JOINT FORUM

TOPIC:	**Future Directions for the Beet Sugar Industry**
SECTIONS:	D - Chemistry and Instrumentation F - Factory Operations
MODERATOR:	Vic Jaro, The Amalgamated Sugar Company LLC

INTRODUCTION

Welcome to a joint forum on future directions for the Beet Sugar Industry.

A distinguished panel of technologists, scientists, and engineers have agreed to present a combination of today's state-of-the-art reality and some forward-thinking concepts that can move us as an industry to higher levels of processing efficiency, environmental compliance, innovative new markets, and application of new processes.

The panel will attempt to present ideas to chart a course from today to tomorrow ----- a tomorrow filled less with today's uncertainties, and more with optimism derived from taking appropriate actions — of taking control and moving our industry truly into and through the 21st century.

The following relevant topics will be presented:

- Discussing from his experience the factory of tomorrow and addressing environmental, labor, and energy issues:

  Mark Suhr
  Vice President of Operations
  Southern Minnesota Beet Sugar Cooperative

- An Environmental Perspective – environmental issues, ensuring compliance, and strategies for the future

  Jeff Carlson
  Director of Technical Services
  Minn-Dak Farmers Cooperative

- Sugar processing opportunities

  Charles Rhoten
  Vice President of Operations
  Monitor Sugar Company

- New Products, New Uses, and New Concepts

  Mary An Godshall
  Managing Director
  Sugar Processing Research Institute, Inc.

- New technologies under development that could help our industry

  Vadim Kochergin
  Amalgamated Research Inc.

Panel speakers will be given latitude on time to fully present their ideas. Questions and open discussion will follow the presentation.

SMBSC Expansion

Mark Suhr, Vice President Operations
Southern Minnesota Beet Sugar Cooperative

Decisions SMBSC Faced

- Modernize
- Modernize with Expansion
- Evaporate

Cooperative Review

- Equipment Wear Rate
  - Maintenance Increase
  - Mechanical Down Time
- NAFTA/GATT Agreements
- Environmental Impact

Cooperative Review

- Costs
  - Labor
  - Fuel
  - Limestone
  - Chemical
  - Maintenance

Project Goals

- Increase factory slice
  - 9,500 tons to 14,500 tons per day
- Acreage Expansion
  - 100,000 acres to 147,000 acres
- Shorten campaign length
  - 220 days to 180 days

Project Reductions

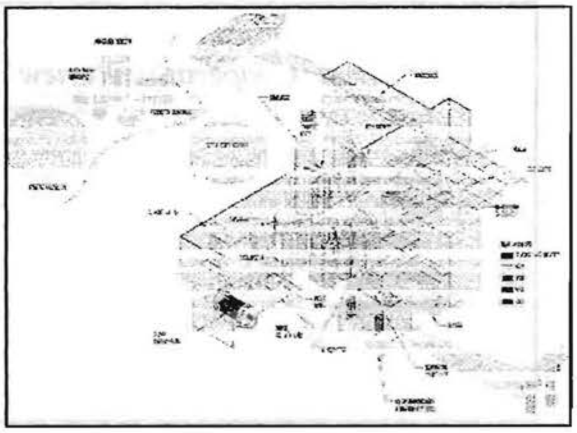
- Energy: 40% to 20% steam on beets
- Labor: 58 people/shift to 30 people/shift
- Maintenance: 25% reduction
- Extraction: 3 extraction points
- Environment: No fines; less odors

In-House Team

- Utilized Sugars™ Software
- Phil Thompson
  - SKIL
- Steve Ahlschlager
  - Ace Services

Expansion Focus

- Beet End Installations
- Sugar End Installations
- Waste Water Treatment
- Thick Juice Storage
- Electrical Power



Trials and Tribulations

- Beet Conveyor Angle
- Head Pulley
- Boiler Outage
- Juice Campaign
- Aggressive First Year Schedule

Trials and Tribulations

- Permit Requirements
  - Steam dryers
- Permit Delays
  - Wastewater treatment plant

Successes

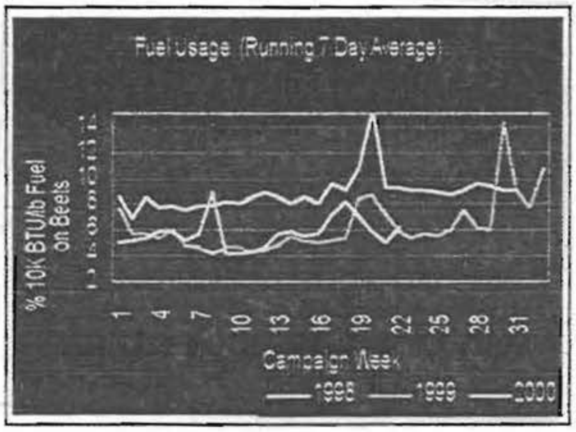
- Employee Dedication
- Control Screens
  - Instrumentation design
- Equipment Installation from Dry Handling, Beet Receiving to Carbonation Installed on time
  - All piping replaced
  - All electrical renewed including distribution

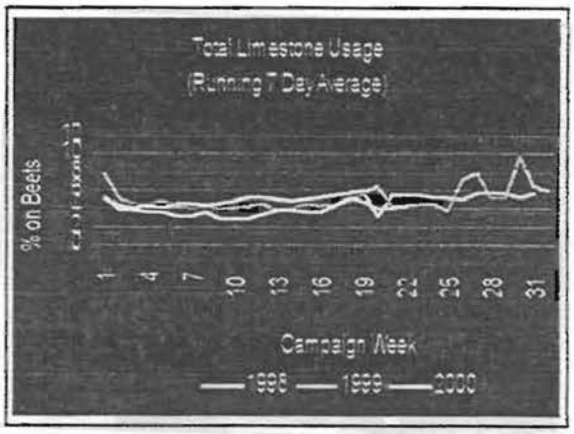
Successes

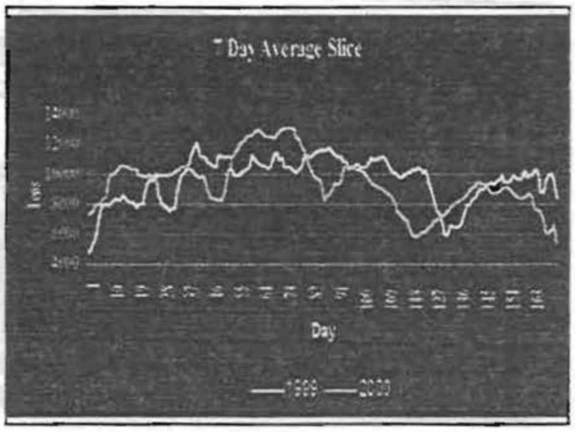
- Equipment Performance
- Pump Model Standardization
  - VFDs
- Municipal Power
- Waste Water Treatment Plant
  - Decanter centrifuges
  - Anaerobic system

