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TECHNOLOGY PLANNING FACTORS IN THE CANE SUGAR INDUSTRY

Background Paper

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TECHNOLOGY PLANNING FACTORS IN THE CANE SUGAR INDUSTRY

by

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INTRODUCTION

It is worth noting that in as far as the sugar industry is concerned. It involves successive processes to extract and purify sugar from plant tissues wherein several very complicated synthesis changes take place. In fact sugar is produced at the fields and this explains the very tight ties between the field and the factory in a modern sugar industry.

Commercial sugar is extracted from two crops: Sugar cane stalks which is a tropical crop grown mainly in developing countries and beet roots, a temperate zone crop, grown mainly in industrialized countries.

Sugar is amongst the most moderate-price nutrient substances for human consumption, whereas it represents roughly 10% of the calory requirements of the world population. It is also worth noting that although commercial sugar is basicly a food the industry tends to produce almost a chemically pure compound. This tendency is mainly dictated by the specification laid down by the food administration of given country on the one hand and the requirements of the consumer on the other hand. The consumption pattern varies widely from one country to another. In general, this pattern is governed by the level of industrialization and the per capita income. In highly industrialized countries 50 to 65% of the

total consumption is channelled to industrial uses and the balance to household, restaurants and alike. While in developing countries the the bulk of consumption is channelled to household uses. It follows that the pattern of consumption affects to a great extent the conditioning of the final product. Sugar for industrial uses could be moved from the factory as crystals in bulk or as liquid sugar, while sugar for household and other domestic uses has to be packed either as crystals or cubes.

The basic foundations of the modern sugar technology were laid down after the introduction of steam in sugar factories for heating and driving engines. Since then the main features of cane sugar industry remained almost unchanged, except for the following differences :

(a) Greater attantion has been focused on the role of the field and a considerable progress has been achieved in variety selection, weed and cane diseases control, irrigation and field mechanization. The result of that progress evidenced in higher sugar yields per unit area of cane fields.

(b) The replacement of batch operation by continuous ones. The actual generation of sugar machinery may have twenty times the capacity of their respective first generation.

(c) Mechanization of factory operation and process control automation.

(d) Economic utilization of by-products.

(e) Controlling of environmental pollution.

It may be interesting to allude to objectives of developing countries in this concern. Developing countries produce about 55% of the world output. Many of those contries actually or implicitly suffer from unemployment or masked unemployment. Therefore machanization schemes either in agriculture or industry may seem contradictory to the logical approach to a social problem. Nevertheless in general they have no discretion. They have to adopt modern technology and apply new devices in order to have a share in the process of development.

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1. FACTORY SIZE & LOCATION

1-1 Processing sugar cane into commercial sugar being a seasonal agro-industry. It is difficult to identify a general rule that fixes the most economical factory size. The actual availability of high capacity machines and equipment makes it feasible to build a cane sugar factory of capacity upto 20.000 T.C.D. However the most economical size of a given factory has to the subject of an individual evaluation taking into consideration the following factors :

a. The expected available crop within a distance of 20 to 30 km. from the factory site.

b. The duration of the crushing season which is mainly governed by the climatic condition of the location. For a given annual sugar production factory size is inversely proportional to the duration of the crushing season.

c. Market size, final distination of the product and, whether sugar production is intended for local consumption or for the world market.

1-2 In a cane sugar factory a chain of several unit operations takes place starting with juice extracting and ending by sugar storage. Depending on the factory size the capacity of specific machines and equipment at each station has to be chosen. Apart of the extraction station all other stations of the sugar-house

could operate in one stream line.

Due to design limitations the factory could be equiped with one or more extraction stations depending on its crushing capacity. In case of exetraction by straight milling and provided that the daily crushing rate does not exceed 10.000 T.C.D., the factory could b e conceived with one train of mills, otherwise it would be advisable to conceive the factory with two independent trains of a dequate capacity. In casé of extraction by the mill-laxcivation process the factory could be concerned with one extraction station up to a crushing rate of 6000 T.C.D.

