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Sugar technology and slave labor in Martinique, 1830-1848

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The sugar plantation or *habitation sucrière* as it was called in Martinique, integrated within a single productive unit both the agricultural and manufacturing operations necessary to produce sugar. The interdependence of the various sectors of the production process developed the industrial character of sugar production while constraining it within technically determined limits. The plantation formed an integrated mechanism. Each phase of the sequential process of production depended upon the preceding ones. The distribution of labor and resources within each sector had to be coordinated with the other sectors. The organization of the production process as a whole impelled the maximization of output in each individual sector and of the speed and continuity between sectors. At the same time, this tendency was counterbalanced by the need to maintain the technically determined equilibrium among the various sectors of the process. While the ideal limit of production remained the complete extraction and conversion of all the sucrose contained in the cane plant, a wide variety of techniques, all with a significant effect on the quantity and quality of the product, was practiced in every phase of the process; and the selection of particular techniques depended upon an enormous variety of political, economic, social, and technical conditions that differed from estate to estate. The transformation of the world and national sugar markets during the first part of the nineteenth century created conditions for improvements in productive technique that developed this integration of agricultural and manufacturing processes to its fullest extent while exposing the self-contained plantation as the limit to technological improvement in the colonial sugar industry.

By the 1830s, the need to reform the organization of sugar production
pressed upon the plantation system in Marinique. Competition from metropolitan beet sugar and foreign cane sugar constantly threatened the market position of the colonial product. Further, with the rapid expansion of the previous decades, the effective physical limits of cultivation on the island had been reached, while the abolition of the slave trade prevented the planters from increasing their labor force. Finally, the rapid technological progress of the beet sugar industry made the reappraisal of colonial production in the light of scientific principles a necessity. From the end of the eighteenth century onwards, there were a series of advances in every aspect of sugar manufacture. The appearance of new techniques including steam-power, the all-metal horizontal grinding mill, the clarifier, carbon filters, the swing boiler, steam heat for evaporating and boiling, and most importantly, the vacuum pan revolutionized sugar production. For the most part, these advances originated in the French beet sugar industry which was compelled to seek every possible means to off-set the natural disadvantages of the sugar beet. The European beet sugar industry quickly became what Eric Williams (1970:380) has aptly described as “the great school of scientific agriculture.” In France, scientific understanding of the process of refining sugar was raised to a new level, and manufacturing techniques were developed that were proven by practical experience. These innovations were directly applicable to the colonial sugar industry; however, the problem of their assimilation into the technical, economic, and social organization of the West Indian plantation remained to be resolved.

There was a wide variety of individual responses to these new conditions by the West Indian planters. The majority of planters lacked the means and often the inclination to apply scientific principles to colonial production and to adopt the methods developed in the beet sugar industry. Traditional routines remained the norm, and the pace of change was slow. But not all of the planters submitted to their fate passively. Sainte Croix, among others, argued that the advances of beet sugar production should be adapted to colonial sugar manufacture.

The successes of beet sugar manufacture in Europe show how science combined with experience can lead to rapid progress.... Let us profit from the efforts of our rivals and use their means in the hope that, in treating a richer and less complex material than theirs, we will arrive at more advantageous results. (Sainte Croix 1843: 3-5.)

Some colonial planters hoped that by ameliorating their wasteful manufacturing methods, the natural superiority of cane over sugar beet would enable them to overcome the challenge of their metropolitan rivals and restore colonial prosperity. In the words of one such planter: “There is,
thus, enormous wealth which perishes each year in the colonies. It is an imposing reserve which cannot but be developed a few years from now and which will change completely the face of the debate." (Gueroult 1842: 64-67) The processes and techniques of colonial sugar production underwent systematic scrutiny by agronomists, engineers, political economists, and by the planters themselves, and an unprecedented number of technical treatises were published. There were a growing number of attempts to experiment with the new technology, and in 1839, in the face of hostility of many of their compatriots, a group of leading planters founded the Société d'agriculture et d'économie rurale to study and promote the scientific improvement of agriculture in the colonies. (Martinique, 9 [99]; Lavollée 1841:83; Derosne and Cail 1844: 6; Moreno Fraginals 1976: 111; Schnakenbourg 1980: 175-178)

