



Visual Modeling and Simulation Tool for Process Industries

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Fujitsu Research Institute
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Introduction



■ Requirements of the prompt action to environmental change

Managers need to know in a timely manner the quantitative and economical effect of the company's correspondence to environmental change.

■ LP Applications for Process Industries

Good tool for case study, business model for enterprise. But, technical knowledge is required for creation of LP model, and creation/change takes time.

- determining the best balance of quantity with the global optimal view
- model including volume and money
- solving problems with complicated selection and tradeoff

- Business planning is restricted to a specialist.
- Large-scale and complicated formulization takes time.

Purpose



**To aid decision-making suitable for environmental change,
we offer the planning simulation platform
where everyone can understand and a share.**

- **Visual modeling process**

- Simulation which does not need special knowledge

- Reducing the planning of LT by information share and joint work

- **Flexible modeling**

- According to the purpose, the model design is flexible

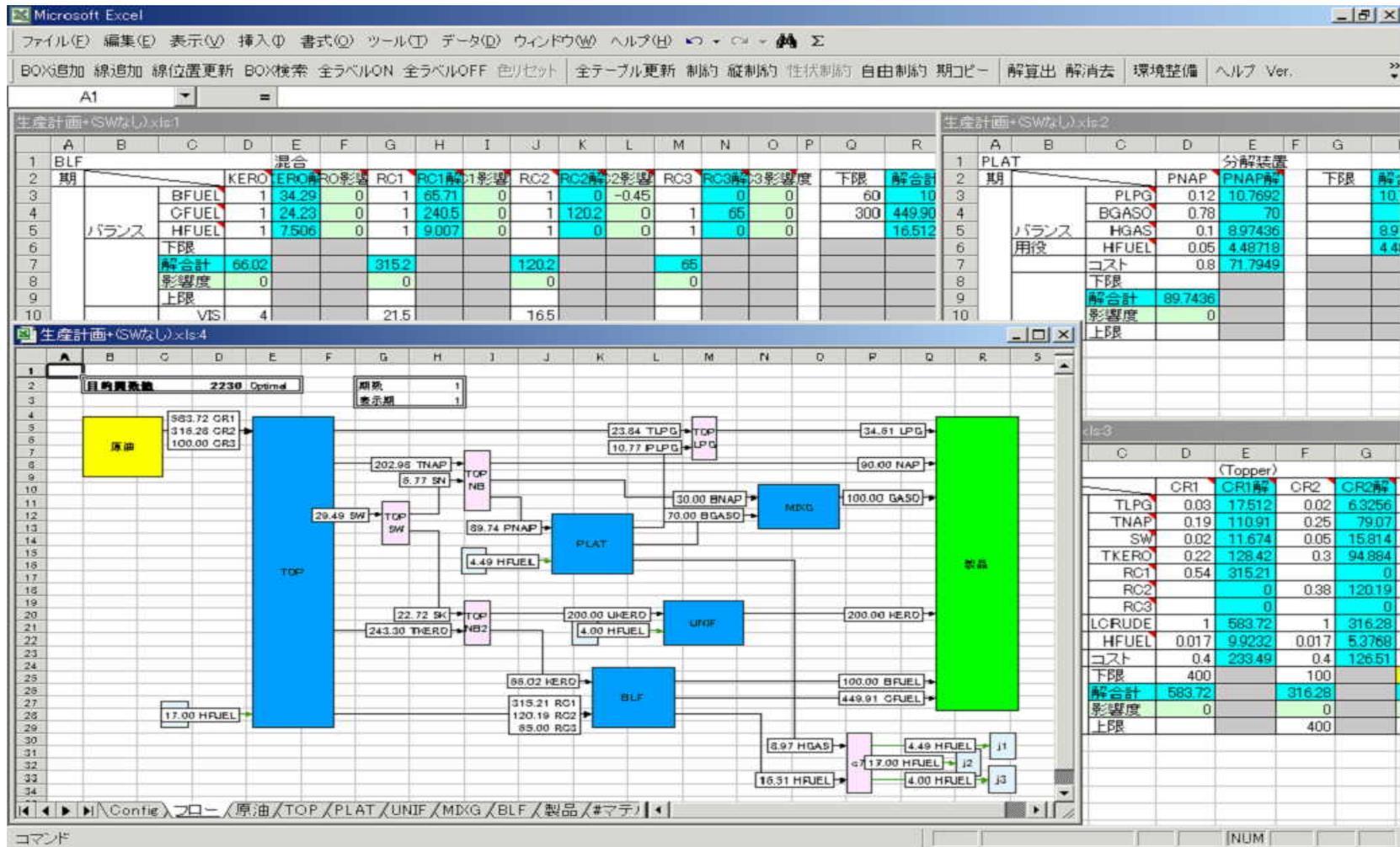
- Correspondence in change of various environment is possible