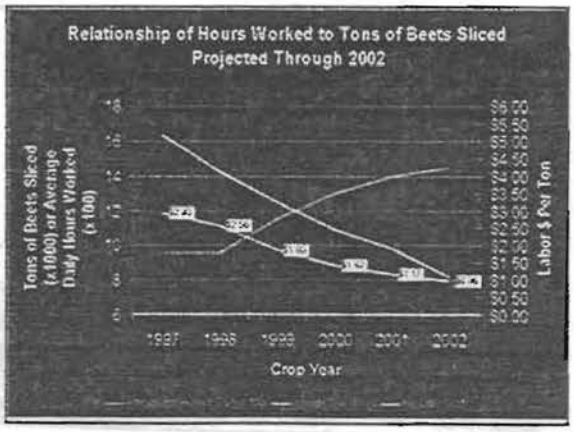
Successful Reductions

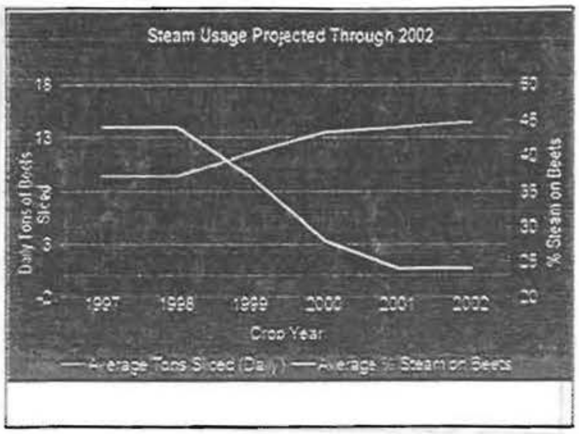
- Fuel Usage
  - 8% on beet standard fuel to 5% on beet
- Limestone Usage
  - 5.5% - 3.9%
- Emissions
  - 800 tons reduced
- Labor Reduction

