Appreciative Inquiry: A Mechanism for Maximizing Empower in Social Systems

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Abstract

Appreciative inquiry explains social change by identifying mechanisms for collective action which establish a normative vision that guides the evolution of the social system or group. In its essence this theory suggests that social systems evolve toward the highest ideals held by the social group. Systems that develop positive images of the other and heliotropic, or positive, reinforcement loops show how social change can be guided by affirmative images. Change in social systems must also follow success in competition during an evolutionary process which is guided by the Maximum Empower Principle. This principle states that system designs which maximize empower (emergy per unit time) production for the whole system are the ones that survive. Emergy normalizes the many kinds of energy flows in a hierarchical system so that they are expressed in equivalent units. We designed a simple experiment to determine if social systems with heliotropic loops generated more empower than systems without such interactions. We determined the empower production of six possible modes of interaction between two social groups competing for the same resource base by simulating six Energy Systems models, each representing a mode of social interaction. The cumulative empower produced by these models was compared to rank the interaction modes in order of their expected competitiveness in the evolutionary process. A path for the evolution of social systems where two groups compete for the same resources was proposed based on our simulation results. In general the three designs containing heliotropic loops generated more empower than the design with no social interaction and the two designs with negative social interactions.

Keywords: appreciative inquiry, maximum empower, evolution of social systems, simulation

Introduction

Community-based assessment and management means involving an entire community, consisting of many social groups with disparate goals for their environment, in a collaborative process of managing change. Environmental scientists and managers participating in this process must consider the principles that govern social interaction and social change to ensure that a community is able to understand and act on scientific assessments to reach the best management decisions for the community and its environment. To improve our understanding for the forces at work in community-based environmental management and assessment, we examined several principles and mechanisms that may govern social change.

Appreciative inquiry (Cooperrider and Srivasta 1987) is a theory that purports to explain social interaction and social change (Bushe and Coetzer 1995). The essence of this theory is that social groups, and by extension social systems, evolve toward the highest ideals held by members of the social group. Bushe and Coetzer (1995) equate appreciative inquiry with the socio-rationalist view that social groups do not follow lawful principles and that social orders are inherently unstable and continuously recreated, as opposed to the logical positivist view that social phenomena are sufficiently enduring, stable, and replicable to allow for lawful tendencies or at least probabilistic inferences. These two views of social processes are not necessarily contradictory because lawful principles can result in continuous change including realms of chaotic behavior which may appear to be random. In this paper we hold that social systems are subject to the same laws and principles that govern the rest of nature, i.e., the Laws of Thermodynamics and other general laws and principles of the sciences recognized in Energy Systems Theory (Odum 1994). Governance by laws and principles does not exclude the central thesis of the theory of appreciative inquiry which is that social systems evolve toward the highest good perceived by members of the group.

Odum (1996) has proposed the Maximum Empower Principle as a 4th Law of Thermodynamics that can be used to identify system designs that will be the most competitive in an evolutionary process. This principle states that the criterion for success in evolutionary competition is that empower (energy production per unit time) is maximized. Emergy is defined as the available energy of one kind previously used up directly and indirectly to make a service or product. Its unit is the emjoule. (Odum 1986, Scienceman 1987, Odum 1996). Emergy normalizes the many kinds of energy flows in a hierarchical network so that they are expressed in equivalent units. The solar emjoule, sej, is commonly used to normalize energy flows of many kinds in environmental systems. Solar transformity is the solar energy required to make one joule of a product or service. Its units are sej/J. Energy can be converted to emergy by multiplying by its transformity. The Maximum Empower Principle implies that systems evolve toward designs that generate more empower. This principle is general and it should apply to all hierarchical levels in nature. Nevertheless, it is often difficult to see how individuals, groups, and societies that are focused on their own self-interest can evolve toward actions, policies and designs that will maximize competitive fitness for the whole system.

The heliotropic hypothesis (Cooperrider 1990) provides a mechanism for social change by demonstrating how positive image and positive action form a reinforcing loop. One example of such a positive loop has been discussed by Jussim (1986) as the Positive Pygmalion Dynamic. This loop can exist when one social group forms a positive image of another group. This image gives rise to affirmative cognition and affirmative treatment of the other. Affirmative treatment results in better performance of the other or a heliotropic confirmation of the first group's positive action. The social group observes this improved performance and reinforces its positive image of the other. If the theory of appreciative inquiry explains the direction of social evolution, then system designs structured with heliotropic loops should generate more empower than designs without such loops. We tested this proposition by measuring the cumulative empower generated by models representing six different modes of interaction between two social groups competing for the same resources. From a comparison of the empower generated by the models, we proposed a path for the evolution of social systems by identifying the conditions under which different modes of social interaction lead to maximum empower for an individual social group and for the social system as a whole.

Methods

The six models were diagramed using Energy Systems Language (Odum 1994) and then translated into a set of simultaneous 1st order differential equations. The constant coefficients, forcing functions, and state variables of the models were assigned initial values based on a model of competitive exclusion simulated by Odum and Odum (1995). The differential equations and the model parameter values were programmed using Microsoft Quick Basic version 4.5 and simulations were carried out on a Dell Optiplex Gxi computer.

Energy Systems Language consists of a set of mathematically defined symbols that allow the easy representation of interactive networks. These diagrams are a kind of visual mathematics because they can be translated directly into a set of differential equations. The Energy Systems Language symbols used in these six models are defined as follows:

(1) External forcing functions are shown as circles.

(2) State variables are shown as a tank.

(3) Interactions are shown as rectangular arrow heads containing a mathematical symbol, e.g. multiplication or division.

(4) Consumers are used to represent the social groups. They are shown as hexagons which include a tank and several interaction symbols that describe the stored energy and interactions of the group.

(5) A large rectangle defines the system's boundaries which divide the system components from the external forcing functions.

(6) Small rectangles attached to a tank or enclosing a portion of a pathway are sensors that supply information in the model but no appreciable energy flow.

(7) Flows along pathways are shown as black lines with arrow heads indicating the flux of energy.

(8) Used energy no longer capable of doing work is shown by a gray line flowing from an interaction or storage into the heat sink or ground symbol.

The model equations are constructed based on the force-flux law in a manner analogous to Ohm's law for electrical currents. Each equation consists of a set of mathematical expressions that include the constant coefficients, the k's, the state variables, Q, and Q2 for the social groups, and IMQ and/or IMQ2 for the image that Q2 forms of Q and the image that Q forms of Q2, respectively. Each social group was assigned the same value for the k governing a process, e.g. the maintenance cost of storage k3 for Q and k4 for Q2 are assigned the same value of 0.05 (Figures 1a - 6a). The only difference between the two social groups is that Q processes the available energy more efficiently than Q2, e.g. k5 is 0.08 for Q but k6, the equivalent coefficient for Q2, equals 0.06. The coefficients k5 and k6 represent the net increase in production for Q and Q2, respectively. Values for other k's govern the cost of building and maintaining images of the other and the effect that those images have on the production process of the other. These values were kept similar in each of the six models so that the cumulative empower generated by a model would be an accurate indicator of the relative competitiveness of the system designs representing different modes of social interaction. The initial values for the energy source, I, the energy state variables, Q, Q2, IMQ, and IMQ2 , and the solar transformities of the sources and state variables were the same for all model configurations. The model equations are shown within boxes on Figures 1a- 6a. The values for the constant coefficients, state variables, and forcing functions are written on the model diagrams and can be keyed to the equations because a set of common symbols is used in both the diagram and in the mathematical expressions that comprise each equation.

The diagrams and equation boxes in Figures 1a and 2a demonstrate the method for simulating changes in emergy production and use in the models. The emergy calculations are not shown for the models in Figures 4-6, because the same rules are used to calculate emergy from energy flows and storages in all the models and because showing the emergy calculations on these diagrams would make them unnecessarily complicated. The emergy change, dEm/dt, is calculated by multiplying the energy inflow or outflow from an energy storage by the appropriate solar transformity, the ST's. Emergy is not decreased by the maintenance cost of storage as long as the stored energy is increasing. When energy losses exceed energy gains for an energy storage the stored emergy also decreases. The stored emergy was not allowed to increase if the increase in stored emergy was less than 0.01 of the emergy stored.