The debate among the planters was not whether to accept or reject technological innovation, but under what conditions it could be successfully implemented in the colonies. As a result of long and successful experience, progressive planters like Guignod, Sainte Croix, and Jabrun were cautious in their approach to reform. Their empirical approach to plantership made them suspicious of abstract formulas and general panaceas and heightened their sensitivity to local variations. They rejected risking wholesale renovation of production techniques, the outcome of which was, in their minds, uncertain. Instead, they choose to emphasize the gradual perfection of the existing organization of production through partial reforms and attempted to adapt each individual plantation to its particular local conditions. Changes were adapted to and elaborated within the prevailing division of labor. During these years, the habitation sucrière attained its most complete development and exhausted its technical possibilities. While the processes of sugar production underwent gradual modification, the basic structure of the self-contained plantation remained intact on the scale on which it had been established in the seventeenth century and suppressed alternative paths of development (Généralités, 52 [449]; Sainte Croix 1843; Généralités, 56 [543]).

Given the social and technical conditions of sugar production in Martinique, this course of action was not illogical. The problem with such a solution, however, was that the planters were guaranteeing their own obsolescence. The changes they introduced were not always insignificant, but their consequences were limited by the effects of the integration and interdependence of the organization of the plantations as a whole. By themselves, they were neither sufficient nor widespread enough to rejuvenate the colonial sugar industry. Furthermore, the planters' vision, never realized if not unrealizable, of a perfect balance of the elements of production
where men, implements, land, and animals were combined in complete harmony and with maximum efficiency, led them to reject the steam engine and the vacuum pan, the two most revolutionary technical advances in sugar manufacture during the nineteenth century, as being incompatible with the organization of the plantation. Martinique thus continued to lag behind both the French beet sugar industry and other tropical cane sugar producers. In the face of an expanding market, dynamic competitors, and the constant transformation of production processes, the pressure against them could only continue to mount and create the need for more radical solutions.

The new techniques of sugar manufacture were adopted either individually or in various combinations by a number of planters in the French West Indies. However, their utilization was confined to a minority of large, well-off estates whose owners were in a position to experiment with them, and they failed to resolve the malaise of the colonial sugar industry. The most immediate obstacle to the adoption of the new technology was the lack of money and credit in the colonies. Three-quarters of the planters in the French West Indies were indebted for sums equivalent to half, and sometimes the entirety, of the value of their real and moveable property, and uncertainty over the resolution of the colonial question had sharply restricted commercial credit. (Derosne and Cail 1844: 16-18; Généralités, 56 [543]). In Daubrée's view, some of the richest planters, who operated on a large scale, were in a position to successfully renovate their entire production facility, but for the great majority, who produced on a more modest scale and only made enough to maintain their operation, this was out of the question. Without even considering the vacuum pan, he estimated that there were not 10 out of 100 who were able to bear the expense of a steam engine or a horizontal grinding mill and not 5 out of 100 who could afford to renew their entire milling and refining system. (Daubrée 1841: 28-31)

Yet the shortage of capital, important as it was, was not at the root of the problem. Rather, the self-contained plantation and the organization of labor as slave labor as they had been historically constituted in Martinique had become the chief obstacles to the transformation of the production process. The closely integrated technical organization of sugar production and the need to maintain the balance between its various elements, including labor, gave internal solidity to the sugar plantation and made it resistant to change. The relation between the agricultural and manufacturing operations on the habitation sucrière in Martinique was established within definite proportions by the physical requirements of sugar production. At the same time, the appropriation of workers as slaves fixed labor in
relation to this technical division of labor. A determinate number of workers were adapted to the preestablished organization of the labor process. Once production was established on a given scale, it could be expanded only if all the sectors were increased proportionally and labor was appropriately redistributed. Within limits determined by the quantitative relation between sectors, small economies or inefficiencies in a particular sector would only have a limited impact on overall productivity. But any significant attempt to increase the capacity of one sector without corresponding changes in the other sectors would simply create a disequilibrium and waste the intended economy. The changes either became superfluous or increased the burden on the other elements of the process requiring longer and harder use of slaves, land, animals, or equipment. For example, the adoption of the plow might allow more land to be cultivated and increase the size of the harvest. But such an innovation might upset the balance between arable land and pasture. Valuable pasturage could be reduced just when more animals were needed to draw the plow; or, conversely, the potential advantages of the plow could be offset by maintaining or increasing pastureland at the expense of land for sugar. Beyond this problem, increasing the amount of land cultivated and the size of the harvest, even if it were possible, could intensify the pressure on the slaves, the transport system, the fuel supply, the mill, and the refinery, yet have only a limited effect on final production unless the capacity of each of these sectors was increased accordingly. Finally, the capital investment entailed in restructuring the labor process might become prohibitive if, for example, in addition to buying new implements, more slaves had to be purchased. (Tomich 1990; Ministère du Commerce et des Manufactures 1829:53; Moreno Fraginals 1976: 26; Green 1973: 448-463.)