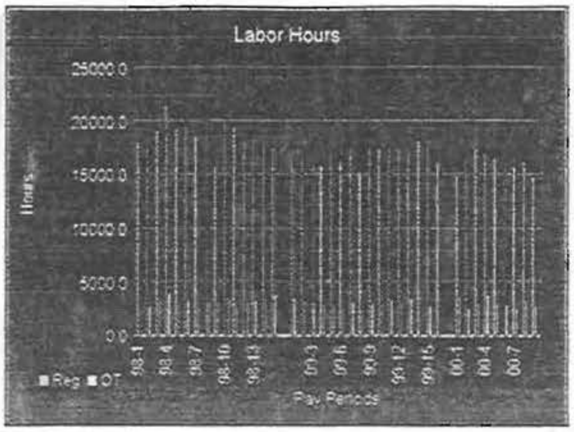


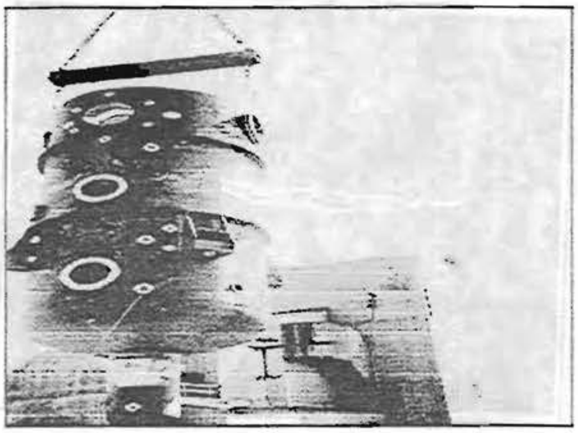


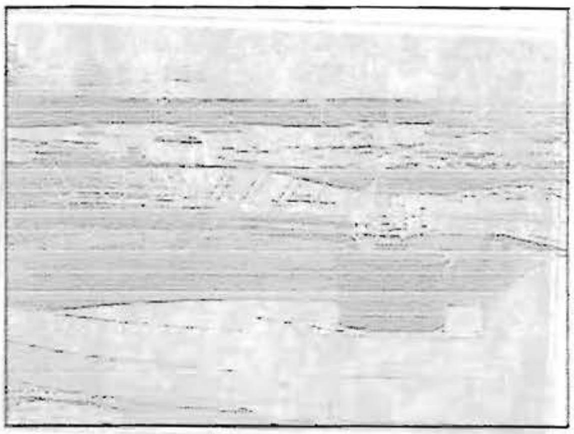


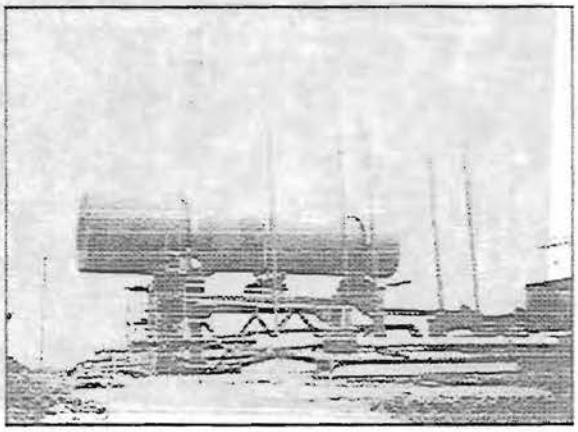


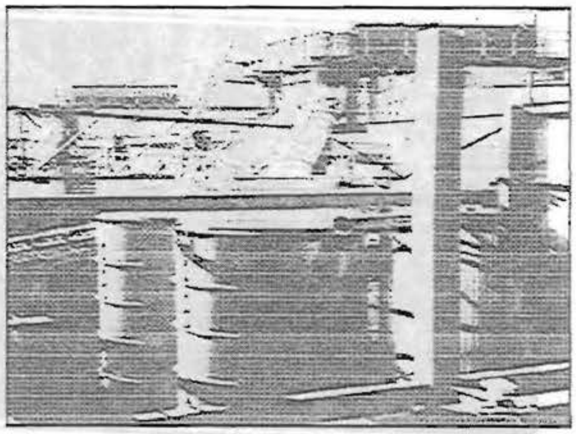

Steam Usage Projected Through 2002
Daily Tons of Beets Sliced
% Steam on Beets
1997 1998 1999 2000 2001 2002
Crop Year
Average Tons Sliced (Daily)
Average % Steam on Beets

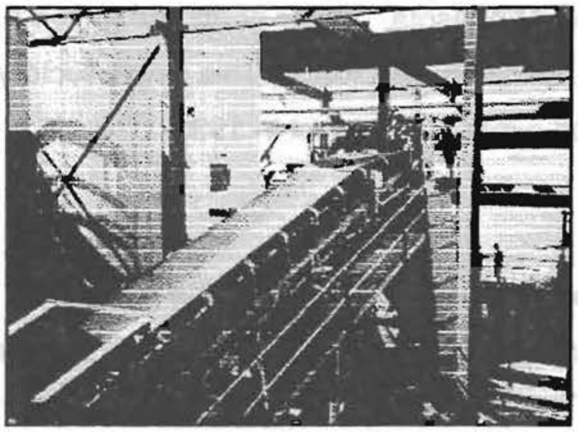

Labor Hours
25000.0
20000.0
15000.0
10000.0
5000.0
0.0
Hours
98-1 98-4 98-7 98-10 98-13 99-3 99-6 99-9 99-12 99-15 00-1 00-4 00-7
Reg OT
Pay Periods

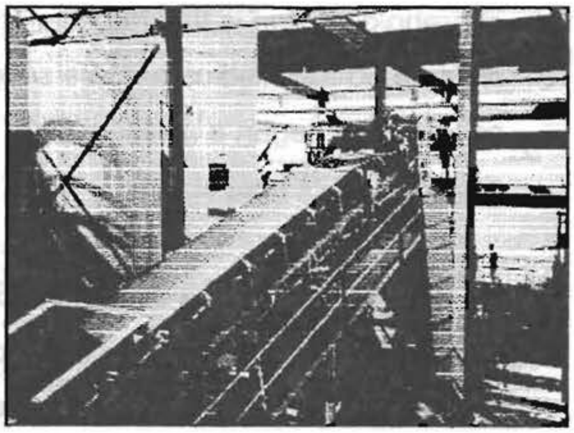


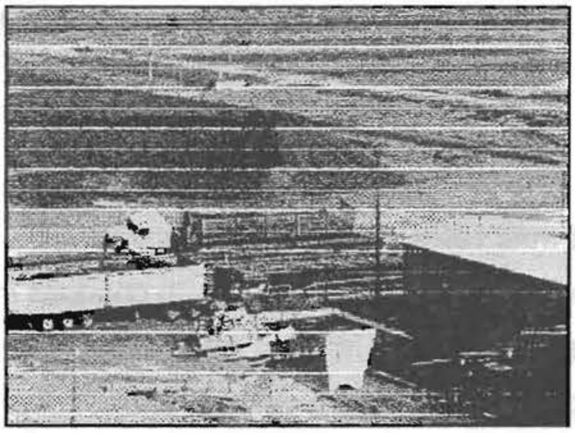












Southern Minnesota Beet Sugar Cooperative (SMBSC) is owned by 550 shareholders and is located near Renville, Minnesota. Sugar beets are grown within a 60-mile radius and are supplied by the shareholders. This single factory cooperative began a massive $103 million expansion project in 1999. The project is in its final stages.

The factory was built in 1975 on one square mile of land. The plant capacity has grown from originally processing 800,000 tons of sugarbeets to over 2,000,000 tons per processing season. The daily slicing capacity has increased from 6,000 to 9,500 tons along with increases in thick juice storage. Over the years, this was accomplished with only modest capital investments, allowing shareholders a good investment return. The only major capital investment made to the original facility was a molasses desugarization plant, designed by FinnSugar, in 1990.

Evidence of increasing equipment wear rates, declining equipment reliability despite a rapidly increasing maintenance budget, along with changes in environmental constraints necessitated a review of the need to modernize. In addition, the impacts by the farm bill, depressed commodity pricing, and NAFTA/GATT agreements were evident. The Cooperative's ability to continue to effectively compete in the market needed to be evaluated.

In the modernization evaluation, it became apparent that $60,000,000 was needed to bring the Cooperative's processing facility into environmental compliance and replace worn equipment. Obtaining funds at this investment level would be difficult to justify with the minor efficiency gains offered only by equipment replacement.

An expansion of the processing facility would allow us to raise equity, meet modernization needs and gain on efficiency. The design criteria was simple: expand without increasing any input (with the exception of sugar beets), reduce labor, fuel, limestone and chemical costs, as well as reduce daily operating maintenance. It was also important that the expansion meet the environmental issues and provide satisfactory returns in addition to reducing exposure to inflationary effects.

Utilizing the 1997 campaign year as a base and comparing these results to forecasted factory results, an analysis of the return to the shareholders was performed. This allowed our shareholders an evaluation method without allowing sugar and by-product pricing and inflation to distort the comparisons. The result was a positive response by the shareholders and an approval from the Board of Directors.