1-3 When selecting the location of a sugar factory the following factors are decisive :

(a)The closest proximity to the cane growing fields in order to avoid excessive transportation cost of a bulky material.

(b)The possibility of transporting the crop from the fields to the factory either by road or by rail at a reasanable cost.

(c)The availability of an ample water supply, since a sugar factory is a big water consumer.

(d)The possibility of linking the factory to the national network of roads or railways to transport the two products namely sugar and molasses to the respective market or to the nearest part in case of export.

(e)Proximity to an urban center with a view to reduce investment cost of the factory village.

1-4 In a modern cane sugar factory cane is transported to the factory either by trucks or railway cars.

The initial investment cost in the first case is much less than in the second, however, on the long run the second alternative is more economical since the running cost is much less. In certain cases one or the other alternative becomes the only option due to the state of distribution of cane fields with respect to the factory site.

1-5 The net weight of cane per truck or car varies widely and is generally affected by the following factors :

(a)Whether loading is mechanical or manual.
(b)The percentage of trash.
(c)The factory size or the daily crushing rate.
(d)Working hours per day of the transport system.

II. RANGE OF TECHNICAL OPTIONS

2-1 Whether the cane received at the factory is produced by out-growers or by the factory estate, it has to be weighed, sampled and analysed for sugar contents and purity to fix the price to be paid by the factory.

For cane unloaling several mechanical solutions are available: Tilting, dumping or by gantry crane. The choice depends on the size of the cane yard and the feeding table or feeding conveyors. From there on the sequence of unit operations is as follows :

(a) Juice extraction and bagasse disposal.
(b) Juice purification and disposal of mud.
(c) Juice concentration.
(d) Crystallization.
(e) Crystal drying in case of white or refined sugar productions.

2-2 Juice Extraction :

2-2-1 Cane washing and detracting before crushing is only necessary where cane is mechanically harvested and carries with it a certain amount of soil. In case cane is hand-cut, there is no need to have a washing system preceding the cane knives.

2-2-2 Juice extraction by crushing the cane between massive rollers was the only process in use in the sugar industry. Until 1962, when extraction by lixiviation

has been introduced.

The lixiviation process (Known as a diffusion process) have the following advantage over straight milling.

a. Lower investment cost since a cane "diffuser " replaces three to four mills.
b. Lower maintenance costs.
c. The mixed juice have a lower starch content.
d. Hihger extraction efficiency.

2-2-3 In both processes cane has to be prepared by knives or knives and shredder before starting the extraction operation. The number of knives and the installed driving power depend on the crushing rate on the one hand and the fiber contents of the cane on the other hand. In the case of extraction by lixiviation special care has to be given to cane preparation to secure that 95% of the cells are opened.

For the bed type diffusers, it is important to have a uniform particle size as far as possible.

2-2-4 The majority of Cane sugar factories uses the bagasse as fuel. When bagasse is used as raw material to produce paper or panels it has to be depithed as it comes out from the last mill and stored in bulk in the case of paper production or baled and stored.

2-3 Juice Purification

2-3-1 There are three distinct qualities of commercial cane sugar:

a) Raw Sugar.
b) Plantation white or mill white indicating that the white sugar is produced at the sugar factory.
c) Refined sugar which is produced mainly at a sugar refinery processing raw sugar and, to limited cases, in the sugar factory processing cane into refined sugar.

The term refined sugar applies only when a sugar liquor is further purified by carbonation and the filtered liquor is further decolorised by bone char or active charcoal.

It is worth mentioning that only refined sugar is used for industrial uses, especially processed brown sugar is sometimes used in bakery.

