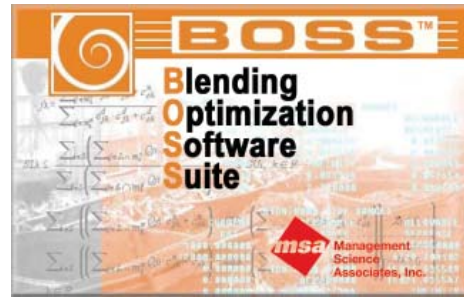




BOSS™
Blending Optimization Software Suite™

Blending Optimization Software Suite™ (BOSS™)

Management Science Associates, Inc.'s (MSA) Metals and Advanced Manufacturing Division has been providing blending optimization systems in the metals industry since our group's founding in 1982. The Blending Optimization Software Suite (BOSS) offered by MSA can deliver significant savings by helping to reduce the costs of raw materials. MSA's BOSS Charge Design determines the least-cost combination of materials needed to produce a given heat, line up, or production schedule, accounting for the various operating and quality constraints. A prime differentiator is the multi-grade/multi-heat capability whereby least-cost material requirements can be generated across any number (or campaign) of grades and heats. A 'Buy Plan' determines the materials to



purchase for an order book or production schedule. An Alloy Additions calculation provides the determination of the least-cost set of materials to complete a melt. A ManMix calculation provides the capability to generate a predicted chemistry for a selected set of inventory materials and can be compared to a grade specification.

Demonstrable savings have been obtained for each component of the BOSS.

BOSS Models

MSA's BOSS utilizes the latest techniques in mathematical programming to implement various optimization models, including:

- Purchase Planning
- Single Heat Charge
- Multi-Grade/Multi-Heat Campaign Optimization
- Alloy Additions Calculations
- ManMix Calculation
- Market Price Calculator
- Under-Crane Loading Optimization
- Marshalling Yard Planning

The blending optimization models consider the current inventory, available market materials, actual chemistry information, and chemical and physical constraints to calculate the least expensive mixture of materials to meet the specific requirements, along with the associated weight, yield, chemistry, and cost information. All models contained in the BOSS provide the ability to do "what-if" scenarios and to analyze the costs/savings associated with using alternative materials and various constraints.

Charge Design
Compare

Scenario ID: 63
Scenario Name: Multi Heat Charge Design
Cost Options: ☒ Actual ☐ Current ☐ Standard
Optimize (F7)

Last Run: 03/14/2011 16:28:30
Model Status: LP Optimal Solution.

Schedule

Shop	Grade	Heat Number	Vessel	Number of Heats	Max Materials	Min Weight (LB)	Max Weight (LB)	Min Recovery	Min Density	Sequence
StainlessShop1	316	ARC2		20	0	200,000	205,000	0.00	0	1
StainlessShop1	304	ARC2		10	0	200,000	205,000	0.00	0	2

Charge Design | Global Restrictions | Inventory | Charge Results | Material Exclusions | Global Results | Sensitivity Analysis | Model Options | Elemental Contribution

Type	Code	Lot	Name	Unit Weight LB	Total Cost per Heat	Ordered Amount (LB) Per Heat	Percent Total Weight	Percent Total Cost
On Hand...	159	159	304 HEAVY	1	63,127.2964	105,861	50.00	48.22
On Hand...	300	300	12CR 23Ni 3 MO	1	62,703.4384	59,154	27.94	43.74
On Hand...	155	155	201 CROP ENDS	1	5,855.8500	19,500	9.21	4.09
On Hand...	9	9	CARB STEEL FL...	1	593.5629	14,839	7.01	0.41
On Hand...	95	95	T/S TINGS	1	206.3795	9,381	4.43	0.14
On Hand...	919	919	40Ni 40CU	1	4,826.5364	2,908	1.37	3.37
On Hand...	361	361	05 CARBON LCCR	1	33.4271	79	0.04	0.02

Model Heat Predictions
Total Heat Cost: 143,346.4928
Charge Heat Weight: 211,722 LB
Predicted Heat Weight: 200,000 LB
Composite Density: 1

Schedule Item Summary
Per Heat Summary
Cost per LB: 0.7167
Recovery Pct: 94.46%

Solution
Finalize

Summary Information

Element	Min	Max	Exact	Pred. Chem.	Contained Units
C	0.0800		0.0800		3.200
Si	0.7500		0.5275		21.098
MN	2.0000		1.6904		67.214
P	0.0450		0.0283		1.134
S	0.0300		0.0053		211
CR	16.0000	18.0000	16.0000		640.000
MO	2.0000	3.0000	2.0000		80.000
NI	10.0000	14.0000	10.0000		400.000
B			0.0002		7
AL			0.0605		2.422
CO			0.1710		6.839
CU			1.0547		42.188
FB			0.0010		41

Predicted Chemistry

Example of a multi-grade/
multi-heat charge design
scenario.