The five-year capital plan was announced which would expand the factory capacity to obtain the lowest cost for capital invested. The project itself was to expand daily processing from the current 9,500 tons of sugarbeets to 14,500 tons and the daily sugar granulation from 20,000 cwt to 27,500 cwt. Once completed, the expansion project would result in a $5 per ton increase in the beet payment and provide a hedge against the inflation effect on employee cost and potential higher energy costs. The acreage for sugar beets would also be increased in a planned sequence from the 100,000 acres to 147,000 acres. With the increase in acres, additional piling sites were added along with upgrades to existing pilers. Refer to *SMBSC Acreage Expansion* insert.

An in-house team undertook the project's design, planning and engineering with limited input from external specialists. Phil Thompson of SKIL and Steve Ahlschlager of ACE Services aided process design and equipment selections. They were responsible for process modeling using Sugars^{Tm} software to analyze many different scenarios. This allowed the design to be optimized for thawed and frozen beet conditions at a range of throughputs as the factory capacity was progressively increased.

Equipment selection and process design was done based on the best available proven technology after reviewing experiences in several countries and selecting the best match to SMBSC's expansion objectives.

Major cost centers were identified and included labor, energy, limekiln and maintenance. Within this report are the charts reflecting the expected performances.

The future operating parameters and results were also identified and designed around these constraints:

Operating Parameters	**Operating Results**
14,500 tons beets/day	604 tons/hour
Tare dirt	< 4.0%
Extraction	82.9% on sucrose
Sucrose in the beet	17.0% on beets
Thick juice purity	90%
Main sewer loss	0.20% sucrose on beets
Diffusion loss	0.20% sucrose on beets
Lime cake loss	0.05% sucrose on beets
Standard liquor purity	92%
B-sugar purity	96%
Affinated C-sugar purity	93%
C-sugar purity	88%
Sucrose loss in molasses	14.8 tons/hour
Sucrose loss in molasses on beets	2.45%
Sucrose production	75 tons/hour
Standard liquor to storage	51.1 tons/hour
Molasses purity	60% purity
Molasses production	31.5 tons/hour at 80 brix
Draft	105%/112% (frozen)
Lime cake	28 tons/hour
Pulp press moisture	72.5% max
Beet pulp pellet production	35.6 tons/hr

An obstacle to this expansion centered on a cultural shift in how SMBSC operated as much as in selecting and installing the correct equipment. We shifted from staffing for the worst case scenario with limited scope and responsibility to a staff that is one-third smaller, adjusting to all new equipment and having greater operational discretion. The workforce was a veteran group, which was an asset since many were still here from the original start-up. It was important for them to change their skills and efforts in order for us to meet the operational needs. Workforce reduction would only come by attrition.

The expansion's initial focus involved the beet-end equipment. This was due to the current equipment's wearing as well as the slice capacity required to process beets from the increased acreage. The sugar-end modifications were scheduled to begin later. Additional thick juice storage would be utilized to offset the sugar-end constraints prior to the sugar-end completion.

Previously, the factory was decentralized with most stations essentially operating without centralized control monitoring. The expansion allowed a completely centralized area with all controls monitored and adjusted from the control room with the exception of adjustments from the boilerhouse and limekiln operations. It is important to note throughout the expansion, the workforce adjusted to this control change and their performance has been remarkable.

During the planning progress, a second turbine generator of eight mega watts was planned. In discussion with our municipal electrical power supplier it was determined a rate structure could be developed that essentially made the need to generate any electrical power unnecessary. The 10-year agreement still allows an option to export power from our existing generators if economics warrant. This unique opportunity was good for both parties but did require additional work in the summer of 1999.

The expansion project's first stage was very aggressive. Scheduling and completion were difficult the first year due to environmental permitting constraints, needing to have the wastewater treatment facility and the two steam dryers operating, and undergoing a complete electrical system change.

A majority of the equipment was installed within the existing facility structure and required the installation to be complete and operational in only 130 days. (A complete equipment listing is identified in the1997-2002 Capital Equipment Expansion outline). It became apparent that during this first campaign not only were we going to deal with the new equipment, but a near record crop was produced and had to be processed.

It took incredible effort and dedication to have the factory slicing beets on September 13, 1999. The instrumentation and control screens developed by our own employees were exceptional and allowed start-up to be remarkably trouble free. The washhouse had initial difficulty with entrained air in pumps that took time to solve. Slice, however, remained relatively constant. The major miss was the 16° angle involved with the dirty beet conveyor from dry handling to the pre-washer. The beets would not consistently convey at the selected belt speed so a 24-hour shutdown was made to change the angle to 13.66° with small cleats added to the belt to ensure optimal performance the rest of the campaign.

Another operational issue was the head pulley on the beet conveyor for both clean beets and cossettes. The problem was apparent only when we processed frozen beets, as the conveyors with the oversized lagged head pulleys and snub pulleys experienced problems of hydroplaning and consequently slippage. Ceramic head pulleys were installed which eliminated the issue. The overall campaign results showed an increase in slice, and reductions in energy, labor and limestone. The installation proved to be robust and allowed much operating flexibility.

In the factory's beet end, a common pump model was used for almost all areas. The pumps chosen are reliable and robust units from Chesteron with high chrome wear parts. By using belt drives and variable frequency drives (VFDs) it was possible to match most duties with a single pump, and some larger duties with two running parallel. In general, there are no installed spares and in the event of a failure, a spare pump can be obtained from inventory. This is one of the benefits of standardization, along with a reduction in inventory and increased familiarity for the maintenance staff.

VFDs are used extensively at Southern Minnesota Beet Sugar Cooperative in preference to control valves wherever possible. A large portion of the factory load is now powered through VFDs including the beet slicers, diffusers, pulp presses, pumps, steam dryers, batch centrifugals etc. An unusual feature is the use of steam turbines on large drives involving the boiler FD air, coal pulveriser mills, boiler feed pump and lime kiln gas compressors. These factors combine to give a relatively low electrical power demand of nine mega watts at a 500 ton per hour slice rate (20kWh per metric ton of beet).