Models

Six models were structured to answer the question "Do modes of social interaction based on heliotropic loops result in more empower production than some other kinds of social interaction?" Since social interactions have evolved in a milieu of competition for scarce resources the six models were built using two consumers competing for a common resource base. Social groups interacting under these conditions are the source of some of the bitterest rivalries in the modern world. For example, the present conflicts between Israelis and Palestinians, Hutus and Tutsis, and the Protestants and Catholics of Northern Ireland have all developed in environments where both groups must share the same resources. In building the six models we have assumed that , before an interaction is possible, a social group must first form an image of the other. These images are stored energy that represents the costs of building and maintaining the information that forms the basis for one social group's image of another. Information decays quadratically (Odum 1994); therefore, a considerable amount of the energy available for growth must go into building and maintaining the image. There is a strong evolutionary reward for forming such images because they can result in the survival of a group that might otherwise be eliminated.

The diagram in Figure 1a represents two social groups focused on their own well-being without direct positive or negative interaction with each other. Of course, these two groups interact indirectly by exploiting a common pool of resources. This mode of interaction represents the competitive exclusion model familiar in biology which always results in the more efficient group eliminating the less efficient group (see Figure 1b). In the second model (Figure 2a) the less efficient social group forms a negative image of the more efficient group and this image inhibits production of the more efficient group in proportion to its magnitude. The third mode of social interaction has both social groups forming a negative image of the other (Figure 3a). The fourth model (Figure 4a) shows an interaction in which the more efficient social group develops a positive image of the less efficient group and reinforces the productivity of the less efficient group in proportion to this image. This model formulation assumes that a connection has been established between the less efficient group, Q2, and the production function of the more efficient group, Q. This connection must be established to complete the positive feedback loop. The fifth model is the converse of the fourth, because it shows an interaction in which the less efficient group forms a positive image of the more efficient group. Once again a connection between the more efficient group, Q, and the production function of Q2 must be assumed. We will further consider this assumption in the discussion. In Figure 6a, both social groups invest energy in forming positive images of the other. In this case the connections between groups are both supported by an image. The social interactions diagramed in Figures 4a, 5a, and 6a all have positive interactions that are governed by heliotropic loops as discussed by Cooperrider (1990). For example, in Figure 5a IMQ, the positive image of Q, controls k8*Q2*IMQ*Q*R, an affirmative action or positive feedback from Q2 to Q, which in turn results in heliotropic confirmation or improved productivity of Q as demonstrated by increased energy flow on the pathway governed by k5. This improvement in productivity is detected by Q2 and results in an increase in its positive image of Q along the pathway governed by k11.

Simulation Results

The competition between social groups without direct interaction (Figure 1b) results in the elimination of Q2, the less efficient group. This process is called competitive exclusion in ecology. Figure 1b shows that the emergy of social groups, Q and Q2, follows the pattern established by the energy levels of these groups. If the less efficient group, Q2, invests the energy to form a negative image of Q, the efficiency of Q decreases to the point where Q2 becomes the more efficient competitor (Figure 2b). The negative image of Q formed by Q2 persists long after Q has been reduced to a very low level. When both social groups invest in negative images of each other either one can prevail depending on the values chosen for the coefficients. If the cost of creating and maintaining the images and the effectiveness of their negative feedback are the same for both groups, the more efficient group, Q, is again able to eliminate the less efficient group, Q2 (Figure 3b). The negative image that the dominant group, Q, has of the other, Q2, does not decay over time even though Q2 exists at a very low level (Q2 is prevented from going to zero). In contrast, the negative image that Q2 holds of Q is gradually lost. In the model formulations with no feedback or with negative feedback, one social group always loses in competition with the other.

If at least one social group is able to develop a positive image of the other, both groups are able to survive. Figure 4b demonstrates this result when the more efficient group, Q, forms a positive image of the less efficient group, Q2. For the parameter set simulated, Q2 is able to maintain a higher emergy level that Q. Q is able to reach higher emergy levels if its feedback to Q2 is less effective in enhancing Q2's productivity. On the other hand, Q2's emergy level can be increased by contributing more to the productivity of Q. If the less efficient group, Q2, forms a positive image of the more efficient group, Q; Q eventually reaches a higher emergy level than Q2. However, in the short run Q2 has higher emergy than Q (Figure 5b). The converse of this pattern is observed in Figure 4b where Q has formed a positive image of Q2.

The system with social interactions governed by a double positive image could not be supported by the original resource base, I=5. However, when available resources were doubled, I=10, the resource base was able to support this system design. Figure 6b shows that the emergy levels attained by Q and Q2 are more equal when both social groups have positive images of each other. The positive images of the other are robust and persist in time at emergy levels that are greater than those developed by a single positive image. The proportion of the available emergy that went into image building was greater for the interaction mode with two positive images than for the modes with only one positive image.

The cumulative empower developed by the models for each mode of social interaction are compared for the original resource base (Figure 7a) and for double the original resources (Figure 7b). Systems designs in which social interactions develop a positive image produce more cumulative empower when time = 320 than system designs with no interaction or designs which develop negative images. The mode of social interaction in which the less efficient group develops a positive image of the more efficient group develops the most empower for the low resource base. The smallest amount of empower is generated when the less efficient group has a negative image of the more efficient group. No interaction between the social groups generates more empower than is produced by creating a negative image, but this design generated less empower than designs with positive images. When the available resource base is doubled the system design in which social interaction leads to the development of two positive images can be supported. This design develops the most cumulative empower from this resource base. An interesting feature of the cumulative empower comparison when the resource base is doubled is that the mode of social interaction with two negative images generates the most empower in the short run. This system design generates the second most empower through the 200th time unit, and only falls decisively behind the two designs with a single positive image near the end of the simulation.

Discussion

Our comparison of the cumulative empower generated by the six models of social interaction demonstrates that system designs containing single heliotropic loops generate more empower than designs with no interaction or designs with negative interactions for the low resource scenario. The system design with two positive images could not be supported on low resources but it generated the most cumulative empower when the resource base was doubled. These results support our hypothesis that systems which develop heliotropic loops develop more empower than the other designs tested. The development of a single positive image of one group by the other allows both social groups to survive with reasonable levels of emergy attained by each group. Thus, heliotropic designs have an advantage over the other modes of interaction both in producing more cumulative empower and in allowing the survival of both social groups as significant contributors to the system.

The models and simulation results shown in Figures 1-7 can be used to think about the evolution of social interactions. One scenario in which social interactions may have evolved is represented by a system design with two social groups competing for the same resources. Taken together these six models can be used to represent a logical path for social development under the above scenario. This path should proceed from designs with lower empower production toward designs with higher empower.

As mentioned earlier the system design without interaction between the groups (Figure 1) is the classic competitive exclusion model in ecology that always results in the more efficient group eliminating the less efficient group. This system design may change because survival must be the primary concern for any rational social group. Therefore, the less efficient social group has a strong impetus to develop a negative image of the more efficient group (Figure 2). The development of a negative image by the less efficient group leads to its survival because it acts to decrease the productivity of the more efficient group. In this case survival, and therefore empower production, at the lower hierarchical level of the social group has taken precedence over empower at the higher level of the system. This situation, however, is not stable because the more efficient group now has a strong incentive to survive by developing a negative image of the less efficient group.

System designs with two negative images generate more empower than those with only one negative image and thus the evolution of social interaction should proceed in this direction. In addition, both social groups have a chance to survive depending on the coefficient values. Evolution toward a system design with two negative images explains how a connection can be established between each social group and the production function of the other when they compete for the same resources. Recall that this kind of connectedness is a prerequisite for the development of a single image heliotropic loop. Once these dual connections have been established it is possible that an intended negative action of one social group might result in an increase in the productivity of the other due to natural variations in the factors controlling production. Such a scenario is one way to explain how a heliotropic loop can get started. A heliotropic loop can not be initiated directly from a design with the no social interaction because it is evident that any attempt to enhance the productivity of the other without a reciprocal connection will hasten the elimination of the altruistic group. A dual positive connection between social groups might also arise if the resource base being exploited was sufficiently different to allow trade to develop. However, this scenario violates our initial assumption that the two social groups are evolving in competition for the same resources.

It is significant that empower production by the system design with two negative images overlaps the empower produced by systems with a single positive image for the high resources scenario. This implies that in our modern high energy world, conflict may be preferable to the unilateral development of positive images of the other e.g., in Northern Ireland, Palestine and perhaps Rwanda. It is also clear that empower production on the larger resource base is decidedly greater for a design with two positive images. Social interactions should evolve toward designs with mutual heliotropic loops when sufficient resources are available. In a lower energy world, a single positive image results in more empower than conflict or no interaction e.g. the early colonial relationships between Great Britain and her colonies in places such as India, Jamaica, and Hong Kong. A positive image of the more efficient group resulted in greater empower generation for the low energy scenario, but this result was reversed when resources were doubled. Maximizing empower production for the whole system implies that the evolution of social interactions should proceed from negative to positive interactions guided by images of the other. The imperative for group survival under competition for the same resources leads from indifference to the other toward negative images of the other that may result in the survival of the a less efficient group. However, conflict generated by negative images is not the ultimate goal of social evolution if it is guided by maximizing empower. Maximum empower for a system appears to result from designs that include heliotropic loops based on positive images of one group for another.

