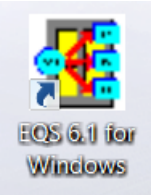
Quick guide to Confirmatory Factor Analysis

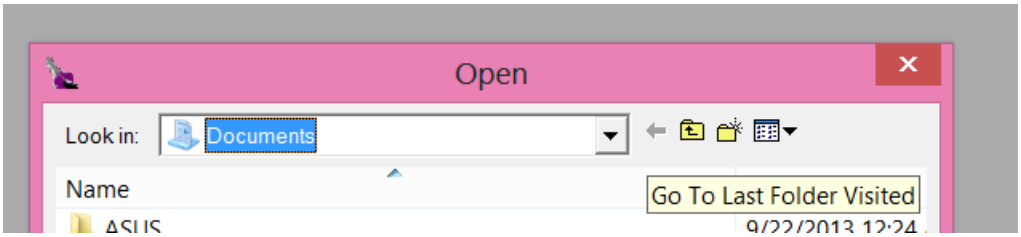
Merle Canfield

Click on:

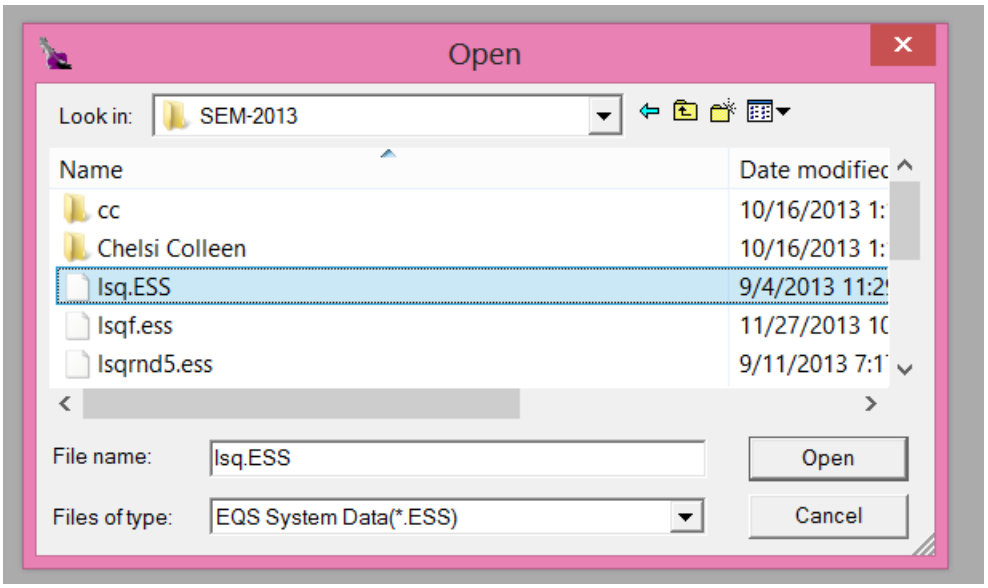


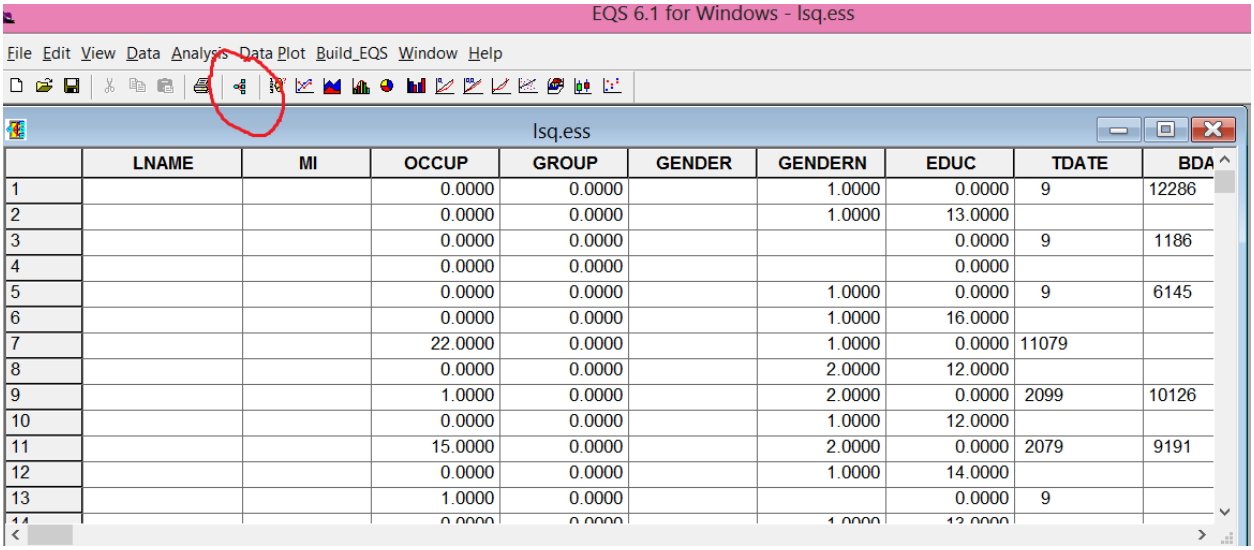
Click File > Click Open

From the top box browse for the file that you can see (or have created from scratch or from existing correlations matrix [go here to see how to create a correlation matrix]). Make sure the File Type is ESS.



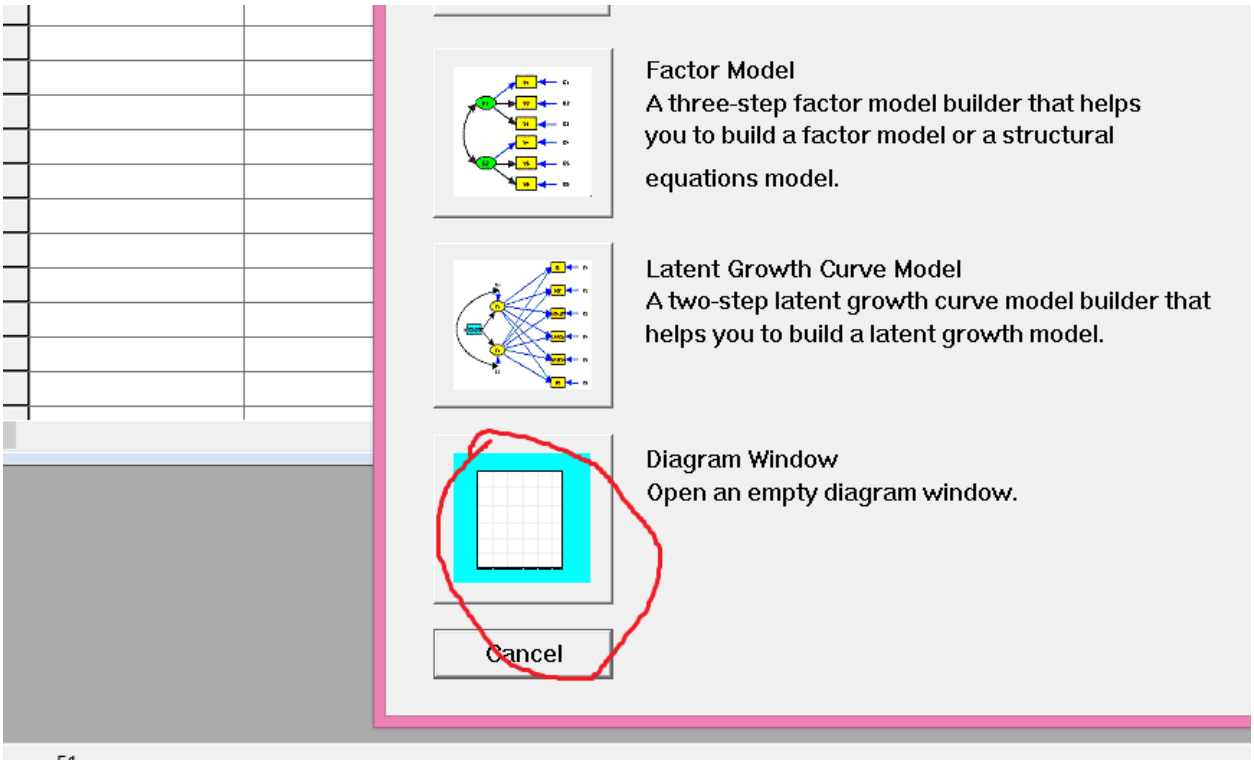
I have selected the lsq.ess file from the SEM-2014 folder





	LNAME	MI	OCCUP	GROUP	GENDER	GENDERN	EDUC	TDATE	BDA
1			0.0000	0.0000		1.0000	0.0000	9	12286
2			0.0000	0.0000		1.0000	13.0000		
3			0.0000	0.0000			0.0000	9	1186
4			0.0000	0.0000			0.0000		
5			0.0000	0.0000		1.0000	0.0000	9	6145
6			0.0000	0.0000		1.0000	16.0000		
7			22.0000	0.0000		1.0000	0.0000	11079	
8			0.0000	0.0000		2.0000	12.0000		
9			1.0000	0.0000		2.0000	0.0000	2099	10126
10			0.0000	0.0000		1.0000	12.0000		
11			15.0000	0.0000		2.0000	0.0000	2079	9191
12			0.0000	0.0000		1.0000	14.0000		
13			1.0000	0.0000			0.0000	9	

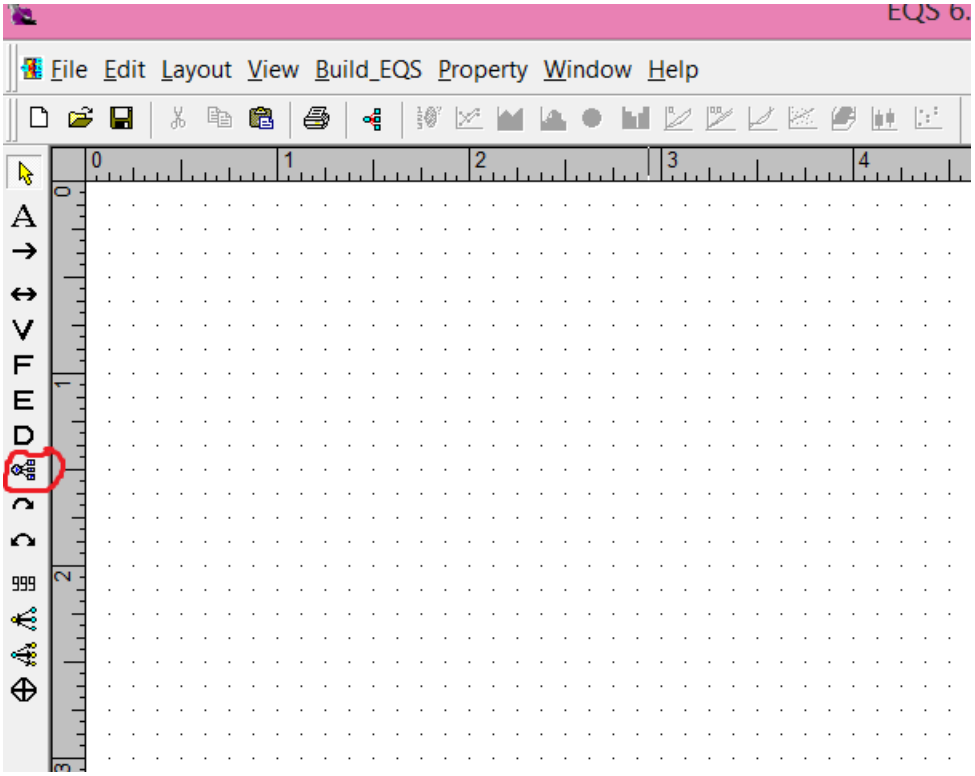
Click on red circled icon above. And then the Diagram Window below.