With the two steam dryers installed, the turbo generator was taken out of service and all of the factory power is imported from a municipal power supplier via one of two 16-mega watt high voltage transformers. The supplier was able to offer low prices down to three cents/kWh for a large supply contract. This low price combined with the relatively low boiler steam pressure and the existing direct drive turbines made generation unattractive as relatively little steam was available to pass through to exhaust pressure. In the future, the turbine may be brought back into use as power prices for cogenerated electricity are rising.

An additional 1.5 - 2 mega watts are used in the water treatment plant where Broadbent decanter centrifuges are used to remove solids from the beet washing water before the anaerobic and aerobic treatments. The anaerobic and aerobic treatments result in a discharge water meeting very high water quality standards.

Total factory fuel consumption has fallen from 8% on beet standard fuel (10,000 Btu/lb or 23 MJ/kg coal basis) to around 5% on beet. This reduction is mostly due to the steam dryers that effectively eliminate the pulp dryer fuel demand previously met with natural gas. The financial savings have increased by recent high gas prices while the boilers continue to run on low priced coal. When the new evaporators and heat recovery systems are fully operational, the process steam demand will fall to 24% beet (frozen beet basis) which equates to a standard fuel demand of 3% beet:

	Fuel kWh/t Beet	Electricity kWh/t Beet	Total	kWh/t Sugar
1998	469	26	495	3325
1999/2000	293	24	317	2078
2002	176	22	198	1247

The 180-day operating campaign length was selected to give the overall best economy. The dry matter "shrink" or loss from beets increases with increasing campaign length. This effect is compounded by the reduction in sucrose yield, which can occur if storage conditions are less than perfect. The 2000 campaign experienced freezing night temperatures and above average day temperatures (86°F), which severely affected the beet before harvest and led to deterioration in storage, illustrating the vulnerability of the factory to climatic variability. For these reasons, the factory design is on the cautious side rather than aiming for a maximum 220-230 day campaign. Extensive thick juice storage combined with the molasses desugarization facility allows the sugar warehouse to be operational for most of the year, producing some 375,000 metric tons of granulated sugar per year from a single facility.

Environmentally, over 800 tons of emissions were eliminated by removing the conventional direct-fired pulp dryers and installing two fluidized steam dryers. The wastewater treatment facility was modified and expanded with the addition of an anaerobic system. The system's capacity of 1.5 million gallons per day (MGD) and an extended aeration/activated sludge system with nitrification capabilities and a hydraulic capacity of approximately two-MGD. Final clarification, effluent filtration and effluent aeration completed the treatment.

The existing ponds remained in service to treat and/or store barometric condenser water, dryer and evaporator condensates, boiler blowdown, effluent from the mechanical wastewater treatment facility (as needed) and smaller waste streams. The expanded wastewater treatment facility discharges, on a continuous basis, to a county ditch. An interesting aspect of the wastewater treatment facility involves phosphorus trading. Phosphorus trading is done not only to offset what we are discharging, but it provides a 40% reduction in phosphorus discharged to the Minnesota River. SMBSC is involved in several projects that reduce phosphorus such as use of cover crops, exclusion of cattle from streams, stream bank protection as well as other similar projects.

Due to a boiler failure in the spring of 2000, and a 20-year low in sugar prices, the stock sales slowed and the second phase of the expansion was delayed.

The new six-effect Balcke-Duerr falling film evaporators were installed and put into operation during the current 2000-2001 campaign. Given the condition of a dehydrated frost damaged beet crop this season, the short retention time and high heat transfer coefficient of the evaporators have helped greatly.

The remaining items to be addressed with the expansion include the installation of continuous pans and centrifugals for high and low raw sugar, carbonation replacement and a back-up boiler to our single pulverized coal-fired boiler.

In summary, the overall results of the expansion provided environmental improvements to land, water and air. It will also enable us to meet projected returns and clearly place Southern Minnesota Beet Sugar Cooperative as a leader in the North America factories in reducing labor and energy.

SMBSC ACREAGE EXPANSION

Year	*Stock Acres*	*Stock Sale*	*Expected Slice*	*Expected Harvest Tons*
1998	110,000	10,000	9,400	2,000,000
1999	120,000	10,000	10,800	2,225,000
2000	120,000	2,000	11,500	2,400,000
2001	123,000	0	13,000	2,600,000
2002	130,000	2,000	14,000	2,720,000
2003	140,000	2,000	14,500	2,800,000
2004	147,000	5,000	14,500	2,900,000

CAPITAL EXPLANSION PLAN

Fiscal 1998 Installations

Project Description	Capital Request (estimate)
Pre-construction	$1,000,000
Initial purchase payments For FY-99	$7,000,000
Waste water treatment	$6,800000

Fiscal 1999 Installations

Project Description	Capital Request (estimate)
Agricultural 2 pilers	$1,200,000
Dry handling of beets	$3,600,000
Wash station for beets	$5,600,000
Extraction station	$15,300,000
Pulp press station	$8,000,000
Pulp drying station	$9,200,000

Fiscal 2000 Installations

Project Description	Capital Request (estimate)
Agricultural 2 pilers and 2 new sites	$2,800,000
Powerhouse upgrade	$4,500,000
Evaporators	$8,500,000
White centrifugal upgrade	$2,000,000
Continuous hi-raw pan	$2,000,000
Tare lab upgrade	$1,000,000
Carbonation Phase 1	$2,000,000

Fiscal 2001 Installations

Project Description	Capital Request (estimate)
Agricultural 2 pilers and 2 sites	$2,800,000
Carbonation Phase 2	$2,500,000
White pan modifications	$2,000,000
Pond improvements	$2,800,000
Pulp pellet loading and storage improvements	$3,500,000
Juice storage	$2,000,000
White sugar loading and packaging	$3,500,000

Fiscal 2002 Installations

Project Description	Capital Request (estimate)
Agricultural 1 piler and 1 site	$1,400,000
Water management	$1,200,000
Affination	$ 800,000

Southern Minnesota Beet Sugar Cooperative
1997 to 2002 Capital Expansion Plan

Beet End Installations

Beet Receiving

- Receiving System Concrete Station
  6 - Drive over truck hoppers (max 250 Tons/Hr ea.)
  Hydraulic controlled conveyors
  2 – 60' Hydraulic controlled truck side dumping units
  2 – Self-dumping high capacity yard truck stations
  Above to supply factory with a total 750 Tons/Hr. PLC controlled for a total capacity of 18,000 tons/day
  Designed by Dakota Machine Inc.
  Installed by North Central Construction Inc.

