Modelling Church Growth
Micro & Macro Models

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Why Model Church Growth?

Significant Social Movements
- Rapid growth: Asia Africa and South & Latin America
- Long decline: Western Europe. England church attendance in 1900 30% population, now about 7%.
- Continued strength and influence in USA, Canada & Australia

News Worthy
- Welsh Revival 1904. Dominated the Welsh media. 100,000 converts.
- Toronto Blessing 1994. Revival movement that starting in Toronto, word spread by internet and reported widely in UK summer 1994

System Dynamics

What is System Dynamics?

Modelling Methodology

- Originated with JD Forrester a former control engineer
- Developed at MIT 1960's onwards
- Application of feedback ideas to social systems
- Diagrammatic method that is understandable to people not conversant with mathematics
- Builds cause and effect into the models in a natural way. Easy to see what causes what
- Based on differential equations, delay differential equations and integro-differential equations
- Can be simulated with specialist software
- Can be analyzed with standard methods of systems of non-linear ODE's

System Dynamics

Applications

- **Business Modelling. See Peter Senge Firth Discipline, John Sterman Business Dynamics**
- **Social Models. Especially diffusion modelling and epidemiology**
- **World Models. System dynamics models of world population and resources predicting overshoot and collapse around the middle of 21st century**
- http://www.systemdynamics.org/
- http://www.inta.gatech.edu/peter/world3.html
- http://sysdyn.clexchange.org/road-maps/home.html
- http://en.wikipedia.org/wiki/Limits_to_Growth

SD is ideal for modelling church growth as models can be explained to non-math people such as church growth practitioners and sociologists of religion

Basic Processes of SD

Compounding
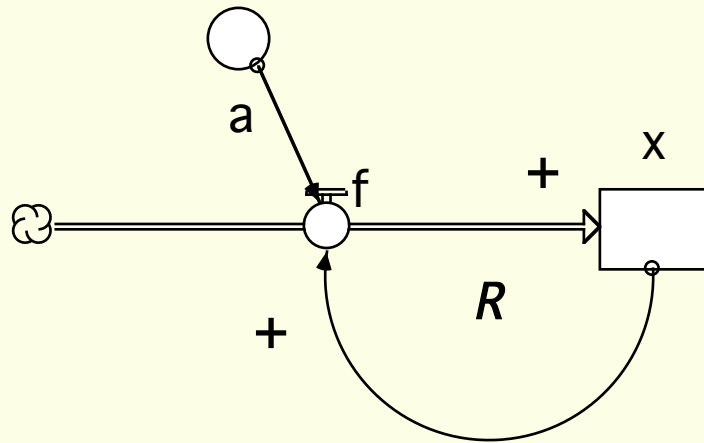
$$\frac{dx}{dt} = f(a, x) \qquad \frac{dx}{dt} = ax$$

Stock (rectangle) is variable $x(t)$

Flow f is rate of increase of x

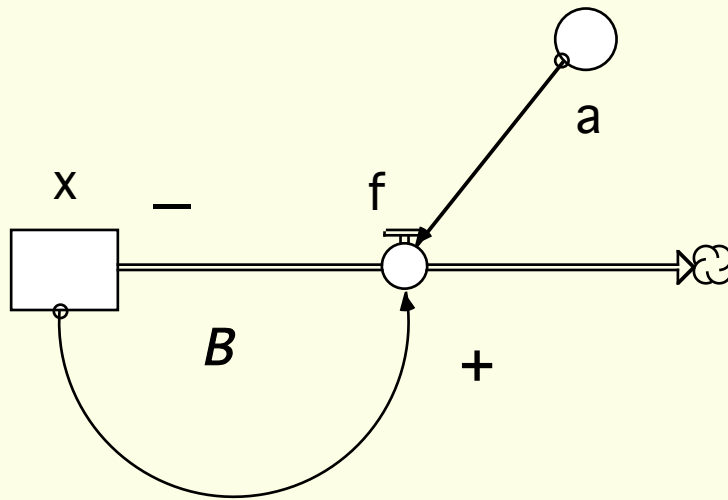$+$ sign indicates same way functional dependence

$$\frac{\partial f}{\partial x} > 0$$

Positive feedback loop (reinforcing loop) through x

$f = ax$ gives exponential growth

Basic Processes of SD

Draining

- sign indicates opposite way
    functional dependence

Negative feedback loop
    (balancing loop)
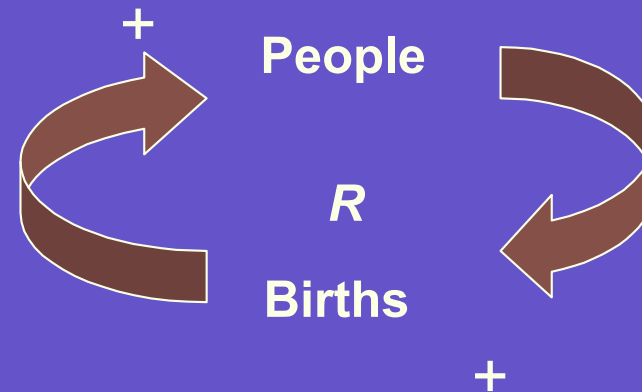   through x
$f = -ax$ gives exponential
    decay

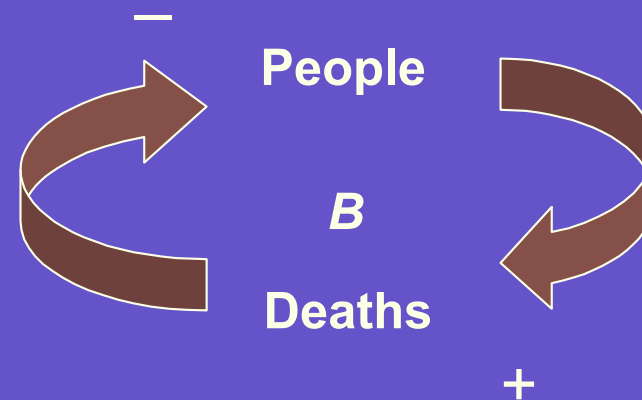$$\frac{dx}{dt} = -f(a,x) \qquad \frac{dx}{dt} = -ax$$

Causal Loops

Dynamics can be explained using causal loops

Birth process is an example of a reinforcing loop and is unstable

+ **People**

R

Births

+

Death process is an example of a balancing loop and is stable

− **People**

B

Deaths

+

Called Systems Thinking

Church Growth Models

Two models of Church Growth will presented:

1. Limited Enthusiasm Model
   - Churches grow through conversion growth
   - "Micro" Model as it is based on a model of the behavior of an individual

2. Spiritual Capital Model
   - Church grows through build up of spiritual capital
   - "Macro" Model as it is based on a model of the behavior of a group of people

Limited Enthusiasm Model

1. Churches grow through conversion growth
2. Conversion occurs through contact between some believers (enthusiasts) and unbelievers
3. Each enthusiast is treated as having the same potential to recruit