The initial evolution of social interactions toward a lower empower state for the system can be explained by considering empower production at the level of the individual group. At first such a movement seems to contradict the Maximum Empower Principle but this principle is completely general and to understand its workings we must consider all hierarchical levels. The inclusion of an autocatalytic feedback loop (the double arrows surrounding k5 and k6 in the consumer symbol used to represent each social group) implies that each group possesses a positive image of itself and will work toward maximizing its own empower. The positive image that a social group holds of itself explains the initial development of a negative image of the other because empower for the first group is maximized. Thus, a single negative interaction develops to maximize empower for the less efficient social group. The first development of a single positive image might be explained by the fact that initially the group that forms the positive image has a higher emergy level than the other (Figure 4b and 5b). Therefore, at the level of the individual social group, the development of a positive image of the other is favored in the short run because empower for the group forming the image is greater than it is when the other first forms a positive image.

If the evolution of social interactions is guided by the progressive development toward designs that maximize empower for the whole system, system designs with heliotropic loops will eventually develop because they produce more empower than the other designs tested. The two opposing views of social evolution mentioned in the introduction can be reconciled, if the socio-rationalist interpretation of appreciative inquiry is understood as a chaotic choice generator within a deterministic system. This method of searching for knowledge effectively identifies alternative modes of social interaction, i.e. those that include heliotropic loops. These new normative visions for society point the way to the changes in system design that will allow the group to realize its vision. The new social designs are then tested in evolutionary competition and those that lead toward more empower survive.

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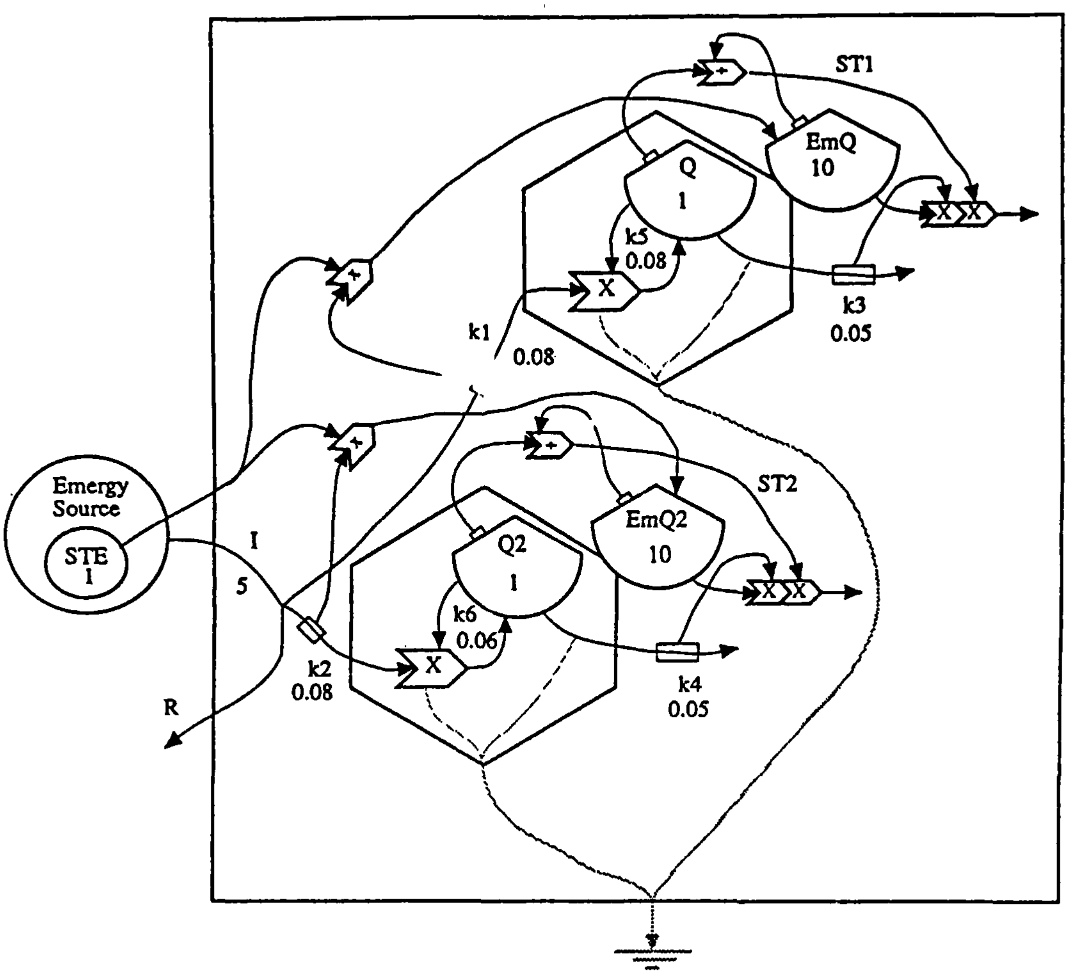


Energy equations:

(1) $dQ/dt = k5*Q*R - k3*Q$

(2) $dQ2/dt = k6*Q2*R - k4*Q2$

(3) $R = I / (1 + k1*Q + k2*Q2)$

Emergy calculations:

(1) $dEmQ/dt = STE * k1*Q*R - ST1*k3*Q$,
where $ST1*k3*Q = 0$, if $STE*k1*Q*R >= ST1*k3*Q$

(2) $dEmQ2/dt = STE*k2*Q2*R - ST2*k4*Q2$
where $ST2*k4*Q2 = 0$, if $STE*k2*Q2*R >= ST2*k4*Q2$

Figure 1(a) An energy systems diagram of two social groups, Q and Q2 competing for the same resources, I, without direct interactions. The initial values for the pathway coefficients, storages, and the emergy source used in the equations are shown on the diagram. ST indicates solar transformity, Em emergy, and a gray line energy no longer able to do work.