Depending on the quality of the commercial sugar to be produced one of the following processes is adopted

2-3-2 Lime defecation :

Juice purification in the sugar industry consists essentially of precipitating calcium phosphate which has a good ability to adsorb colloids and certain colouring matter. It is a very effective and universally adopted step, relatively simple and cheap. When phosphorous starved canes are processed it is necessary to step up the P_2O_5 content of the mixed juice to 300 p.p.m.

Several variatieis of lime defecation has been developed to improve the basic clarification stage. Typical of these are fractional liming with various variation of the temperature at which the milk of lime is added. Heating the juice before the clarifiers is essential. The most suitable temperature has been found to be about 103°C. Amongst the benefits of heating the juice to that temperature are the coagulation of the precipitate, liberation of air bubbles attached to the precipitate, dehydration of hydrophyllic colloids as well as effective sterilization of the juice.

In cases where the mixed juice contains a high proportion of starch (example variety N.CO. 310) it is advisable to hold the mixed juice at 70°C before liming for same time to eliminate considerable proportion of starch by enzymatic action

After liming and heating, the juice passes through continuous clarifiers: the clear juice goes to the evaporation station while the mud is mixed with a certain proportion of bagacillo and the mixture is filtered in rotary vacuum filters. The filterate joins once more the mixed juice while the filter cake has to be sent back to the cane fields.

This simple process is universally used in sugar factories producing raw sugar.

2-3-3 Sulfitation

Whereas sugar is for direct consupmtion, it is to be produced at the cane sugar factory, while either sulfitation or carbonation of the mixed juice is to be adopted.

Several variations for SO_2 usage are in application, mainly :

a) Presulphitation of the cold mixed juice to p.H. 3.5 - 4.0, followed by simultaneous liming and sulphitation.

b) Simultaneous liming and sulphitation of the mixed juice at 72 - 75 ^{o}C to p.H. $\pm$ 7.5

c) Thick juice sulphitation to p.H. 5.6 - 5.8

For continuous juice presulphitation and thick juice sulphitation, the juice and the gas are introduced, in counter current into an absorption tower where the retention time of the juice is adjustable. Simultaneous liming and sulphitation is carried out usually in a tower equipped with a recycling pump to avoid localized high alcalinity.

Although juice and thick juice sulphitation is the cheapest process to produce white cane sugar, certain problems are associated with its usage:

a) Heavier scale deposit on the heating surface of heaters and evaporators.

b) Corrosion of the condensers and the pipelines between the condenser and the evaporation and vacuum pans.

c) Condensates of the 2nd effect could be acidic if the p.H of the clear juice drops below 6.5 .

d) Inversion at the vacuum pans might occur if the p.H. of the sulphured thick juice drops below 5.8.

2-3-4 Carbonation :

There too the mixed juice is limed at a temprature not exceeding 41°C and the Ca.O is neutalized with CO_2. Fine crystals of calcium carbonate are formed and act through adsorption as clarifying agent and filter aid.

Usually the saturation with CO_2 is carried out in two steps, followed by filtration after each step. After the first carbonation the bulk of the precipitate could be seperated in a clarifier.

The application of the carbonation process in the cane sugar industry to produce white sugar is quite limited, for the following reasons.

a) A substantial proportion of world cane sugar is produced as raw, where a simple defecation with milk of lime is quite sufficient for juice purification.

b) Due to technological and cost considerations it would be more economical to produce white cane sugar by simple deffecation of the mixed juice and adopting a four boiling scheme.

To obtain a good quality of white sugar A and B combined melt should be filtered before boiling.

2-3-5 Refined sugar Production at the Sugar Factory :

This case is quite limited and it could be only justified if the sugar factory was to operate during the off-season as a sugar refinery. In such case juice purification is carried out by simple liming. The combined melt of A & B sugar is further processed in the same way as in classical sugar refinery; melt carbonation, filteration, decolouring of carbonated filtrate with bone char or active charcoal.