Limited Enthusiasm - Conversion

Conversion driven by a reinforcing loop as the more enthusiastic
   believers the more conversions
Slowed down as the pool of unbelievers shrinks due to conversion, an
   enthusiast less likely to contact an unbeliever
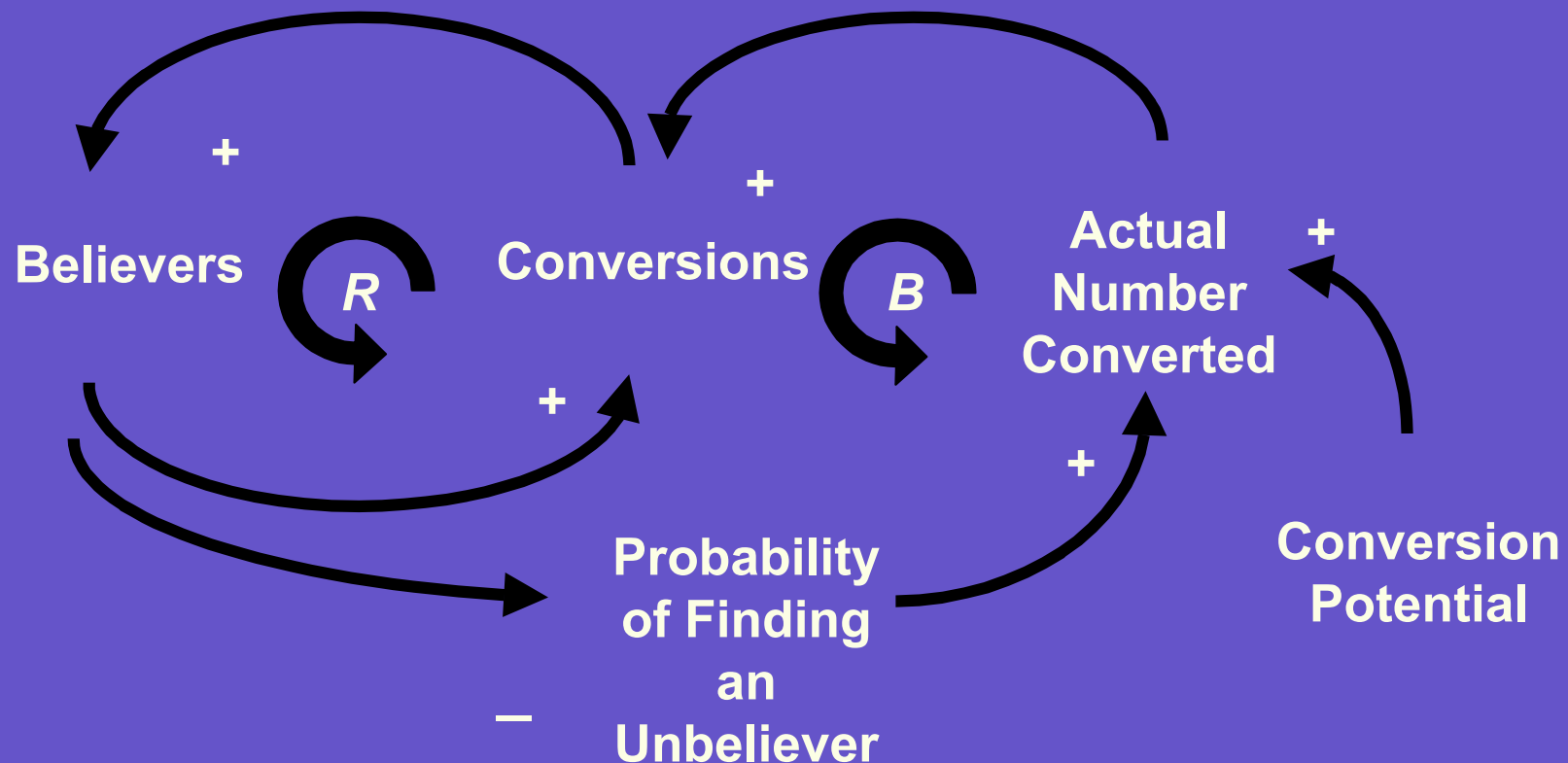
Limited Enthusiasm

Enthusiasts are:

- a subset of believers involved in conversion
- new converts - they have most contacts with unbelievers and a new zeal
- lose ability to recruit as they become integrated into church and lose unconverted friends

Not all converts are enthusiasts

Unbelievers   Enthusiasts   Inactive Believers

conversion active   loss of enthusiasm

conversion inactive
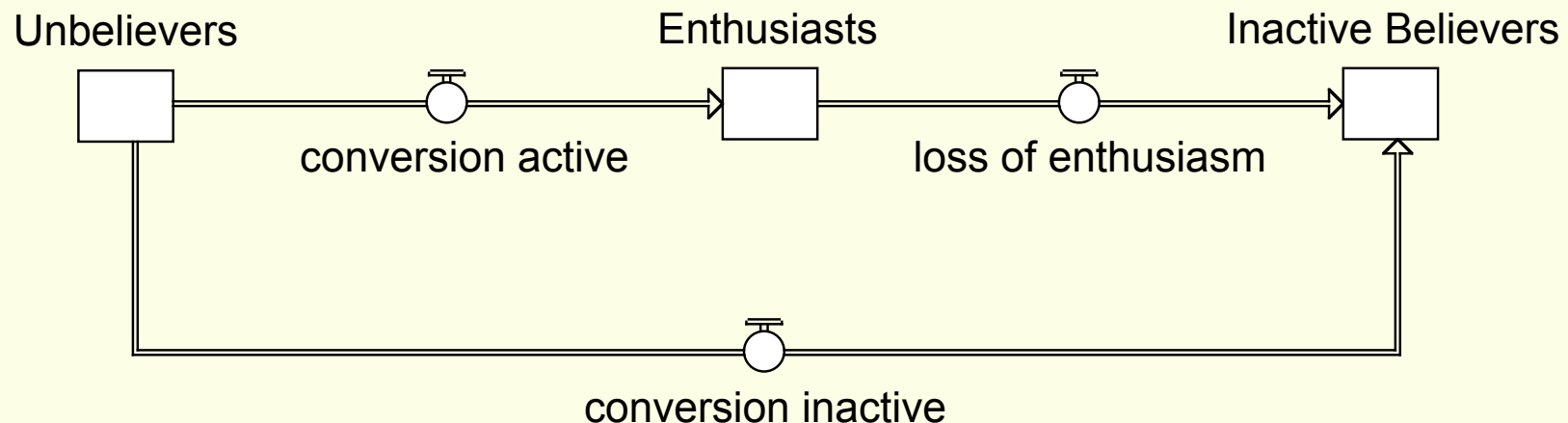
Limited Enthusiasm - Equations

The equivalent ODE's are non-linear set of three equations.
U Unbelievers, *A* Enthusiasts or active believers, *B* inactive believers
Cp is conversion potential τ_a is the time enthusiastic
g is proportion of converts who become enthusiastic
N total population

$$\frac{dU}{dt} = -\frac{C_p}{\tau_a N}UA$$

$$\frac{dA}{dt} = \frac{gC_p}{\tau_a N}UA - \frac{1}{\tau_a}A$$

$$\frac{dB}{dt} = \frac{(1-g)C_p}{\tau_a N}UA + \frac{1}{\tau_a}A$$

Similar to General Epidemic

The rate of loss of unbelievers is proportional to both unbelievers and enthusiasts
- Enthusiasts are the infected people
- Unbelievers are the susceptibles
- Inactive believers are the removed

$$\frac{dU}{dt} = \boxed{-\frac{C_p}{\tau_a N}UA}$$

$$\frac{dA}{dt} = \frac{gC_p}{\tau_a N}UA - \frac{1}{\tau_a}A$$

$$\frac{dB}{dt} = \frac{(1-g)C_p}{\tau_a N}UA + \frac{1}{\tau_a}A$$
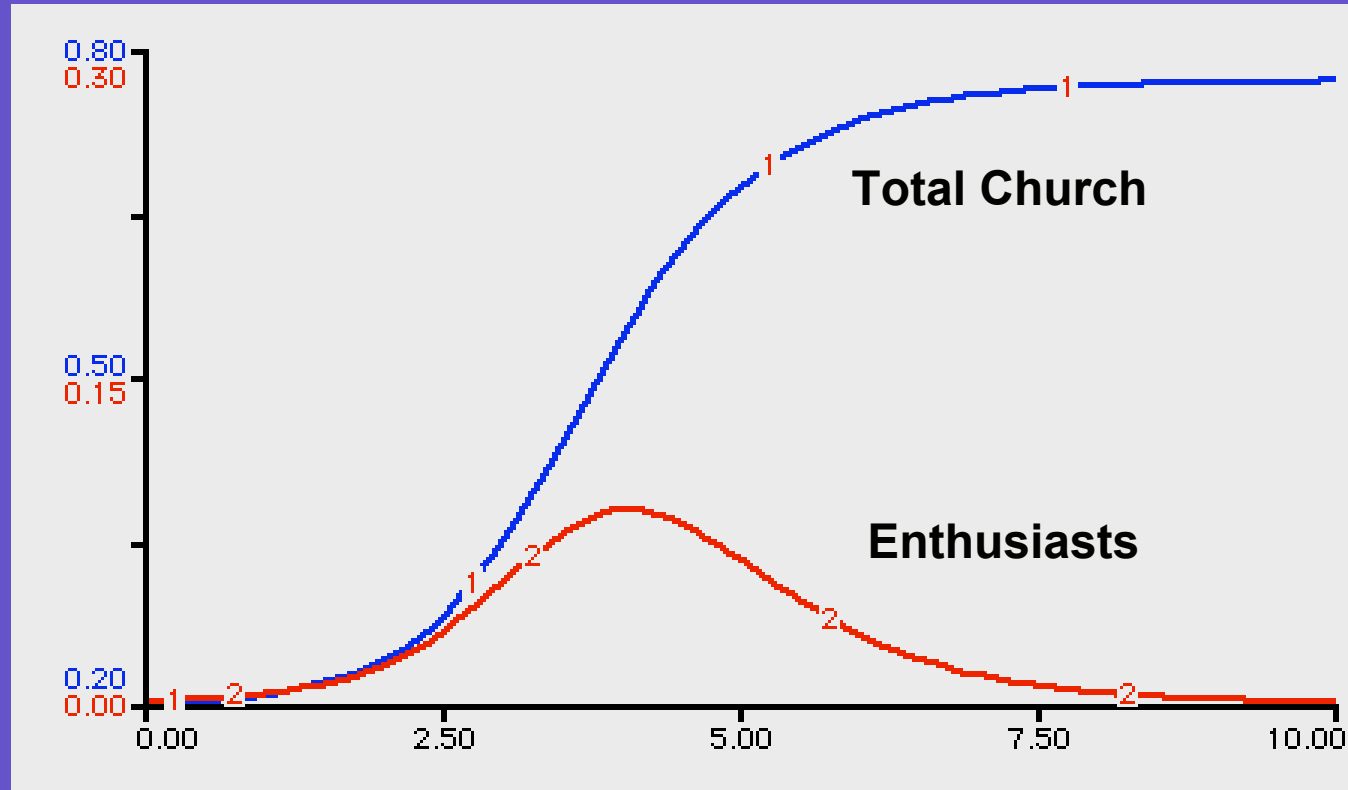
Some Miss Infectious Stage