- **GUI in Excel**

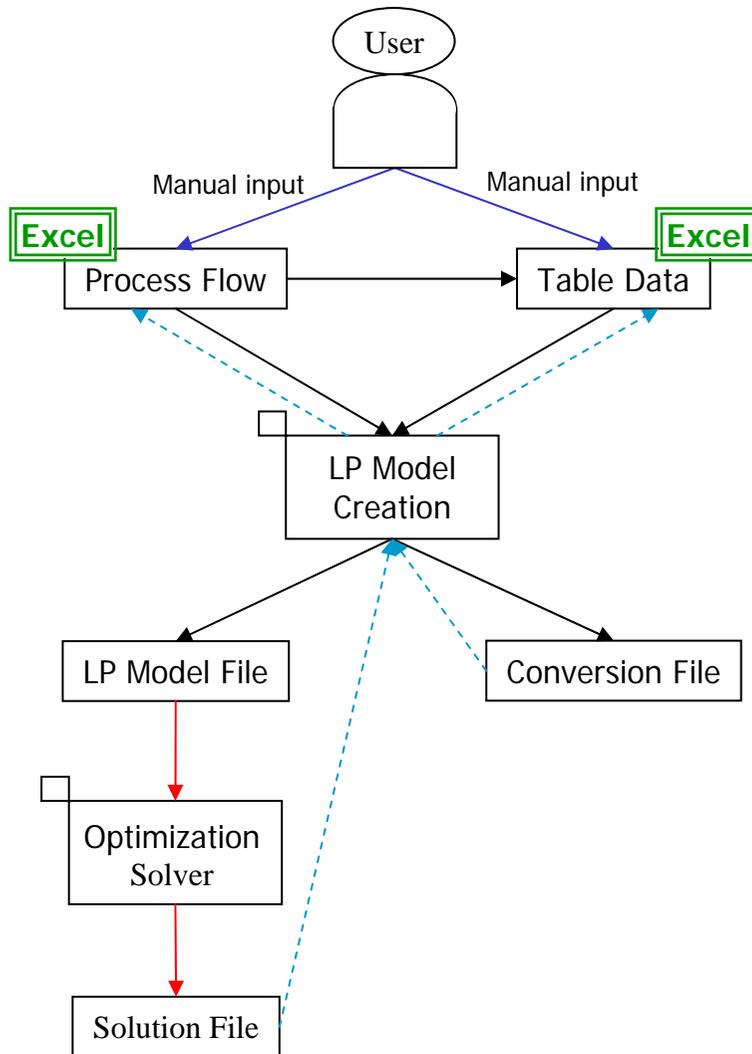
- Simple and smooth operation

- Practical connectivity with business system is high

Image



Function Outline



■ What is an LP Visual Model?

To draw Process Flow
+
Input Table Data

《Function Flow》

- ① LP model is automatically created from process flow and table data
- ② Optimization by Solver
- ③ To display the activity

Input Table Data



Microsoft Excel - ProductionPlan.xls

ファイル(F) 編集(E) 表示(V) 挿入(I) 書式(O) ツール(T) データ(D) ウィンドウ(W) ヘルプ(H) 質問を入力してください

Add BOX Add Line Update Line Reset Color Update Table Update All Table Constraint Vertical Const Profile Free Constraint Optimize Clear Activity Files Help