2-4 Clear Juice Concentration :

Multiple effect evaporation is the only technique used in the sugar industry to concentrate the clear juice. The number of effects varies between four and five, four effects is more common. The total heating surface of the station is fixed according to the crushing rate of the factory. The distribution of the heating surface between the different effects depends on the bleeding scheme set when fixing the steam balance of the factory.

Due to scale deposit on the heating surface an extra heating surface in the cleaning sycle should be foreseen In small factories one extra vessel could be sufficient to secure the periodic cleaning of the heating surface of the operating vessels. However in big factories and if the rate of scale formation is quite rapid it could be justified to leave an extra evaporation set in the cleaning cycle.

2-5 Crystallization :

2-5-1 In general all raw cane sugar factories follow a three boiling scheme. A four boiling scheme is adopted if the factory has to produce white sugar for direct consumption. If the sugar factory was to produce refined sugar during the crushing season a five to six boiling scheme should be adopted. A larger number of boilings means a bigger boiling house, a higher capacity of vacuum pans and centrifugals and a higher steam consumption.

2-5-2 While all other unit operations in the sugar industry has become continuous operations, crystallization is still a batch operation. Since few years commercial continuous vacuum pans are operating in very limited number. Nevertheless one can state that finally continuous crystallization in the sugar industry became a fact.

The importance of this development is that the boiling station being a big and irregular steam consumer where the rate of evaporation per unit of heating surface is subject to wide variation in the course of one and the same strike.

The introduction of continuous boiling pans in the sugar industry would even out considerable fluctuations in steam consumption and ease many problems at the steam generating station.

2-6 Condensing Plant :

2-6-1 The condensing plant of a sugar factory is the main water consumer. The quantity of condenser cooling water per ton of

cane is variable and ranges from 12 to 25m^3/ton cane/h. Such variation depends on several factors namely :

a) The quantity of juice vapour produced at the last effect of the evaporation station.

b) Whether the juice vapours of the last vessel of the evaporation station are used for heating the mixed juice or not.

c) The boiling scheme and the number of strikes.

d) The quality of sugar to be produced.

It goes without saying that the capacity of the pumping station supplying the factory with its requirements of condensing cold water depends on the crushing rate per hour on one hand and whether the cold water is used only once or it is recycled.

In the former case the installed capacity of the main pumping station supplying the factory with process water would be about ten times that in the case of recycling. However if the cold water supply by the factory site is limited or if the factory has to pay a high price for the industrial water it consumes, the hot water from the condenser leg has to be recycled through a cooling tower or a spraying pond.

2-6-2 Two main condensing systems are well known to the sugar Industry :

a) The counter-current condenser, where a vacuum pump is used to extract the air and non-condensable gases from the top of the condenser.

b) The jet condenser which is a co-current type condenser. This system eliminates the vacuum pump as well as the air piping between the condenser and the last vessel of the evaporation or the vacuum pans.

In practice, the condensing water requirements of the first type is about 30Kg per Kg of vapour to be condensed while it is about double that value for the second type.

In cases where the water supply to the factory is subject to certain limitations and when the condenser cooling water is recycled through a cooling tower, the counter current condenser and an air pump would be the only solution.

The second system could be only used where an ample water supply is available next to the factory. Nevertheless it is likely that when comparing the savings attributed to the elimination of the air pump and the air piping against the extra investment incurred to install a larger water pumping station from source to factory, a larger ducts for cold and not condenser water, the results would be in favour of a counter-current condenser and air pump.

2-7 Steam Economy :

2-7-1 The cane sugar industry has a considerable advantage over the beet sugar industry in so far as it could be self sufficient in fuel in the form of bagasse. It is likely that the cane sugar industry having a free fuel at hand does not optimize its use.

With attention being focused on the critical situation of the world energy supplies, it is pertinent to draw the attention to the real energy potential especially in high fiber situations. If the steam utilization in a sugar factory was optimized, many sugar factories could generate a surplus of electric energy to feed the national power grid or to feed an irrigation scheme near the factory.

