TERNIUM MEXICO SUPPLY CHAIN INTEGRATION PROJECT WITH STEELPLANNER[1]

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Abstract

Ternium Mexico integrated former Hylsa and Imsa companies, and transformed in a new entity, required new operation possibilities and perspectives. The purpose of this paper is to describe the implementation of an integrated production planning system to attend gradually the different planning and scheduling challenges of Ternium Mexico, using SteelPlanner modules, in cooperation with A.I.Systems.

Key words: Production planning; Production scheduling; Slab assignment; Coil assignment; Optimisation.

PROJETO DE INTEGRAÇÃO DA 'SUPPLY CHAIN' DE TERNIUM MEXICO COM STEELPLANNER

Ternium Mexico integra as antigas companhias Hylsa e Imsa, e se transformou numa nova entidade, oferecendo novas possibilidades operacionais assim como novas perspectivas. O objetivo deste documento é de descrever a implantação de um sistema de planejamento da produção que atende gradualmente aos diferentes desafios de planejamento e programação de Ternium Mexico, usando os módulos SteelPlanner, em cooperação com a A.I. Systems.

Palavras-chave: Planejamento de produção; Programação da produção; Alocação de placas; Otimização.

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2 *Ternium Mexico, IT models*
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INTRODUCTION

In summer 2007, Ternium group has acquired Imsa group, increasing its presence in the city of Monterrey where they owned former Ternium Hylsa. This new Mexican champion, Ternium Mexico, produces over 5 million tons a year and has production processes going from mini mill and hot strip mill to coating lines and steel service centers.

A.I.S. (Advanced information Systems) is specialized in the development and the implementation of software for decision support in the areas of production planning and supply chain logistics in process industries.

Following a long partnership, Ternium relies on AIS's SteelPlanner® solutions for the integration of planning and scheduling of both entities.

The SteelPlanner is a powerful production planning and control solution, developed by A.I.S., which optimizes the performance of a metallurgical plant in terms of product output, quality, order-to-delivery time and cost.

PROJECT GOALS

The purpose of this solution implementation is:

- To coordinate and integrate all the production processes, obtaining:
    - An integrated solution of the production planning.
    - A transfer plan of inter-plants flows of materials.
    - An easy way to adjust and/or upgrade the scheduling strategies.
    - A better visibility of potential problems.
- Give a global order balance in the integrated perimeter and an expected delivery time for every order
    - Customer orders
    - Internal supply orders

PROBLEM DESCRIPTION

Ternium Mexico is composed from the union of facilities of the former companies of Hylsa, Galvak, APM and IMSA, what currently shapes part of the underlying IT systems infrastructure.
The current production systems have an historic reminiscence of the fact that these works were different companies.
Churubusco works has a STRATIX system, Universidad an SAP system, Monclova another SAP system