Beet Washing

- Beet Pre-washing Drum (for dry beet feeding)
  92' long x 16' diameter, total through put capacity of 18,000 tons/day
  3 compartments: prewashing, water separation, and washing
  Friction tire double electric drive system
  (1 ¼" shell thickness w/ 3CR12 internals)
  Designed by MAGUIN (Fr.)
  Installed by North Central Construction Inc.

- Beet Washing Drum (for dry beet feeding)
  50' long x 14' diameter, total through put capacity of 18,000 tons/day
  3 compartments: prewashing, water separation, and washing
  Friction tire double drive system
  (1 ¼" shell thickness w/ 3CR12 internals)
  Designed by MAGUIN (Fr.)
  Installed by North Central Construction Inc.

- Stone Catchers (2)
  Rotary drum type, 13' diameter
  12 rock catching pockets with discharge chutes
  Designed by MAGUIN (Fr.)
  Installed by North Central Construction Inc.

- Fork Type Weed Catcher
  Designed by MAGUIN (Fr.), Installed by North Central Construction Inc.

- Sand Catcher

Rotary drum type, 9' diameter
8 sand catching pockets
Designed by MAGUIN (Fr.)
Installed by North Central Construction Inc.

- Vibrating Screens (2), Weed Washing, Sand Screening
  Designed by FMC (USA)
  Installed by North Central Construction Inc.

- Weed and Chip Separator
  Separates weeds & chips from wash water
  By means of a Dynamic separator discharges beet chips onto clean beet belt, & discharges weeds to weed washing station.
  Designed by MAGUIN (Fr.)
  Installed by North Central Construction Inc.

- Beet Screw
  6' Diameter x 32' long 3CR12 screw
  Designed by MAGUIN (Fr.)
  Installed by North Central Construction Inc.

- Final Washer
  High pressure spray bar washing table with reciprocating motion
  Designed by MAGUIN (Fr.)
  Installed by North Central Construction Inc.

Beet Slicing

- Beet Slicer Hopper
  500 Ton capacity (45 min @ 16,000 Ton/Day Slice)
  Designed by SMBSC

- Putsch Slicers (3) (model 2200-22-600)
  Horizontal drum type slicer
  Approx. capacity of 430 ton/hr unfrozen beets per unit/10,000 tons/day ea.
  Designed by Putsch, (Ger.)

Extraction

- Countercurrent Cossette Mixer
  Feed hopper, mixer body, AC drive shaft mounted, defoaming screens, mixer conveying shaft
  Designed by BMA (Ger.)

- Extraction Tower (2)
  Vertical design, bottom cossette feed, top cossette discharge, internal flighting 3CR12, 25' diameter x 110' tall
  VFD top shaft mounted drive system
  Designed by BMA (Ger.)

Pulp Pressing

- Vertical Tower Presses (2 per extraction tower) model HP 4000
  Vertical design, upper feed, center spindle, screened internal shell for water, juice, & pulp separation
  16' diameter x 60' tall
  Bottom Mounted 10 unit drive system
  Designed by BMA (Ger.)

Pulp Drying

- Vertical Steam Pulp Dryer (2) Size H
  Pressurized fluid bed type
  35' diameter x 60' tall
  Designed by (NIRO)

Pellet Cooling

- Vertical pellet coolers (4)
  Model: CPM 2GA2 vertical coolers
  Approx. 3.6 Ton/Hr/unit, retention time 5 min.
  Designed by California Pellet Mill

Sugar End Installations

Evaporation

- 6 Effect Plate Type Falling Film Evaporator
  Approx. 430,600 total ft^2
  300,000 lbs./hr steam introduced, 733 ton/hr juice rate, evaporation to 70 brix
  50% juice to storage, remainder processed to white sugar
  Evaporator design by Balcke Duerr

Juice Heating

- Alfa Laval plate type multipass heat exchangers
  Models: MA-30SMFM, M-20MFG
  Extraction heaters: 7 heaters totaling 13,154 ft^2
  Raw juice heaters: 6 heaters totaling 19,858 ft^2
  Carbonation heaters: 4 heaters totaling 17,661 ft^2
  Thin juice heaters: 5 heaters totaling 8,864 ft^2
  Wastewater heaters: 2 totaling 6,232 ft^2

High/Low Raw Continuous Centrifugals

- Continuous Centrifugals (7)
  High Raw
  Normal Station Throughput: 75.4 Ton/Hr
  Max Station Throughput: 90.4 Ton/Hr
  Low Raw
  Normal Throughput: 33.4 Ton/Hr
  Max Throughput: 40.1 Ton/Hr
  30 degree basket, 1,300mm basket
  Operating Speed: 1,885 RPM
  Designed by BMA (Ger.)

White Centrifugals

- Batch Centrifugals (4)
  1,700mm inside basket diameter
  Operating Speed: 1,030 RPM
  Designed by BMA (Ger.)