The importance of economical use of steam in a cane sugar factory is highlighted if the factory was to sell its bagasse as a raw material to be transferred into panels or paper.

2-7-2 The main factors influencing steam consumption are the following :

a) The Brix of the clear juice to be concentrated at the eveporation station which mainly depends on dilution at juice extraction station and the dilution at the rotary vacuum filters. Considerable steam saving could be realized through optimizing these dilutions .

b) Correct design of the evaporation station which requires :

i - High rate of evaporation at a small temperature difference between the heating vapour and the heated juice and the shortest possible retention time of the juice.

ii - A reliable discharge system of condensates and non condensable gases.

iii - Easy and efficient device for cleaning the heating surface.

It is not uncommon that a low efficiency of the evaporation station resulting into low Brix of the thick juice is corrected by a much higher load of evaporation at the pan station and a higher steam consumption.

c) For a given sugar quality, steam consumption could be optimized by controlling dilution at the pan station and centrifugals

d) Fluctuation of crushing rates attributed mainly to poor maintenance.

III. CHOICE OF CAPACITY

3-1 Early in this century the crushing capacity of the majority of cane sugar factories ranged from 500 to 2000 T.C.D. At that time the capacity of individual machinery used in the sugar industry was one of the main limiting factors of the factory size. Another limiting factor was that certain unit operations were still batch wise. With the evaluation of technology in all fields and the continuous increase of labour cost especially in industrialized conuntries which are at the same the main machine suppliers, almost all unit operations in the sugar industry became continuous and the individual capacity of machines has been stepped up to considerable proportions compared to the respective old generation. To give few examples bagasse boilers of 120 ton steam/h. replaced boilers of 10 -20 ton/h. Rotary-vacuum filters of 3000 T.C.D. replaced small filter presses of 100 T.C.D. each and continuous centrifugals of 9 ton Massecuite C/h replaced small batch centrifugals of less than one ton M.C.C. per hour.

At the same time automation has been introduced to a very great extent to replace many hands either as operators or supervisors. Remote control are frequently used nowadays to operate mills and evaporators. Closed circuit T.V. systems are in use to facilitate operation and supervision of cane yard and mills. Fully automatic batch centrifugals with capacities up to 20 tons of massecuits per hour are currently used and only need top-class maintenance but hardly any operator.

3-2 Such evolution led to the actual tendency of building big cane sugar factories with crushing rate up to 20.000 T.C.D. as well as the rehabilitation and extention of old factories to follow the actual trend.

Looked at from both view points of technical viability and management there is nothing against such big factories provided the following conditions are fulfilled :

3-2-1 That the agricultural infrastructure surrounding the factory are sufficient to saturate the requirements of the factory during a crushing season of reasonable duration, 150 days or more.

3-2-2 That all field operations including harvesting and loading should be fully mechanized. It follows that in such a scheme there would be a place for small outgrowers.

3-2-3 That the factory site with respect to the fields would allow the establishment and management of an efficient cane transport system at reasonable investment and running cost.

3-2-4 That an elaborate training scheme for the upper and the middle technical staff is realized and so timed that such staff be present during the whole period of erection.

3-2-5 To Secure a first class maintenance service.

3-3 Any project related to the building of a new sugar factory or to the extention of an existing one is tailored to suit a given situation. If follows that it is difficult to state what would be the absolute optimum size of a cane sugar factory but one can determine the optimum size of the factory under given conditions. However, it is likely that the area of small factory of 500 to 2000 ton has passed for the following reasons :

3-3-1 In general the schedule of production of sugar machinery makers does not include such low capacity equipment adequate for small factories. On the other hand if such machinery has to be produced on purpose their cost related to their capacity would be excessive.

