W of the SE corner, which is 3.15 ft. wide. A doorway is located 5.0 ft. further west along the wall.

The train is about 32.3 ft. long and 8.9 ft. wide. The eastern wall of the train is curved, as opposed to the western wall:

<table>
<thead>
<tr>
<th>Flue</th>
<th>Distance to E train wall (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.6</td>
</tr>
<tr>
<td>2</td>
<td>2.2</td>
</tr>
<tr>
<td>3</td>
<td>2.1</td>
</tr>
<tr>
<td>4</td>
<td>2.2</td>
</tr>
<tr>
<td>5 (below clarifier)</td>
<td>1.2</td>
</tr>
</tbody>
</table>
Wall SE45-2-H1, the western boiling house wall, ranges in elevation from 3.1 to 5.6 ft. Reading north to south, the flue openings are placed at 1.4 ft., 3.7 ft., 2.7 ft., 3.0 ft. and 7.2 ft. apart.

<table>
<thead>
<tr>
<th></th>
<th>Height</th>
<th>Width</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flue 1</td>
<td>1.7</td>
<td>1.7</td>
<td>5.0</td>
</tr>
<tr>
<td>Flue 2</td>
<td>1.1</td>
<td>1.0</td>
<td>2.4</td>
</tr>
<tr>
<td>Flue 3</td>
<td>1.1</td>
<td>1.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Flue 4</td>
<td>1.1</td>
<td>1.1</td>
<td>2.85</td>
</tr>
<tr>
<td>Flue 5</td>
<td>1.8</td>
<td>2.8</td>
<td>2.0</td>
</tr>
</tbody>
</table>

This furnace is constructed of coursed rubble and mortar, well fitted, with patches of brick. Flues have cut stone lintels, except perhaps for flue 4.
CONSULTED WORKS


Avalle Habitant cultivateur de Saint-Domingue. Tableau comparatif des productions des colonies francaises aux Antilles, avec celles des colonies anglaises, espagnoles et hollandaises; de l'aine 1878 à 1788. Suivi de l'establissement et mouvement d'une miciocaid sucrerie; pendant le cours d'une annee... Par le citoyen Avalle, et. Paris, Goujon fils (etc. 1799) micro-opaque. Louisville, Ky.: Lost Cause Press, 1967. 5 cards 8 x 13 cm.

Ayisi, Eric C. A Diachronic and Synchronic Study of a Little Community in the Caribbean: An Ethnography of St. Eustatius. (A collaborative venture of archaeologists and a social anthropologist.) In press, College of William and Mary.


Spence, William (F.L.S.). The Radical Cause of the Present Distresses of the West-India Planters Pointed Out; and the inefficiency of the measures which have been hitherto proposed for relieving them; demonstrated; with remarks on the publications of Sir William Young, Bart, Charles Bisanquet, Esq., and Joseph Lowe, Esq. relative to the value of the West-India Trade. London: Luke Hanford and Sons for T. Cadell and W. Davies, in the strand, 1807.


Waller, Dr. John Augustine. *A Voyage in the West Indies*: containing observations made during a residence in Barbados, and several of the Leeward Islands; with some notices and illustrations relative to the City of Paramarabo, in Surinam. London: Sir Richard Phillips and Co., 1820.


VITA

LINDA GAIL FRANCE

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