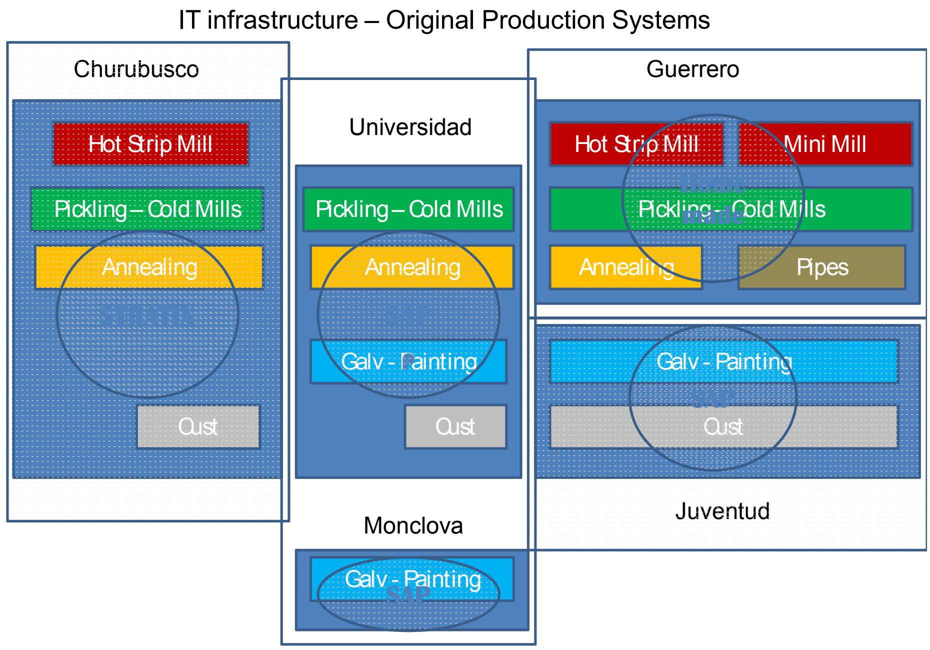


Figure 1 – IT Infrastructure – Original Production systems of each plant

In order to integrate the supply chain for the new company Ternium Mexico, a SteelPlanner layer is implemented above in order to manage in one single model formalism the union of the different production units as one single factory with a new supply chain model as well as potentially new operations practices.

This was carried out by using different SteelPlanner modules to attend specialized planning, scheduling and material assignment problems.

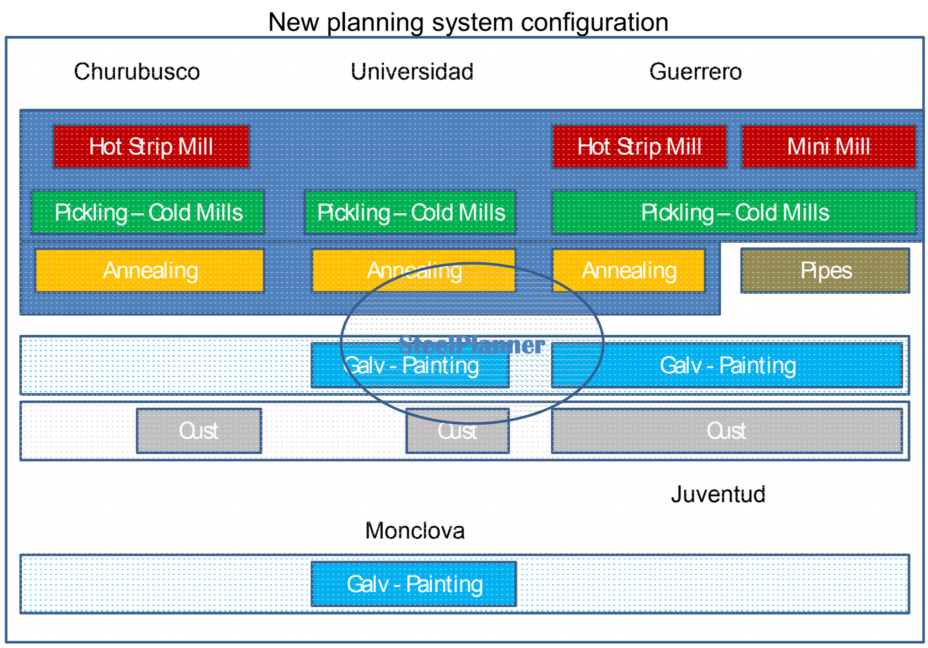


Figure 2 – New planning system coverage

METHODOLOGY

The methodology consisted in having a stepwise and modular approach that would shorten business releases of functionalities in short time frames. For example, a first subset of the plant was implemented and gradually expanded to downstream plants.

Then, at each project cycles, new objectives were set for the next releases of deliverables to achieve supply chain priorities and intermediate milestones as usable deliverables.