Not all people "infected" are themselves infectious. A fraction g become infectious, the rest (1-g) are removed and are never involved in the conversion of others.

$$\frac{dU}{dt} = -\frac{C_p}{\tau_a N} UA$$

$$\frac{dA}{dt} = \boxed{\frac{gC_p}{\tau_a N} UA} - \frac{1}{\tau_a} A$$
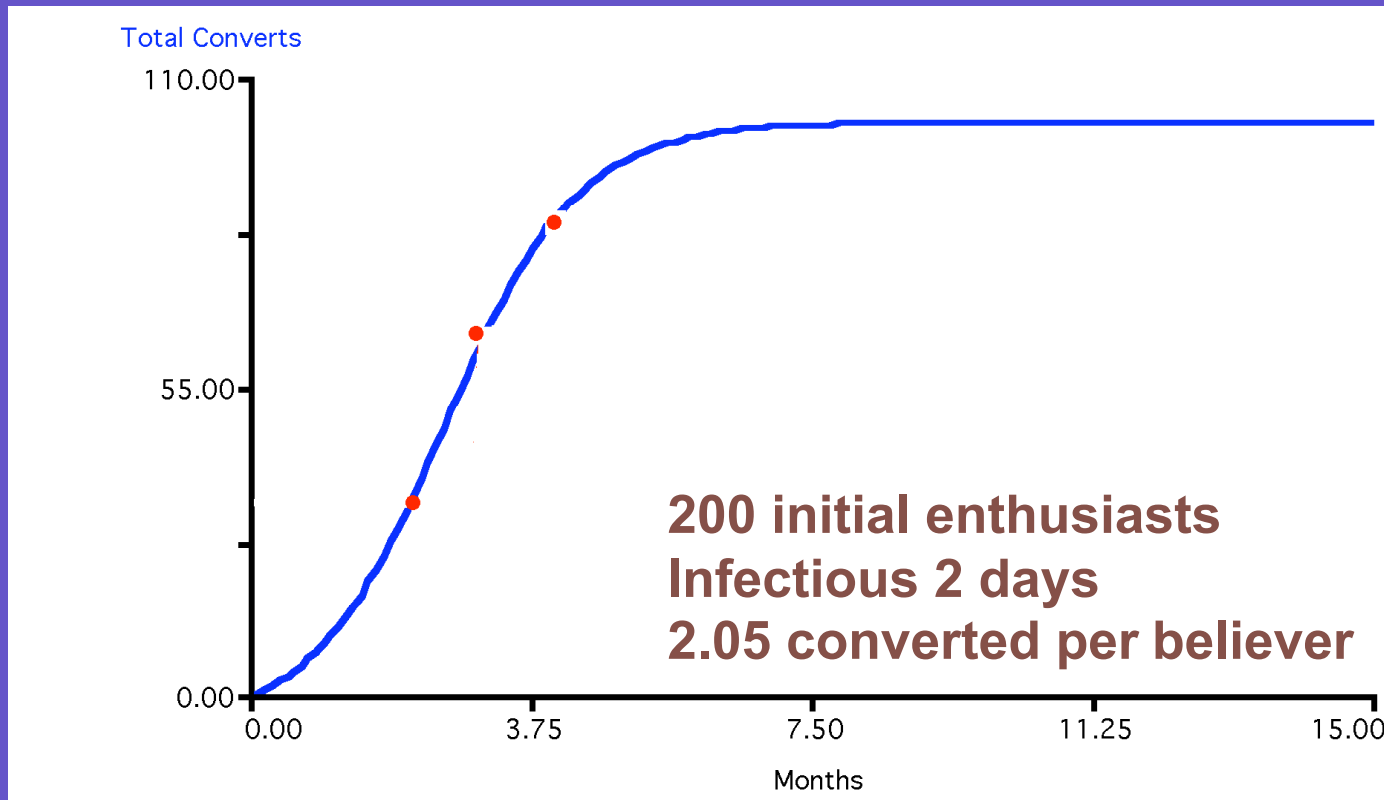
$$\frac{dB}{dt} = \boxed{\frac{(1-g)C_p}{\tau_a N} UA} + \frac{1}{\tau_a} A$$

S - Shaped Growth

- Initially dominated by reinforcing loop, later by balancing loops
- Church growth stops for lack of enthusiasts, they find it harder to reproduce themselves as unbelievers get less
- Not all of society gets converted to the church

Wales 1904

Total Converts (y-axis: 0.00 to 110.00 with 55.00 marked)

Months (x-axis: 0.00, 3.75, 7.50, 11.25, 15.00)

200 initial enthusiasts
Infectious 2 days
**2.05 converted per believer**

- S- shaped growth seen in Welsh revival of 1904
- Number of Converts Reported in Welsh Newspaper Western Mail
- Final Number 100,000 converted in one year - Church Statistics (11% adult population)
- Gives short enthusiastic period with just over 2 converted per enthusiast

Longer Term Processes

To model church growth and decline in the longer term then need:

- **Births and Deaths**
- **Reversion - people leave church (many reasons)**
- **They return to church after a period where they are hardened to conversion**
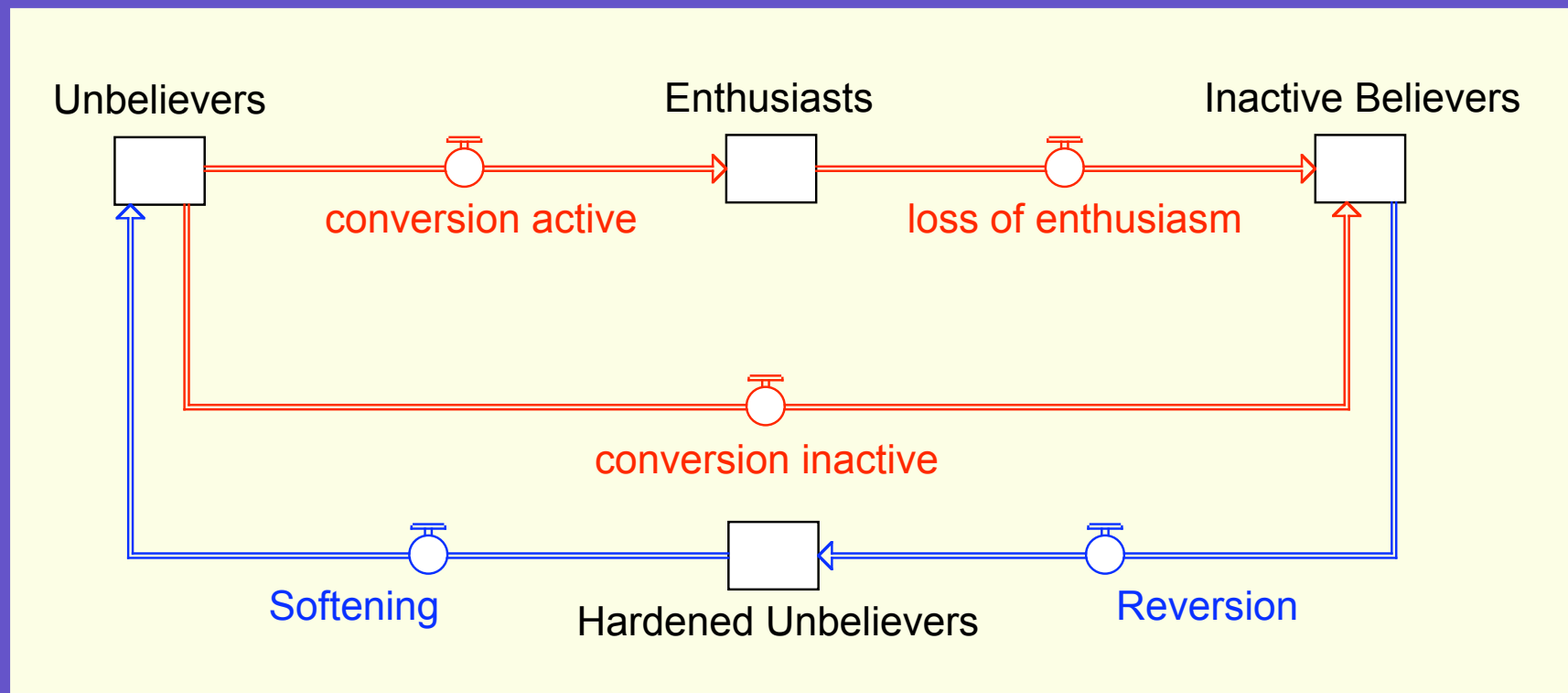
Longer Term Processes Equations