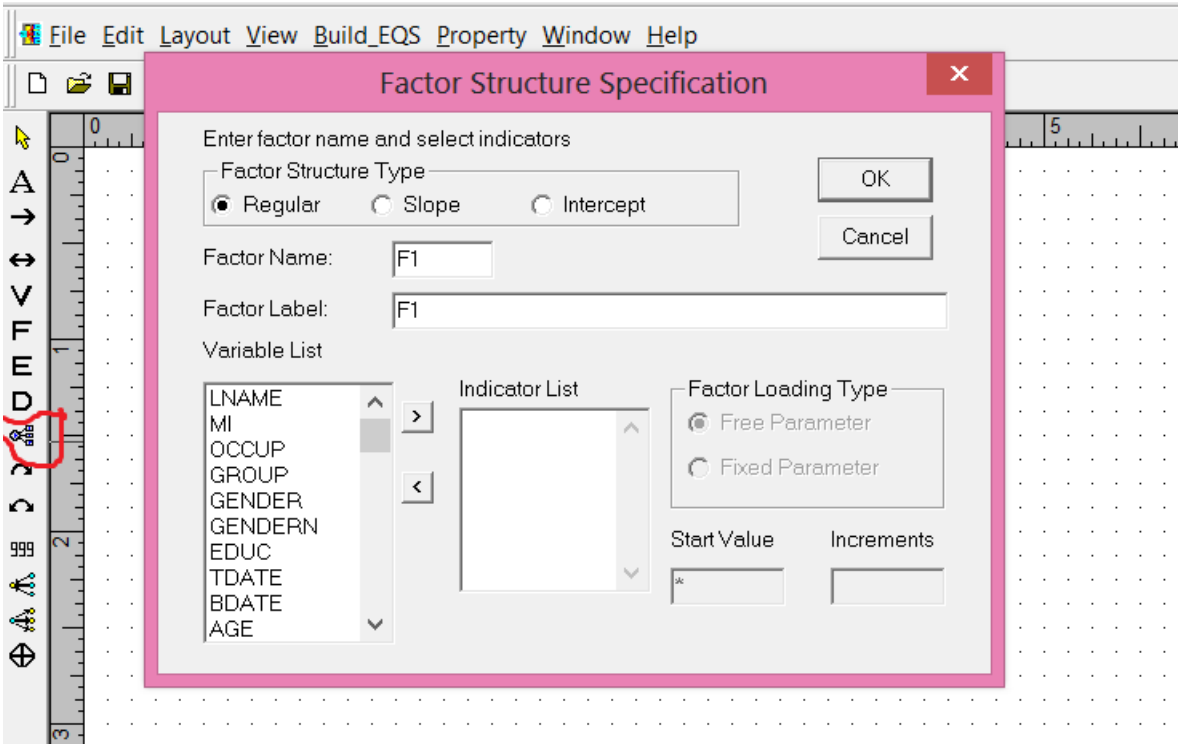
NEED TO SAVE *.EDS FILE AT THIS POINT.

AT THIS POINT MAKE SURE THAT YOU ONLY HAVE 1 EDS FILE open.

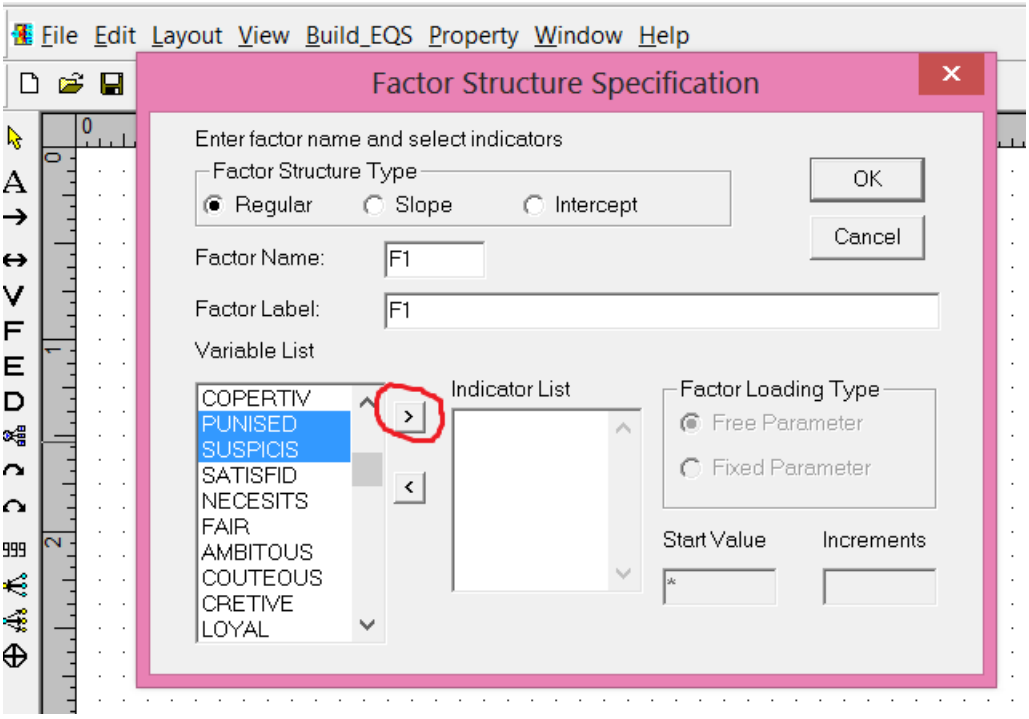
Then click the “factor” icon below.



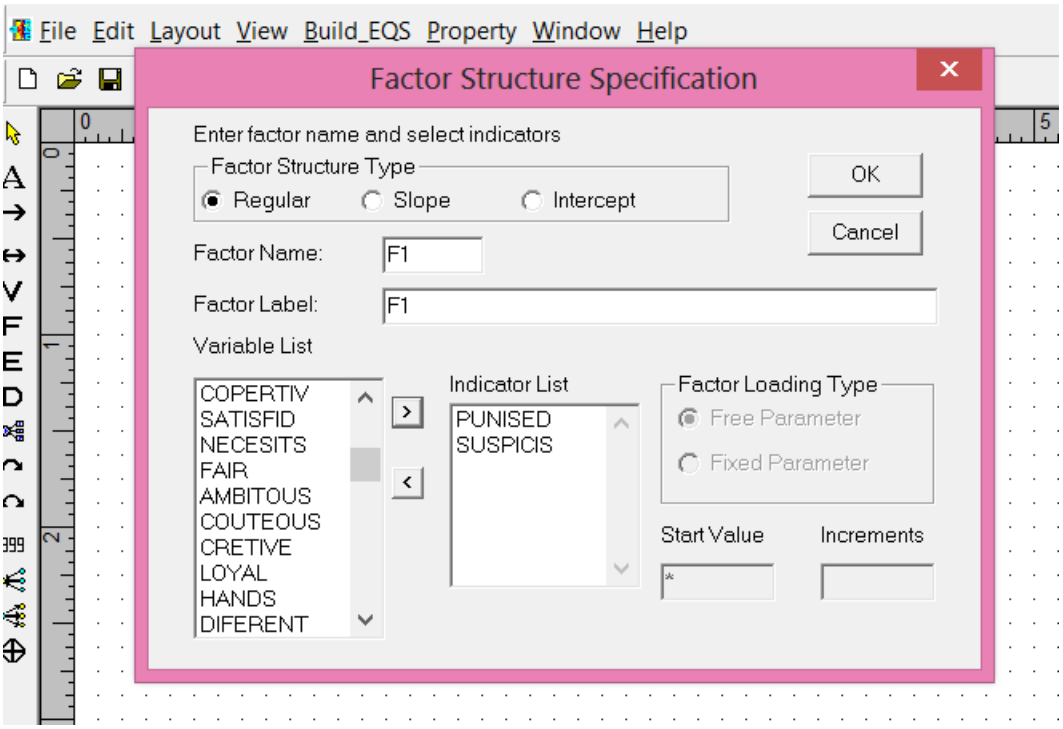
Click on red circled icon then click on dotted area and the following appears.