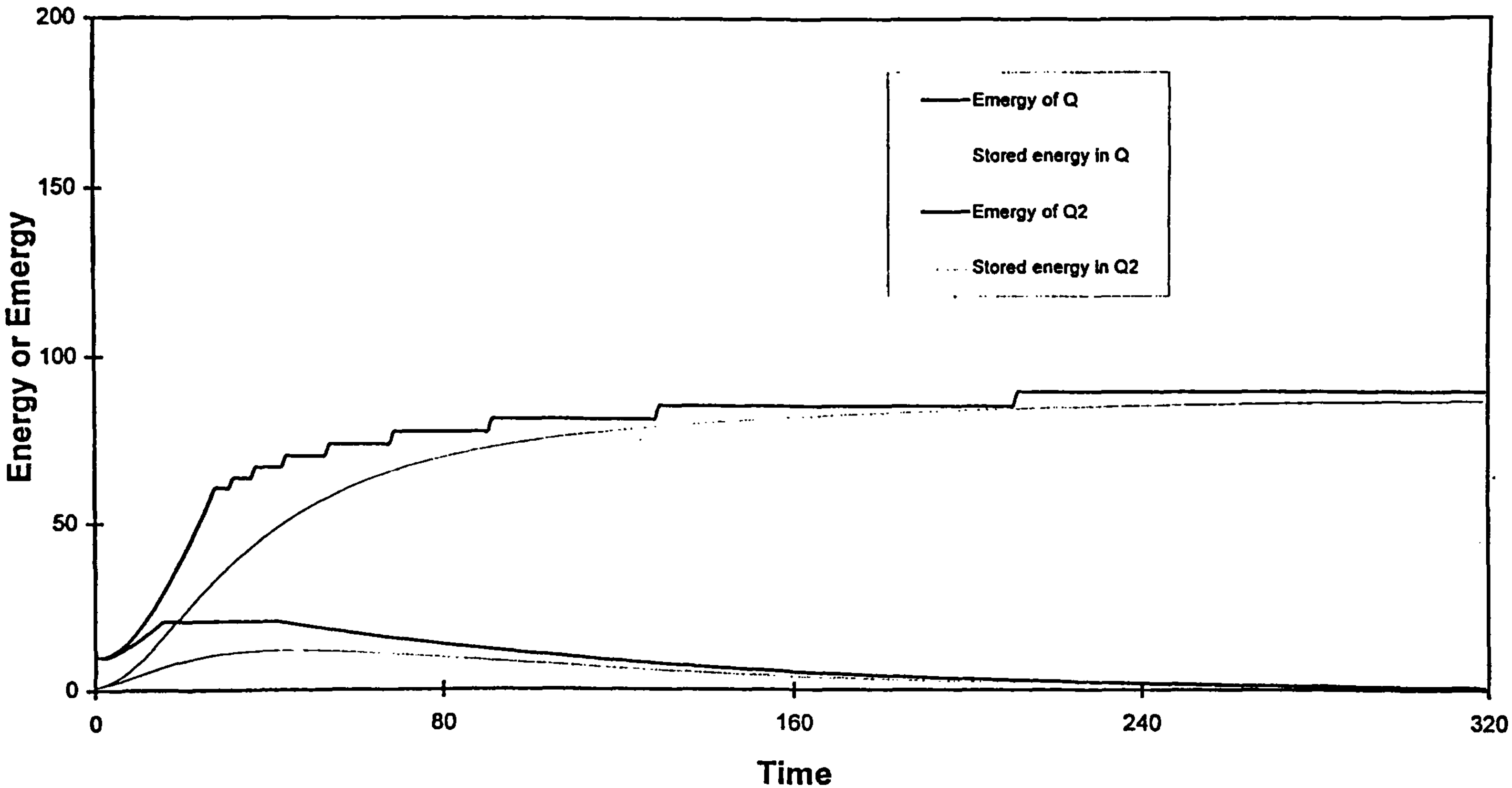
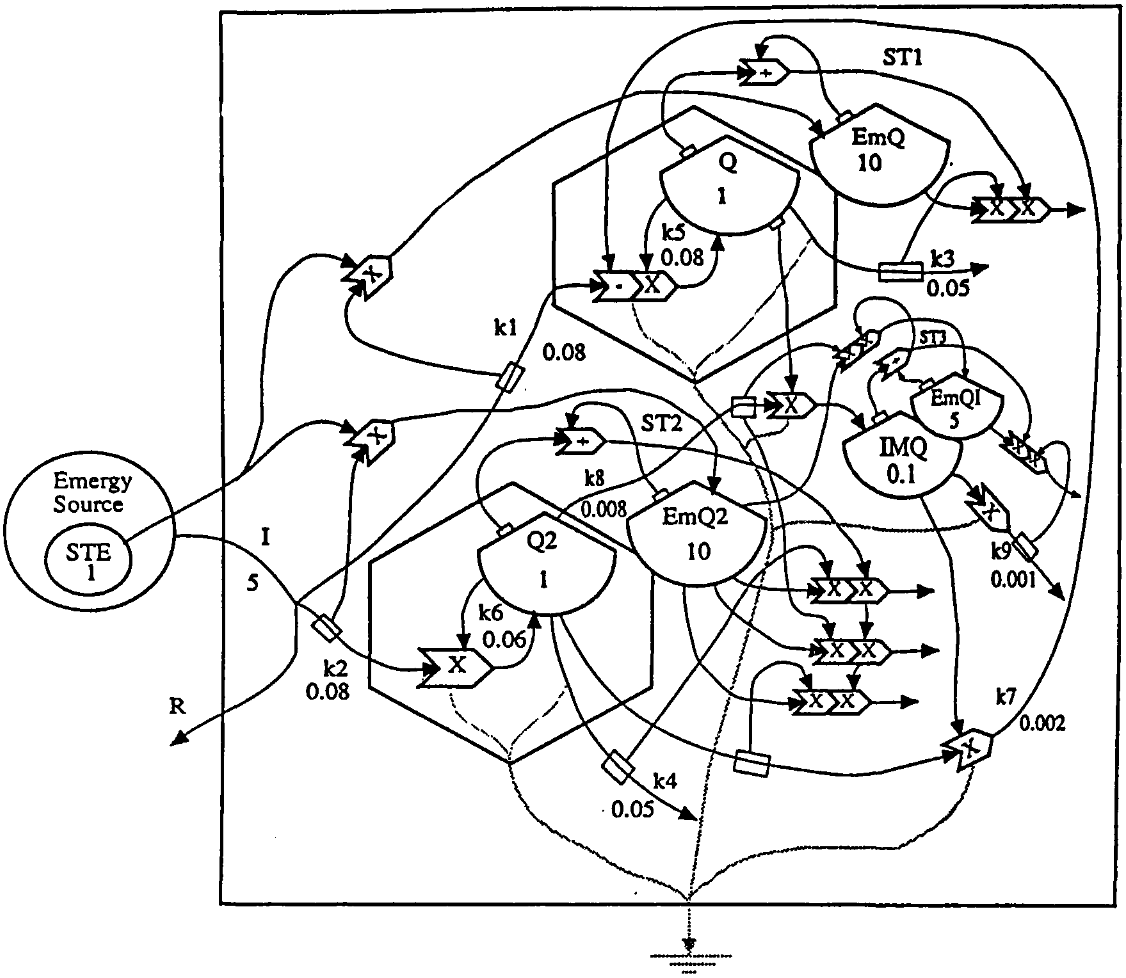


Figure 1(b) Stored energy (light line) and emergy (heavy line) of the two social groups, Q and Q2, in competition for the same resources without direct interaction. The legend lists model outputs in order of their magnitudes at time = 320.



Energy equations:

(1) $$dQ/dt = k5*Q*R*(1-kd*Q2*IMQ) - k3*Q, \text{ where } kd = 0.05$$

(2) $$dQ2/dt = k6*Q2*R - k4*Q2 - k7*IMQ*Q2 - k8*Q2*Q$$

(3) $$dIMQ/dt = k8*Q*Q2 - k9*IMQ^2$$

(4) $$R = I / (1 + k1*Q*(1 - kd*IMQ*Q2) + k2*Q2)$$

Emergy calculations:

(1) $$dEmQ/dt = STE*k1*Q*R*(1 - kd*IMQ*Q2) - ST1*k3*Q,$$
$$\text{where } ST1*k3*Q = 0, \text{ if } STE*k1*Q*R >= ST1*k3*Q$$

(2) $$dEmQ2/dt = STE*k2*Q2*R - ST2*k4*Q2 - ST2*k7*IMQ*Q2 - ST2*k8*Q*Q2$$
$$\text{where } ST2*k4*Q2 = 0, \text{ if } STE*k2*Q2*R >= ST2*k4*Q2$$

(3) $$dEmQI/dt = ST2*k8*Q*Q2 - ST3*k9*IMQ^2$$

Figure 2(a) An energy systems diagram of two social groups competing for the same resources, I, when the less efficient group Q2 has a negative image of the more efficient group, Q. The initial values used in the equations are shown on the diagram. ST indicates solar transformity, Em emergy, and a gray line energy no longer able to do work.