PROPOSED SOLUTION

The integrated solution is based on the implementation of different SteelPlanner modules to support the different required business functionalities.
The SteelPlanner modules used to solve each task the different tasks are the following:

1. MATERIAL FLOW COORDINATOR (MFC), FOR THE FLOW PLAN AND MASTER SCHEDULE

   The MFC has the purpose of integrating the planning and scheduling environment and is responsible for interfacing flows, orders, material units and job information with Ternium production systems and to interface material units, production orders and jobs to the Product Match, BetaPlanner and SigmaPlanner.
2. BETAPLANNER

   The BetaPlanner is specifically designed for the scheduling of rolling mill, on the basis of the order book (input file) and the selection (production goal).
3. SIGMAPLANNER

   SigmaPlanner is specifically designed for scheduling mini-mills (CSP mills). It calculates the schedules for the two casters and the direct charge rolling mill.
4. PRODUCTMATCH

   ProductMatch is a system that given a yard of material units, an order book and assignment rules, generates an optimal material to order assignment in a second phase. This module was implemented for slab yards and several coil yards.

SOLVING THE TERNIUM MEXICO FLOW PLAN

- **Purpose**

  A Flow Plan of the integrated entity that will provide:
  - Global view of the throughput of the facilities load balancing and routing;
  - Transfer plan between facilities;
- **Module**:

  This problem has been addressed by SteelPlanner® MFC (Material Flow Coordinator) capacity planning solution that models facilities by lines (or processes in case of equivalent lines), orders by product families and provides a daily flow plan per line and per day in a time horizon of 60 days with the resulting stock evolution and transfer plan between facilities.
- **Considered Restriction**
  - Order due date;
  - Order routing : including technical restrictions (cooling time, transportation time) and alternative routes;

- Line capacity :availability of the line (stops, maintenance, startup) as well as order productivity on the line and campaigns;
- Stock restrictions : minimum, maximum, per family of product and per period;
- Objectives of the commercial industrial plan in total volumes and target inventories.

➢ **Solver**

The MFC solver runs within a time range of 20' for the Flow Plan and provide the best tradeoff between defined constraints. The user interacts with the model through several simulations until he reaches optimal flow plan. This plan validates transfer between plants and decides on which alternative route it is preferable to produce a given product family requirement.

➢ **Results**

Inventories have been reduced subsequently and consequently lead times have been reduced. Lines stops are anticipated in the flow plan so that alternative strategies are evaluated and the inter-plants required flows of material can be simulated.

➢ **Graphical Reporting**

The end user can review the result thanks to several user friendly .net reports directly connected to the model and published in the site's intranet.