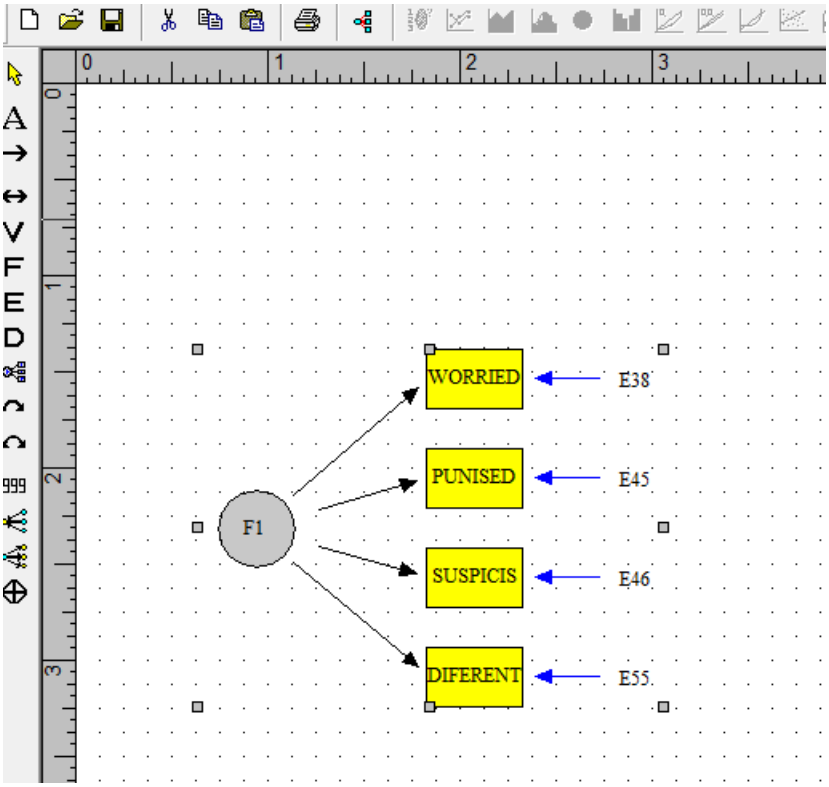
Scroll down to desired variable – see below.



Select variables as shown then click on the “greater then”, “>” character to move the selected variables into the Indicator List (below).

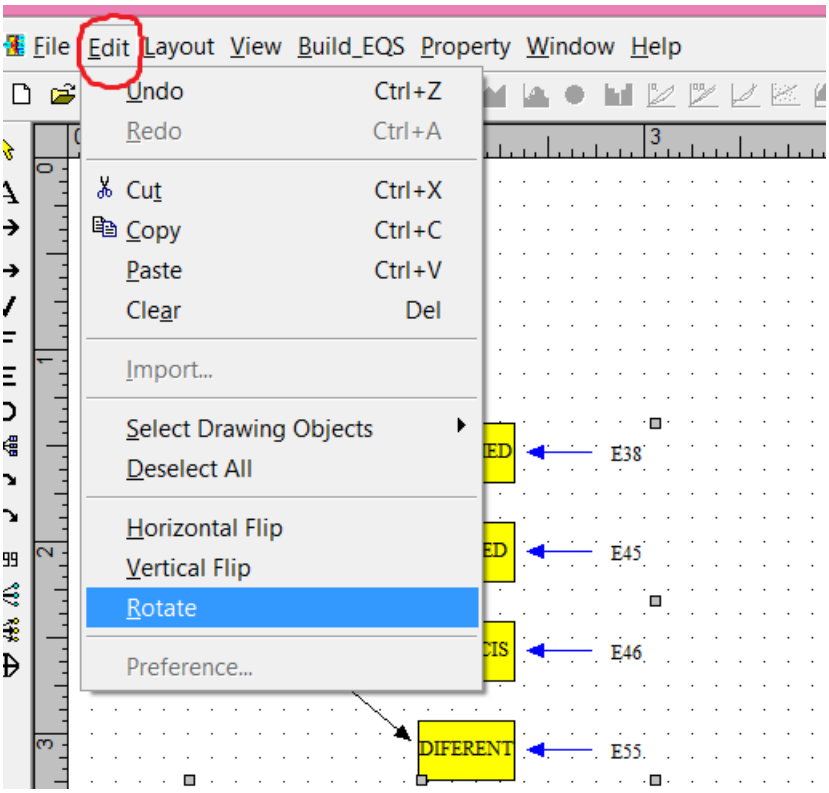


I have selected two more variables and click OK and the factor below was generated:

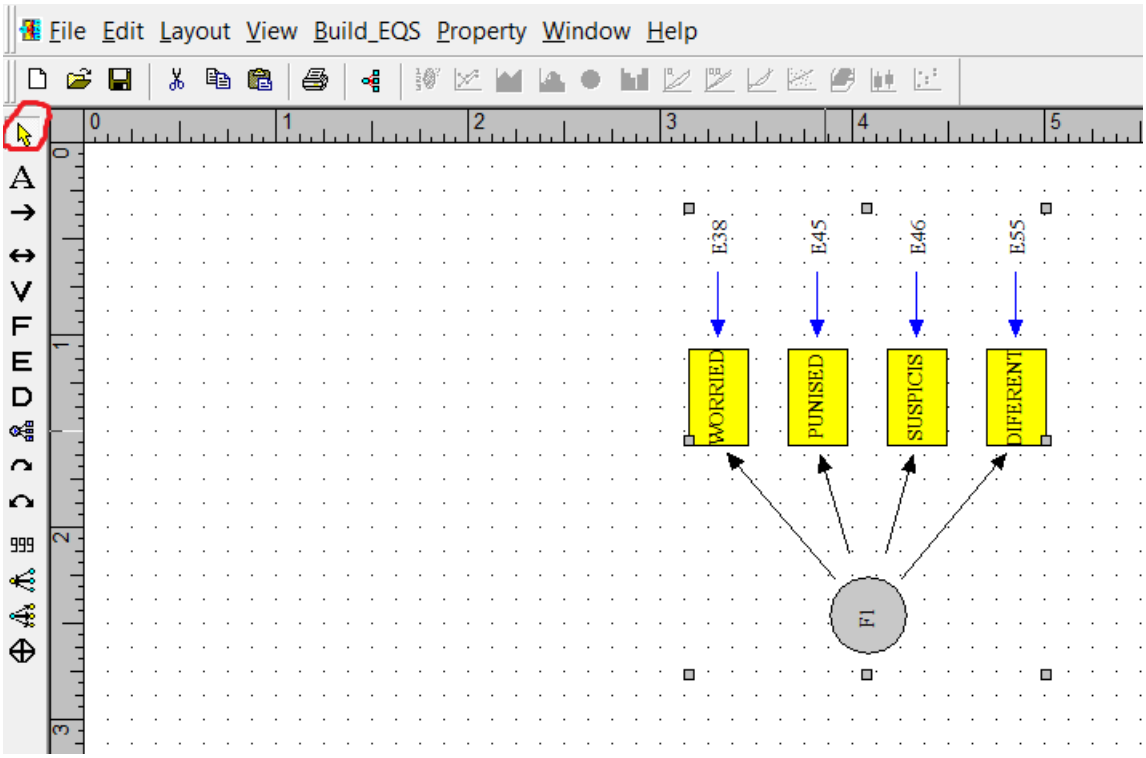


NEED TO DO A “SAVE AS…” FILE AND MAKE SURE THE NAME IS THE SAME AS ABOVE.

Since we are doing a confirmatory factor analysis the factors should be on the “inside” of the drawing and the measured variables (squares) around the “outside.” Consequently, we should rotate the factor and move the variables to the outside as below.

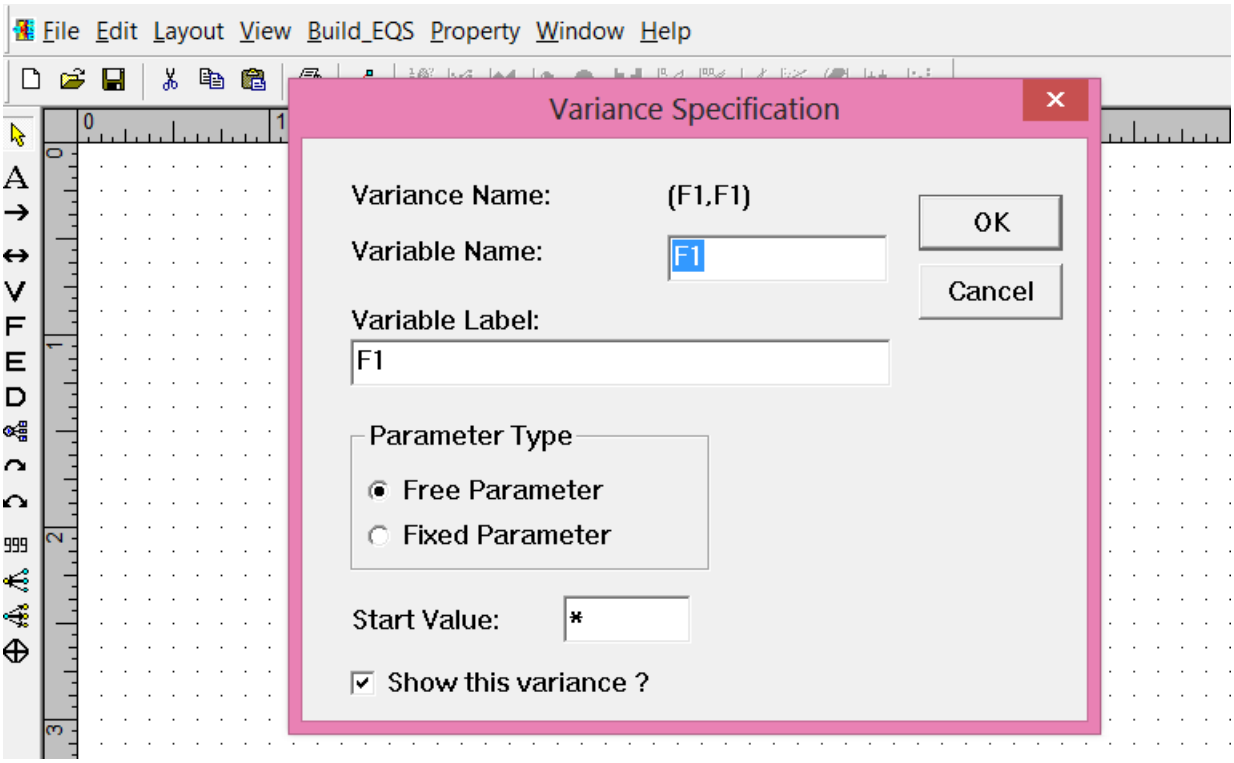


Once the factor drawing is rotated it then needs to be moved. Select the yellow arrow in the upper left hand corner (see below) then hover over the factor drawing then hold down the left mouse button and move the drawing.