A1 Topper

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Topper			Separator										
2	Term			CR1	CR1 Activity	CR2	CR2 Activity	CR3	CR3 Activity		Lower	ActivitySum	Impact	Upper
3			TLPG	0.08	0	0.02	0	0	0			0		
4			TNAP	0.19	0	0.25	0	0.13	0			0		
5			SW	0.02	0	0.05	0	0.02	0			0		
6			TKERO	0.22	0	0.3	0	0.2	0			0		
7			RC1	0.54	0		0		0			0		
8			RC2		0	0.38	0		0			0		
9		Balance	RC3		0		0	0.65	0			0		
10		Constraint	Capacity	1	0	1	0	1	0			0		1000
11		Utility	HFUEL	0.017	0	0.017	0	0.017	0			0		
12		Operation Cost	cost	0.4	0	0.4	0	0.4	0					
13		Input Lower Bounds	Lower	400		100		100						
14		Upper	ActivitySum											
15			Impact											
16			Upper			400		200						

Box Input

Output Lower/Upper Bounds

Box Output

Input Lower Bounds

Input/Output Balance data
 Separator ... input gives to output rate
 Mixer ... output constitutes input rate

コマンド NUM

Mathematical model①



Objective function

$$\begin{aligned} \max \quad & \sum Price * Product \\ & - \sum COST_{purchase} * Material \\ & - \sum COST_{operation} * Production \\ & - \sum COST_{storage} * Stock \\ & - \sum COST_{transportation} * Transportation \end{aligned}$$

Subject to

$$Box_Output = A * Box_Input \quad \text{for all Box}$$

$$Lower_Bounds \leq Box_Output \leq UpperBounds \quad \text{for all Box}$$

$$Lower_Bounds \leq Box_Input \leq UpperBounds \quad \text{for all Box}$$

- A : Input/Output Balance data

Mathematical model ②



'Sell' Table

Product		Sell					
T		LPG	NAP	GASO	KERO	BFUEL	CFUEL
	price	7.1	6	9	8.5	8	7.5
1	Lower						
	Upper						

'Buy' Table

CrudeOil		Buy			
T		cost	Lower	Upper	
	CR1	4.5			
	CR2	5			
1	Balance	CR3	5.5		

'Separator' Table

Topper		Separator				
T		CR1	CR2	CR3	Lower	Upper
	TLPG	0.03	0.02	0		
	TNAP	0.19	0.25	0.13		
	SW	0.02	0.05	0.02		
	TKERO	0.22	0.3	0.2		
	RC1	0.54				
	RC2		0.38			
	RC3			0.65		
	Balance					
	Constrain	Capacity	1	1	1	1000
	Utility	HFUEL	0.017	0.017	0.017	
	cost		0.4	0.4	0.4	
1	Lower		400	100	100	
	Upper		400	200	200	

Objective function

$$7.1 * \text{LPG} + 6 * \text{NAP} + 9 * \text{GASO} + 8.5 * \text{KERO} + 8 * \text{BFUEL} + 7.5 * \text{CFUEL} \\ - 4.5 * \text{CR1} - 5.0 * \text{CR1} - 5.5 * \text{CR1} \\ - 0.4 * \text{CR1} - 0.4 * \text{CR1} - 0.4 * \text{CR1}$$

Subject to

<Balance expression>

$$\begin{aligned} \text{TLPG} &= 0.03 * \text{CR1} + 0.02 * \text{CR2} \\ \text{TNAP} &= 0.19 * \text{CR1} + 0.25 * \text{CR2} + 0.13 * \text{CR3} \\ \text{SW} &= 0.02 * \text{CR1} + 0.05 * \text{CR2} + 0.02 * \text{CR3} \\ \text{TKERO} &= 0.22 * \text{CR1} + 0.30 * \text{CR2} + 0.20 * \text{CR3} \\ \text{RC1} &= 0.54 * \text{CR1} \\ \text{RC2} &= 0.38 * \text{CR2} \\ \text{RC3} &= 0.65 * \text{CR3} \end{aligned}$$

<Bounds>

$$\begin{aligned} 400 &\leq \text{CR1} \\ 100 &\leq \text{CR2} \leq 400 \\ 100 &\leq \text{CR2} \leq 200 \end{aligned}$$