3-3-2 If on the other hand a small sugar factory was to be equipped with the standard machinery currently constructed today the factory would have single machines at several stations Ex.:
One clarifier, one rotary vacuum filter and one centrifugal for curing each strike. Such arrangement would deprive the factory from the flexibility of

operating at partial load in case of failure of one of those single machines.

3.3.3 The duration of the crushing loader is one of the most important factors that determines the choice of the the factory size. Small factories of 2500 T.C.D., could be quite justified if the crushing season lasts for 7 to 8 months per year. In such case particular care has to be given to the choice of the unit capacity of difinit machinery and equipment as well as to the preventive maintenance and to the annual maintenance

3-4 The two by-products of a cane sugar factory are bagasse and molasses. The former has been and is still used to a very large extent as fuel to secure the requirements of the factory in steam and electrical energy. The later is mainly used for cattle feed to substitute corn or as raw material in the the fermentation industry.

3-4-1 In the case of small factories bagasse would continue to be used as fuel and molasses are oftenly difficult to commercialize especially in isolated factories. Considerable quantities of molasses are lost because of lack of means of transport at reasonable cost or because local conditions cannot make use of that commodity as cattle feed.

3-4-2 Big sugar factories processing one million tons or more of cane per season could be the center of an industrial complex diversifying the agricultural basis of the area; and helping to grade up the standard of living of its population.

When bagasse is depithed itgives two fractions : Fibers and pith. Bagasse fibers could be processed into writing and printing paper; boards for variable uses and newsprint *. On the other hand the pith fraction could be processed into a pelletized feed mix.

A cane sugar factory processing one million tons of cane per season and, using other fuel than its bagasse could make available to further processing 100 000 tons of B.D.fibers and 30 000 tons of B.D. pith per year . Both materials could be conveyed to the storage area of the respective consumer by belt conveyors. Such arrangement has the advange of cutting down the cost of transport of such bulky material. In the case of board or paper industry using other annual plant fibers as raw material bagasse produced by a big factory would have the advantage of cutting down the cost of harvesting and transport of the fibers. The pith fraction after drying could be mixed with molasses and urea, then pelletized to give a valuable feed mix.

The viability of such project would depend on the availability of a local fuel substitute of bagasse such as liquid fuel or natural gas. In cases when local fuel prices are subsidised, the price of bagasse sold to a transforming industry should be calculated on the basis of fuel world price and not on the basis of any shadow price.

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* For the first time two commercial mills of 90.000 ton/year of bagasse based newsprint are at advanced stage of construction are in Mexico and one in Peru.

3-4-3 For a factory of the above mentioned size the annual molasses production would amount to 40 000 tons. Depending on local conditions molasses could be either :

a) Used locally for cattle feed. or ;

b) Transformed into ethanol, fodder or bakers yeast either for local consumption or for export. or;

c) Exported to the world market which creates a source of foreign currency to the sugar factory.

It is worth noting that although cane sugar is mainly produced by developing countries who suffer from lack of protein the use of molasses as cattle feed in those countries is far from being developed.

The production of power alcohol from molasses to substitute imported gasoline partialy could be economically viable provided that the local sugar industry would not suffer from imposed very low prices for their molasses.

Looking into the respective world price of gasoline and absolute ethanol the transformation of molasses into power alcohol does not seem justified unless under very particular conditions where molasses are considered as sunk value due to marketing difficulties .

IV. CONTRIBUTIONS OF THE SUGAR INDUSTRY

4-1 Usually a cane sugar factory is built next to the cane field. Since sugar is a cash crop which in many cases outweights alternative crops the establishment of a sugar industry in a rural area enormously influences the betterment of the standard of the living of that area. A good number of field hand turn into semi-skilled and skilled labourers working either on specific field jobs or at the factory. Gradually agriculture labour will change their main career into industrial labour with similar influence on their successors in the future. The industry being a seasonal industry, the number of seasonal field labour per ton of sugar produced would vary widely depending on the following factors :-

a) Whether cane is manually detached or burnt before cutting.

b) Whether harvesting and loading operations are mechanized or not.

