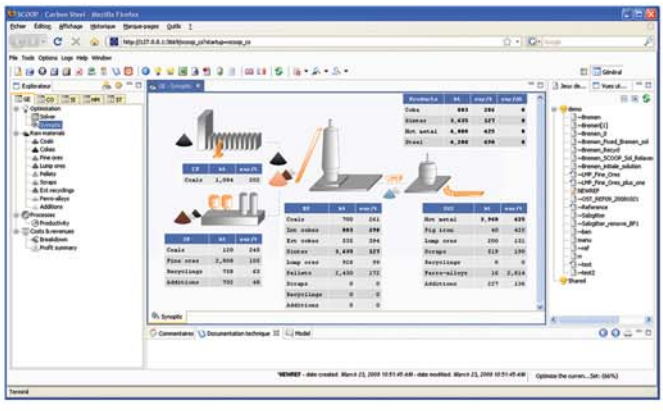
SCOOP
Steel Cost Optimization by N-SIDE

BENEFITS

1. INTRODUCTION

SCOOP (Steel Cost Optimization) is a strategic decision aid tool aiming for selecting the best combination of raw materials that matches all quality and technical requirements of an integrated operation.

It is a technical and economical model that takes into account all the chemical, thermo-dynamic, mechanical, productivity, avail-ability, logistical formulas into account and that allows optimization by department (coke plant, sinter plant, blast furnace or steel shop for an integrated steel company) or for the entire set of departments all together, which is unique in the market.



Typically used by the process manager in an integrated steel works company it is a simulation tool that can re-compute in a few seconds the best response to any change in the process, availability or price of the raw material. It allows estimating the impact of the introduction of a new raw material and determines its optimal quantity and price.

SCOOP is also a tool for the raw material procurement people. It allows them to negotiate prices based on the Limit Marginal Price calculation of SCOOP. This price indicates when a given raw material becomes attractive in terms of quality and price and how the system would react to any price variation.


GE - Fine ores

Fine Ores

Code	Label	MASS [kt W]	Price [¤/t]	LMP [¤/t]	ATTRACT [¤/t]	¤
1010	concentr 01	0.00	124.83	122.13	-2.70	usd
1020	concentr 02	800.00	125.54	127.94	2.40	usd
2010	fine ore 01	432.06	121.61	119.79	-1.82	usd
2020	fine ore 02	800.00	127.60	150.97	23.37	usd
2030	fine ore 03	157.68	102.07	102.18	0.11	usd
2040	fine ore 04	618.29	156.48	154.80	-1.68	usd
2050	fine ore 05	0.00	151.32	137.08	-14.24	usd
2060	fine ore 06	0.00	151.88	137.88	-14.00	usd

Mass by sourcing | Mass by process | Cost by sourcing | Cost by process | LMP | Detailed LMP

By its nature, SCOOP will be the perfect tool to help the dialogue between the process people (who need some raw materials allowing them to achieve the quality of steel they need to produce) and the procurement people (who are trying to get those materials at the best price). Process experts and R&D should also be interested by the documentation features of SCOOP. All formulas coming either from the literature or from the site experience, sometimes accumulated over many years, are documented in SCOOP. You can easily view where and how a parameter is used in a formula and other parameters influencing this formula. This is what we call the knowledge aggregation.

The benefits of SCOOP are easy to calculate. They vary between 3 (carbon steel) and 50$ (stainless steel) per ton of steel produced, making it one of the quickest return on investment solution on the market (a few weeks in general). As it targets the raw material costs, which represents up to 85% of the total production costs of steel, it represents a strategic asset to any steel producer.

What is very important to understand is that SCOOP is a tactical model, used for quarter and annual budgets and for estimating the value of new raw materials. It is not an oven charging model giving the exact mix of material to use for the next days of production. Once the raw material mix is calculated by SCOOP for the next quarter or year, charging process is done through other classical solutions.

SCOOP is a parameter-driven tool that can be easily reconfigured to comply with any change in production (a blast furnace relining for instance) or market conditions. During the 2009 economical crisis, SCOOP has been used with a Cash-Out Minimization objective function on top of the more traditional Cost Minimization.

2. RETURN ON INVESTMENT

Return on Investment with SCOOP is very quick. A site producing 5 million tons of steel has a raw material budget above $1 billion. By optimizing the mix according to the production process, we can reduce the raw material costs by a fraction of percent, which translates immediately in millions of dollars of savings.
Factors influencing the ROI are:

- The type of steel being produced. The higher the value of the steel produced, the higher are the raw material costs and the higher will be the benefits. For Flat carbon steel, depending on the quality, we can get from 3 to 10$ per ton of steel of cost reduction.
- The tools already in place before using SCOOP. Many companies have charging models. As we explained before, those tools will continue being used as they complement SCOOP in the close horizon. Some companies have budgeting tools working on a more global horizon, as SCOOP would do. Very rare, though, are the tools working on the quarterly or yearly horizon and being fully integrated from the Coke Plant to the Steel Shop. Some tools also only handle simplified models, sometimes only including linear programming. In this case, they can't include the Steel Shop in the process neither thermodynamics models for the different production flow as those processes are typically non linear. Approximations can be done to make those models linear but it reduces the scope of validity of the model. SCOOP is the only model available in the market that fully optimizes the production process from end to end up to the crude steel.
- The degrees of freedom: the main difference between a simulation model, where, for a given input, we can predict the output and an optimization model, are the degrees of freedoms. In SCOOP, there are many process parameters, raw material quantities and other constraints that are set up with minimum and maximum boundaries. This gives the degrees of freedom used by the Integrated Optimization to find the optimum solution of the problem (typically the raw material mix and the process parameters values). The more flexibility we give to such a model, the more freedom the system will have to find an optimal solution to the problem.