BOSS - Alloy Additions

File Edit Editors Optimize Reports Shop Tools Configuration Windows

Grade Specifications **Actual Chemistry**

Seq. No: 52-1 Bath Weight: 2000 Cost: Current Sample Time: 10/17/2007 14:59:01 Sample Result: Passed
 Heat No: HEAT002 Aim Weight: 2000 No. Materials: 0 Last Alloy Calc.: 03/20/08 11:49:09 Alloy Calc Result: Optimal
 Grade: 253SL Furnace: SS1 Current Rev: 2 Start New Rev. Optimize [F7]

Analysis/Materials/Results Grade Spec Restrictions Sensitivity Analysis Sensitivity Analysis Help

Show All Elements

El	Min	Max	Exact	Sample ID	Pred. Chem.
C	0.0800	0.1200	0.1000	0.1000	0.1000
MN	1.4000	1.5000	1.4500	1.4500	1.4500
SI	0.8000	1.0000	0.8000	0.8000	0.8000
CR	23.5000	24.5000	24.0000	24.0000	24.0000
SN	0.0000	0.0100	0.0000	0.0000	0.0000
NI	37.0000	38.0000	37.7000	37.5000	37.7000
MO	0.0000	0.2000	0.2000	0.1989	0.1989
CU	0.0000	0.1500	0.1186	0.1186	0.1186
PB	0.0000	0.0050	0.0000	0.0000	0.0000
P	0.0000	0.0300	0.0135	0.0135	0.0135
S	0.0000	0.0200	0.0041	0.0041	0.0041
CO	0.0000	0.5000	0.0282	0.0282	0.0282
W	0.0000	0.2000	0.0753	0.0749	0.0749
NB	0.7000	0.9000	0.8000	0.8000	0.8000
N	0.0000	0.0400	0.0045	0.0045	0.0045
V	0.0000	0.1000	0.1000	0.0994	0.0994
ZR	0.0000	0.0400	0.0000	0.0000	0.0000
AL	0.0000	0.1000	0.0069	0.0070	0.0070
MB	0.0000	0.0200	0.0000	0.0000	0.0000
O	0.0000	0.1000	0.0000	0.0000	0.0000
FE	100.00		34.7988	34.6019	

Avl.	Material	Lot	Form	Ordered Amount	Actual Amount	Min
<input checked="" type="checkbox"/>	Nickel	41	PVIR	48		
<input checked="" type="checkbox"/>	Chrome	14	PVIR	32		
<input checked="" type="checkbox"/>	EMn	18	PVIR	17		
<input checked="" type="checkbox"/>	NiCb	40	PVIR	15		
<input checked="" type="checkbox"/>	SI	11	PVIR	9		
<input checked="" type="checkbox"/>	c dust	13	UNKNOWN	3		
<input checked="" type="checkbox"/>	316 plate	7	PSLD			
<input checked="" type="checkbox"/>	4130purchase...	8	PSLD			
<input checked="" type="checkbox"/>	Al Wire	9	PVIR			
<input checked="" type="checkbox"/>	Arc Iron	10	PSLD			
<input checked="" type="checkbox"/>	Arc Moox	11	PVIR			
<input checked="" type="checkbox"/>	Armco	12	TRN1			
<input checked="" type="checkbox"/>	304 plate	6	VIRG			
<input checked="" type="checkbox"/>	25/35 LC	5	TRN2			
<input checked="" type="checkbox"/>	Cobalt	15	PVIR			
<input checked="" type="checkbox"/>	Copper	16	PVIR			
<input checked="" type="checkbox"/>	Die Steel	17	TRN1			
<input checked="" type="checkbox"/>	137-01	4	INGT			
<input checked="" type="checkbox"/>	10/10	3				
<input checked="" type="checkbox"/>	FeCb	20	SLDS			
<input checked="" type="checkbox"/>	FeMnSi	21	PVIR			
<input checked="" type="checkbox"/>	10FeCr	2	PVIR			

Example of an alloy additions scenario.

Chosen Materials
Color Coding on Boundary Conditions

Advantages & Features of BOSS

- State-of-the art mathematical formulations – via a third-party solver
- Very fast solution times
- Cost savings of multi-grade/multi-heat vs. single-heat optimization
- Sensitivity analysis information (i.e., reduced costs, dual prices)
- Assistance with diagnosing infeasible results
- Ability to limit the number of materials in the solution
- Ability to use materials in discrete quantities (i.e., unit weight materials)
- Minimum use amount constraints
- Ability to solve polynomial and non-linear fractional constraints
- Ability to filter material candidates by a variety of criteria
- Multiple user selectable inventory (on-hand, market, unlimited) and costing (actual, replacement, standard) options

Sensitivity Analysis

Sensitivity Analysis is a powerful tool to allow a better understanding of the costs of various constraints and opportunities related to material pricing. From the Sensitivity Analysis, the actual cost for holding to a specific chemistry (min/max) constraint can be determined. This information can

be used to adjust working aims and can result in significant cost savings. Material price adjustment information is also provided, indicating the price change required for a given material to be used in a solution.

Cost Saving Examples

The savings cited below come from actual trials and studies conducted for clients.

- Savings of 3-8% (and greater) when no previous blending optimization was used.
- When an existing in-house optimization model or another blending system was being used, typically a 1-5% savings was noted, and:
 - An additional 1-3% savings was demonstrated due to a multi-grade/multi-heat simultaneous solution, providing for better utilization of inventory.
 - An additional 1-3% savings due to better purchase planning decisions.
- Savings of 5-8 % were demonstrated for an integrated mill by modifying their standard

charge mix and expanding the types of scrap to consider.

- A foundry operation reported a 15% decrease in raw material costs when a purchase planning function was implemented.

Blending Optimization Trials

MSA can provide Blending Optimization Trials whereby clients' current mixes are compared against charges generated by MSA's BOSS package. These trials can be used to understand potential cost savings and more easily determine a return on investment (ROI) value.

About MSA's Metals & Advanced Manufacturing Division

MSA's Metals and Advanced Manufacturing Division has supplied integrated process automation systems and services to a variety of process and manufacturing industries. Industries serviced by MSA include steel, chemical, pulp and paper, laboratory, and environmental.

MSA specializes in providing turnkey computer systems, system design, and engineering and

consulting services. Our process knowledgeable engineers and our technology expertise combine to result in leading edge systems and services for our clients.

Our mission is to improve our clients' productivity, quality, and profitability by providing innovative, reliable, and easy-to-use automation systems, on time and on budget.



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