On the other hand the man hour per ton of sugar of permanet and seasonal laborer in the factory varies widely from one factory to another. Such variation is largely influenced by the following factors :

a) The size of the factory.

b) Whether the cane trasport system is managed by the factory or by an external body.

c) The degree of mechanization of the cane yard, the cane unloading system and sugar handling.

d) The degree of automation of the process

4-2 In modern sugar factories of 10 000 T.C.D. or more about 7 man hour are used per ton of sugar produced.

If bagasse and molasses was processed by the factory into other commodities such a complex would create about 1500 to 1700 industrial labour chances of different proffesions. Most of their wages will be spent in the region of the factory, creating a healthy economy and a welfare society.

4-3 The impact of the pressence of a sugar factory in a rural area is not only limited to the creating of gainful employment and the up-grading of its population skills. It extends to cover services and commodities required by the factory and purchased either from the region or from other regions in the coountry :
Cane, Sugar and molasses transport, insurance, consumables for the Industry, medical care , training, education grants.. etc.

V. INVESTMENTS IN THE SUGAR INDUSTRY

5-1 The sugar industry has oftenly faced very low sugar prices and very poor or negative balance of its investments resulting from a production higher than the demand. This explains why the sugar industry production for the world market is today reluctant to increase the volume of production beyond certain limits in order to secure reasonable earnings to the respective investment. On the other hand many developing countries with sufficient land, and adequate climate to grow sugar cane and produce sugar do not have the financial possibilities or the suitable atmosphere to attract investors.

The considerable escalation of sugar prices during the end of 1974 which attained a peak of about 64 cents in November 1974 tempted many countries to increase their sugar production. It seems as if the attained volume of production was on the high side since sugar prices declined once more to attain a minimum of less than 9.0 cents three months ago. At the actual cost of investment per ton of sugar such level of prices would hardly attract any investor unless sugar was produced for a local market or unless sugarexports was subsidized.

5-2 Two main factors exert direct influence on the cost of investement per ton of sugar namely :

(a) Plant size or crushing rate in T.C.D.

(b) Duration of the crushing season at full load of the crushing rate.

The influence exerted by the duration of the crushing season is much higher.

Assuming the case of a plant with an average crushing rate of 10 000 T.C.D. and a season of 150 days thus producing 160 000 tons per season the investment cost would amount to about 600 U.S. $ per ton. A rough breakdown of such figure could be the following :

Sugar Factories and factory facilities	450	US $ per ton
Plant infrastructure	50	" " "
Cane transport facilities	50	" " "
Factory village & community development facilities	50	" " "

5-3 At that high cost of investment per ton of sugar the importance of attaining very high efficiency of operating a sugar factory becomes a must. Taking into account that the price of spare parts has doubled several folds during the last few years and the regular increase of prices of consumables the profit margin in the sugar industry becomes more and more thinner. To attain the desired high efficiency of operation the following factors has to be respected.

5-3-1 Sugar cane being a perishable crop it has to be processed within the first 24 hours of its harvesting. This requires an elaborate planning of the harvesting transport operations and a very tight coordination between the field and the factory.

5-3-2 A new sugar factory should be designed with no bottle-necks. The capacity of the pan and centrifugal stations has to be calculated on the basis of the highest expected yield of sugar and the highest expected yield of molasses. Such conception might cost slightly higher however, it allows the factory to crush at its full load, regardless the fluctuations of the cane quality.

5-3-3 The factory has to operate at its full load and at a regular rate of crushing per hour in order to avoid either mechanical losses of the products or higher retention times of sugar solutions at the clarifier, filtration and evaporation stations.

5-3-4 To keep a very high level of preventive and regular maintenance to avoid shut-downs or crushing at a reduced rate.

5-3-5 To optimize the use of steam and other consumables especially Lub. oils.