$$\frac{dU}{dt} = -\frac{C_p}{\tau_a N}UA + b(U + H) - dU + \varepsilon H + f_{bu}bB + f_{au}bA$$

$$\frac{dA}{dt} = \frac{gC_p}{\tau_a N}UA - \frac{1}{\tau_a}A - \alpha_a A - dA + (1 - f_{au})f_{aa}bA$$

$$\frac{dB}{dt} = \frac{(1-g)C_p}{\tau_a N}UA + \frac{1}{\tau_a}A - \alpha_b B - dB - (1 - f_{bu})bB + (1 - f_{au})(1 - f_{aa})bA$$

$$\frac{dH}{dt} = \alpha_a A + \alpha_b B - \varepsilon H - dH$$

Four coupled non-linear ODE's

Children may not follow birth category

$$\frac{dU}{dt} = -\frac{C_p}{\tau_a N}UA + b(U+H) - dU + \varepsilon H + \boxed{f_{bu}bB + f_{au}bA}$$

$$\frac{dA}{dt} = \frac{gC_p}{\tau_a N}UA - \frac{1}{\tau_a}A - \alpha_a A - dA + \boxed{(1-f_{au})f_{aa}bA}$$

$$\frac{dB}{dt} = \frac{(1-g)C_p}{\tau_a N}UA + \frac{1}{\tau_a}A - \alpha_b B - dB - \boxed{(1-f_{bu})bB + (1-f_{au})(1-f_{aa})bA}$$

$$\frac{dH}{dt} = \alpha_a A + \alpha_b B - \varepsilon H - dH$$

A fraction of the children of believers leave church at a young age and are effectively are born unbelievers

Not all children of enthusiasts become enthusiasts

Limited Enthusiasm - Equilibrium
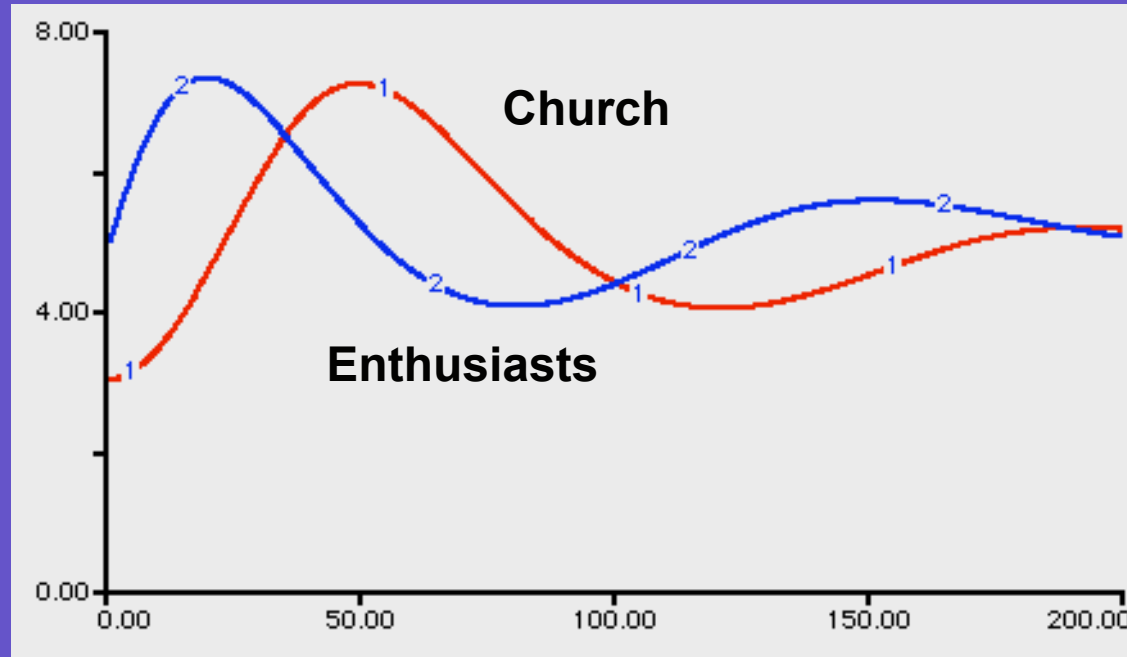
Equilibrium is determined by:

- **Reproduction Potential** $R_p = g\,C_p$ - **number of enthusiasts made by one enthusiast**
- **Duration of Enthusiastic Period**
- **Adult Reversion Rate**
- **Fraction of Children who Leave**
- **N.B. Equilibrium is longer than lifetime of parameters**

Thresholds
for the Reproduction Potential

Of more significance are the thresholds which are compared with the reproduction potential

- **Reproduction potential over the "revival growth" threshold there is rapid epidemic growth**
- **Reproduction potential under the extinction threshold the church will become extinct**

Revival Growth

Depends on other parameters and number outside church

Extinction

Depends on other parameters

Thresholds - Extinction

Methodist UK
1979-2006

An example of a church where the reproduction potential is under extinction threshold - denomination heading for extinction
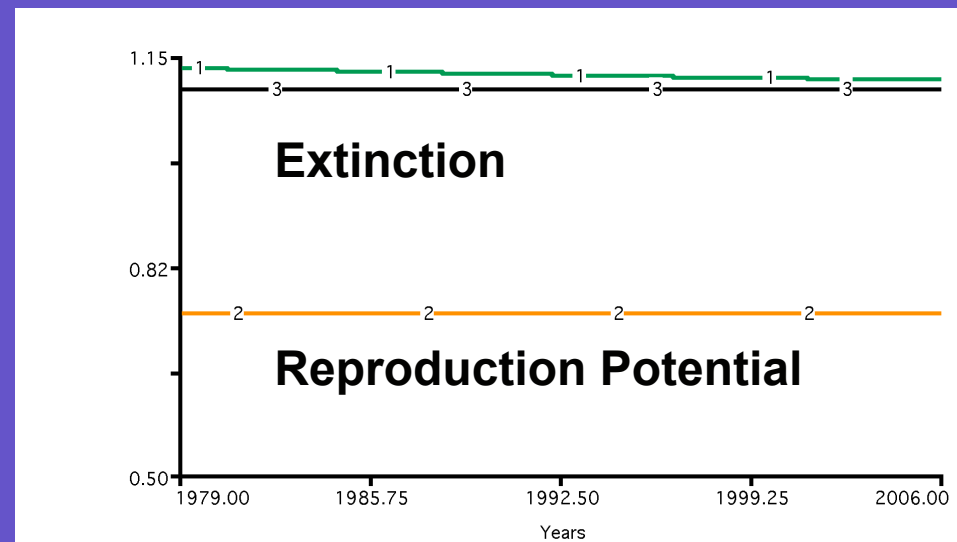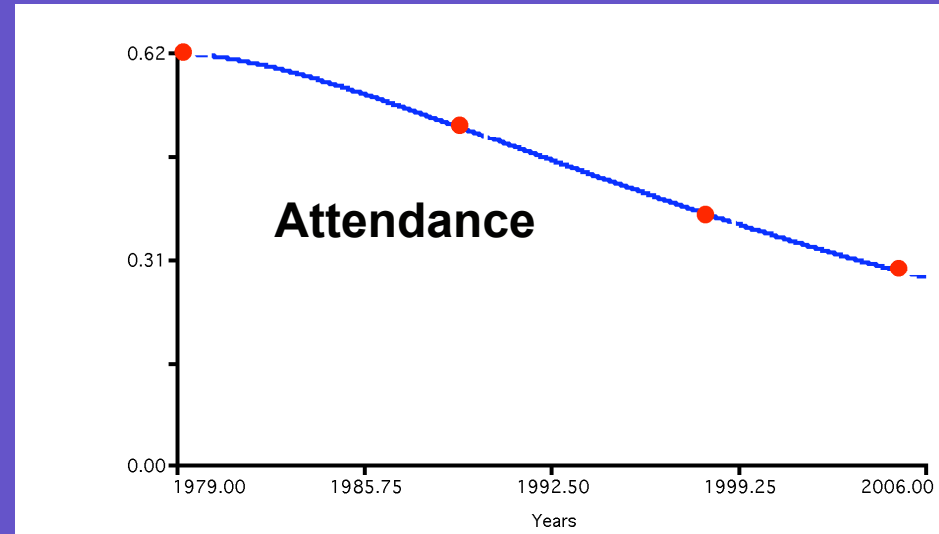
Enthusiastic Period
  2.5 Years
Reproduction Potential 0.75
Enthusiasts 0.25%