Example: Throughput by line / Product family

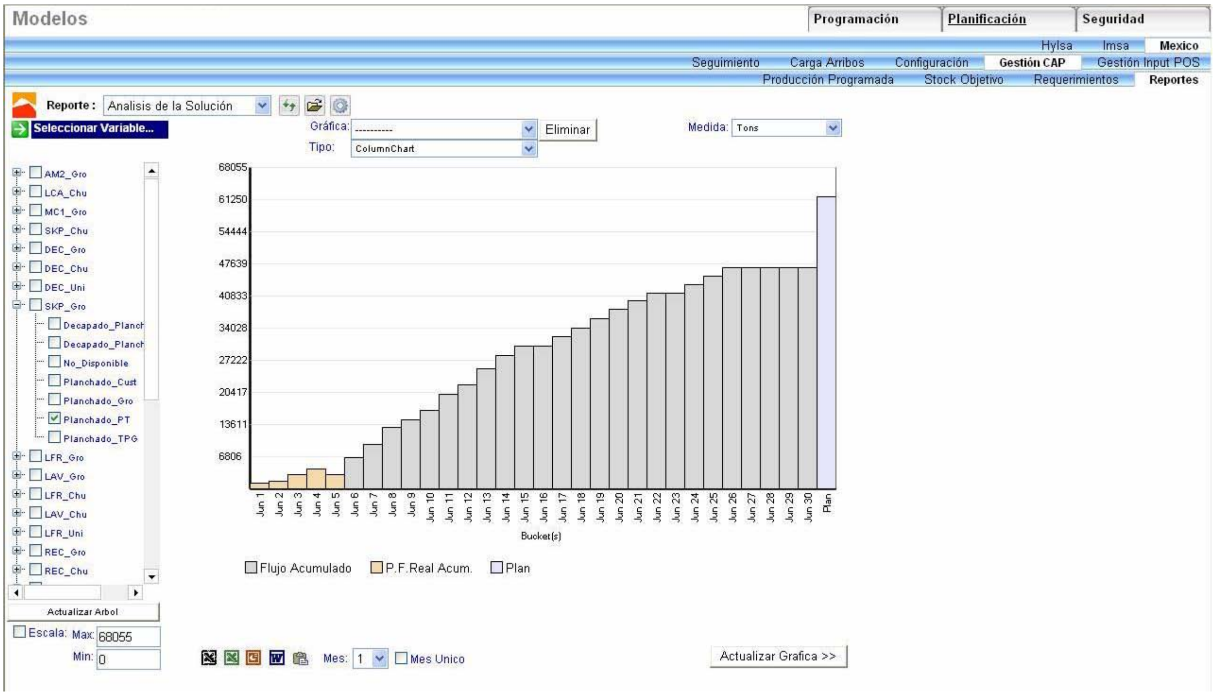
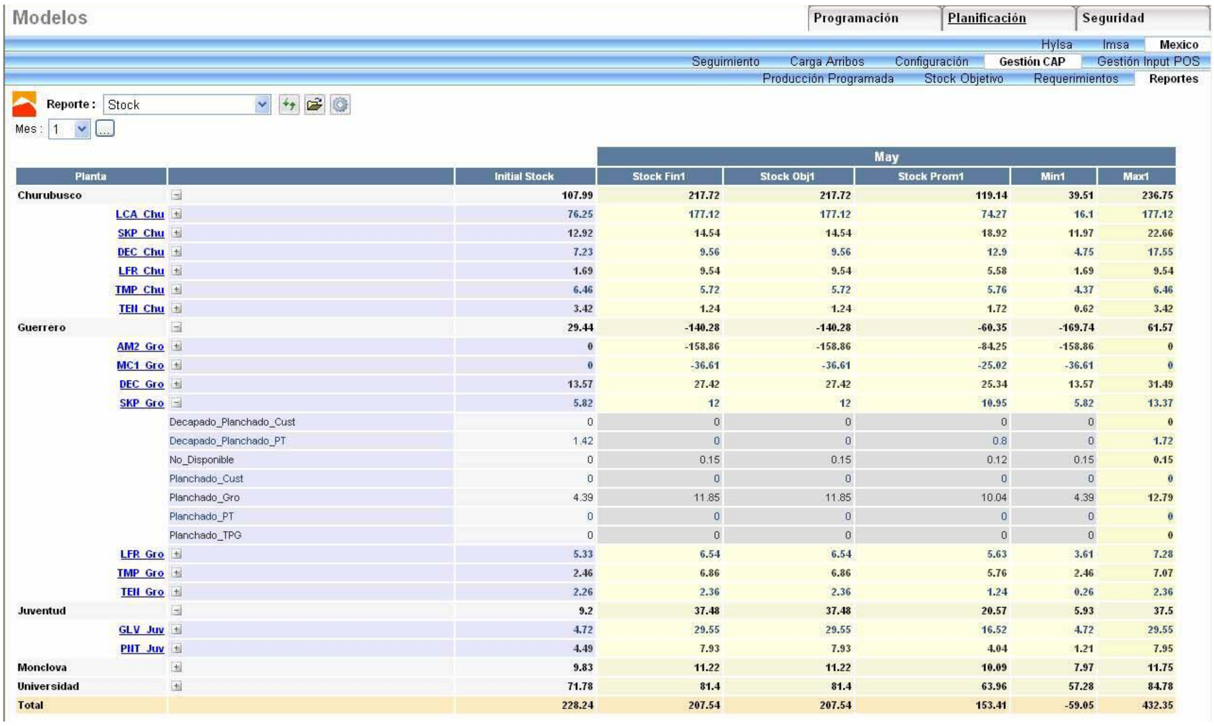