The importance of this technical limitation of slave sugar production becomes more evident in an old plantation colony like Martinique. By 1714, its primary sugar lands had been occupied, and the majority of the estates in existence during the July Monarchy – including all the principal ones – had already been established. The scale and level of productivity of these plantations had been determined by the relation between agricultural and manufacturing operations during that epoch. The capacity of the mill and the need for the cane to be planted near it, especially given the bad state of transportation, had determined the extent of land that could be profitably cultivated and the size of the labor force. Once most agricultural land on the island had been occupied through the multiplication of these productive units, the relation between agriculture, manufacturing, and labor was stabilized. An equilibrium was formed around the amount of land that could be cultivated on a given estate.
The pressure from either sector, field or mill, to increase the efficiency of the other was reduced. (Tomich 1990)

Under these circumstances, the technological transformation of the labor process was restricted by the structure of the plantation as a whole rather than the particular conditions in any individual sector. Thus, for example, steam power did not revolutionize sugar manufacture in Martinique, but rather was adapted to the existing organization of production. The potential improvement in production represented by the steam engine was inhibited by the technical limits of the mill. Up until 1840, sugar mills were designed to be used with any source of power; none were manufactured especially for steam. Instead, steam engines were substituted for other sources of power and adapted to existing mills. The most successful adaptation appears to have been to the new all-metal horizontal mills of the type introduced by Fawcett, Preston, and Company. However, while this combination allowed a greater mass of cane to be ground, it resulted in no improvement in the rate of sugar yielded from a given quantity of cane. In Martinique, the steam engine was frequently used in conjunction with the old vertical mill which, as Sainte Croix emphasized, had a capacity of 600 litres of cane juice per hour no matter what source of motive power was used. (Moreno Fraginals 1976: 102-103, 106; Sainte Croix, 1843: 28)

The great advantage of the steam mill in the eyes of the planters of Martinique was not that it produced more sugar than mills powered by other sources of energy, but that it provided a more reliable and regular source of motive power, and spared the enormous expense of mules and oxen. W. Macomb, an engineer who, with the backing of one of the Perrier brothers, proposed to convert the sugarmills of Martinique to steam power, wrote to Governor Donzelot in 1820:

> The great interest of the colonists is to adapt the steam engine to the presently existing mills and by that means to replace the incomplete force of water for those who lack it and the costly use of mules whose labor, as I have said, is subject to a number of disadvantages and which is of no use when they are unfit for service.

The steam engine, he continued, could replace the second-rate and bad mills which had a number of disadvantages, by a solid, dependable machine which always generated sufficient power and could be easily and cheaply maintained. Not only would the power necessary for grinding be more reliable, but the continual cost of mules, and slaves to work and care for them, could be saved and the loss of foreign exchange to Latin America for their purchase avoided (Martinique, 20[169]).

The great obstacle to replacing mules and other inadequate sources of
power with steam was the expense involved. Planters were reluctant to purchase steam engines not only because of the cost of new machinery, but also because the considerable amount of capital already invested in existing mills would be lost if these facilities were abandoned in favor of the steam mill. For this reason, Macomb proposed adapting steam power to the existing apparatus of the sugar mill rather than replacing this with new equipment and buildings. He argued that the best solution to the problems of the sugar industry in Martinique was to fit the steam engine to the already existing mule-driven mills. A four horsepower steam engine, he maintained, was most appropriate to this task (Martinique, 20[169]). Thus, the application of steam power was initially conceived within the framework of the already existing structure of the sugar plantation. Not only was the potential of steam to transform the production process suppressed by subordinating it to this technical and social organization, but the mill remained underpowered. According to Daubrée, the force necessary to grind sugar cane was commonly underestimated. The new steam mills installed in the colonies did not have more than six or seven horsepower and generated insufficient power. Ten to twelve horsepower was the minimum necessary, and in New Orleans, where admittedly the mills were larger than in the French colonies, the smallest steam engine in use had twenty horsepower. (Daubrée 1841: 25-26) Thus the adoption of steam power in Martinique reinforced a form of plantation organization that was becoming increasingly outmoded under the changing conditions of the nineteenth century world economy.