All attendance data from surveys by Christian Research
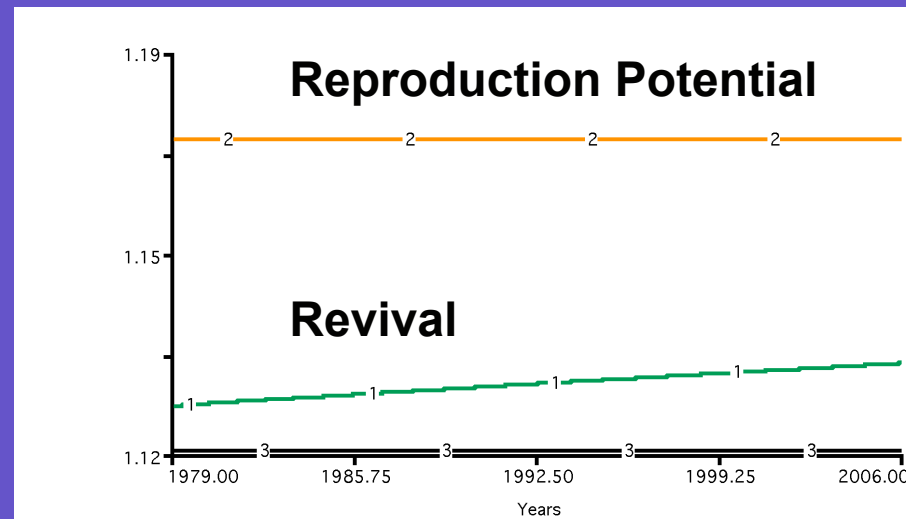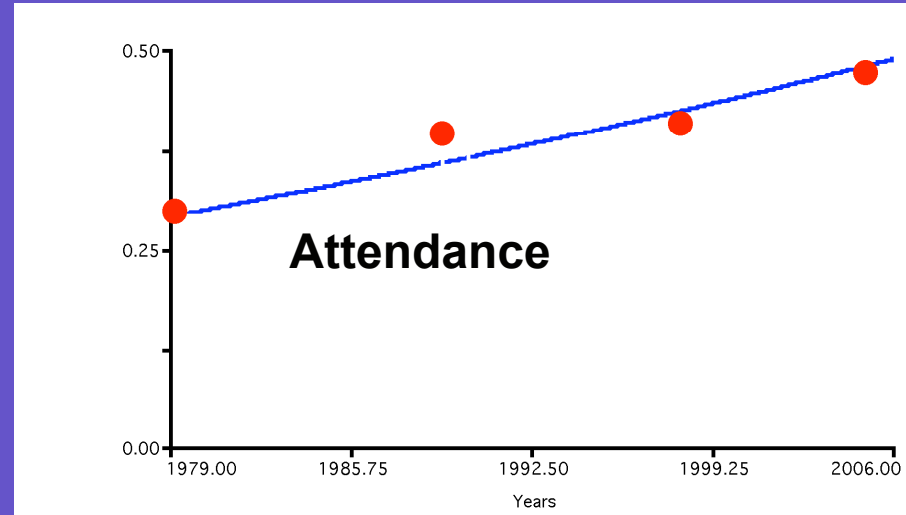http://www.christian-research.org.uk/

Thresholds - Revival

Pentecostal UK
1979-2006

Example of a church where the reproduction potential 1.18 is over Revival Threshold - churches seeing rapid growth

Note that the revival threshold rises as church gains people

Unbelieving pool depleted

Survival?

Church of England
1979 - 2006

Reproduction Potential equals extinction threshold 1.11

This is an improvement on 4 years ago - evidence the C of E is starting to recover as some parts are seeing revival growth and are generating enthusiasts

Growth in London area and churches affected by "Alpha" course

Some years before the total number of enthusiasts could start growing but C of E has evidence it will survive
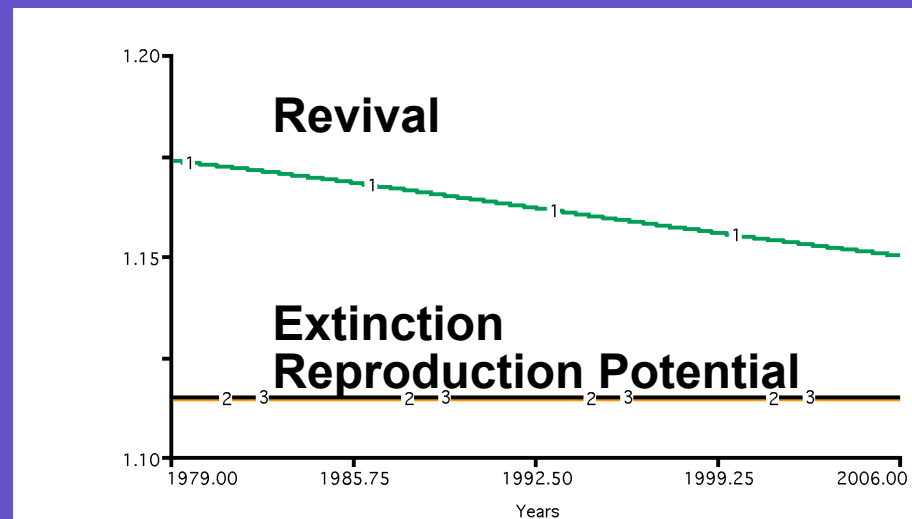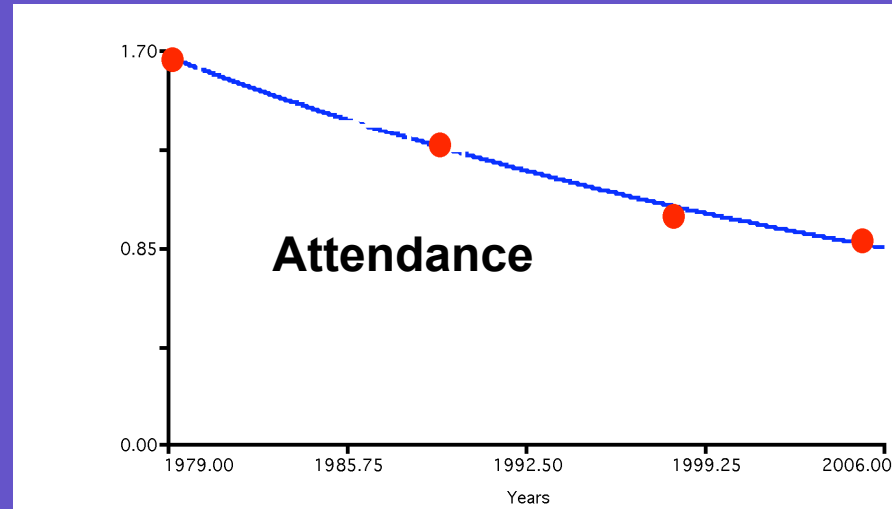
Prospects for a Declining Church

What could the Church of England do to improve its survival/growth?