Figure 3 – Cumulated production and planned volumes



Planta		Initial Stock	May Stock Fin1	Stock Obj1	Stock Prom1	Min1	Max1
Churubusco		107.99	217.72	217.72	119.14	39.51	236.75
LCA_Chu		76.25	177.12	177.12	74.27	16.1	177.12
SKP_Chu		12.92	14.54	14.54	18.92	11.97	22.66
DEC_Chu		7.23	9.56	9.56	12.9	4.75	17.55
LFR_Chu		1.69	9.54	9.54	5.58	1.69	9.54
TMP_Chu		6.46	5.72	5.72	5.76	4.37	6.46
TEN_Chu		3.42	1.24	1.24	1.72	0.62	3.42
Guerrero		29.44	-140.28	-140.28	-60.35	-169.74	61.57
AM2_Gro		0	-158.86	-158.86	-84.25	-158.86	0
MC1_Gro		0	-36.61	-36.61	-25.02	-36.61	0
DEC_Gro		13.57	27.42	27.42	25.34	13.57	31.49
SKP_Gro		5.82	12	12	10.95	5.82	13.37
	Decapado_Planchado_Cust	0	0	0	0	0	0
	Decapado_Planchado_PT	1.42	0	0	0.8	0	1.72
	No_Disponible	0	0.15	0.15	0.12	0.15	0.15
	Planchado_Cust	0	0	0	0	0	0
	Planchado_Gro	4.39	11.85	11.85	10.04	4.39	12.79
	Planchado_PT	0	0	0	0	0	0
	Planchado_TPG	0	0	0	0	0	0
LFR_Gro		5.33	6.54	6.54	5.63	3.61	7.28
TMP_Gro		2.46	6.86	6.86	5.76	2.46	7.07
TEN_Gro		2.26	2.36	2.36	1.24	0.26	2.36
Juventud		9.2	37.48	37.48	20.57	5.93	37.5
GLV_Juv		4.72	29.55	29.55	16.52	4.72	29.55
PNT_Juv		4.49	7.93	7.93	4.04	1.21	7.95
Monclova		9.83	11.22	11.22	10.09	7.97	11.75
Universidad		71.78	81.4	81.4	63.96	57.28	84.78
Total		228.24	207.54	207.54	153.41	-59.05	432.35

Figure 4 - Report example: Stock analysis

Calculation of Order balance and Master Scheduling

- **Purpose**

To give a global order balance in the integrated perimeter and an expected delivery time for every order

  - Customer orders
  - Internal supply orders

- **Module**

This problem has been addressed by SteelPlanner® MFC production order scheduling solution that models the production route of every order and schedules the work in progress projecting it in downstream lines according to the pre defined balanced flow plan.