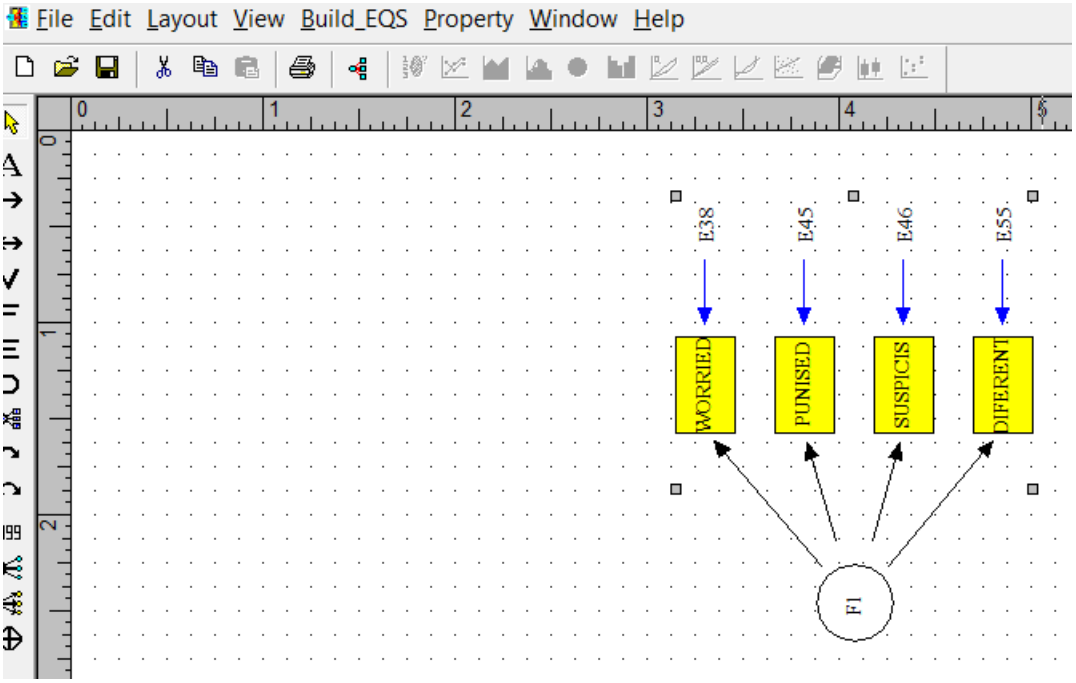


SOMETIMES A MOVE CAUSES TROUBLE (A BUG IN THE PROGRAM) SO AT THIS POINT CLICK ON LAYOUT AND CLICK “BREAK GROUP”. If it falls apart get ahold of a part and move it slightly. Everything should return.

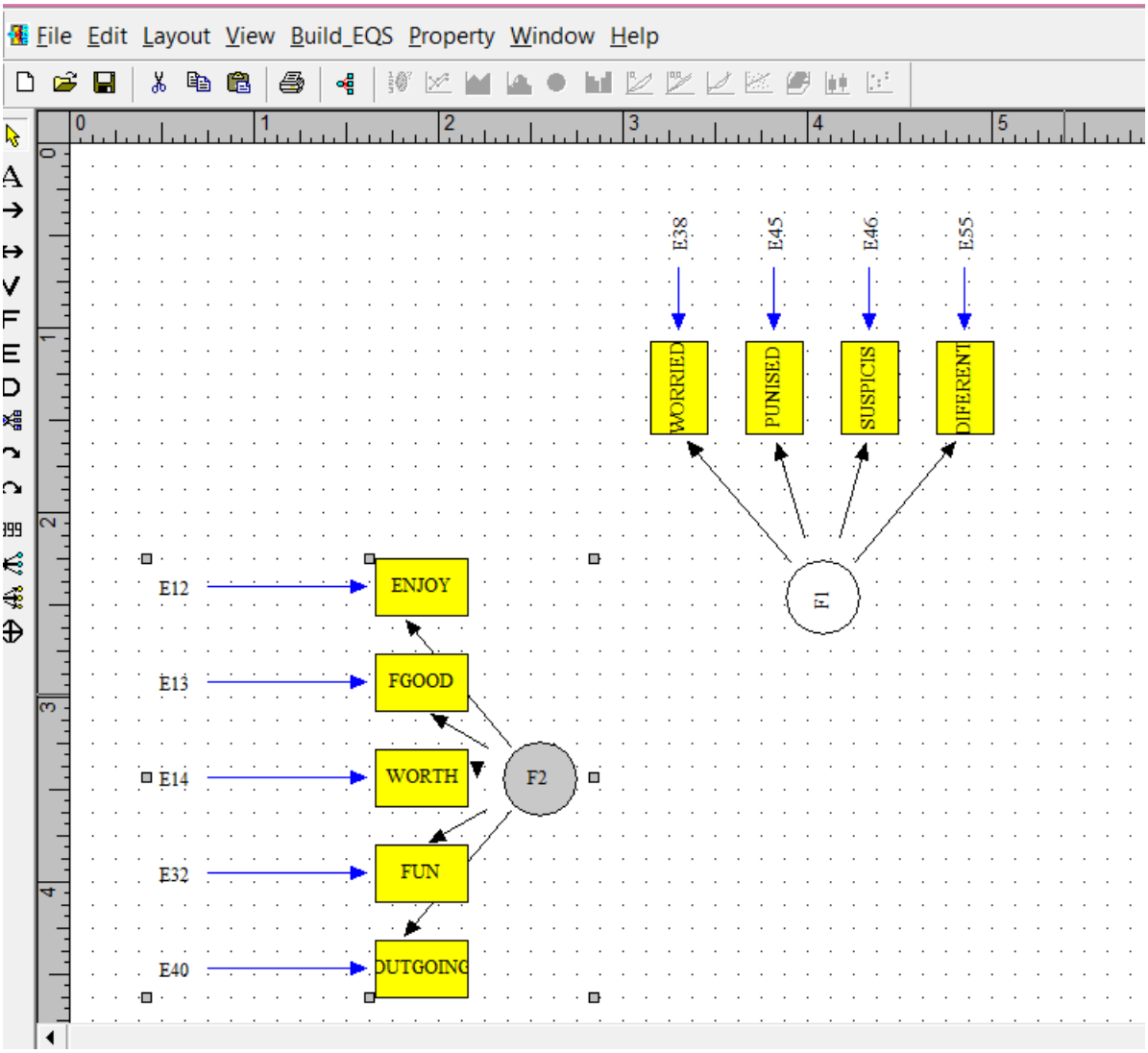
For independent factors (as is the case in confirmatory factor analysis) the variance should be set to 1.0. Double click on the factor and the following window will appear.



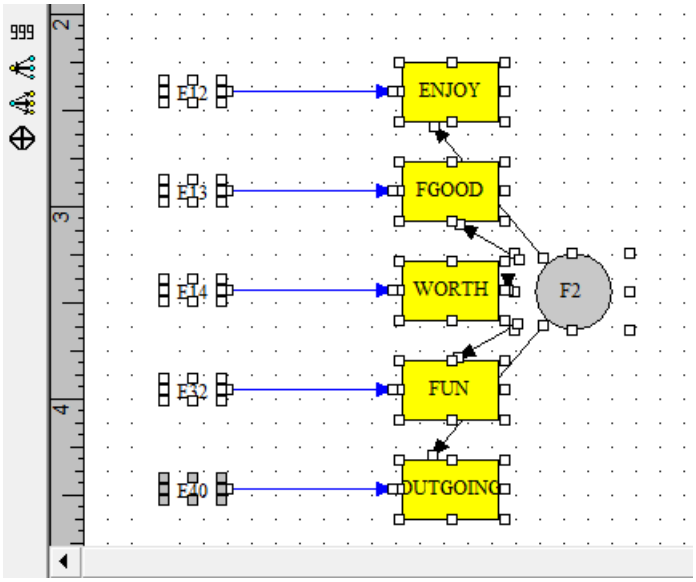
Click on Fixed Parameter and then OK and the variance will be set to 1.0, and the greyed factor changed to white (see below)



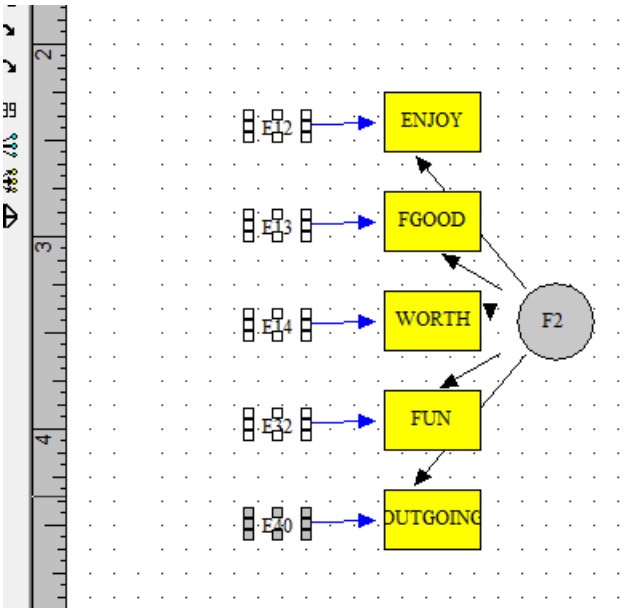
Select the remaining desired variables and factors using the above methods.

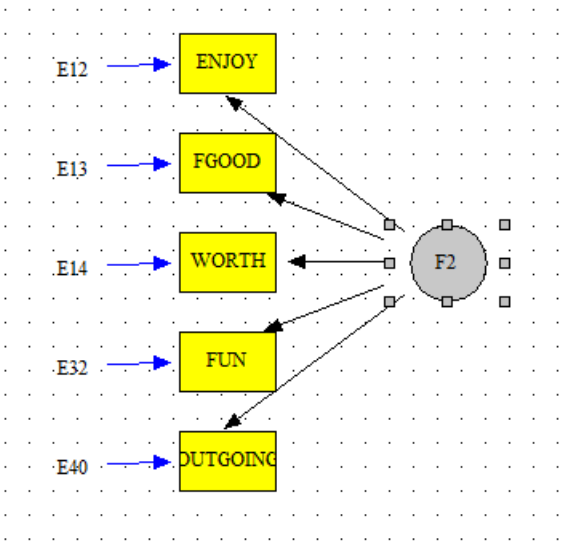


I generated F2 (factor 2) in the usual manner and then clicked on Edit and then Horizontal Flip and as can be seen there is a slight bug in the program because the parameter drawings are not quite in the proper perspective. That can be corrected in the following manner. Click on Break Group and the following appears.