Waste Water Treatment

Anaerobic Upflow Sludge Blanket Treatment System, & Aerobic System
W/ Double Aerobic Basins & Double Secondary Clarifiers
Flume Water Clarifier: 1- 160' diameter 5.1mil/gal/day
Equalization Tank: 1- 126' diameter
Anaerobic Tank: 1- 95' diameter
Aerobic Tank: 2- 126' diameter
Secondary Clarifier: 2- 60' diameter
Biosolids Sludge Tank: 1- 126' diameter
Biofilters: 3
Total water treated: 1.5mil/gal/day per design
Treatment Design: Applied Technologies

Thick Juice Storage

3 API Welded Thick Juice StorageTanks
150' diameter x 40' tall - total juice capacity of approx. 5.3 mil/gal

Sound Strategies for Addressing Environmental Issues at Beet-Sugar Processing Plants

Jeffrey L. Carlson

MINN-DAK FARMERS
COOPERATIVE
WAHPETON, NORTH DAKOTA

Issues

- More Environmental Laws
- More Regulations
- More Enforcement
  - Government and Citizen
- More Record-Keeping Requirements
- Greater Penalties

Ensuring Compliance

- Top-Management Commitment
- Environmental Management Progr
  - Effective Training Program
  - Effective Record Keeping
  - Effective Internal Enforcement
  - Internal and External Auditing

Controlling Costs

- Maintain Compliance
- Examine all Capital Projects for the **TOTAL ENVIRONMENTAL COS**
- Incorporate Environmental Matters Intimately into all Medium-to-Long Term Planning

IN SEARCH OF GREATER SECURITY AND PROSPERITY FOR THE NORTH AMERICAN BEET SUGAR INDUSTRY

What Does History Teach Us?

- Sugar and traditional byproduct prices remain relatively flat and under pressure.
- Operating costs keep increasing.
- Increased production leads to increased market pressures and lower prices.

What are the Realities of the Current Business Climate?

- Strictly a commodity business.

  Sugar is a highly developed, highly competitive commodity market significantly influenced by political agenda.
- Most of the profits for beet sugar companies come from the production and sale of refined sugar. Relatively minor contribution from downstream byproducts.
- Pulp and molasses, as animal feed materials, must compete with a variety of low cost, readily available and increasingly diverse commodities.
- Largely, with the current product mix, the only answer to continued profitability has been production growth and/or continued protection.
- Further sugar production growth will lead to greater oversupply and greater market depression without reduced imports.
- Government protection is coming under increasing attack in the U.S. and worldwide.
- U.S. cost of beet sugar production is approximately twice (or more) of that of the most efficient world producers of raw cane sugar.

What Does Survival of the U. S. Industry Depend On?

- Government protection from cheaper imports.
- Higher prices for sugar, pulp and molasses.
- Lower Costs of Production
- Development of "value added" products from sugar beets as a raw material.

What is the REAL Question to be Asked?

- How can we derive maximum value from sugar beets in order to compete with all competitors in the beet, cane and HFCS corn processing sectors in a world-class arena without government intervention?

How Do We See Ourselves as an Industry?

Sugar Producer (Sugar and byproducts)

-or-

Beet Processor (Primary and Secondary downstream product supplier)

Are there Signs of Such Thinking in the Sweetener Industry?

Cane Milling:

Non-feed products from molasses:

- Alcohol (food, fuel)

Non-fuel products from bagasse:

- Furfural and downstream products (Furfural Alcohol, Diacetyl)
- Ethanol
- Lignin
- Single-cell protein
- Building products
- Fodder

Corn Wet Milling:

The name alone implies the thinking and strategy. (In both examples)

Are there Opportunities to Increase the Value-Added Contribution of Byproducts?

- Possible Directions:
  - ✓ Develop multiple product streams from traditional byproducts exploiting major byproduct stream constituents and precursors for manufactured products.
  - ✓ Develop high value, small-scale downstream processes to produce high-value products for niche markets.
  - ✓ Find new and higher value uses for existing products and by-products. Develop non-traditional uses for existing byproducts. Search for and develop markets and demands for higher valued uses. Customize products to be "user friendly".
- Some Possibilities (Dreaming Out Loud):
  - ✓ Molasses desugarization is a step in the right direction but still focuses on sugar production. What else is there of value in molasses that might only be a separation step away? Small scale, High value Micro-Separations.
  - ✓ Is pulp exploitable?

Pulp constituents:

Hemicellulose	32%
Pectin	24%
Cellulose	20%

Protein	11%
Lignin	4%
Sugar	4%
Minerals	4%

- ✓ What can be produced from pulp that is commercially exploitable?
  - ✓ Work is being conducted to develop enzymes that convert pressed pulp to alcohol. What is left over after alcohol production and how might it be used? (Potential is there to possibly double pulp revenue.)

    Alcohol (hemicellulose, sugar, pectin?)

    Absorbent fiber (cellulose)

    Enriched protein feed (Protein, minerals and "other")

- ➢ How could we accomplish such development?
  - ✓ Individual Corporate Endeavor
  - ✓ Research & Development Partnerships
  - ✓ Development & Marketing Consortiums?

What is Needed from Coproduct Development?

- ✓ About four times the current byproduct value is a worthy goal.

	Current Economics ($25 Sugar in USA)		World Production Environment ($18 Sugar in USA)	
	WO Desug	W Desug	Current	Needed
Input Cost	$74.00	$77.00	$77.00	$77.00
Revenue Generated				
Sugar	$67.50	$76.50	$55.08	$55.08
Coproducts	**$8.40**	**$6.75**	**$6.75**	**$28.17**
Margin	$1.90	$6.25	($15.17)	$6.25

In Search of Greater Security and Prosperity for the North American Beet Sugar Industry

What Does History Teach Us?

- Flat Prices for Commodities
- Increasing Costs
- Higher Production Leads to Lower Prices

What are the Business Realities?

- A Mature Commodity Business
- Only Sugar Produces Significant Profits
- Byproducts Compete on Commodity Basis
- Only Growth Offsets Increased Costs
- Government Protection is Weakening
- US Production Costs High

What Does Industry Survival Currently Depend On?

- Government Protection
- Higher Prices
- Lower Production Costs
- Development of Value Added Products

The **REAL** Question

How can sugar beets as a raw material be exploited to derive the highest possible finished product value?

How Do We See Ourselves?

Sugar Producer

-or-

Beet Processor

Does Such Thinking Exist in the Industry?

- Cane Milling:
  - Molasses & Bagasse Downstream Products
- Corn Wet Milling:
  - Diverse Product Streams

Are there Opportunities for Value Added Downstream Products?

- Exploitation of Byproduct Components
- Small Scale, High Value, Side-Stream Products
- Higher Value Uses for Existing Products

Molasses

- High Value Micro-Separations
- Ethanol Production
- Yeast Production
- ??????????

