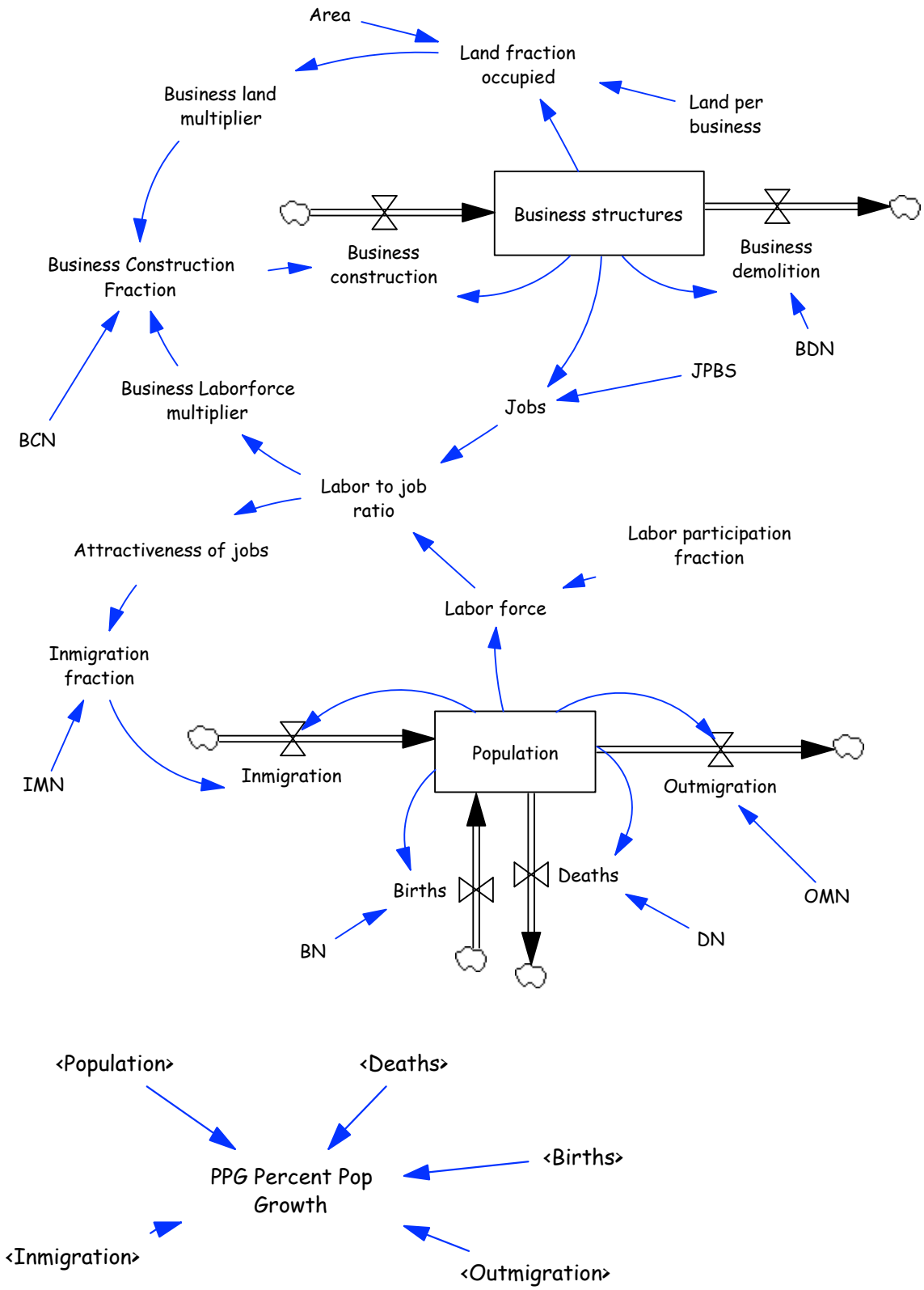
A Simple Urban Model

The model you will create in this assignment is an extension of the model of Business Structures you created and explored in class. In this assignment you will add a second stock to the system, the stock of Population, with its attendant flows. Adding Population dramatically extends the model, enabling the inclusion of the labor force in the city, jobs, a measure of employment and unemployment, and the influences that those will have on urban migration and attractiveness to businesses.