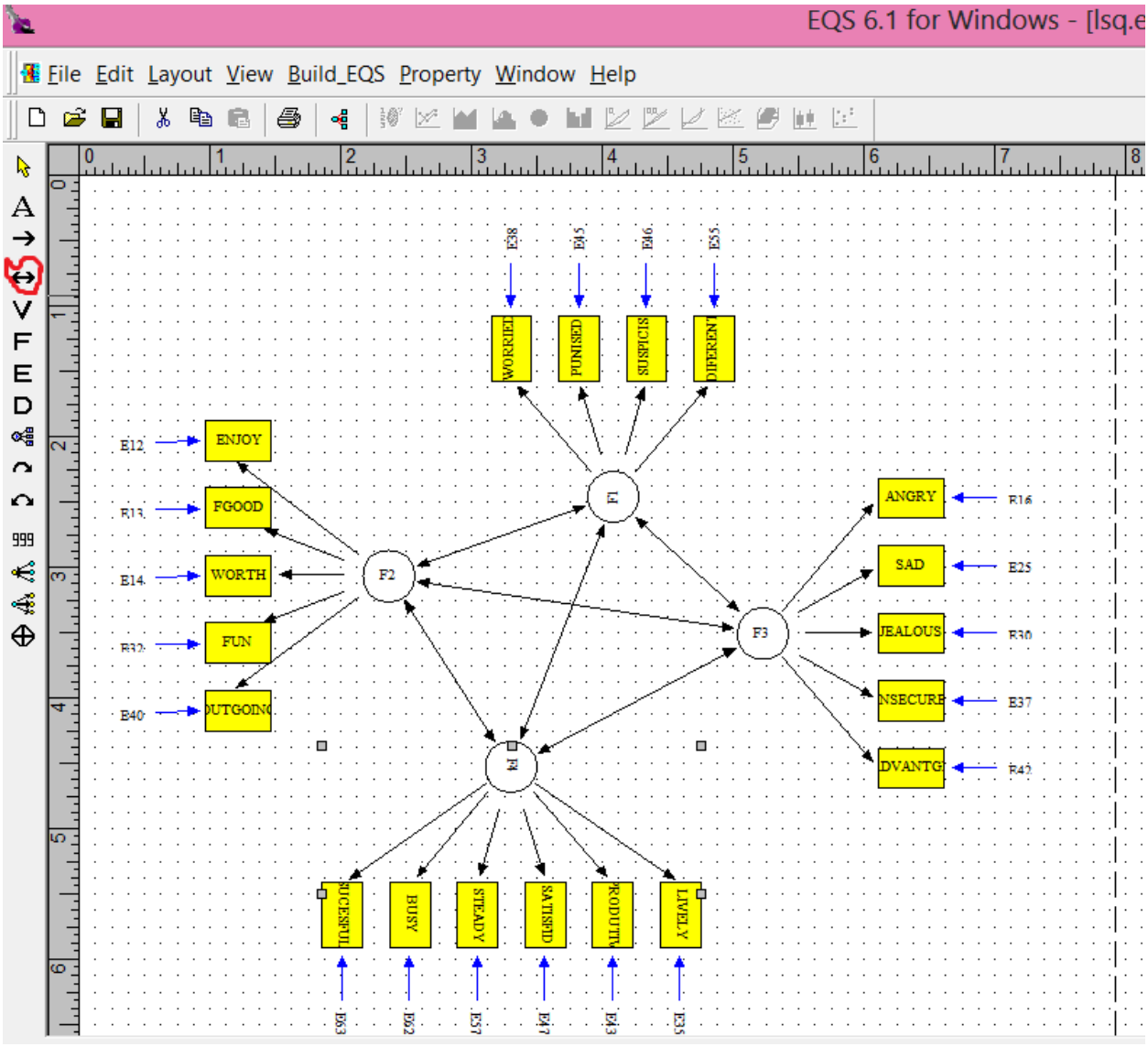
Use the yellow arrow to the Es only and then move them closer to the boxes (measured variables).



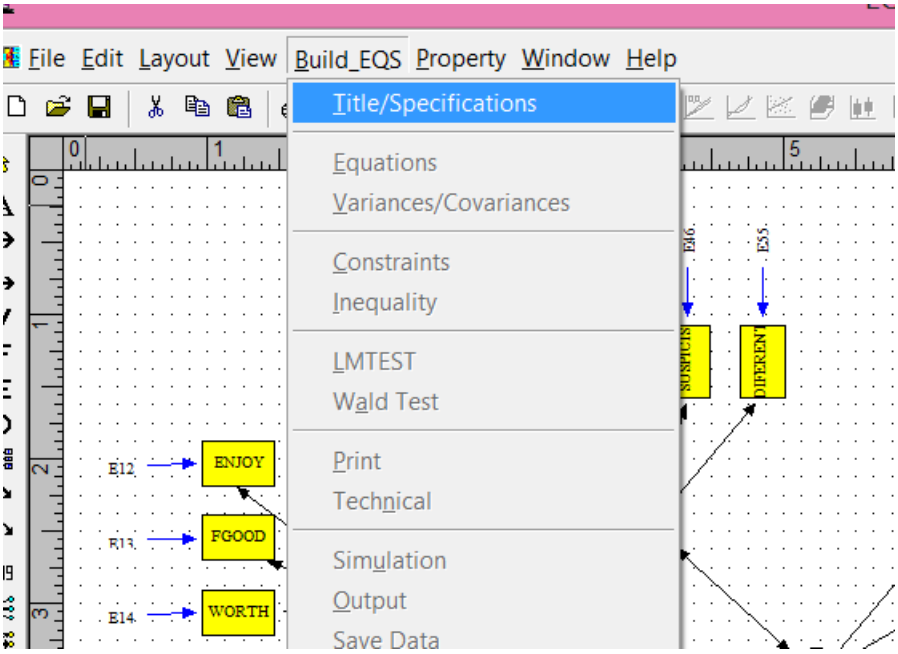


Then select the whole factor (using the yellow arrow) and move it slightly to the left.

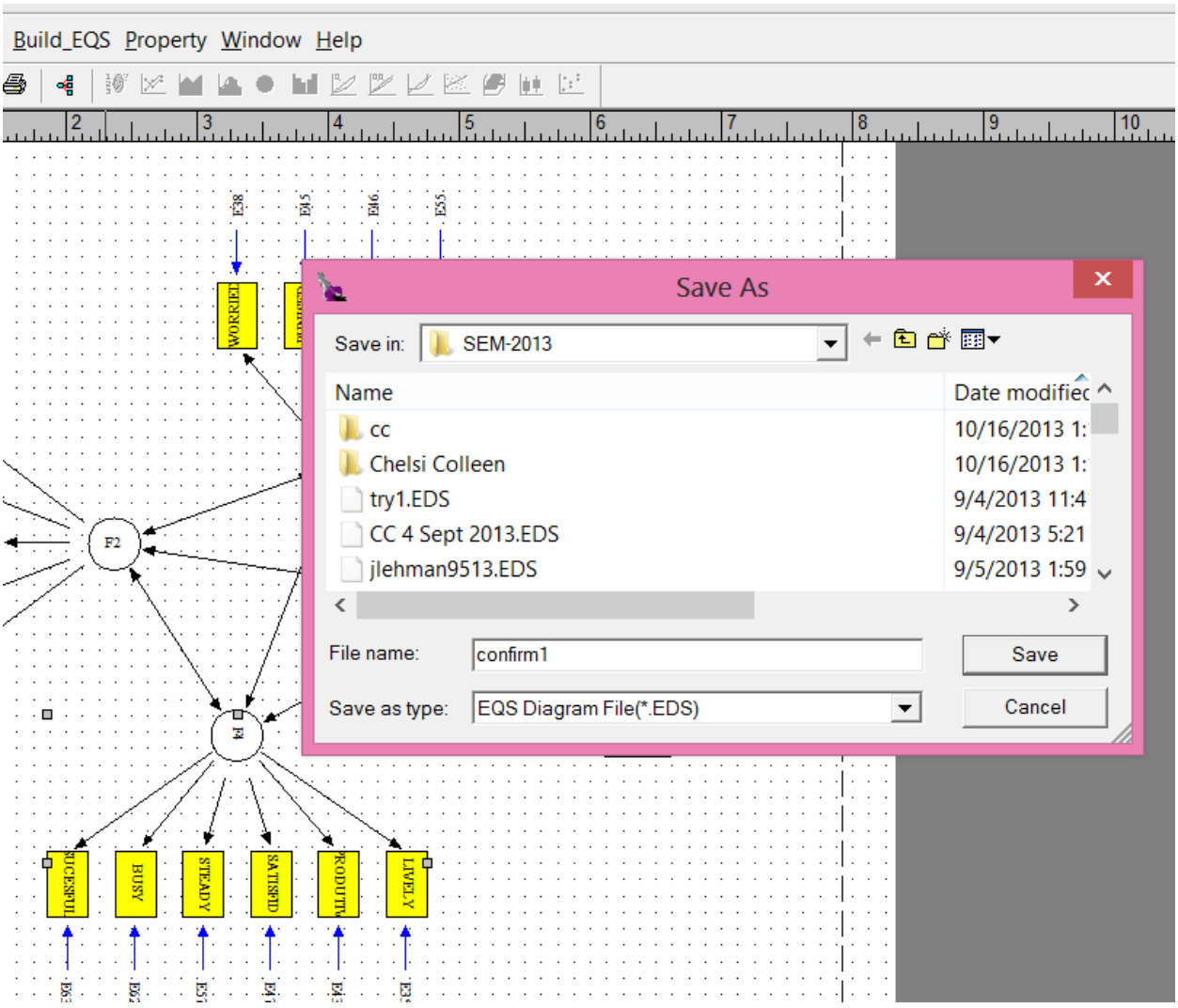
Then using the above methods create as many factors as fits your theory.