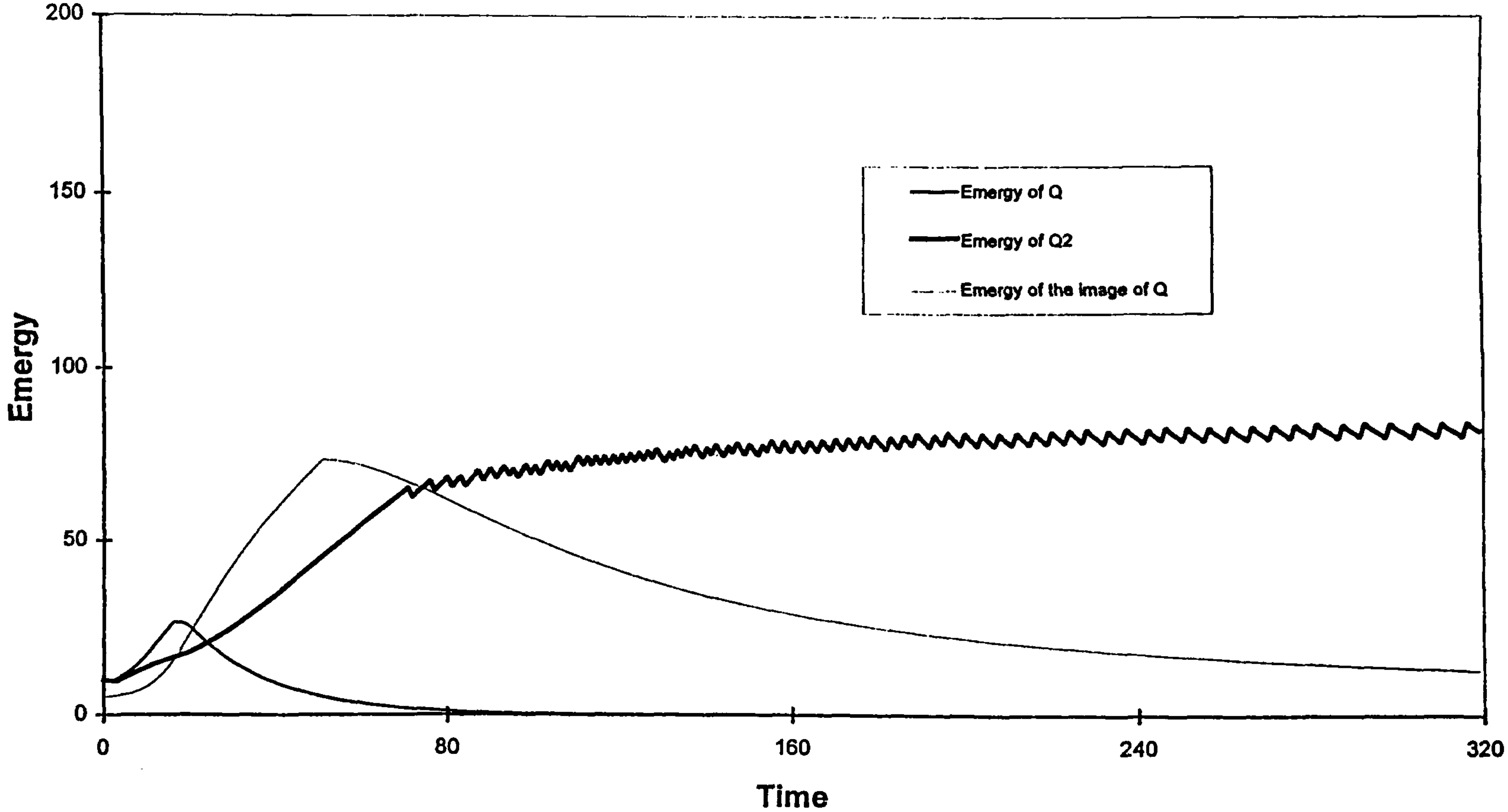
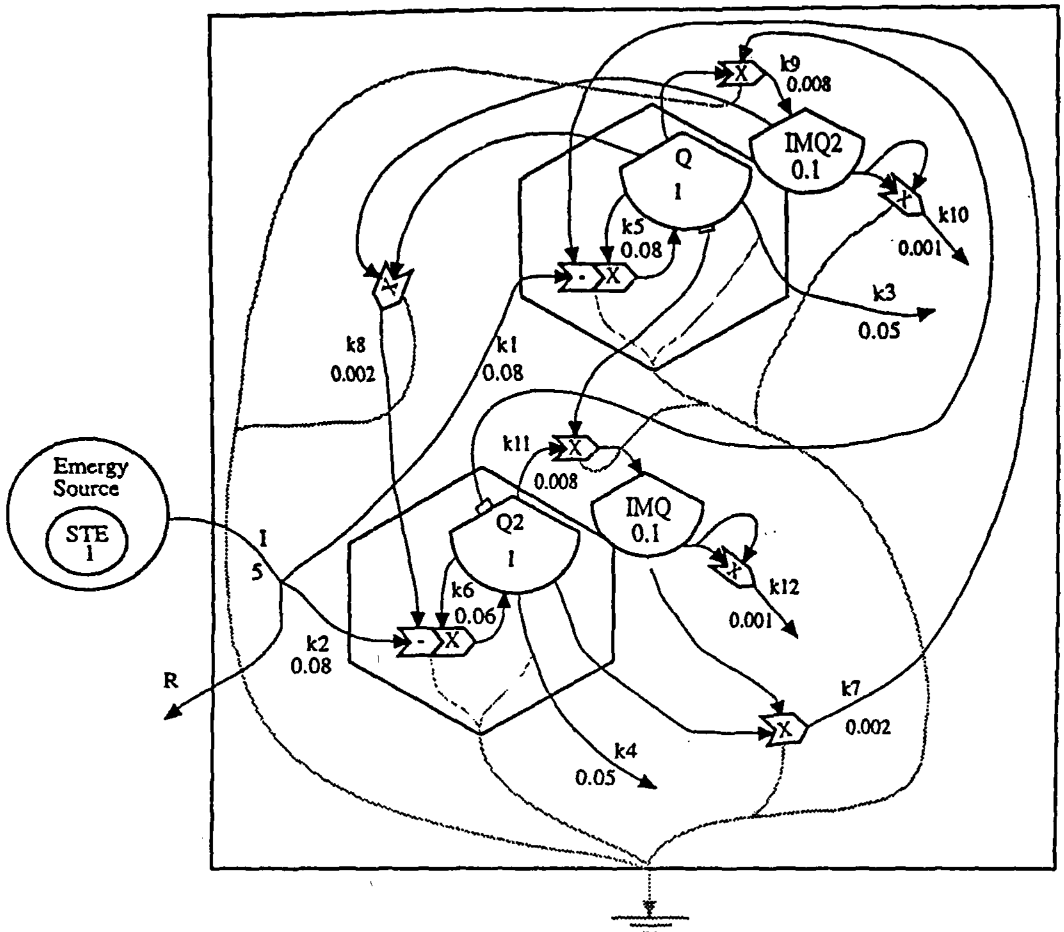


Figure 2(b) Emergy of the two social groups, Q and Q2, when Q2 has a negative image of Q.



Energy equations:

(1) dQ/dt = k5*Q*R*(1-kd*Q2*IMQ) - k3*Q - k8*Q*IMQ2 - k9*Q2*Q
where kd = 0.00001

(2) dQ2/dt = k6*Q2*R*(1-kd*Q*IMQ2) - k4*Q2 -k7*IMQ*Q2 - k11*Q2*Q

(3) dIMQ/dt = k11*Q*Q2 - k12*$(\mathrm{IMQ})^2$

(4) dIMQ2/dt = k9*Q*Q2 - k10*$(\mathrm{IMQ2})^2$

(5) R = I / (1+ k1*Q*(1 - kd*IMQ*Q2) +k2*Q2*(1 - kd*IMQ2*Q))

See Figures 1&2 for the method of calculating emergy.

Figure 3(a) An energy systems diagram of two social groups competing for the same resources, I, when each has a negative image of the other. The initial values used in the equations are shown on the diagram.