Within the framework of the *habitation sucrière*, the technical division of labor (the division of tasks) and the social division of labor (the division of laborers) reciprocally develop and constrain one another. The interdependence of agricultural and manufacturing operations leads to the elaboration of specialized tasks performed by different workers or groups of workers, and their integration within a unified and continuous process. Thus, it develops the cooperative character of labor as a collective force, but only within technically determined qualitative and quantitative limits, beyond which the socialization of labor is blocked. Conversely, within these technical limits, the social relations of slavery allowed the development of the social character of labor, the increase in the scale of production, and the expansion of the division of labor. But, as Weber and Hall among others have pointed out, the physical appropriation of the *person* of the laborer as the property of the slave owner and the assimilation of the labor force into the constant capital of the estate impeded the adoption of new technologies, the development of the division of labor, and the
transformation of the labor process. (Hall 1961: 348-349; Weber, 1978 I: 162-163) Within the slave form, labor could be adapted to a given technical organization of production. But once the scale and the degree of complexity of production are established, innovation does not save labor or increase the rate of surplus production. Even though the total product may be increased and the labor component of each individual product diminished, the cost of labor, i.e. the cost of slave maintenance, remains independent of the amount of sugar produced. If technological innovation replaces labor in the production process, the slave laborers remain the property of the slaveowner. They can neither be dismissed nor easily adapted to the new technical division of labor in the required proportions, and, whether they work or not, they must be maintained in order to preserve the value of their person. Thus, the specific form of production relations itself restricts technological innovation and the development of the cooperative force of collective labor. Rather than the rationalization of the labor process, the result of such efforts is the intensification of the activity of labor and the rigidification of technical and social conditions of production (Tomich 1990: chapter four).

The relation of slave labor to technological change has been the subject of historical controversy and requires further discussion. The limited impact of the new technology on West Indian sugar manufacture has frequently been attributed to the unsuitability of slaves for any but the simplest routine tasks. Indeed, the incompatibility of slave labor with mechanized production processes has virtually become a commonplace in much historical writing. However, to interpret the failure of these new technological advances to rejuvenate colonial production as due to inability of slaves to perform specific concrete tasks is a one-sided view that risks misperceiving the relation of slavery and technological change. Among the evidence, the observations of Victor Schoelcher cast doubt on the accuracy of such a formulation of the problem. In the face of claims by some planters such as Sainte Croix that slaves were incapable of operating steam engines, Schoelcher noted:“There are some steam engines in the French colonies. There are many of them in the English colonies. Everywhere it is the blacks who run them.” (Schoelcher 1842: 158) The antagonism between slavery and the technological transformation of the labor process is not reducible to the incapacity of individual laborers, whether attributed to their biological or their social characteristics, but derives from the social form of the organization of labor itself.²

In opposing the prejudices of colonial planters against innovation and against the capability of slave labor to utilize it, the proponents of the new technology emphasized its simplicity and its role in imposing a new
discipline on the activities of the laborer. The purpose of the new machinery was to do away with the complicated manual labor entailed in sugar manufacture and simplify the activities of the worker (Daubrée 1841: 27; Derosne and Cail 1844: 15-16; 23-24). The new devices required no specialized knowledge or skill. Derosne, describing an early version of his refining system that combined clarifiers, carbon filters, and flat-bottomed copper swing kettles, contended that "Any Negro boiler, in one operation, may be taught to use it, without fear or possibility of anything going wrong." (Derosne 1833:12). Similarly, the routine operation and maintenance of the steam boiling pan was so simple that, according to Jabrun, there was not a worker in the colony who was incapable of learning to run it in a day (Généralités, 56[543]).