<Capacity constrain>

$$\text{CR1} + \text{CR2} + \text{CR3} \leq 1000$$

LP file and Conversion file



```
lptemp.lp - メモ帳
ファイル(F) 編集(E) 書式(O) 表示(V) ヘルプ(H)

Maximize
+ 7.1X000001 + 6X000002 + 9X000003 + 8.5X000004 + 8X000005 + 7.5X000006
- 0.5X000023 - 0.8X000027 - 0X000030 - 0X000029
- 4.9X000007 - 5.4X000008 - 5.9X000009
Subject To
s1: 0.03X000007 + 0.02X000008 + 0X000009 - X000010 = 0
s2: 0.19X000007 + 0.25X000008 + 0.13X000009 - X000011 = 0
s3: 0.02X000007 + 0.05X000008 + 0.02X000009 - X000012 = 0
s4: 0.22X000007 + 0.3X000008 + 0.2X000009 - X000013 = 0
s5: 0.54X000007 + 0X000008 + 0X000009 - X000014 = 0
s6: 0X000007 + 0.38X000008 + 0X000009 - X000015 = 0
s7: 0X000007 + 0X000008 + 0.65X000009 - X000016 = 0
s8: 1X000007 + 1X000008 + 1X000009 - &000017 = 0
s9: 0.017X000007 + 0.017X000008 + 0.017X000009 - X000018 = 0
s10: X000019 + X000020 - X000018 - X000021 - X000022 = 0
s11: 1X000023
s12: 0.02X000024
s13: 1X000024__X000005 + 1X000014__X000005 + 1X000015__X000005 +
0X000016__X000005 - X000005 = 0
s14: 1X000024__X000006 + 1X000014__X000006 + 1X000015__X000006 +
1X000016__X000006 - X000006 = 0
s15: 1X000024__X000020 + 1X000014__X000020 + 1X000015__X000020 +
1X000016__X000020 - X000020 = 0
s16: X000024 - X000024__X000005 - X000024__X000006 -
X000024__X000020 = 0
s17: X000014 - X000014__X000005 - X000014__X000006 -
X000014__X000020 = 0
s18: X000015 - X000015__X000005 - X000015__X000006 -
X000015__X000020 = 0
s19: X000016 - X000016__X000005 - X000016__X000006 -
X000016__X000020 = 0
LP file X000024 + X000014 + X000015 + X000016 - X000005 - X000006 -
```