1. **Predicted Decline**
2. **Reduce losses to 75% of current value by policies to help retain members**
3. **Increasing reproduction potential to the Pentecostal figure has a greater long-term effect**
4. **Applying both policies together has a dramatic effect bigger then the sum of the two. Patience is needed church recovery is slow even without aging effects**
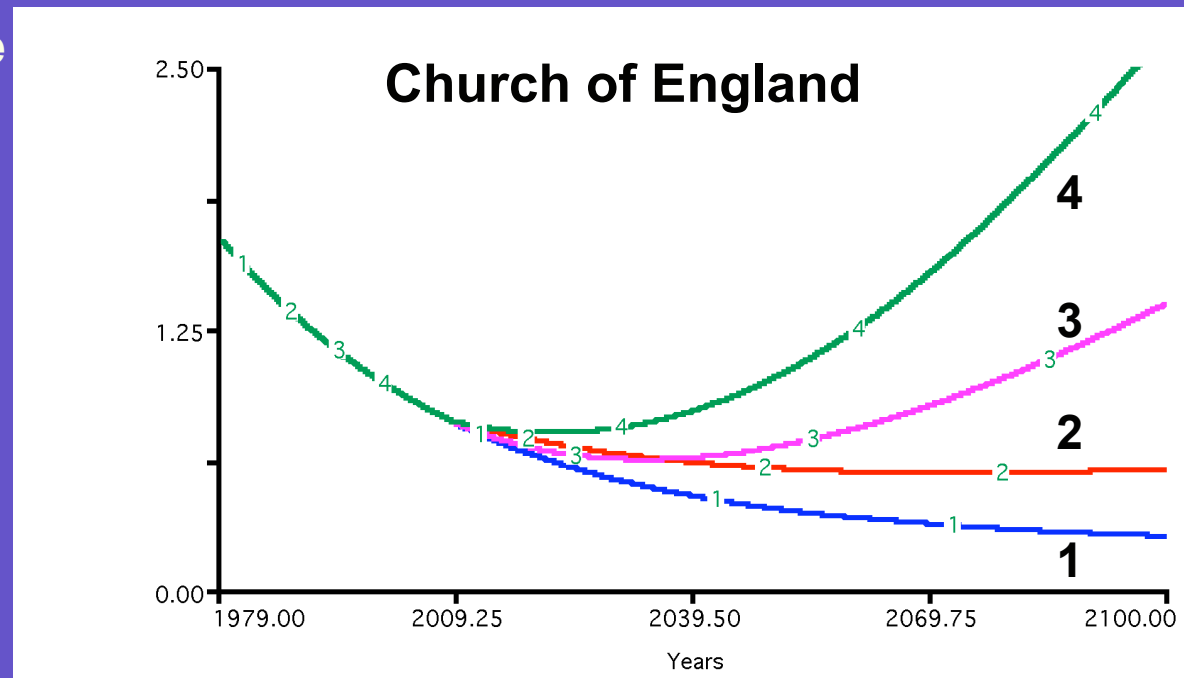
Changes from 2008

Renewal of Inactive Believers

What if existing inactive believers could be made enthusiasts again?

In the church this is called "renewal" and nearly always happens before revival growth takes place

Enthusiasts are now creating new enthusiasts from within church as well as from outside.

Unbelievers   Enthusiasts   Inactive Believers

conversion active

loss of enthusiasm

renewal

conversion inactive
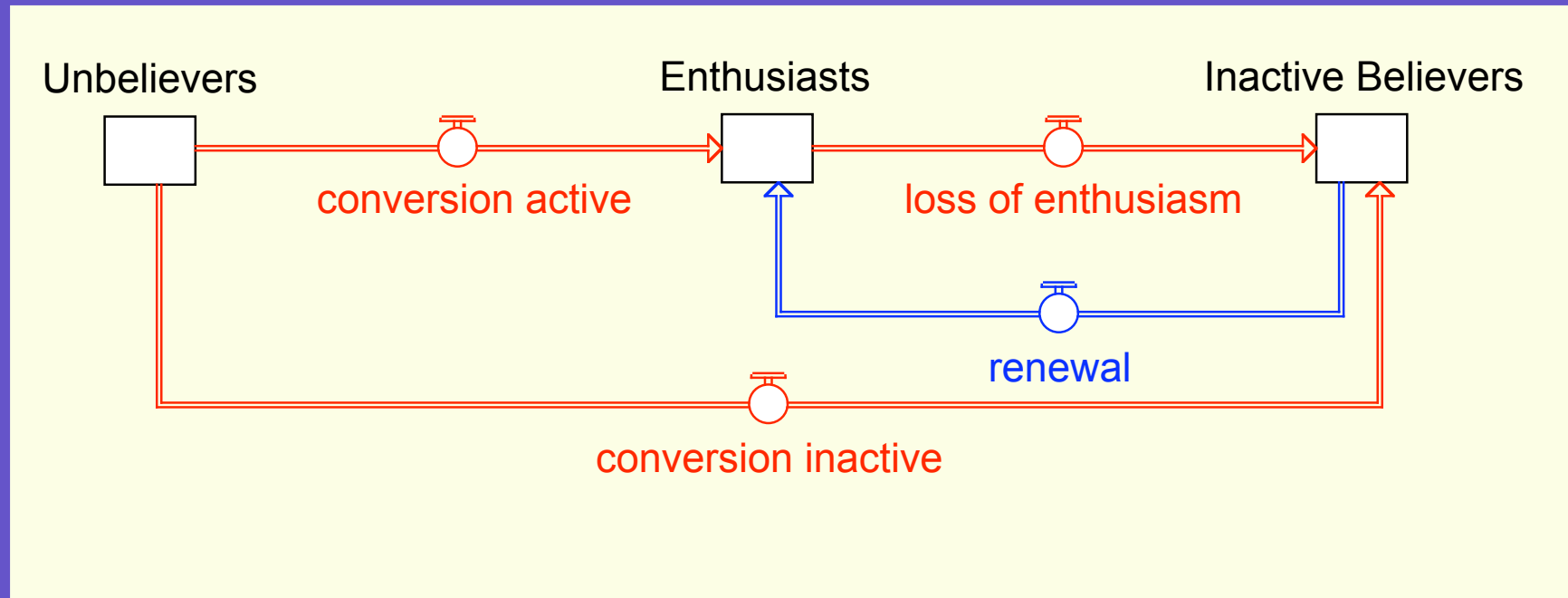
Equations - Key Terms

The first term is the mixing of enthusiasts (A) in the whole community (N) converting and enthusing unbelievers (U) - as before

A new term is added where the enthusiasts work in the church (C) re-enthusing believers (B)

$$\frac{dA}{dt} = \frac{gC_p}{\tau_a}\frac{UA}{N} + \frac{W_p(C)}{\tau_a}\frac{AB}{C} + \ldots\ldots$$

$$C = A + B$$

Whole Community

Church

Equations - Key Terms

Contacts Fixed

Contacts Increase with Church SIze

$$\frac{dA}{dt} = \frac{gC_p}{\tau_a}\frac{UA}{N} + \frac{W_p(C)}{\tau_a}\frac{AB}{C} + \ldots\ldots$$

$$C = A + B$$

In church the equivalent of the reproduction potential has a crowd effect. It is not constant but increases as church increases because churches are generally small enough that they are under the maximum friendship size a person can hold down