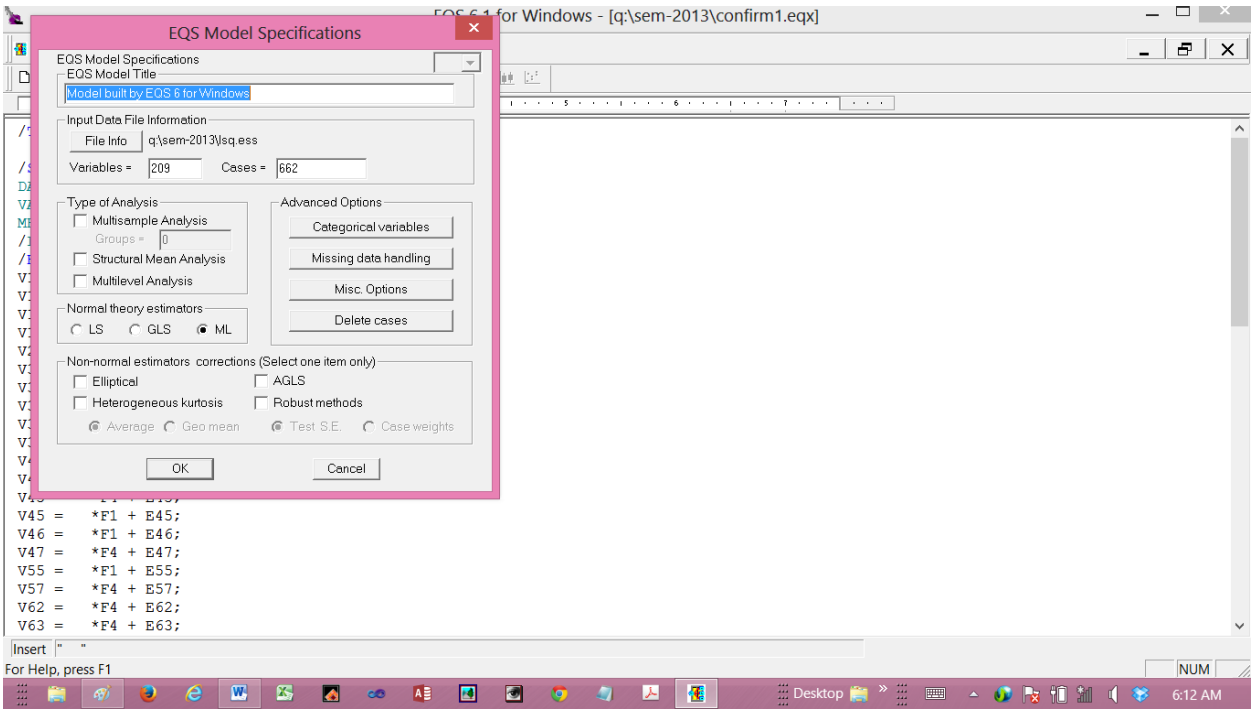


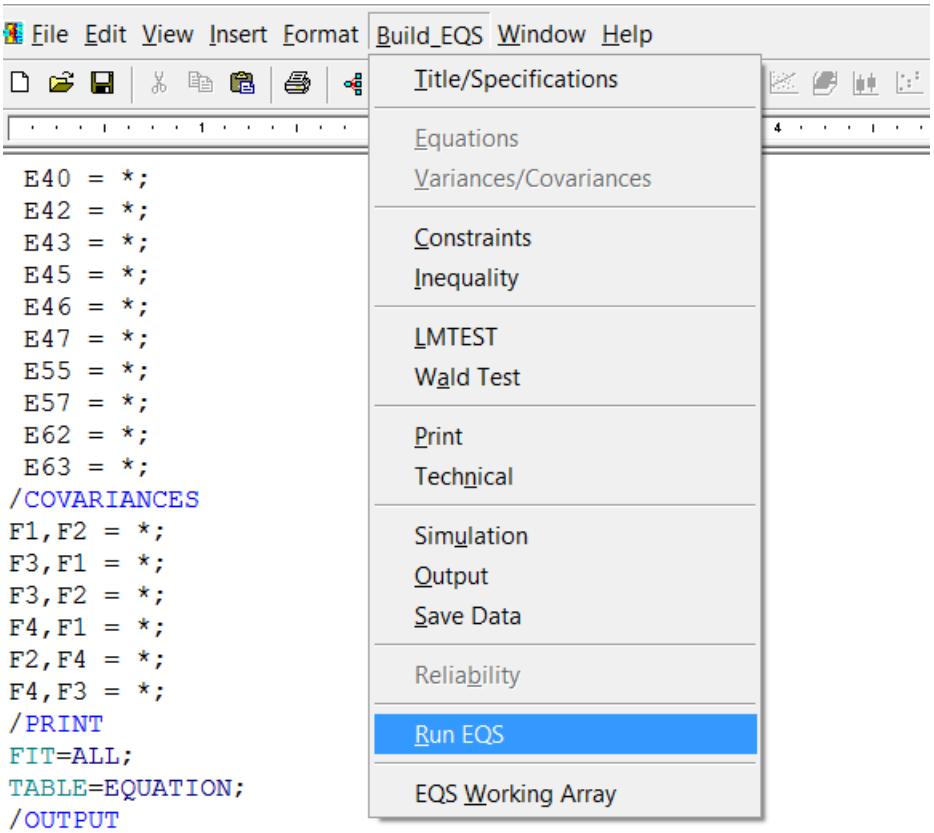
The above diagram was completed using the above methods and then using the double headed arrow (circled in red above) to generated correlations among the variables. The diagram is not ready to run.

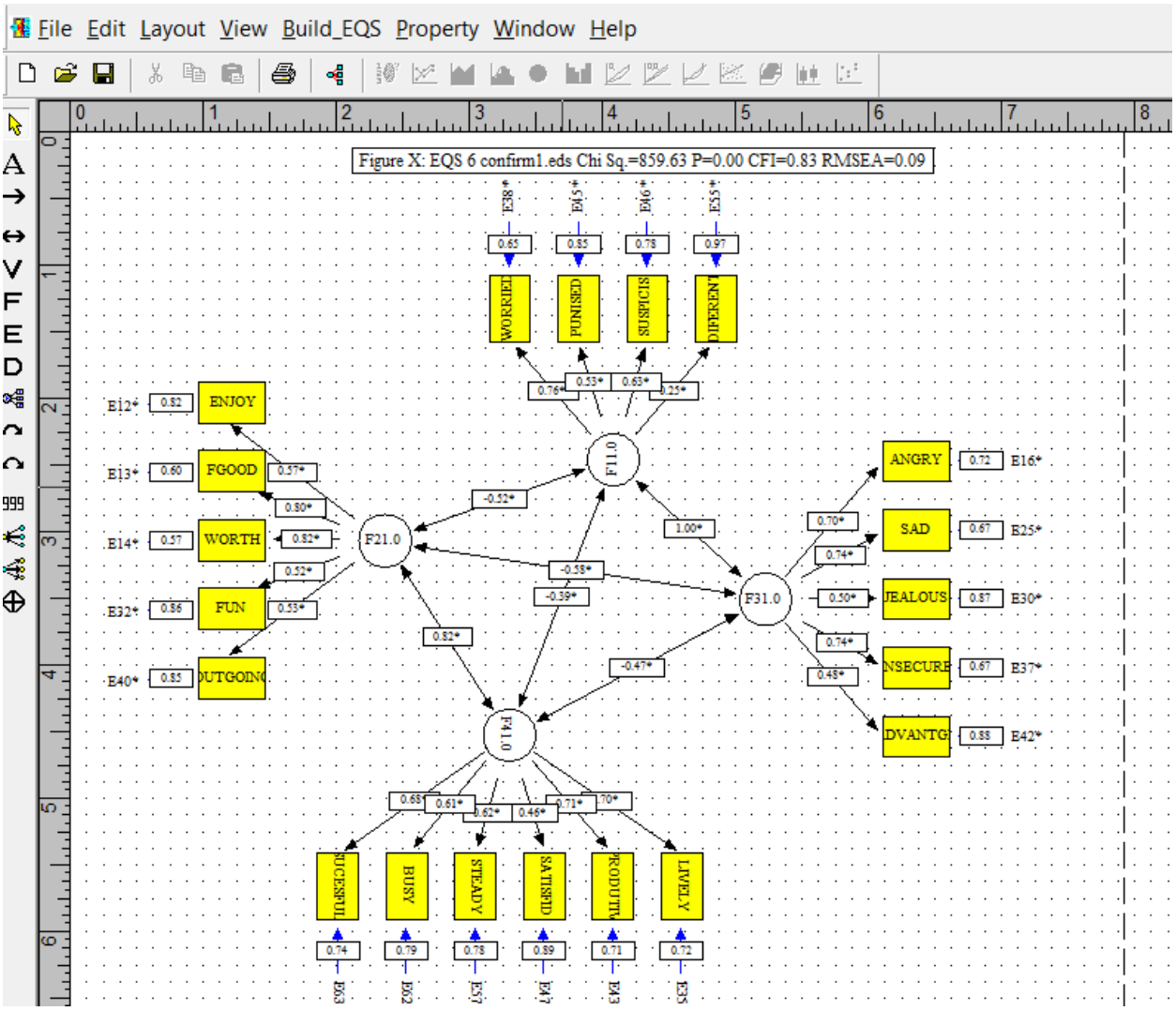


Click on Build_EQS and then click Title/Specifications.