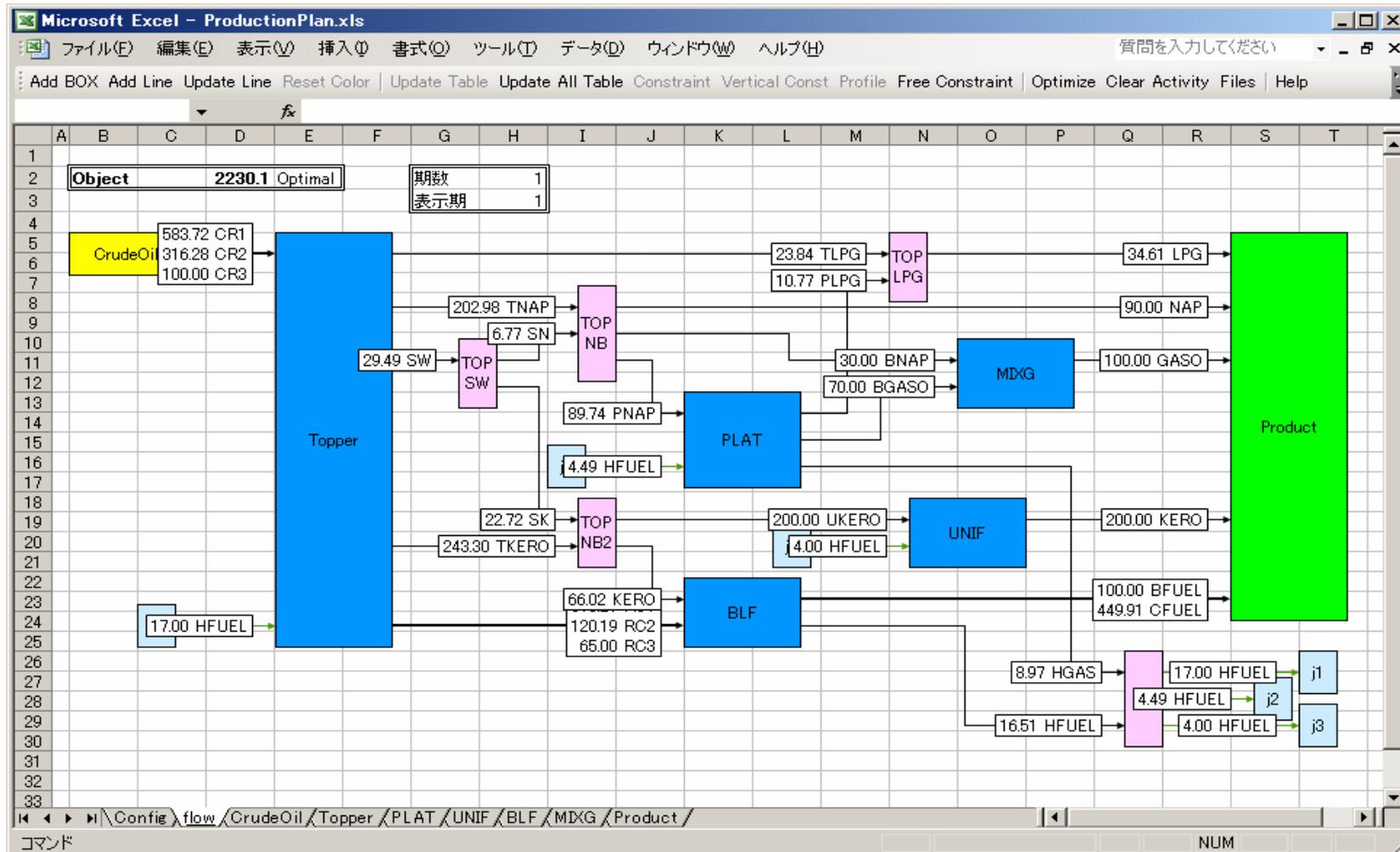
FileName_BoxName_LineName_BoxName_Term

```
VarDump.txt - メモ帳
ファイル(F) 編集(E) 書式(O) 表示(V) ヘルプ(H)

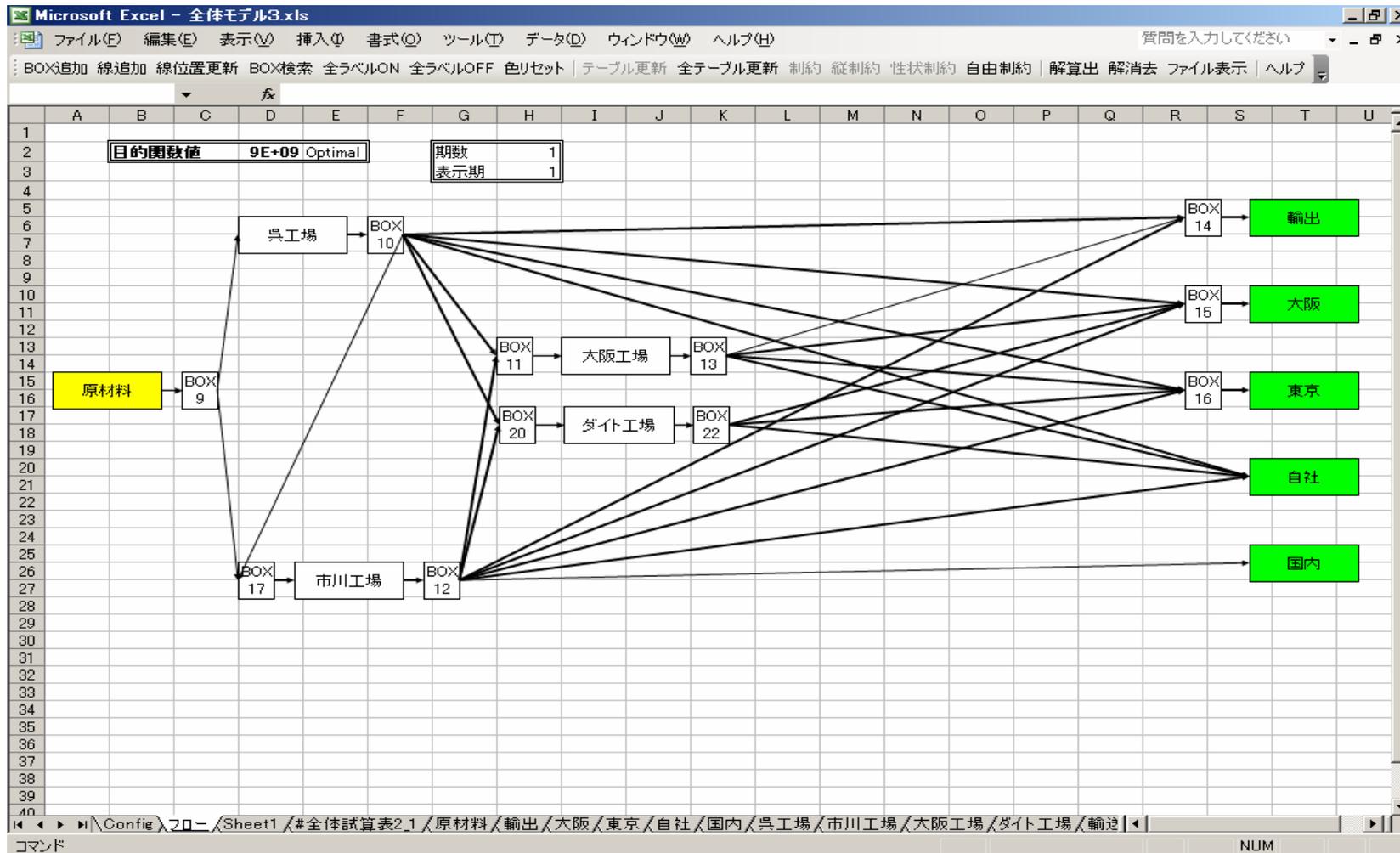
X000028,PLAT_PLPG_TOPLPG_1
X000006,BLF_CFUEL_Product_1
X000029,PLAT_BGASO_MIXG_1
X000018,#C7_HFUEL_Topper_1
X000007,CrudeOil_CR1_Topper_1
X000019,PLAT_HGAS_C7_1
X000008,CrudeOil_CR2_Topper_1
X000009,CrudeOil_CR3_Topper_1
X000030,TOPNB_BNAP_MIXG_1
X000031,TOPSW_SN_TOPNB_1
X000020,BLF_HFUEL_C7_1
X000032,TOPSW_SK_TOPNB2_1
X000021,#C7_HFUEL_PLAT_1
X000010,Topper_TLPG_TOPLPG_1
X000022,#C7_HFUEL_LINIE_1
X000012,Topper_SK_TOPNB2_1
X000001,TOPLPG_LPG_Product_1
X000024,TOPNB2_KERO_BLF_1
X000013,Topper_TKERO_TOPNB2_1
X000002,TOPNB_NAP_Product_1
X000025,VIS
X000014,Topper_RC1_BLF_1
X000003,MIXG_GASO_Product_1
X000026,SUL
X000015,Topper_RC2_BLF_1
X000004,UNIF_KERO_Product_1
X000027, TOPNB PNAP PLAT_1
```

**matches all lines on process flow
and internal variables**

To display the activity①



Network Model



Conclusion



**This tool is the planning simulation platform
Good understanding for anyone**

- The burden by speciality is mitigated by automating LP modeling portion
- According to the purpose, a model design is flexible
- Scenario creations and change of simulations are easy
- The time that decision-making takes in a speedy simulation environment is shortened significantly

Thank you, for your attention!

The Fujitsu logo consists of the word "FUJITSU" in a red, serif font. The letter "I" is replaced by an infinity symbol (∞).

THE POSSIBILITIES ARE INFINITE