- **Master Schedules**

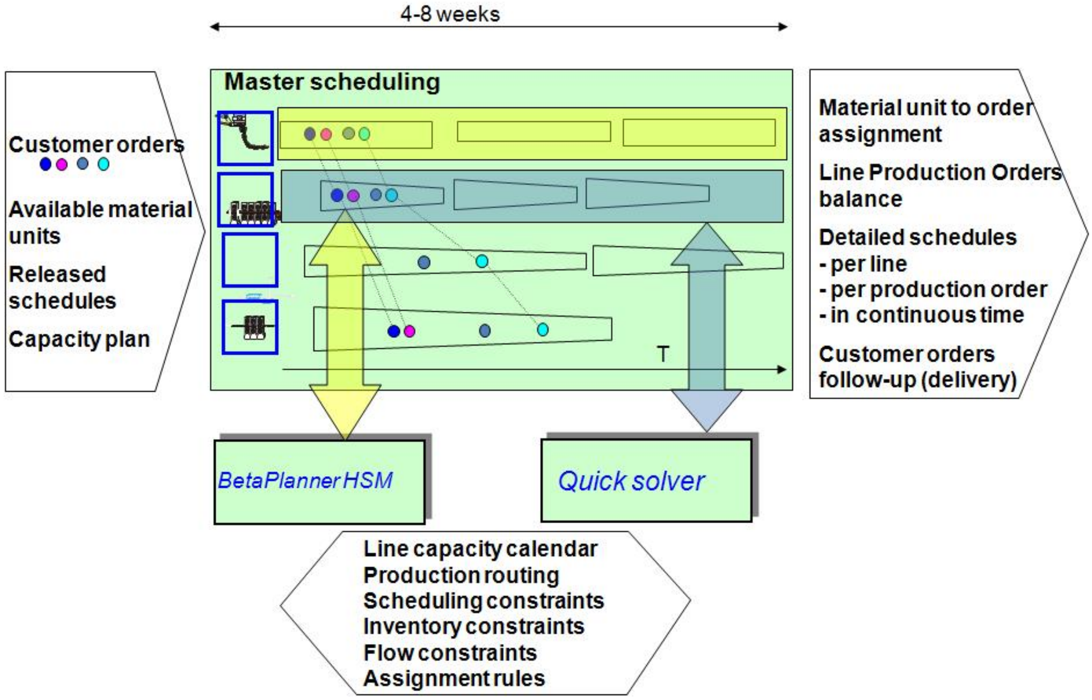


Figure 5 – Master scheduling and local optimisers

The plant situation is loaded in the model and the master schedule is generated respecting the calculated flow plan load balancing as to provide realistic delivery dates of orders, and respect the planned stock levels evolution.
On the short term, detailed scheduling modules such as BetaPlanner and SigmaPlanner are used to schedule the mills with detailed constraints.

- **Results**

The 4 days long manual process has been replaced by an overnight batch calculation providing orders balance and expected delivery dates.

Slab Supply Plan

- **Purpose**

As Ternium Mexico has to supply above 3 million tons a year of slab to numerous suppliers with long lead time, and given the limited casting capacity, a slab supply plan is required for primary material.

- **Module**

Ternium Mexico uses SteelPlanner ProductMatch solution to assign slabs to orders and provide a slab supply net need calculation in a three month time horizon.

- **Resolution**

Confirmed orders and forecasted orders are loaded in the model as well as real slabs in their location (plant, external stock, transit, stock at the provider) and forecasted slabs.
The algorithms will assign material considering:
Real available slabs in available slab yards to confirmed order for hot strip mill scheduling with detailed assigning rules

Real slabs in all slab yards to define slab transportation plan with detailed assigning rules

Forecasted slabs and real/forecasted orders to define net need calculation of slab supply with greedy rules as detailed inputs are not known at that moment

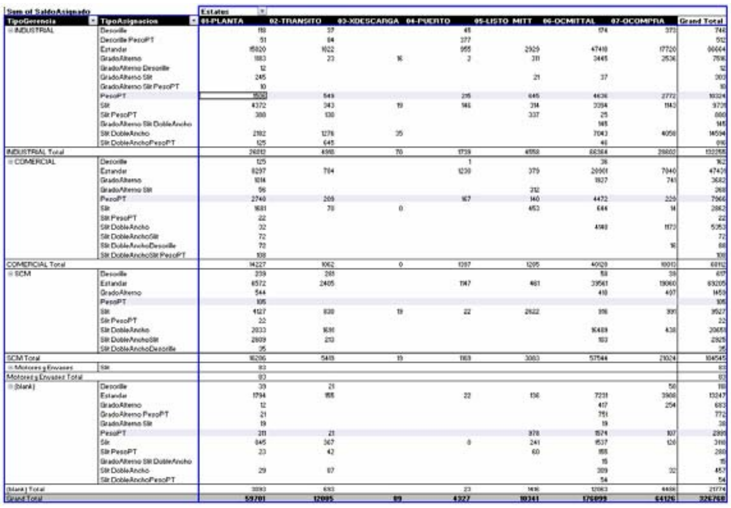
➢ **Assignment rules**

Assignments rules consider the following constraints:

- Process and quality
  - Grade respect (with alternatives)
  - Width with possible edge trimming (proposing slab slitting if necessary / possible)
  - Mill capacity (coil thickness)
  - Slab chemical analysis compliance if required by the order
  - Slab provider rules (to assign only certified provider to given customers)
  - Weight (proposing cutting plan if necessary / possible)
- Supply chain
  - Orders due dates
  - Slabs production date
  - Flow restrictions
  - Mill scheduling restrictions (startup material, intermediate thickenesses)

➢ **Algorithms**

The algorithms will solve the tradeoff among constraints and assign as many slabs as valuable for the plant so as to provide a global report on slab assignment.