The relationship between technological innovation and slave labor was posed most sharply by the vacuum pan. With each historical development of the instruments of production, the manufacturing process appeared less and less as simply the combination of the subjective activity of various specialized workers, but rather progressively assumed an objective organization which confronted the workers as an external, pre-existing material condition of production toward which their activity must be oriented. The vacuum pan carried this process to its extreme consequence. It substituted mechanical power and the conscious and systematic application of scientific principles for the skill, dexterity, and strength of the worker. It was the most complex and sophisticated apparatus introduced into the colonies and the one most responsible for revolutionizing the methods of sugar manufacture. An examination of its impact on the labor process can thus illuminate the general process, common to one degree or another, to the adoption of all the other technological advances.

Describing their system of vacuum pan evaporation, Derosne and Cail wrote:

Combining the machines with care, the operations have been facilitated and made independent of the workers' lack of attention in such a way that today the worker is subject to the machine itself and is unable to incur the faults that bore witness to his incapacity in the old system. And for the very reason that with the new processes the worker is relieved of every laborious operation, more sustained attention can be demanded of him (Derosne and Cail 1844: 15-22).

This system may have been more complex than the implements previously used in its place, but the work performed by the individual slaves became simpler. The purpose of this new machine was the suppression of manual
labor in terms of the difficulty and complexity of the tasks and of the number of workers required to perform them. As manual labor was reduced or eliminated, the craft, skills and subjective judgement of the workers were appropriated as the property of the machine. As particular workers lost their skills and control over their working activity, the vacuum pan reintegrated work as a collective social process through the extension and deepening of the division of labor and the reconstruction of the relation between skilled and unskilled labor. While the skilled workers stepped back from the immediate labor process and became the superintendents of the machine, the unskilled workers were more directly and thoroughly subordinated to its rhythms. The instrument of labor, freed from control by the worker and transformed into a self-activating mechanism, represented the integration of the workers’ activity on the one hand and the domination of the planter over them on the other. The regulation of material production by the machine was at the same time the imposition of labor discipline. The vacuum pan fused the technical supervision of the process of material production and social control over the activity of the workers whose previous separation had been expressed in the coexistence of the black sugar master and the white sugar master. Management was simplified and aspects of it put in the hands of technicians while the workers’ activity was subjected to a new sphere of control.

In the colonies as in France, the complexity of the vacuum pan required a small group of specialized workers for its operation. These generally included an engineer and one or two mechanics or boilermakers. The selection of these workers had less to do with their civil status than with their technical competence. Persons with the necessary qualifications were generally not to be found among the colonial population, slave or free, but rather had to be brought from the metropolis. To focus on the failure of slaves to occupy these positions misses the larger point of the transformation of the labor process and the shifting locus of control over it. Beyond the technical staff, “the main part of the manufacture is only composed of very ordinary labor, as much within the scope of the Negroes as the present manufacture”. Far from exerting pressure to transform the social relations of production throughout the other sectors of the labor process, this isolated nucleus of free workers was dependent upon slave labor and constrained by its presence. The slaves adapted themselves to this new work regime so successfully that the extent to which the technical staff entered into its routine operation beyond the most general supervision may also be questioned. On the plantation of A. Vincent of Bourbon, where pioneering efforts were made with the vacuum pan beginning in 1838, “All the workers... are Negroes, and, nevertheless, they have not
had the least difficulty in habituating themselves to the management of the machines.” On the estate of Vila-Urrutia in Cuba, where Derosne’s vacuum pas was producing 12,000 kilograms of crystalized sugar a day in 1843: “The factory had no other white worker than the sugar master. All the rest of the personnel was composed of Negroes, who have mastered their work very quickly” (Daubrée 1841: pp. 34, 51-52; 76, Derosne and Cail 1844: 8, 15-16, 21-24; Moreno Fraginals 1976: 111-112).