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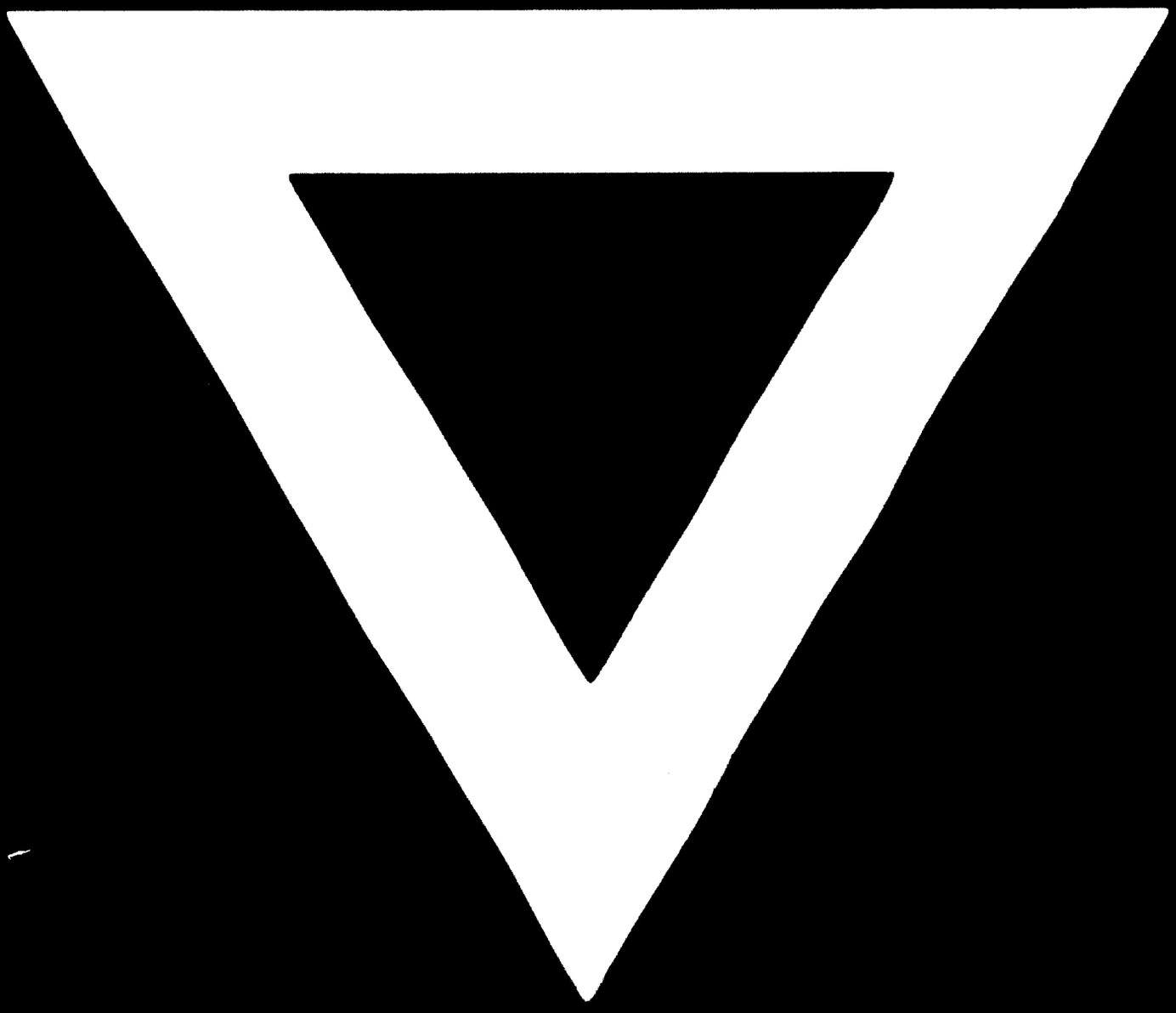

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