Wp will tend to a constant as C rises

Renewal Lowers Thresholds
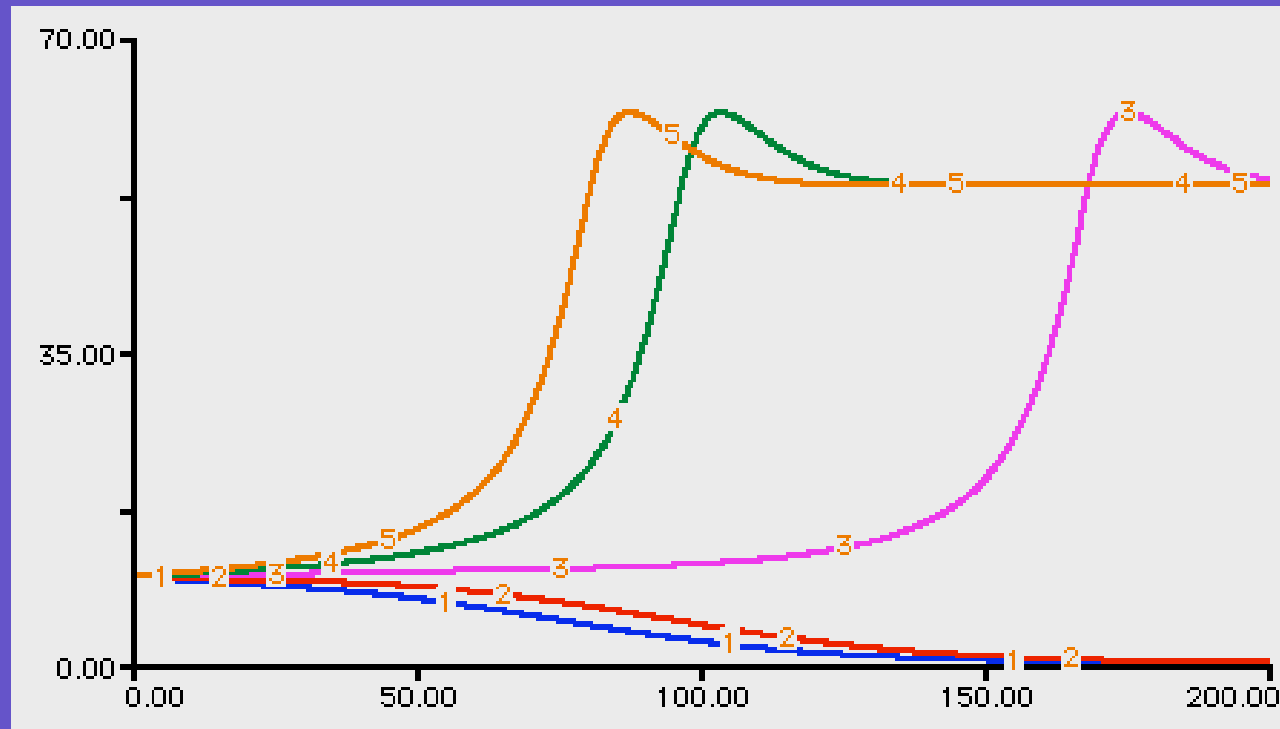
Renewal effectively lowers the extinction and revival thresholds

Thus renewal can help avoid extinction

Renewal can bring revival growth even if a church has an inadequate reproduction potential. Generally easier for churches to implement policies for renewal that better evangelism so a more attractive policy for growth

Two equilibrium points. A critical mass of enthusiasts is can tip the church from the extinction equilibrium to a much higher non-zero equilibrium. In above graph the initial number of enthusiasts is slowly increased from graph 1 to 4

Thus better to gather enthusiasts in one place

Conclusions
Limited Enthusiasm Model

1. Church growth driven by <u>enthusiasts</u> reproduces short-term and some long term growth & decline

2. <u>Thresholds</u> of extinction and revival

3. <u>Reproduction</u> of enthusiasts more impact than stemming losses

4. <u>Renewal</u> of believers has more impact than evangelism alone

5. <u>Critical mass</u> of enthusiasts - congregate enthusiasts together to start rapid growth

Spiritual Capital - Model

By contrast a macro model of a congregation

Church Members

- A congregation is place where communal activity takes place
- Members build up spiritual and communal life of the church "spiritual capital". Makes the church more attractive to outsiders
- Time is also spent on maintenance - keeping physical and human structures working - takes time and members away from building spiritual capital
- Some members of the church just receive benefits of church and make no contribution - free riders

Spiritual Capital - Definition

Social Capital

- Spiritual Capital is a form of social capital, which is a "resource for action". That is a resource that people build which in turn leads to a change in action of those people or other people
- Social capital was popularized by mathematical sociologist James Coleman
- It is a "soft" variable: hard to measure and scale
- http://en.wikipedia.org/wiki/Social_capital

Spiritual Capital

- Religious life of church
- Its spiritual resource incorporating the skills, knowledge and experience unique to religion
- Binds faithful together
- Attracts those who are seeking
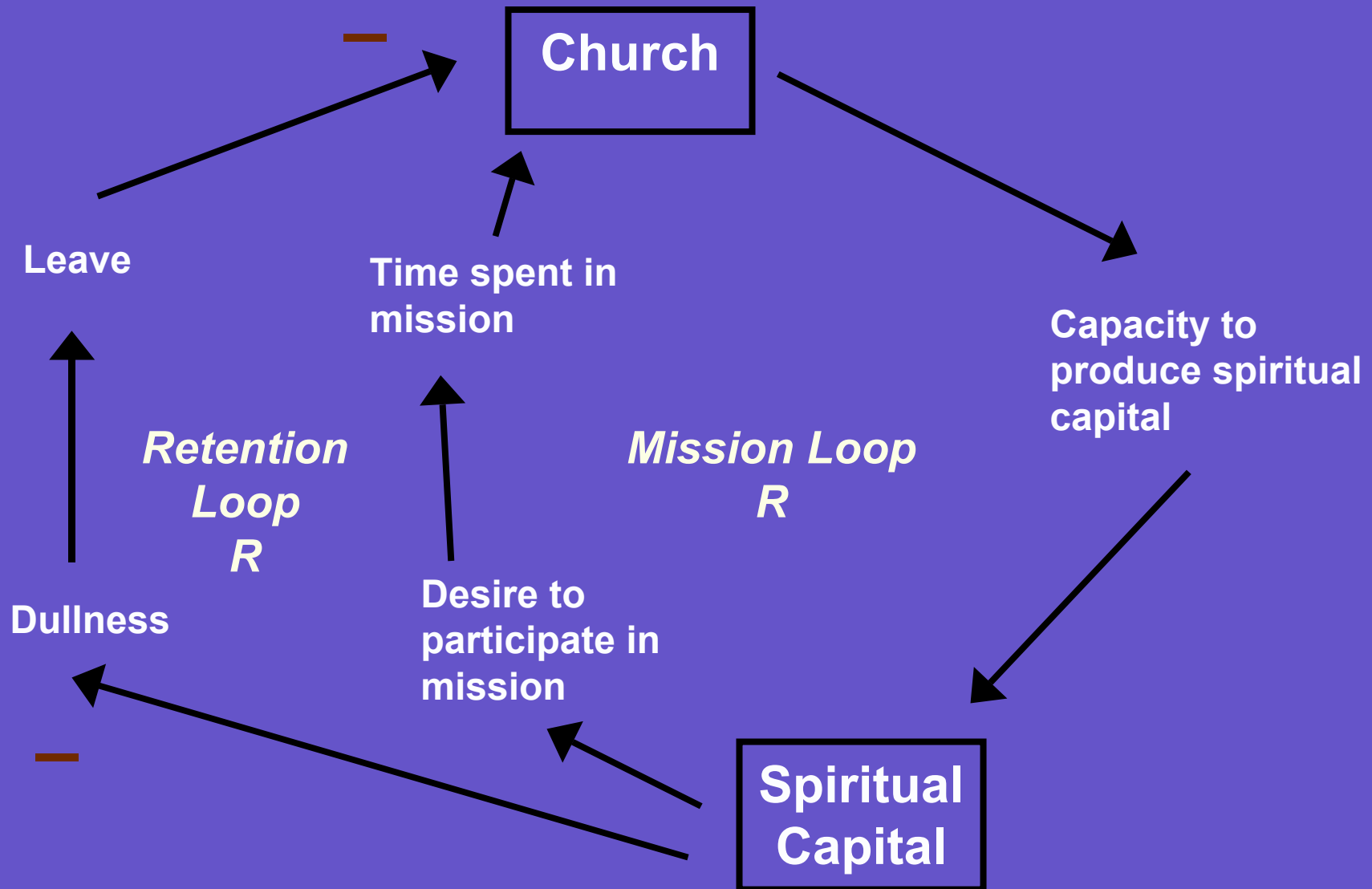
Growth through Two Loops

Mission Loop

- The larger the church the more spiritual capital produced
- The more spiritual capital the more the desire of the church to be involved in mission. (Good churches inspire members to want others to join)
- The more desire to be involved in mission the more conversion and the larger the church becomes

Retention Loop

- The greater the spiritual capital the more interesting (less dull) the church is to its members
- Thus people are less likely to leave the church (perhaps for another)
- Church declines less so grows more

These are expressed in the causal loops on the next slide ->

Growth Through Spiritual Capital

Limits to Growth Loops

Complacency   Loop
- The bigger the church the more complacency or self satisfaction - easier to free ride.
- This has a negative effect on spiritual capital thus slowing growth through less conversions and people leaving more
- May even bring decline mission

Maintenance Loop
- The bigger the church the more time spent on maintenance
- Thus less time spent on mission
- Thus less growth