The benefits of the optimization are mainly found in the following areas:

- **Raw material prices, availability and properties:** the system can choose between many different sources for the optimal mix of raw material that will match the production process. SCOOP does not only consider the chemical balances to reach an intermediate product target (such as coke, sinter, pellets, pig iron…). It also considers quality targets such as mechanical properties constraints (for coke for instance, as this will have an influence on the Blast Furnace costs) and all thermal and thermodynamics process constraints that apply to this material.
- **Global optimization:** one of the key benefits of SCOOP comes from its global optimization form end-to-end of the process. It doesn't look to optimize each department separately as people would naturally do without a tool like SCOOP. Instead, it will calculate a global optimum that could mean increasing the costs of a given department for the global benefit of the plant.
- **Optimization of ALL costs:** SCOOP doesn't only

take into account raw material costs in the model. It considers the complete set of fix and variable costs associated to the production process. This means for instance, that we also consider revenues of sold co-products such as slag, tar, coke or blast furnace gas, naphthalene fuels and others that will generate revenues. SCOOP takes into account all those costs and revenues to calculate the optimal solution.

The particularity of SCOOP is that it is based on a full description of the process that is fed into a mathematical programming optimizer. This means that the levers of improvement are not pre-determined but will be uncovered according to each plant's particular situation.

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To give some examples of levers SCOOP users are typically using, we have:

- **The target Sulfur content** in the Pig Iron would be achieved by a certain mix of coals, iron ores and other additives. Focusing on Sulfur content in coal separately from sulfur content in iron ore would not give such a degree of freedom to get the optimal solution. The same trade-off would apply to Phosphorus or Alkali depending on the availability of raw material and target grades.
- **The productivity** of the Sinter plant, the Blast Furnaces or the Coke plant has an influence on the raw material mix being used and its total cost.
- **The coke quality:** adapting coke hardness and chemical content based on availability of raw materials at the Blast Furnace is an important lever. When coal supply is scarce on the other hand, we might need to adapt the choice of ores based on availability and quality of coking coals.
- **The coal injection at the Blast Furnace:** the right balance of slag quantity, coke and coal injection will depend on the prices and availability of ores and coals and usually evolves from year to year.
- **The Silicon content in Pig Iron:** depending on the different grades of crude steel to produce, the silicon of the pig iron will have a different impact on costs
- **Utilization of recycled materials:** in order to have the full benefit of some recycled materials, the adequate global process parameters must be calculated.

HM - Composition

	Composition [% D]			
	BF1		BF2	
Compounds	min	max	min	max
Fe	93.000	95.000	93.000	95.000
C	0.000	6.000	0.000	6.000
S	0.000	0.100	0.000	0.100
P	0.000	0.100	0.000	0.100
Si	0.000	0.600	0.000	0.600
Al	0.000	0.200	0.000	0.200
Ti	0.000	0.100	0.000	0.100
Mn	0.000	0.600	0.000	0.600
Zn	0.000	0.004	0.000	0.004

Constraints

CO - Productivity

Productivity

-	Unit	
Loading density	[kg/m3 D]	750.00
Cooking time	[h]	20.00
Nbr of cells	[cell]	100
Nbr of empty cells	[cell]	1
Volume of one cell	[m3]	31.00

Production

-	Unit		
Operating rate	[%]	min	100.00
		ref	100.00
		max	100.00
Mass of coke	[kt/...]	min	100.00
		max	1,500.00
-	[...]		per year

General | Products | Coke screening

By optimizing the process parameters and improving the raw material mix yield, we have ***from each of the above elements a cost saving of more than 1$ per ton of steel***.

SI - Int recyclings

Recyclings					
Code	Label	Price [eur/t]	RATE [kg/tsi D]	MASS [kt D]	MASS [kt W]
co_cokebreeze	Coke breeze from cps	100.00	11.05	40.17	42.28
hm_cokebreeze	Coke breeze from bfs	100.00	20.08	72.99	76.83
hm_fluedusts	Flue dusts	10.00	11.62	42.22	46.27
hm_fluesludges	Flue sludges	10.00	2.70	9.81	13.41
st_recyclings	Recyclings from sms	10.00	34.90	126.86	133.54
Total		-	80.34	292.05	312.33

Int recyclings

3. SCOOP IMPLEMENTATION

A typical implementation of SCOOP will start with a blueprint. A Blueprint is a detail analysis of the requirements, equipments, tools and formulas already available. When this phase is complete, we have a precise idea of the benefits we will get and the time it will require to integrate the specific knowledge of a given company.

Implementation starts with a SCOOP containing all standard formulas (thermodynamic, chemical…) for the production flow. As each steel company and even each site has particular, sometimes empirical formulas, resulting from numerous years of experience, the implementation will add those in the tool.

A prototype is typically developed at the end of the Blueprint, using the customer's own data. Although it doesn't contain all the formulas yet, it gives a good idea on the potential savings for the customer. Calculations on actual business cases are the objective of the prototype's optimization.

N-SIDE
OPTIMIZING YOUR DECISIONS