For the critics of colonial agriculture, it was not the ability or inability of slave laborers to operate the new equipment that was the impediment to reform, but the lack of qualified mechanics who could make essential repairs on it (Derosne and Cail 1844: 15-16). The vulnerability of fragile and sophisticated equipment without the development of a technological infrastructure to support it is illustrated by an incident recorded by Governor Mathieu in 1847. While he was visiting the usine centrale of the Sinson brothers in François, the iron grinding mill broke down. There was no way to make or replace the broken parts, and the Sinson brothers had no auxiliary mill. The neighboring plantations either had their own sugar to refine or were dependent on the usine centrale themselves and could not offer any assistance. The Sinson brothers were faced with the failure of their harvest, the loss of their credit, and ultimately their own ruin and the ruin of the properties dependent upon them. However, Mathieu, believing in the importance of their project as an example for the entire colony, acted promptly. He offered the services of a naval engineer and two blacksmiths from a naval vessel. The principal parts, which would have required four or five months to obtain from France, were replaced with hardwood. A new drive shaft was fashioned in the arsenal and various other broken parts repaired. The mill was back in operation in a month. A foundry had been established in Trinité by M. Gastel in order to serve the needs of the modernized plantations but had been unable to supply the necessary parts either in this case or in a similar breakdown on a nearby plantation four months previously (Martinique, 7[83], 20[170]). Lavollée reported that there was only one qualified mechanic in Sainte Pierre, and his services were very expensive. To resolve such difficulties, Derosne offered to send and subsidize a selected group of experienced machinists to each colony that purchased his equipment in order to install, maintain, and propagate his system (Lavollée 1841: 75-76).

Thus, the contradiction between slave labor and technological innovation does not reside in the capacity or incapacity of the individual worker to perform specific concrete tasks; rather, the specific character of slavery as a social relation determined the conditions under which such changes
could be implemented, and their consequences for social and economic development. In the slave relation, the instruments of labor did not function as capital. The reorganization of production did not save labor, i.e., did not diminish the number of workers at the disposition of the slave owner or reduce the cost of their maintenance either relatively or absolutely. De Lavigne, for example, testified before the commission on the sugar industry that he had used a plow on his plantation for ten or twelve years. Before its adoption, he had 200 slaves and cultivated 50 carrés of sugar. Afterward, he cultivated 100 carrés of which 75 were harvested in an average year, but he still had the same number of slaves. Thus, technological innovation increased the amount of sugar produced but did not reduce the number of slaves. The cost of slave maintenance remained unchanged, and their labor was distributed over a larger product. Significantly, De Lavigne attributes the adoption of the plow in Martinique to the shortage of labor caused by the abolition of the slave trade, an event outside of the rationalization of the labor process. (Ministère du Commerce et des Manufactures, 1829: 73-74; Lavollée 1841: 5-13; Reed 1866: 75-78; Hall 1959: 65-66).

Such reorganization of the labor process simultaneously intensified labor and created redundant laborers. The expanded production demanded greater effort of the slaves and shortened their working lives. At the same time, the greater output per slave created a superfluity of laborers whose presence not only drained the slaveholder’s resources, but could smother the changes made in the labor process, as the experience of a planter in the British Caribbean suggests:

The plough is certainly coming into more general use than formerly.... I was, in fact, compelled to adopt this system, by the small number of slaves which I possessed in proportion to the quantity of cultivable land; and I ... only discontinued it in consequence of having purchased about fifty additional negroes, whose labour, although of the greatest importance at certain periods of the year, could not have been fully available but by this filling up the intervals of diminished exertion.

The transformation of the labor process was blocked. Either machines or men were underutilized. Since labor remained at the disposal of the slaveowner and had to be maintained whether there was work or not, the slaveowner’s concern was that it be usefully employed. On the other side, the intensification of work called forth slave resistance. Even if, for example, the use of the plow reduced the back-breaking toil of planting with a hoe, for the slave the larger crop simply meant more work during the harvest without any positive effect on his consumption. Thus, slave
labor could be adopted to a given division of labor, but technological innovation and the alteration of the labor process did not reduce either the number of laborers or the costs of maintaining the slave labor force. Rather, the immobility of the division of labor was reinforced. The rigidity of the organization of production and its resistance to structural transformation were strengthened. The result was that labor was more intensively exploited within fixed technical conditions, and the contradictory character of the slave form was heightened (Sainte Croix, II, 1822: 105; Hall 1959: 49, 60).