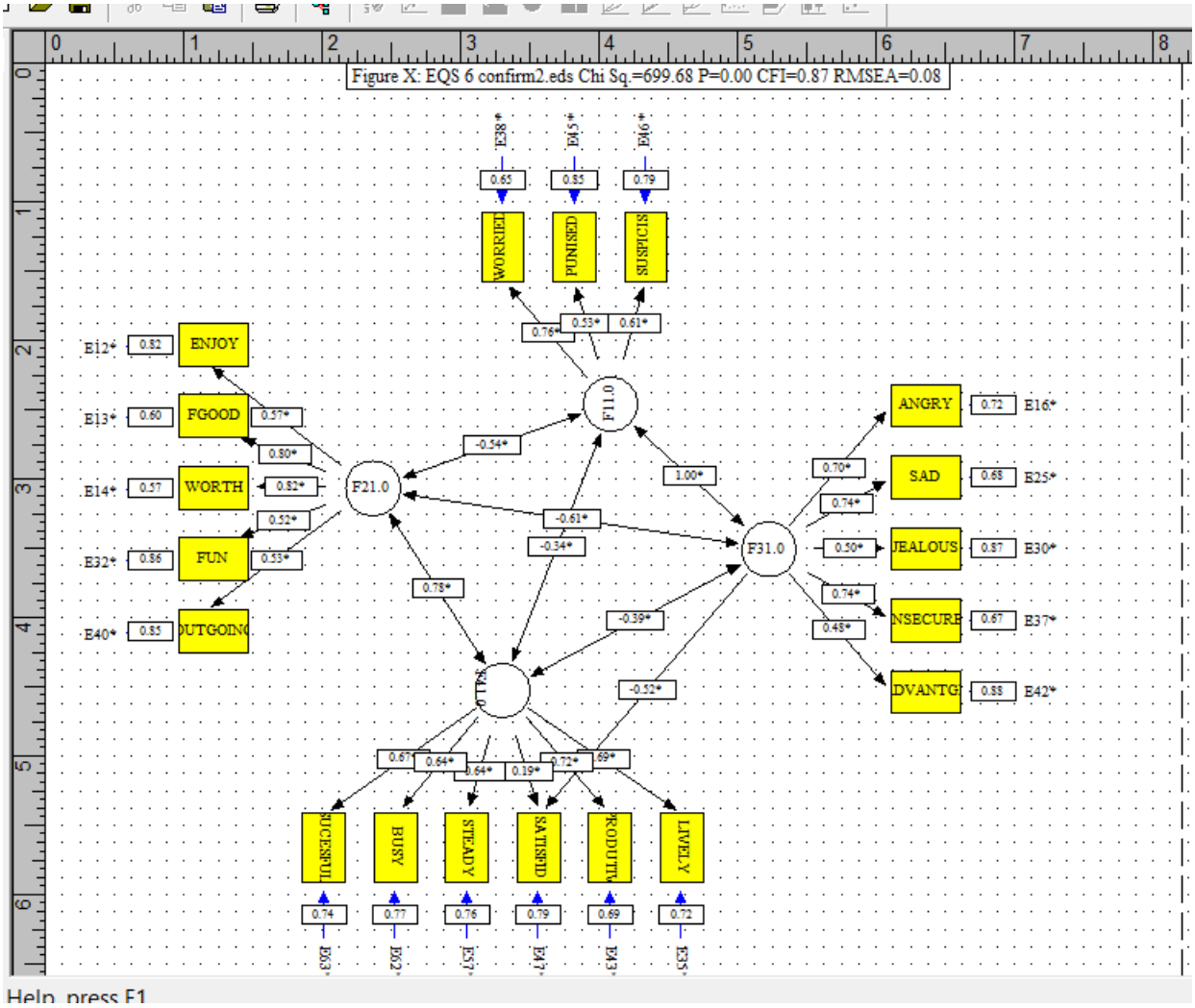

Build_EQS Property Window Help
Save As
Save in: SEM-2013
Name
Date modifiec
cc
10/16/2013 1:
Chelsi Colleen
10/16/2013 1:
try1.EDS
9/4/2013 11:4
CC 4 Sept 2013.EDS
9/4/2013 5:21
jlehman9513.EDS
9/5/2013 1:59
File name: confirm1
Save
Save as type: EQS Diagram File(*.EDS)
Cancel
F2
F4
BUSY
STEADY
SATISFID
LIVELY


EQS 6.1 for Windows - [q:\sem-2013\confirm1.eqx]
EQS Model Specifications
EQS Model Specifications
EQS Model Title
Model built by EQS 6 for Windows
Input Data File Information
File Info
q:\sem-2013\lsq.ess
Variables = 209
Cases = 662
Type of Analysis
Multisample Analysis
Groups = 0
Structural Mean Analysis
Multilevel Analysis
Advanced Options
Categorical variables
Missing data handling
Misc. Options
Delete cases
Normal theory estimators
LS GLS ML
Non-normal estimators corrections (Select one item only)
Elliptical
Heterogeneous kurtosis
AGLS
Robust methods
Average Geo mean Test S.E. Case weights
OK
Cancel
V45 = *F1 + E45;
V46 = *F1 + E46;
V47 = *F4 + E47;
V55 = *F1 + E55;
V57 = *F4 + E57;
V62 = *F4 + E62;
V63 = *F4 + E63;
Insert
For Help, press F1
NUM
Desktop
6:12 AM

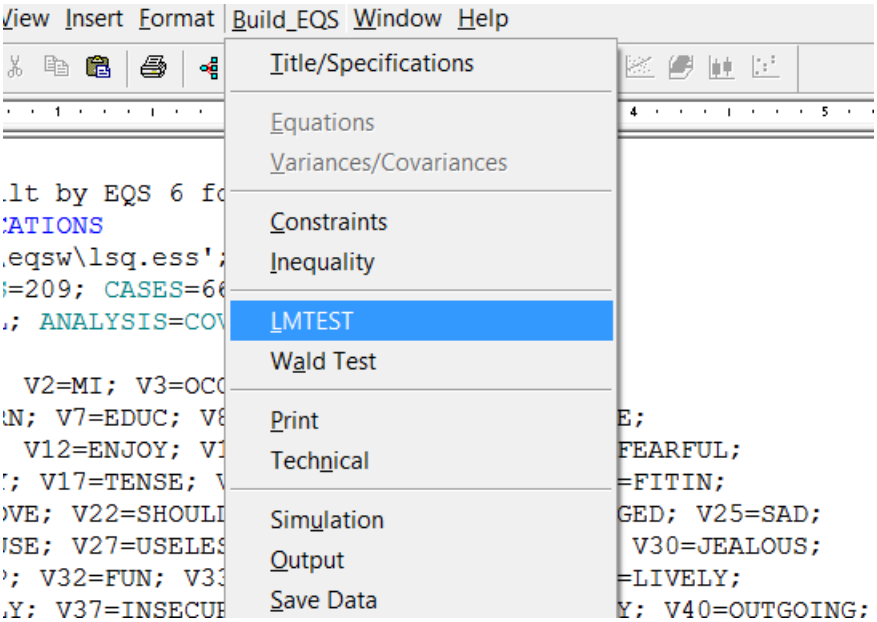

File Edit View Insert Format Build_EQS Window Help
Title/Specifications
Equations
Variances/Covariances
Constraints
Inequality
LMTEST
Wald Test
Print
Technical
Simulation
Output
Save Data
Reliability
Run EQS
EQS Working Array
E40 = *;
E42 = *;
E43 = *;
E45 = *;
E46 = *;
E47 = *;
E55 = *;
E57 = *;
E62 = *;
E63 = *;
/COVARIANCES
F1,F2 = *;
F3,F1 = *;
F3,F2 = *;
F4,F1 = *;
F2,F4 = *;
F4,F3 = *;
/PRINT
FIT=ALL;
TABLE=EQUATION;
/OUTPUT
Parameters;
Standard Errors;
RSquare;
Listing;
DATA='EQSOUT.ETS';
/END

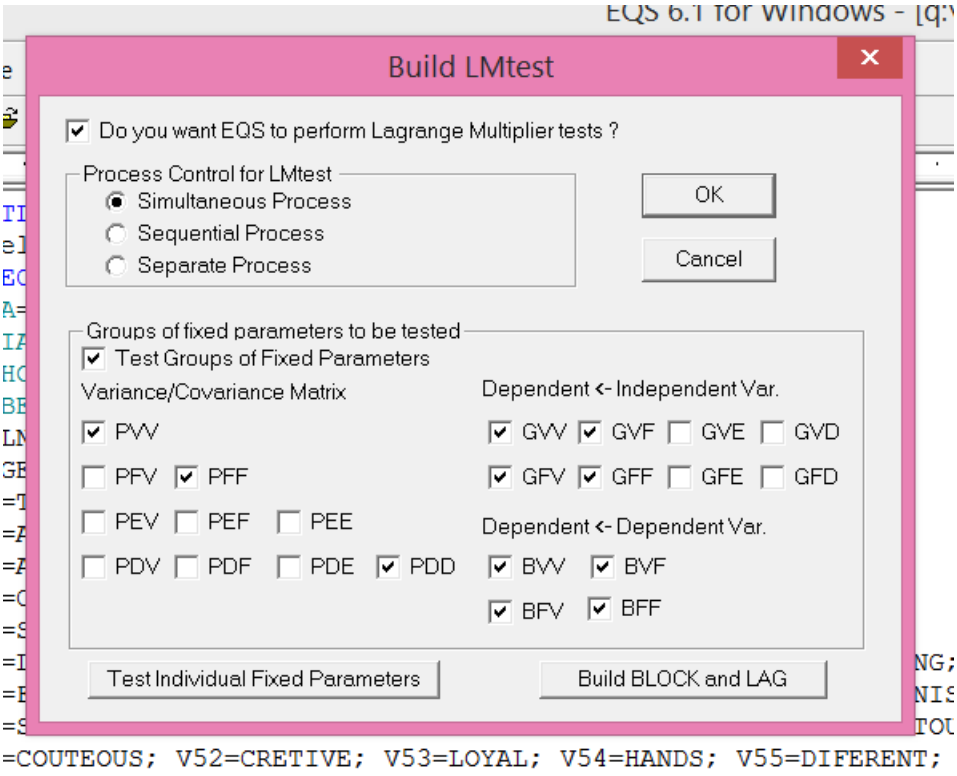


The CFI is .83 and does not "fit." Modifications need to be made. Could start with low correlations – the variable Different is just .25 so I removed it in the next fun.



Some help but not enough CFI is still below .90. However, the RMSEA is below .10 and does indicate a fit. I prefer the CFI index and so will continue to modify. The Lagrange Multiplier provides information about the relationship among the variables and factors. So I have included that in the next run.





Select “Do you want EQS to perform Lagrange Multiplier test?”