These are expressed in the causal loops on the next slide ->

Limits to Spiritual Capital

Church

Time spent in mission

Maintenance Loop B

Time spent on maintenance

Self-satisfaction

Desire to participate in mission

Complacency Loop B
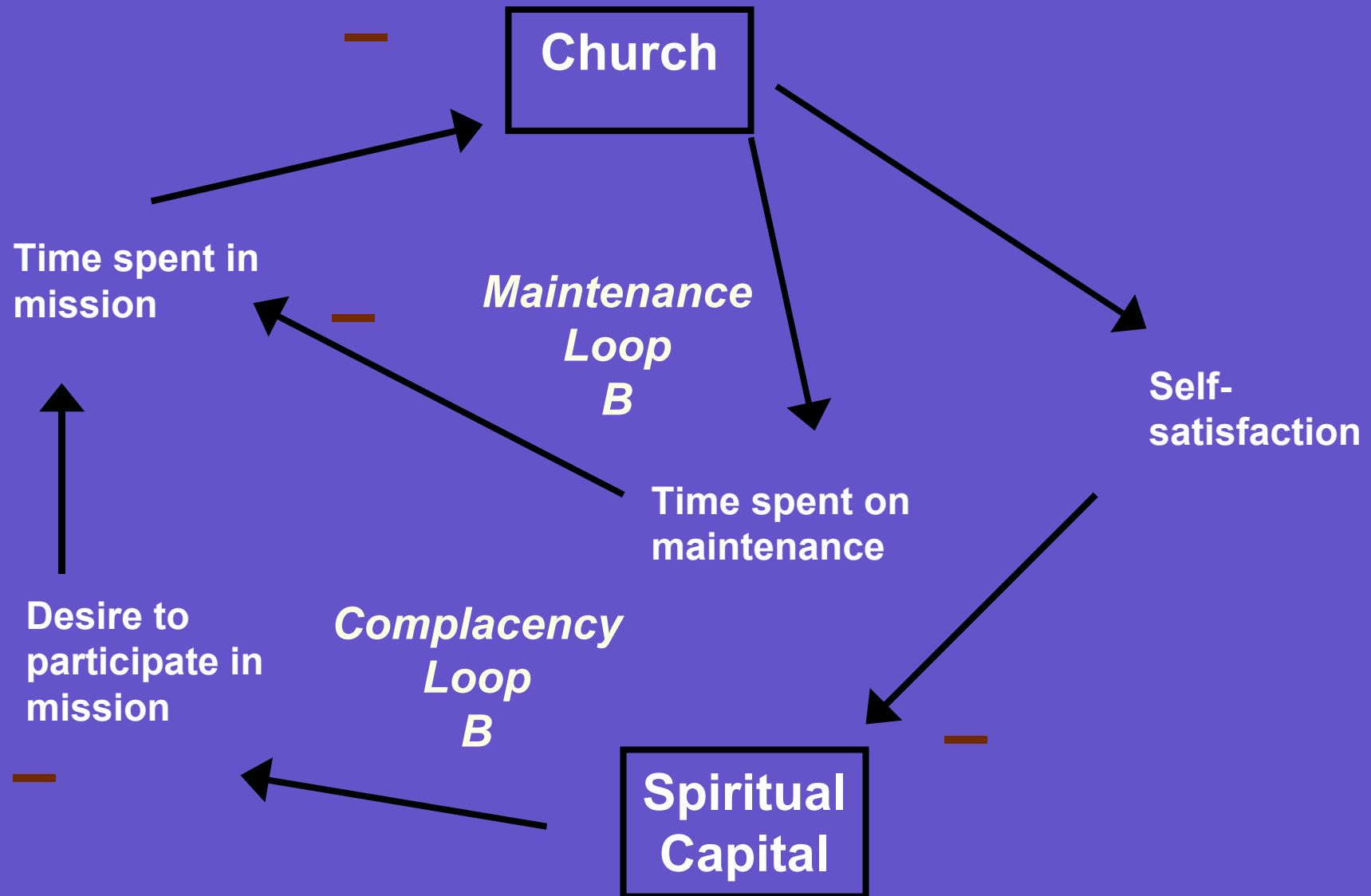
Spiritual Capital

Overshoot and Collapse
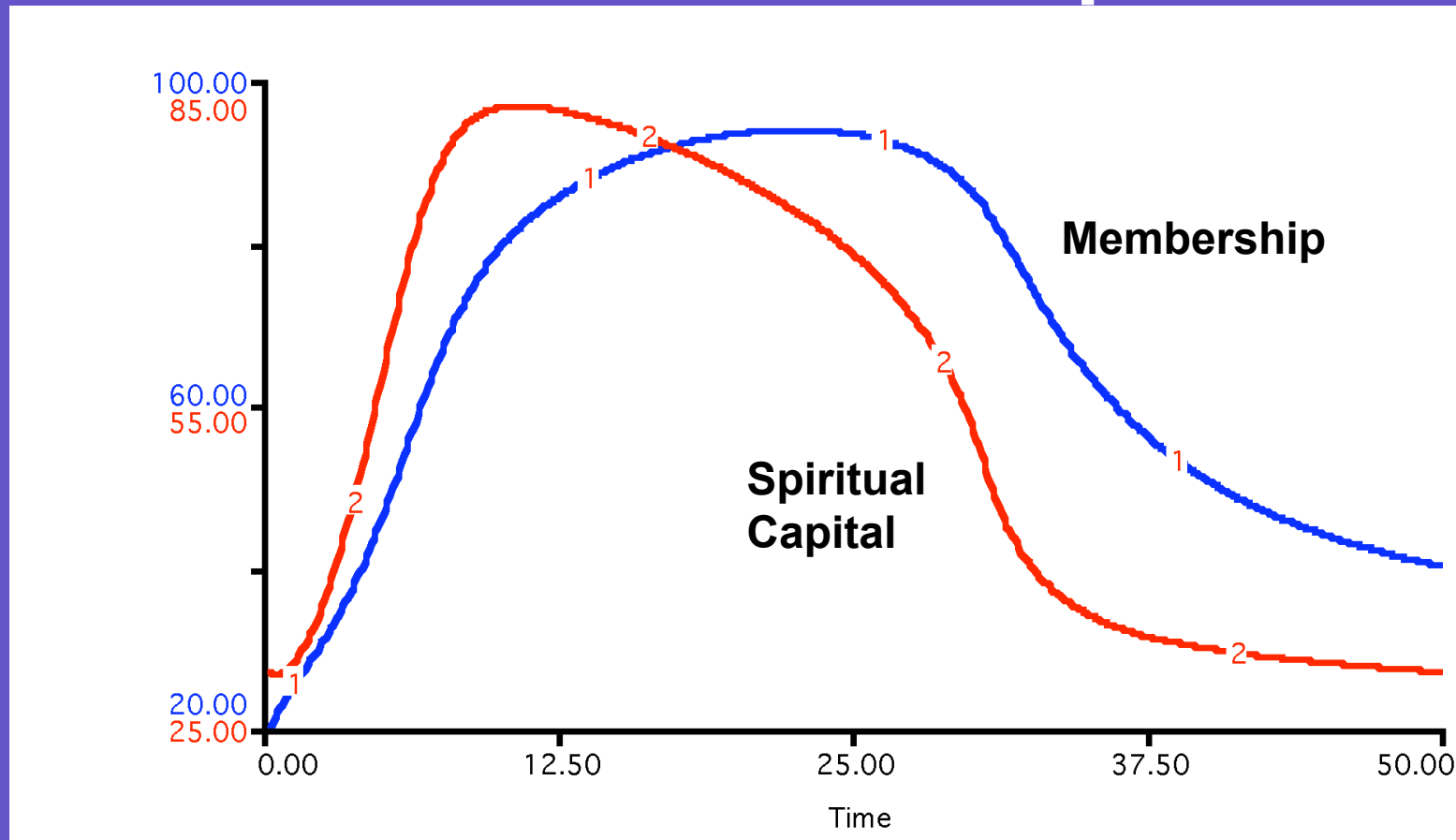
- Resulting SD model shows behavior of overshoot and collapse
- Spiritual capital rises faster than membership in a new church whose emphasis is on mission
- Spiritual capital starts to decline as the large church needs more maintenance and has more people who are not involved
- Resource declines leaving an institutionalized membership now incapable of rebuilding the spiritual capital and slowly die away

Observations
Spiritual Capital Model

1. There is no model of different types of believers in this model

2. Church growth is modeled using the known causes of growth and decline - all macro sociological concepts such as social capital

3. Behavior of growth and decline reflects what is observed in congregations

4. Reasons for decline are similar to other overshoot and collapse models such as world models and rapid birth species in limited environments

5. Model was inspired by a short paper by the Bishop of North Sydney and his observations of congregational lifecycles