Sum of SaldoAsignado — Estatus

TipoGerencia	TipoAsignacion	01-PLANTA	02-TRANSITO	03-XDESCARGA	04-PUERTO	05-LISTO MITT	06-OCMITTAL	07-OCOMPRA	Grand Total
INDUSTRIAL	Descorille	118	37		45		174	373	746
	Descorille PesoPT	51	84		377				512
	Estandar	15820	1022		955	2929	47418	17720	85864
	GradoAlterno	1183	23	16	2	311	3445	2536	7516
	GradoAlterno Descorille	12							12
	GradoAlterno Slit	245				21	37		303
	GradoAlterno Slit PesoPT	10							10
	PesoPT	1507	549		215	645	4636	2772	10324
	Slit	4372	343	19	146	314	3384	1143	9721
	Slit PesoPT	388	130			337	25		880
	GradoAlterno Slit DobleAncho						145		145
	Slit DobleAncho	2182	1276	35			7043	4058	14594
	Slit DobleAnchoPesoPT	125	645				46		816
INDUSTRIAL Total		26012	4109	70	1739	4558	66364	28602	132355
COMERCIAL	Descorille	125			1		36		162
	Estandar	8297	784		1230	379	28901	7840	47431
	GradoAlterno	1014					1927	741	3682
	GradoAlterno Slit	56				212			268
	PesoPT	2740	209		167	140	4472	229	7957
	Slit	1681	70	0		453	644	14	2862
	Slit PesoPT	22							22
	Slit DobleAncho	32					4148	1173	5353
	Slit DobleAnchoSlit	72							72
	Slit DobleAnchoDescorille	72						16	88
	Slit DobleAnchoSlit PesoPT	108							108
COMERCIAL Total		14227	1062	0	1397	1205	40928	10013	68112
SCM	Descorille	239	281				58	39	617
	Estandar	6572	2405		1147	461	39561	13060	63206
	GradoAlterno	544					418	497	1459
	PesoPT	105							105
	Slit	4127	838	19	22	2622	398	391	8527
	Slit PesoPT	22							22
	Slit DobleAncho	2033	1696				16489	438	20656
	Slit DobleAnchoSlit	2609	213				103		2925
	Slit DobleAnchoDescorille	35							35
SCM Total		16286	5483	19	1169	3083	57544	21024	104545
Motores y Envases	Slit	83							83
Motores y Envases Total		83							83
(blank)	Descorille	39	21					58	118
	Estandar	1794	158		22	136	7231	3906	13247
	GradoAlterno	12					417	254	683
	GradoAlterno PesoPT	21					751		772
	GradoAlterno Slit	19					19		38
	PesoPT	311	21			378	1574	107	2391
	Slit	845	367		0	241	1537	126	3116
	Slit PesoPT	23	42			60	155		280
	GradoAlterno Slit DobleAncho						15		15
	Slit DobleAncho	29	67				329	32	457
	Slit DobleAnchoPesoPT						54		54
(blank) Total		3093	633		23	1416	12063	4466	21774
Grand Total		59701	12085	89	4327	10341	176099	64126	326768

Figure 6 – Slab assignment optimization report

➢ **Result**

Unassigned order will provide the net slab requirement for Ternium as the basis for defining the slab purchasing strategy.

GENERAL CONCLUSIONS

The implementation of a SteelPlanner layer on top of the different production systems models of the former factories, allowed modeling an integrated supply chain of the new resulting production facility and exploring the new perspective offered in terms of usage of the resources.

By following a modular and stepwise approach, different aspects of planning and scheduling problems were attended in parallel, such as load balancing, flow planning, inter-plant transfer, order balancing calculation among the plants, assignment problems with product match, or scheduling problems with BetaPlanner and SigmaPlanner, supplying deliverables within short time frames. Inventories have been reduced and consequently lead times have been reduced. Lines stops are anticipated in the flow plan so that alternative strategies can be evaluated, and master scheduling simulation time largely reduced.