The resistance of the *habitation sucrière* to change was the chief obstacle to the technological transformation of the colonial sugar industry in Martinique. The rigid structure of the self-contained sugar plantation worked by slave labor restricted technical innovation. To the extent that the adoption of new refining techniques simply extracted more and better sugar from the same amount of juice, it did not upset the internal equilibrium among the various sectors of the production process. But such reforms integrated the division of labor on each individual plantation ever more tightly. The reorganization of production processes within the established form of organization became increasingly elaborate. The changes in production technique resulted in smaller and smaller marginal increases in output, while the internal structure of the plantation as a whole became ever more solidly congealed. Moreover, as Daubrée argued, even presuming that the planters had sufficient finances and were able to adapt simple reforms such as steam-powered horizontal grindling mills, clarifiers, and copper swing boilers to their manufacturing operation, the increased yield would be insufficient to off-set the rapidly advancing beet sugar industry. Despite the gains in colonial production, its position relative to beet sugar in the French market would continue to decline (Daubrée 1841: 29-30).

Daubrée maintained that only the total reorganization of colonial sugar manufacturing would enable the planters to resolve in their favor the competition with the metropolitan beet sugar industry. In his view, if the methods of sugar refining used in France, including steam boilers and vacuum pans, were adopted in their entirety in the colonies, production would double, and the richer sugar content of the cane plant would secure the advantage for the colonial planters. The more the perfection of these techniques permitted the extraction of all the sugar contained in the cane plant, the more the balance would swing in their favor. However, as Daubrée demonstrated, even if the average planter in the French Antilles doubled his individual output, he would still operate at a loss because of the enormous investment required by the new machinery. The plantation units in Martinique had become too small to be productive. To make effective
use of the new refining technology, Daubrée estimated that a plantation had to produce at least 400,000-500,000 kilograms of sugar annually. This went far beyond the scope of even the largest plantation in Martinique which, at most, produced no more than half that quantity of sugar each year. Furthermore, the immense amount of raw material necessary to attain such a result required that the area under cultivation be drastically expanded. Unlike some of the British Caribbean colonies, Louisiana, or parts of Cuba, this alternative was no longer possible for individual plantations in Martinique. Instead, the necessary relationship between the various sectors of the production process prevailing on each plantation unit formed the historical limit to technological innovation.

The alternatives before the planters were clear: either reject the radical implications of the new technology and attempt to amend the existing structure of production through partial reforms, or radically recast the division of labor and integrate the new methods of production into a new form of plantation organization. However, under the conditions prevailing in Martinique this latter course required the transformation of labor and property relations to be effective. Thus, while the *usine centrale* which completely separated refining operations from agriculture first appeared in Martinique between 1830 and 1848, its development was suppressed by the prevailing organization of production. Only after slave emancipation in 1848 and the resultant crisis of plantation agriculture did it play a significant role in colonial economic life (Daubrée 1841: 31-35; Généralités, 56[543]; Sainte Croix 1843: 58; Tomich 1990).

Notes

1. Material for this article is drawn from my forthcoming book *Slavery in the Circuit of Sugar: World Economy, French Colonialism, and the Crisis of Plantation Agriculture in Martinique (1830-1847)*, (Baltimore, Johns Hopkins University Press, 1990), and appears with the permission of the publisher.

2. The argument for the incompatibility of slave labor and technological innovation in the sugar industry has been made most forcefully by Moreno Fraginals. In this interpretation, slaves are viewed as incapable of attaining the minimal technical level required to operate complicated machinery, and the introduction of free wage workers was necessary to modernize production. (Moreno Fraginals 1976: esp. 40-41, 112-113, 144) Against this technological determinism, Rebecca J. Scott has documented for Cuba the high number of skilled slaves performing technically advanced jobs and the dependence of the largest and most mechanized plantations on slave labor (Scott 1985: 3-41, 84-110). See also Boomgaard & Oostindie in this issue.
Archival Sources:

All archival materials cited here are from the French Archives Nationales-Section Outre-Mer. The first number cited refers to the carton while the number in brackets refer to the dossier.

GÉNÉRALITÉS, 52[449] La situation économique des Antilles. 1843.

——, 56[543] Rapport de Jabrun sur les améliorations à introduire dans la fabrication du sucre aux colonies. 1838.

MARTINIQUE, 7[83] Tournées du gouverneur. 1829-1851, 1870.

——, 9[99] Correspondance générale. Rapports. 1840. C.A. de Moges, Gouverneur.

——, 20[169] Machines et moulin à sucre. 1817-1834.