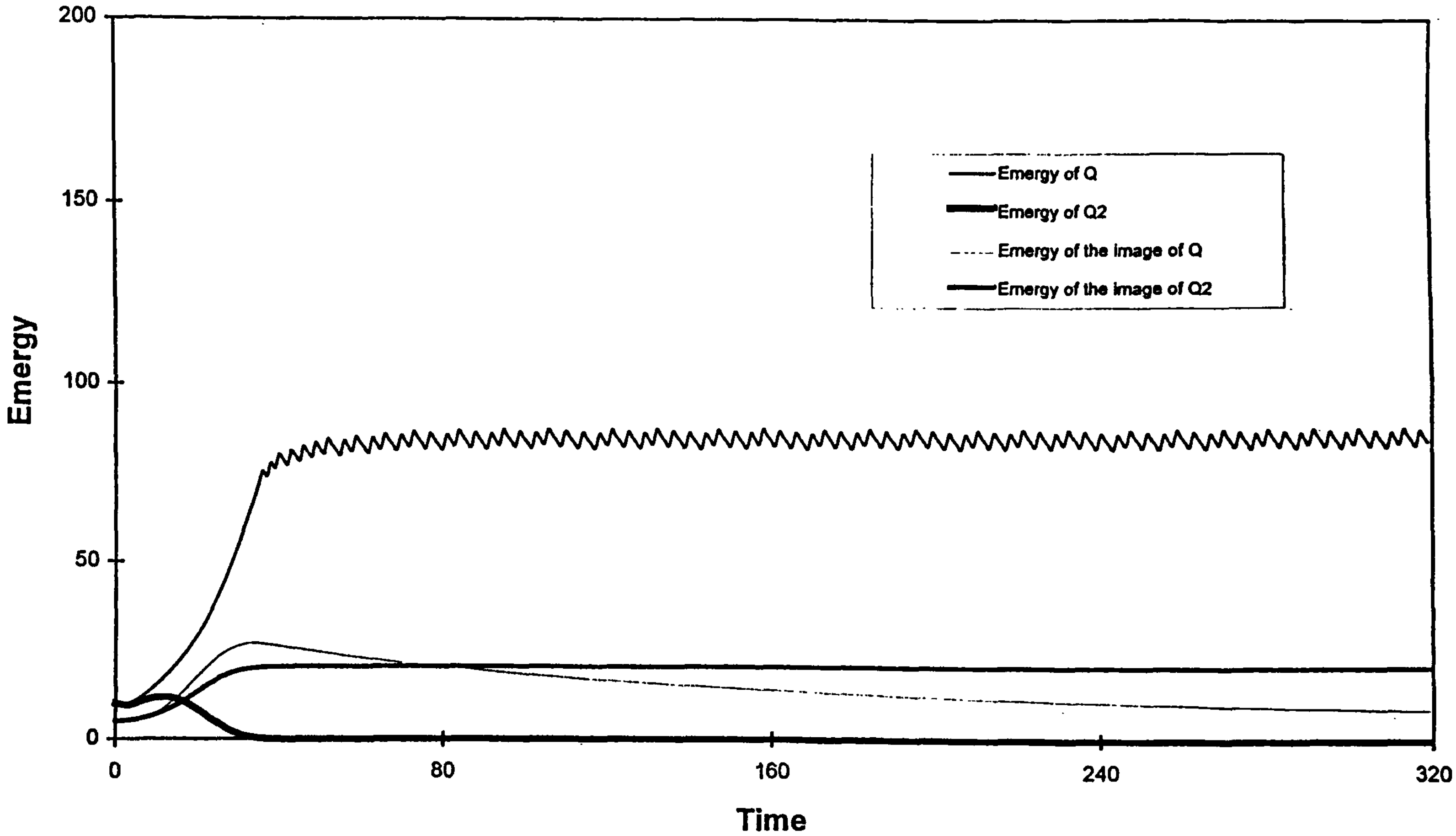
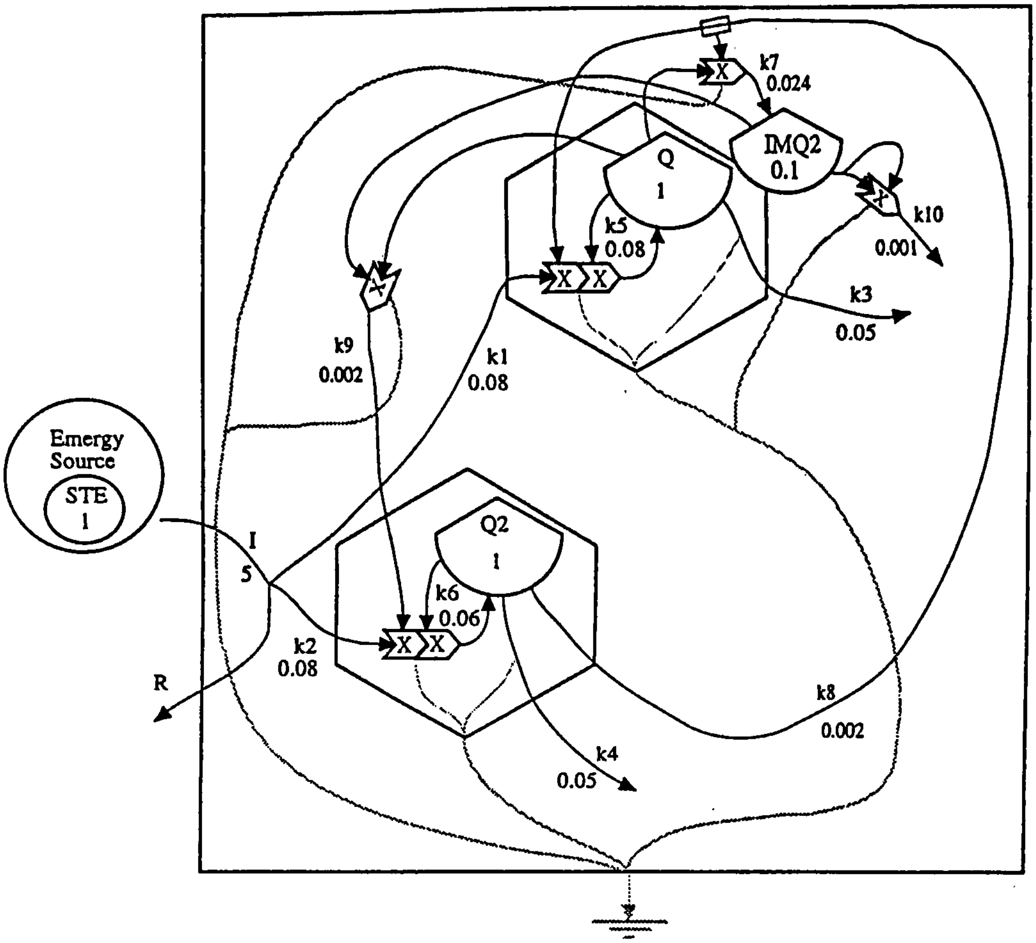


Figure 3(b) Stored emergy produced by the two social groups, Q and Q2, and their negative images of each other in competition for the same resources.



Energy equations:

(1) $dQ/dt = k5*Q*R*Q2 - k3*Q - k7*k8*Q^2*Q2*R - k9*Q2*Q*R$

(2) $dQ2/dt = k6*Q2*R*Q*IMQ2 - k4*Q2 - k8*Q2*R*Q$

(3) $dIMQ2/dt = k7*k8*Q^2*Q2*R - k10*(IMQ2)^2$

(5) $R = I / (1 + k1*Q*Q2 + k2*Q2*IMQ2*Q)$

See Figures 1&2 for the method of calculating emergy.

Figure 4(a) An energy systems diagram of two social groups competing for the same resources, I, when the more efficient group, Q, has a positive image of the less efficient group, Q2. The initial values used in simulating the equations are shown on the diagram.