1) Create a Vensim version of the POPBSN model diagrammed with equations on the next pages. You can create it by simply adding to your Business Structures model in class. [Suggestion: Create the diagram first. Then enter the parameters and equations.]

Note that the portion of the diagram at the bottom uses the "shadow" tool to avoid lots of crossing lines. Note also that when you simulate this you may see a notice from Vensim that says something like "PPG Percentage Population Growth is not used in the model." Don't worry about that -- it's just a true statement: PPG is an indicator variable, telling us how fast population is growing (fraction per year) as the city develops.

Repeatedly edit and simulate the model over a sixty year time frame (longer than the BSN model) until you obtain the behavior shown in the graph below the model. (You can create this custom graph by clicking on the Control Panel button. Again, let Vensim pick the scales — just be sure the values are the same). Don't proceed until you can reproduce the graphs shown below. Call me or email me you model if necessary. Save your model under a new name (POPBSN.mdl might be nice!). Paste the diagram, the documented equation listing (Doc button) , and the base run graph into your homework document to hand in.


Area
Land fraction occupied
Business land multiplier
Land per business
Business structures
Business Construction Fraction
Business construction
Business demolition
BDN
JPBS
Jobs
Business Laborforce multiplier
BCN
Labor to job ratio
Attractiveness of jobs
Labor participation fraction
Labor force
Inmigration fraction
IMN
Inmigration
Population
Outmigration
OMN
Births
Deaths
BN
DN
<Population>
<Deaths>
PPG Percent Pop Growth
<Births>
<Inmigration>
<Outmigration>

Area = 1000
Units: acre

Attractiveness of jobs = WITH LOOKUP(Labor to job ratio , ([(0,0)-(2,2)],(0,2)
,(0.2,1.95),(0.4,1.8),(0.6,1.6),(0.8,1.35),(1,1),(1.2,0.5),(1.4,0.3)
,(1.6,0.2),(1.8,0.15),(2,0.1))
Units: dimensionless

BCN = 0.07
Units: 1/year

BDN = 0.025
Units: 1/year

Births = BN * Population
Units: people/year

BN = 0.03
Units: 1/year

Business construction = Business Construction Fraction * Business structures

Units: structure/year

Business Construction Fraction = BCN * Business Laborforce multiplier * Business land multiplier

Units: 1/year

Business demolition = BDN * Business structures
Units: structure/year

Business Laborforce multiplier = WITH LOOKUP(Labor to job ratio , ([(0,0)-(2,2)
],(0,0.2),(0.2,0.25),(0.4,0.35),(0.6,0.5),(0.8,0.7),(1,1),(1.2,1.35)
,(1.4,1.6),(1.6,1.8),(1.8,1.95),(2,2))
Units: dimensionless

Business land multiplier = WITH LOOKUP(Land fraction occupied , ([(0,0)-(1,2)
],(0,1),(0.1,1.15),(0.2,1.3),(0.3,1.4),(0.4,1.45),(0.5,1.4),(0.6,1.3)
,(0.7,0.9),(0.8,0.5),(0.9,0.25),(1,0))
Units: dimensionless

Business structures = INTEG(Business construction - Business demolition ,
1000)
Units: structure