Click OK.

```
PROGRAM CONTROL INFORMATION

 1  /TITLE
 2  Model built by EQS 6 for Windows
 3  /SPECIFICATIONS
 4  DATA='q:\sem-2014\lsq.ess';
 5  VARIABLES=209; CASES=662;
 6  METHOD=ML; ANALYSIS=COVARIANCE; MATRIX=RAW;
 7  /LABELS
50  /EQUATIONS
51  V12 =   *F2 + E12;
52  V13 =   *F2 + E13;
53  V14 =   *F2 + E14;
54  V16 =   *F3 + E16;
55  V25 =   *F3 + E25;
56  V30 =   *F3 + E30;
57  V32 =   *F2 + E32;
58  V35 =   *F4 + E35;
59  V37 =   *F3 + E37;
60  V38 =   *F1 + E38;
61  V40 =   *F2 + E40;
62  V42 =   *F3 + E42;
63  V43 =   *F4 + E43;
64  V45 =   *F1 + E45;
65  V46 =   *F1 + E46;
66  V47 =   *F3 + *F4 + E47;
67  V57 =   *F4 + E57;
68  V62 =   *F4 + E62;
69  V63 =   *F4 + E63;
70  /VARIANCES
71   F1 = 1;
72   F2 = 1;
73   F3 = 1;
74   F4 = 1;
75   E12 = *;
76   E13 = *;
77   E14 = *;
78   E16 = *;
79   E25 = *;
80   E30 = *;
81   E32 = *;
82   E35 = *;
83   E37 = *;
84   E38 = *;
85   E40 = *;
86   E42 = *;
87   E43 = *;
88   E45 = *;
89   E46 = *;
90   E47 = *;
91   E57 = *;
92   E62 = *;
93   E63 = *;
94  /COVARIANCES
95  F1,F2 = *;
96  F3,F1 = *;
97  F3,F2 = *;
98  F4,F1 = *;
99  F2,F4 = *;
100 F4,F3 = *;
101 /PRINT
102 FIT=ALL;
```

```
 103  TABLE=EQUATION;
 104  /OUTPUT
 105  Parameters;
 106  Standard Errors;
 107  RSquare;
 108  Listing;
 109  DATA='EQSOUT.ETS';


 110  /LMTEST
 111  PROCESS=SIMULTANEOUS;
 112  SET=PVV,PFF,PDD,GVV,GVF,GFV,GFF,BVV,
 113  BVF,BFV,BFF;
 114  /END


    114 RECORDS OF INPUT MODEL FILE WERE READ


COVARIANCE  MATRIX TO BE ANALYZED:  19 VARIABLES (SELECTED FROM 209 VARIABLES)
BASED ON   553 CASES.

PARAMETER        CONDITION CODE
  F3,F1          CONSTRAINED AT UPPER BOUND


MAXIMUM LIKELIHOOD SOLUTION (NORMAL DISTRIBUTION THEORY)




MAXIMUM LIKELIHOOD SOLUTION (NORMAL DISTRIBUTION THEORY)

*** WARNING *** TEST RESULTS MAY NOT BE APPROPRIATE DUE TO CONDITION CODE


GOODNESS OF FIT SUMMARY FOR METHOD = ML

INDEPENDENCE MODEL CHI-SQUARE        =    4281.389 ON   171 DEGREES OF FREEDOM

INDEPENDENCE AIC =  3939.38862   INDEPENDENCE CAIC =  3030.46240
       MODEL AIC =   409.68417          MODEL CAIC =  -361.04274

CHI-SQUARE =      699.684 BASED ON     145 DEGREES OF FREEDOM
PROBABILITY VALUE FOR THE CHI-SQUARE STATISTIC IS       .00000

THE NORMAL THEORY RLS CHI-SQUARE FOR THIS ML SOLUTION IS         760.273.

FIT INDICES
-----------
BENTLER-BONETT     NORMED FIT INDEX =      .837
BENTLER-BONETT NON-NORMED FIT INDEX =      .841
COMPARATIVE FIT INDEX (CFI)         =      .865
BOLLEN   (IFI) FIT INDEX            =      .866
MCDONALD (MFI) FIT INDEX            =      .606
LISREL    GFI  FIT INDEX            =      .873
LISREL   AGFI  FIT INDEX            =      .834
ROOT MEAN-SQUARE RESIDUAL (RMR)     =      .231
STANDARDIZED RMR                    =      .071
ROOT MEAN-SQUARE ERROR OF APPROXIMATION (RMSEA)    =      .083
90% CONFIDENCE INTERVAL OF RMSEA  (        .077,        .089)
```

RELIABILITY COEFFICIENTS

CRONBACH'S ALPHA = .639
RELIABILITY COEFFICIENT RHO = .762
GREATEST LOWER BOUND RELIABILITY = .863
BENTLER'S DIMENSION-FREE LOWER BOUND RELIABILITY = .863
SHAPIRO'S LOWER BOUND RELIABILITY FOR A WEIGHTED COMPOSITE = .675
WEIGHTS THAT ACHIEVE SHAPIRO'S LOWER BOUND:

MAXIMUM LIKELIHOOD SOLUTION (NORMAL DISTRIBUTION THEORY)

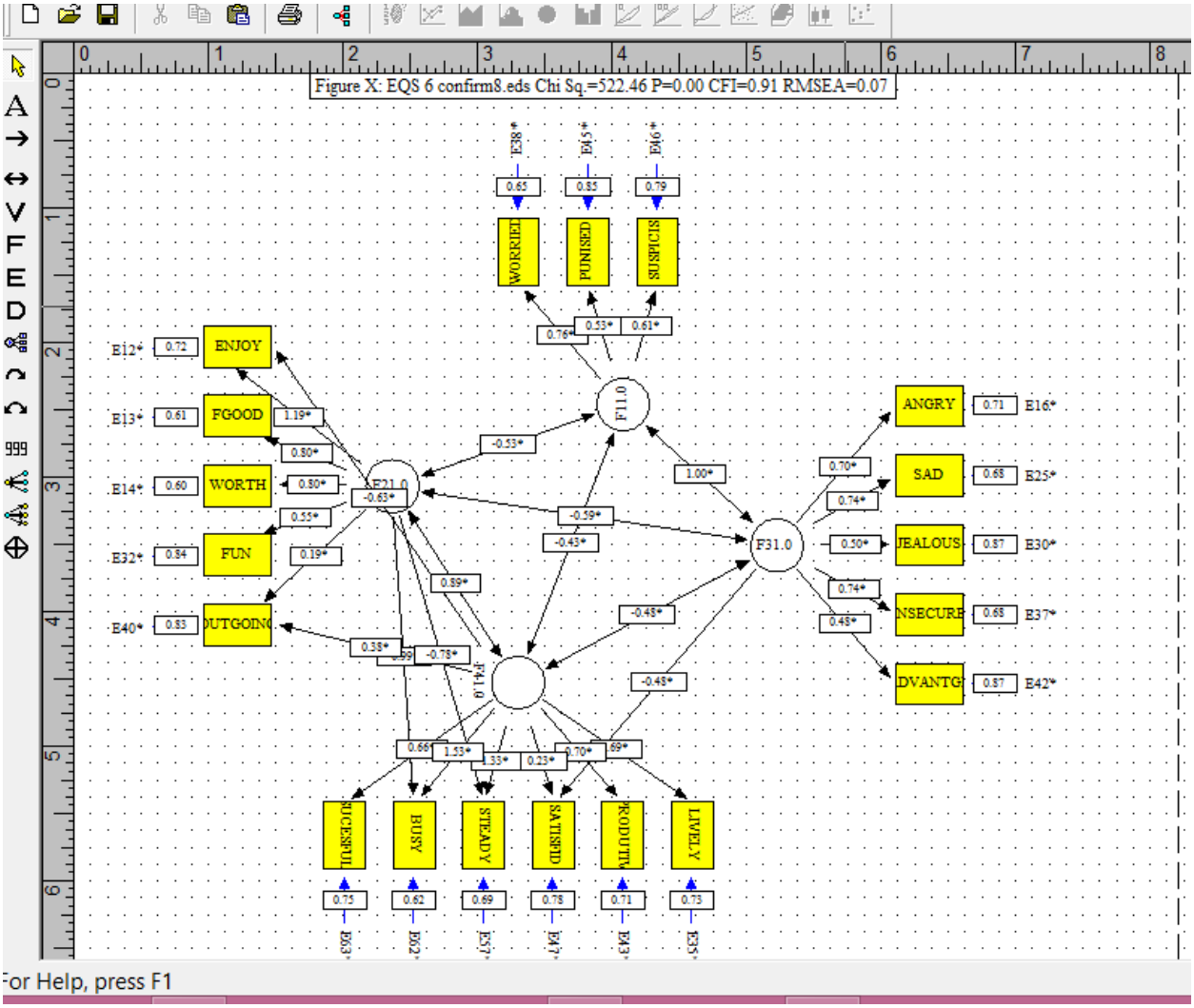
STANDARDIZED SOLUTION: R-SQUARED

ENJOY	=V12 =	.575*F2	+ .818 E12		.330
FGOOD	=V13 =	.804*F2	+ .595 E13		.646
WORTH	=V14 =	.822*F2	+ .570 E14		.675
ANGRY	=V16 =	.698*F3	+ .716 E16		.487
SAD	=V25 =	.736*F3	+ .677 E25		.541
JEALOUS	=V30 =	.497*F3	+ .868 E30		.247
FUN	=V32 =	.517*F2	+ .856 E32		.267
LIVELY	=V35 =	.690*F4	+ .724 E35		.476
INSECURE	=V37 =	.739*F3	+ .674 E37		.546
WORRIED	=V38 =	.762*F1	+ .648 E38		.580
OUTGOING	=V40 =	.533*F2	+ .846 E40		.284
ADVANTGE	=V42 =	.480*F3	+ .877 E42		.231
PRODUTIV	=V43 =	.724*F4	+ .690 E43		.524
PUNISED	=V45 =	.531*F1	+ .847 E45		.282
SUSPICIS	=V46 =	.613*F1	+ .790 E46		.376
SATISFID	=V47 =	-.519*F3	+ .190*F4	+ .785 E47	.384
STEADY	=V57 =	.645*F4	+ .764 E57		.416
BUSY	=V62 =	.638*F4	+ .770 E62		.407
SUCESFUL	=V63 =	.669*F4	+ .743 E63		.448

	CUMULATIVE MULTIVARIATE STATISTICS				UNIVARIATE INCREMENT			
STEP	PARAMETER	CHI-SQUARE	D.F.	PROB.	CHI-SQUARE	PROB.	HANCOCK'S SEQUENTIAL D.F.	HANCOCK'S SEQUENTIAL PROB.
1	V62,F2	48.271	1	.000	48.271	.000	145	1.000
2	V57,F2	107.341	2	.000	59.070	.000	144	1.000
3	V40,F4	136.199	3	.000	28.857	.000	143	1.000
4	V47,F2	164.489	4	.000	28.290	.000	142	1.000
5	V42,F4	190.663	5	.000	26.175	.000	141	1.000
6	V43,F1	213.138	6	.000	22.474	.000	140	1.000
7	V12,F4	234.651	7	.000	21.513	.000	139	1.000
8	V16,F4	251.502	8	.000	16.851	.000	138	1.000
9	V30,F4	262.101	9	.000	10.598	.001	137	1.000
10	V14,F4	271.619	10	.000	9.518	.002	136	1.000
11	V46,F3	279.230	11	.000	7.611	.006	135	1.000
12	F1,F1	283.722	12	.000	4.493	.034	134	1.000

LAGRANGIAN MULTIPLIER TEST REQUIRED 222711 WORDS OF MEMORY.
PROGRAM ALLOCATES ******** WORDS.
1
Execution begins at 03:41:35
Execution ends at 03:41:38

The results from the Lagrange indicate that there a relationship betwseen factor 2 and variable 62 (busy) and variable 67 (steady). I have included them in the next analysis.



The modified model now "fits."

Variables for LSQ can be found here:
http://psy605q.com/lsqScales.pdf