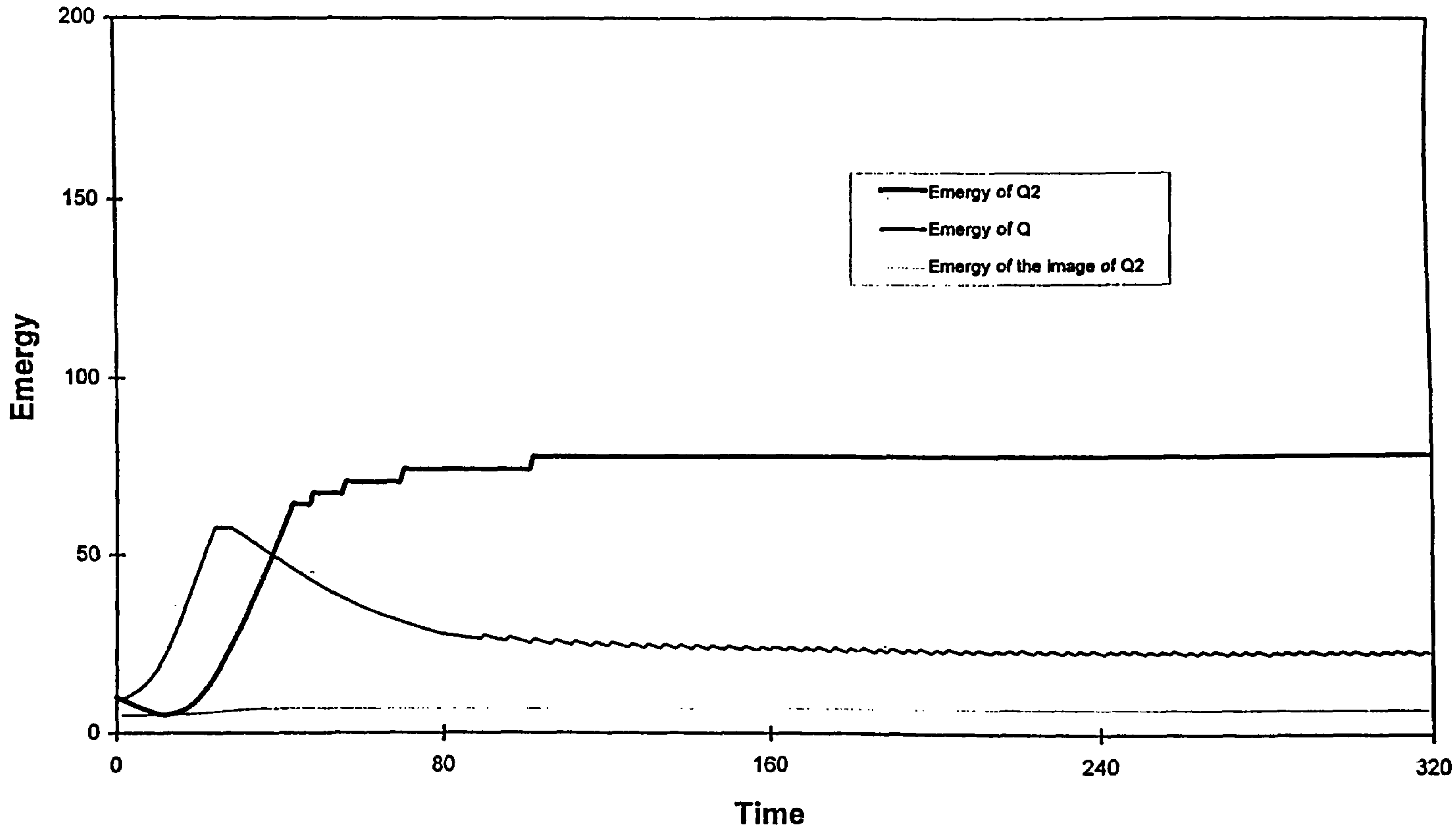
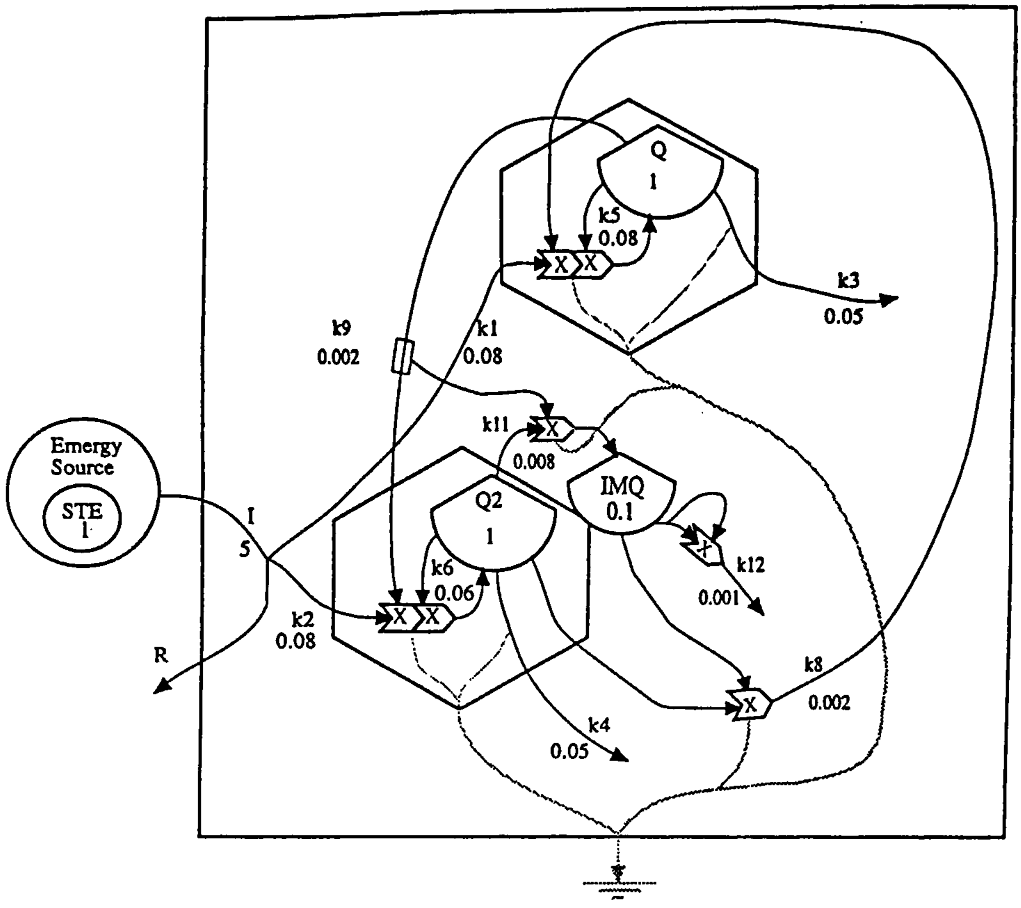


Figure 4(b) The emergy of the two social groups, Q and Q2, when the more efficient group,Q, has a positive image of the less efficient group, Q2.



Energy equations:

(1) dQ/dt = k5*Q*R*Q2*IMQ - k3*Q - k9*Q2*Q*R

(2) dQ2/dt = k6*Q2*R*Q - k4*Q2 -k8*Q*R*IMQ*Q2 - k11*k9*$(Q2)^2$*Q*R

(3) dIMQ/dt = k11*k9*$(Q2)^2$*Q*R - k12*$(IMQ)^2$

(4) R = I / (1 + k1*Q*IMQ*Q2 +k2* Q2*Q)

See Figures 1&2 for the method of calculating emergy.

Figure 5(a) An energy systems diagram of two social groups competing for the same resources, I, when the less efficient group, Q2, has a positive image of the more efficient group, Q. The initial values used in simulating the equations are shown on the diagram.

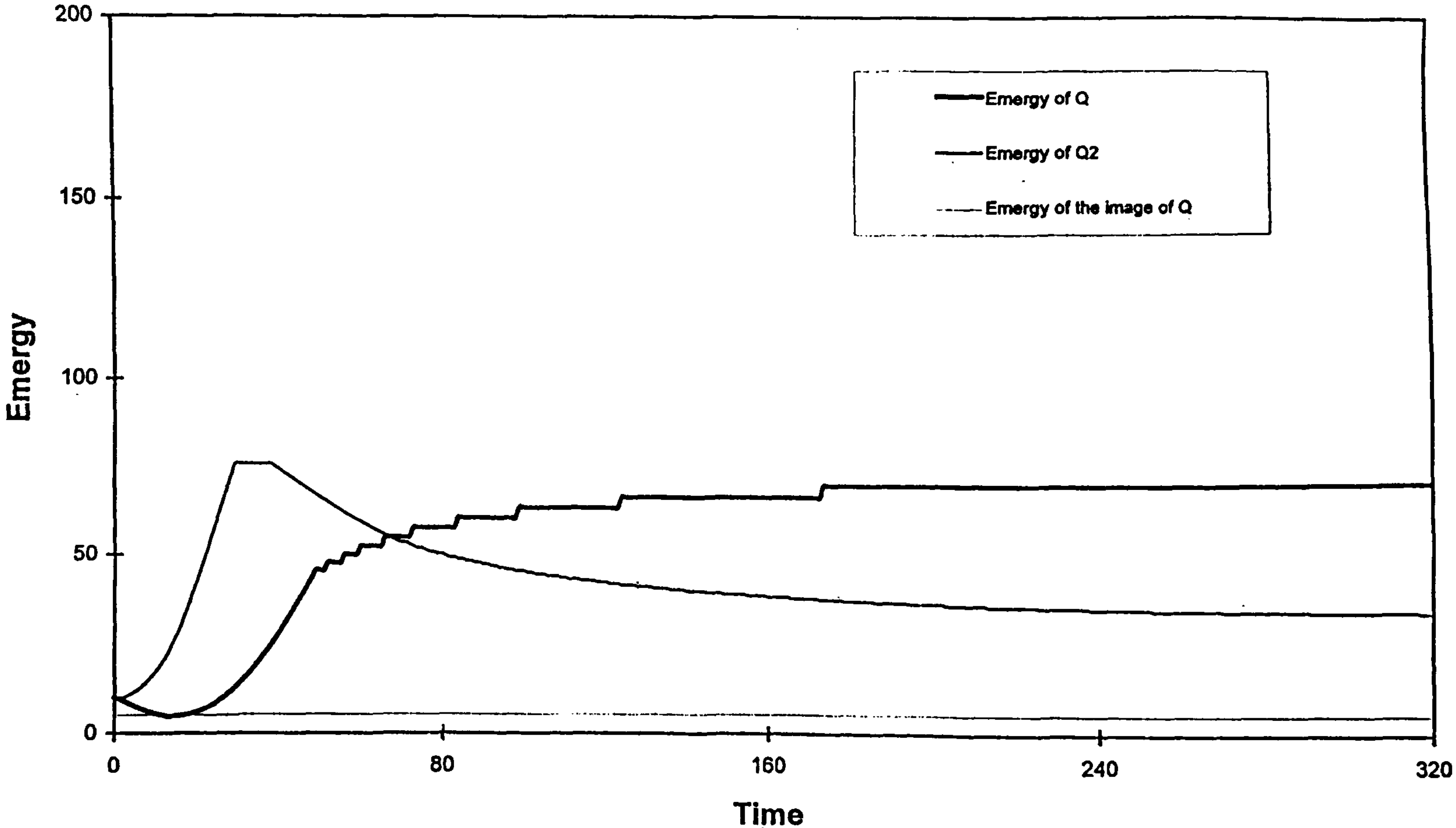
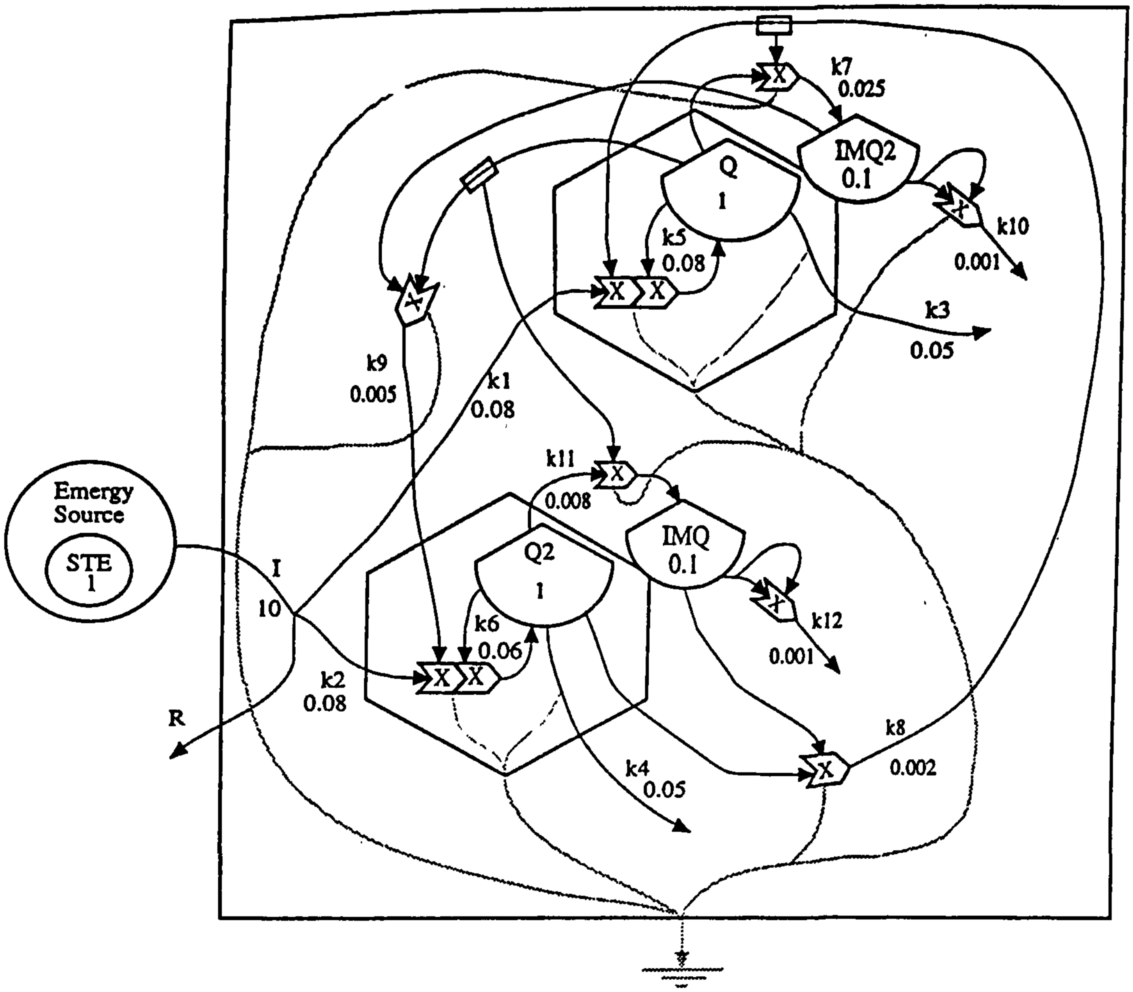