Deaths = DN * Population
Units: people/year

DN = 0.015
Units: 1/year

IMN = 0.1
Units: 1/year

Inmigration = Inmigration fraction * Population
Units: people/year

Inmigration fraction = IMN * Attractiveness of jobs
Units: 1/year

Jobs = JPBS * Business structures
Units: job

JPBS = 18
Units: job/structure

Labor force = Labor participation fraction * Population
Units: people

Labor participation fraction = 0.35
Units: dimensionless

Labor to job ratio = Labor force / Jobs
Units: people/job

Land fraction occupied = (Business structures * Land per business) / Area

Units: dimensionless

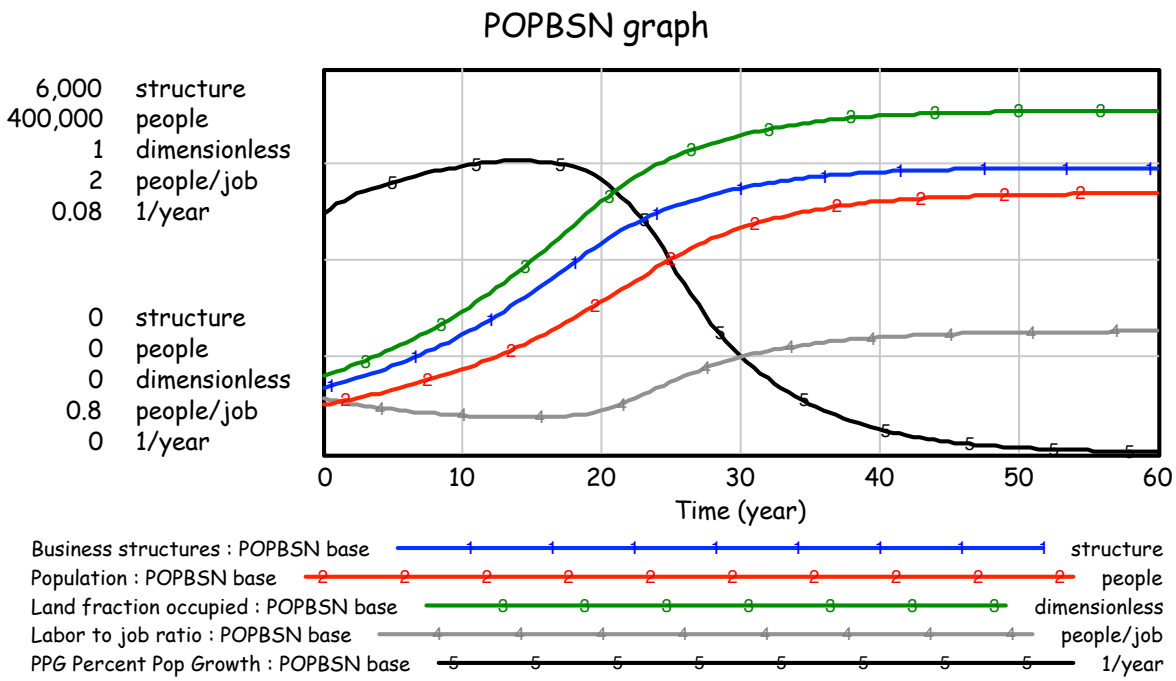
Land per business = 0.2
Units: acre/structure

OMN = 0.07
Units: 1/year

Outmigration = OMN * Population
Units: people/year

Population = INTEG(Births + Inmigration - Deaths - Outmigration , 50000)
Units: people

PPG Percnt Pop Growth = (Births - Deaths + Inmigration - Outmigration) /
Population
Units: 1/year



[You can get the numbers to show up on the curves, to identify the curves even in black-and-white, by going to Preferences (under VensimPLE in the menu) and clicking on Show Line Markers on Graph Lines.]

2) Exercising the POPBSN model

a) Record base run information in a table like the one shown in (c) below. What is employment situation in this city at various times in the base run? How does this compare with real cities?

b) Now simulate the model eight more times, varying each of the parameters BCN, BDN, JPBS, and LPF systematically to test their influence. Do a run with BCN 30% lower than the base run, and another with BCN 30% higher than the base run. Record your observations in a table like the one below. Repeat with each of the other parameters, one at a time.

[Vensim hint: If you click on the spreadsheet tool each time after clicking on BC, LFO, BS, P, and LFJR, you will enter all of them in the spreadsheet display, so can see their actual numerical values. That might be easier for you than trying to read the values off graphs.]

c) Summarize your results in a) and b) in a table like the following:

	Base	BCN lower	BCN higher	BDN lower	BDN higher	JPBS lower	JPBS higher	LPF lower	LPF higher
Time of peak in BC									
Value of LFO at the end of the simulation									
Value of BS at the end of the simulation									
Value of P at the end of the simulation									
Value of LFJR when PPG is greatest									
Value of LFJR at the end of the simulation									

3) Thought-provoking questions

a) Do any of these parameter changes improve the job situation in this simulated city in the long run?

b) What urban policies might these parameter changes represent in a real city?

c) What are the implications of (3a) and (3b) for real cities?

e) Testing your systems thinking abilities: Without simulating, describe what would happen if Jobs per Business Structure were to jump 25% at TIME = 30? Why? Explain in terms of the feedback structure of the model.

> (If you insist on simulating this, rather than use your mental model, you could rewrite JBS in an auxiliary equation using a STEP function, as you did in (2f) with AREA. If you simulate it, you still have to come up with an (even better?) explanation of what happens and why.)

What real policy could such a parameter change represent, and what does your mental model simulation suggest about such a policy?