Pulp

- Hemicellulose 32%
- Pectin 24%
- Cellulose 20%
- Protein 11%
- Lignin 4%
- Sugar 4%
- Minerals 4%

- Ethanol
- Absorbent Fiber
- Enriched Feed

How Could Such Products be Realized?

- Individual Corporate Undertaking
- R&D Partnerships
- Development & Marketing Consortiums

Competition in an Unprotected Environment

Future Directions for the Sugar Industry
New Products, New Uses, New Ideas

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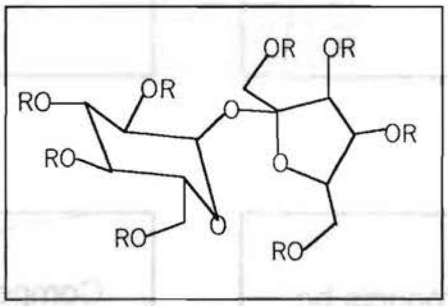
The sugar industry is faced with the dual challenges of oversupply and low prices. Aside from innovations in processing, such as the use of membranes, continuous vs batch equipment, extensive on-line monitoring, and chromatographic methods to recover more sucrose, what avenues are available to the sugar industry for expansion? What are some ways to make more use of sucrose and the feedstocks available from the sugar industry, such as pulp and molasses?

There is a lot of current interest in exploiting agricultural biomass for new products, new energy sources and new chemistries. Using carbohydrate feedstocks creates the possibility making biodegradable, and thus environmentally friendly products, as well as providing a sustainable resource for the feedstock. The sugar industry, therefore, needs to be open to new products, new uses and new ideas. There should also be better use and exploitation of existing products.

Sucrochemistry is the branch of chemistry which deals specifically with modifying the sucrose molecule to make other products. Sucrose has 8 hydroxyl groups available for reactivity (see figure), which is both a hindrance and a benefit: a hindrance because it is difficult to control the reactivity of so many hydroxyl groups, so there is often a large number of different products; a benefit, for the same reason.



Sucrose, R = H
Sucrose Esters, R = Fatty Acids or H

Value is added when a bulk commodity, which is typically very inexpensive, is converted to a fine chemical with desirable properties. Among bulk carbohydrate commodities, sucrose is second only to cellulose and far exceeds in output all other commercial carbohydrates combined. An estimated 1.7% of annual sucrose production goes to non-food uses. Sucrose and its co-products lend themselves to possibilities in many areas: Fine chemicals, pharmaceuticals, polymers, building and structural materials, fermentation or enzyme substrate for chemicals production, new food products, cogeneration/fuel/biodiesel/ethanol, and transformation of the beet plant to make other products.

Among sucrose derived products already on the market are high value food products, pharmaceuticals and specialty sucrose esters. Sucralose is a high intensity sweetener; olestra is a fat substitute; fructo-oligosaccharides are bulking agents and dietary aids made from enzymatic or microbial conversion of sucrose. High value sucrose-based pharmaceuticals and diagnostics include Sucralfate, a sucrose aluminum hydroxide sulfate complex used as an ulcer medication; and Polysucrose, crosslinked sucrose, used to make density gradients for cell separation and as a diagnostic.

Specialty sucrose esters represent one of the most promising areas for the use of sucrose in fine chemicals. Sucrose esters can take many forms because of the 8 hydroxyl groups in sucrose available for reaction and many fatty acid groups, from acetate to larger, more bulky fats that can be reacted with sucrose. This flexibility means that many products and functionalities can be tailored, based on the fatty acid moiety used. Sucrose esters have many food and non-food uses, especially as surfactants and emulsifiers, with growing applications in pharmaceuticals, cosmetics, detergents and food because sucrose esters are readily biodegradable, non-toxic and mild to the skin. The largest volume use of a sucrose ester (~100,000 tons) is that of sucrose acetate isobutyrate (SAIB), used both in food and industrially.

Sugarbeet pulp represents another area for exploitation. A small amount of research has already been done showing its potential to produce paper, dietary fiber, vanillin, and gums and polysaccharides with special properties, such as gelling agents, thickeners, stabilizers and fat replacers. This is certainly an area where more work needs to be done.

New products made from sucrose with novel properties and promising uses continue to appear out of research laboratories. While most of these products are not yet commercialized, they represent the potential for sucrose as a feedstock in various applications. Among these are sucrose thermal oligosaccharide caramel (STOC), a feeding supplement for chickens and a possible non-caloric food bulking agent; sucrose epoxy; and sucrose hydrogels, super porous and fast swelling, with potential use in controlled release drug delivery.

Unexpected findings arise from time to time. A recent study showed that adding sucrose to the fermentation stage in ethanol production (from corn) speeded up the fermentation and enhanced ethanol output.

Perhaps the area generating the greatest amount of excitement concerning new environmentally friendly "green chemistry" is the production by microorganisms of natural biodegradable plastics. These natural polyesters are fermentation products of various bacterial species which can use sucrose as the carbohydrate source. The genes for making biodegradable plastic could also be inserted into a plant, such as the sugarbeet, to make, for example, plastic in the leaves.

Manssur Yalpani stated, in a presentation in 1998, that carbohydrates are the "sleeping giant" of biotechnology, and that carbohydrates will be the next century's feedstock alternative to petroleum-based products. We are now at the start of that "next" century. It will be interesting to see what it holds for the sugar industry.

New Developments in the Beet Sugar Industry

- Lime - free technologies
- Membrane filtration of raw juice
- RO of dilute streams
- Fractal equipment
- Modern process equipment

Raw Beet Juice Purification(ARi)

Raw beet juice

Membrane filtration

Juice softening

Evaporation

Chromatography

Crystallization

Cooling Crystallization of Raw Juice (University of Ferrara, Italy)

Raw beet juice

Membrane filtration

Evaporation

Cooling Crystallization

Modern Process Equipment

- Steam dryers
- Continuos crystallizers
- New generation of centrifuges
- Vertical crystallizers
- Pulp presses,
- etc.

Fractal Equipment

Use the concept of fractal fluid distribution for new generation of process equipment

Softeners, chromatographic systems, clarifiers, silos, etc….