——, 20[170] Fabrication du sucre. Usines centrales.

Publications:

BOOMGAARD, P. & OOSTINDIE, G.J., in this issue.

CANABRAVA, ALICIA P., 1981. O açúcar nas Antilhas (1697-1755). São Paulo, Instituto de Pesquisas Econômicas – Universidade de São Paulo.

DAUBRÉE, PAUL, 1841. Question coloniale sous le rapport industriel. Paris.

DEROSNE, CHARLES, 1833. Notice on the new process for making sugar, lately introduced in the French and English Colonies. Paris.

——, 1824. Mémoire sur la fabrication du sucre dans les colonies par de nouveaux procédés. Paris.

DEROSNE, CHARLES and JEAN FRANCOIS CAIL, 1844. De la elaboración del azúcar en las colonias y de los nuevos aparatos destinados a mejorarla, (trans. D. Jose Luis Casaseca). Havana.

DUTRONE, J.-F., 1791. Précis sur la canne et les moyens d’en extraire le sel essentiel, suivi de plusieurs mémoires sur le sucre, sur le vin de canne, sur l’indigo, sur les habitations & sur l’état actuel de Saint-Domingue. Paris.

GREEN, W.A., 1793. The planter class and British West Indian sugar production, before and after Emancipation. Economic History Review XXVI: 448-463.

GUEROULT, ADOLPHE, 1842. De la question coloniale en 1842. Les colonies françaises et le sucre de betterave. Paris.
HALL, DOUGLAS, 1959. *Free Jamaica, 1838-1865; an economic history*. New Haven, Yale University Press.

———, 1961. Incalculability as a feature of sugar production during the eighteenth century. *Social and Economic Studiea*, X, 3: 305-318.

LAVOLLÉE, P. 1841. *Notes sur les cultures et la production de la Martinique et de la Guadeloupe*. Paris.

LIPPMANN, E.O. von, 1942. *Historia do açúcar desde a epoca mais remota até o começo da fabricação do açúcar de beterraba*, (trans. Rodolfo Coutinho). Rio de Janeiro, Instituto do Açúcar e do Alcool.

MARTIN, GASTON, 1948. *Histoire de l'esclavage dans les colonies françaises*. Paris, Presses Universitaires de France.

MAY, LOUIS-PHILIPPE, 1972. *Histoire économique de la Martinique (1635-1763)*. Fort-de-France, Société de Distribution et Culture.

MINISTÈRE DU COMMERCE ET DES MANUFACTURES, 1829. *Commission formée avec l'approbation du Roi... pour l'examen de certaines questions de législation commerciale. Enquête sur les sucrers*. Paris.

MORENO FRAGINALS, MANUEL, 1976. *The sugarmill. The socioeconomic complex of sugar in Cuba*, (trans. Cedric Belfrage). New York, Monthly Review Press.

REED, WILLIAM, 1866. *A history of sugar and sugar yielding plants together with an epitome of every notable process of sugar extraction and manufacture from the earliest times to the present*. London, Longmans, Green & Co.

SAINTE CROIX, FELIX RENOUARD, Marquis de, 1843. *De la fabrication du sucre aux colonies françaises et des améliorations a y apporter*. Paris.

———, 1822. *Statistique de la Martinique*. Paris.

SCHNAKENBOURG, CHRISTIAN, 1980. *Histoire de l'industrie sucrière en Guadeloupe (XIXe-XXe siècles).* Tome I. *La Crise du système esclavagiste. 1835-1847*. Paris, l'Harmattan.

SCHOELCHER, VICTOR, 1842. *Des colonies françaises. Abolition immédiate de l'esclavage*. Paris.

SCOTT, REBECCA J., 1985. *Slave emancipation in Cuba: the transition to free labor, 1860-1899*. Princeton, Princeton University Press.

TOMICH, DALE, W., 1990. *Slavery in the circuit of sugar: world economy*, *French colonialism and the crisis of plantation agriculture in Martinique (1830-1847)*. Baltimore, Johns Hopkins University Press.

WEBER, MAX, 1978. *Economy and society*. 2 vols. Berkeley, University of California Press.
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WILLIAMS, ERIC, 1970. *From Columbus to Castro: the history of the Caribbean, 1492-1969.* New York, Harper and Row.

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