Figure 5(b) The emergy of the two social groups, Q and Q2, when the less efficient group,Q2, has a positive image of the more efficient group, Q.



Energy equations:

(1) dQ/dt = k5*Q*R*Q2*IMQ - k3*Q - k9*Q2*Q*R*IMQ2 - k7*Q^2*k8*Q2*R*IMQ

(2) dQ2/dt = k6*Q2*R*Q*IMQ2 - k4*Q2 - k8*Q*R*Q2*IMQ - k11*$(Q2)^2$*k9*Q*R*IMQ2

(3) dIMQ/dt = k11*$(Q2)^2$*k9*Q*R*IMQ2 - k12*$(IMQ)^2$

(4) dIMQ2/dt = k7*Q^2*k8*Q2*R*IMQ - k10*$(IMQ2)^2$

(5) R = I / (1 + k1*Q*Q2*IMQ+ k2*Q2*IMQ2*Q)

See Figures 1&2 for the method of calculating emergy.

Figure 6(a) An energy systems diagram of two social groups competing for the same resources, I, when each has a positive image of the other. The initial values used in the equations are shown on the diagram.

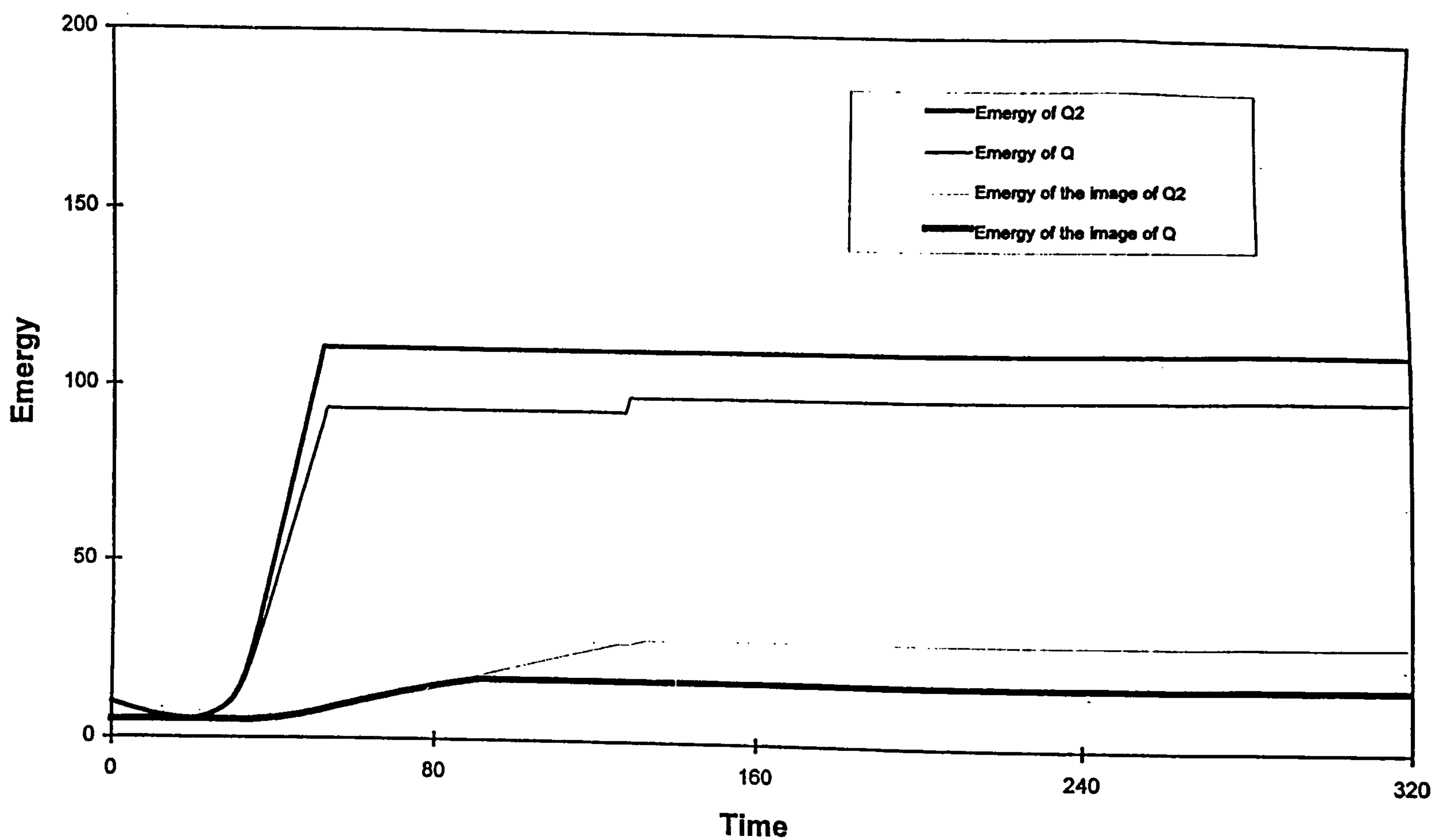


Figure 6(b) The emergy of the two social groups, Q and Q2, and their positive images of each other while in competition for the same resources.

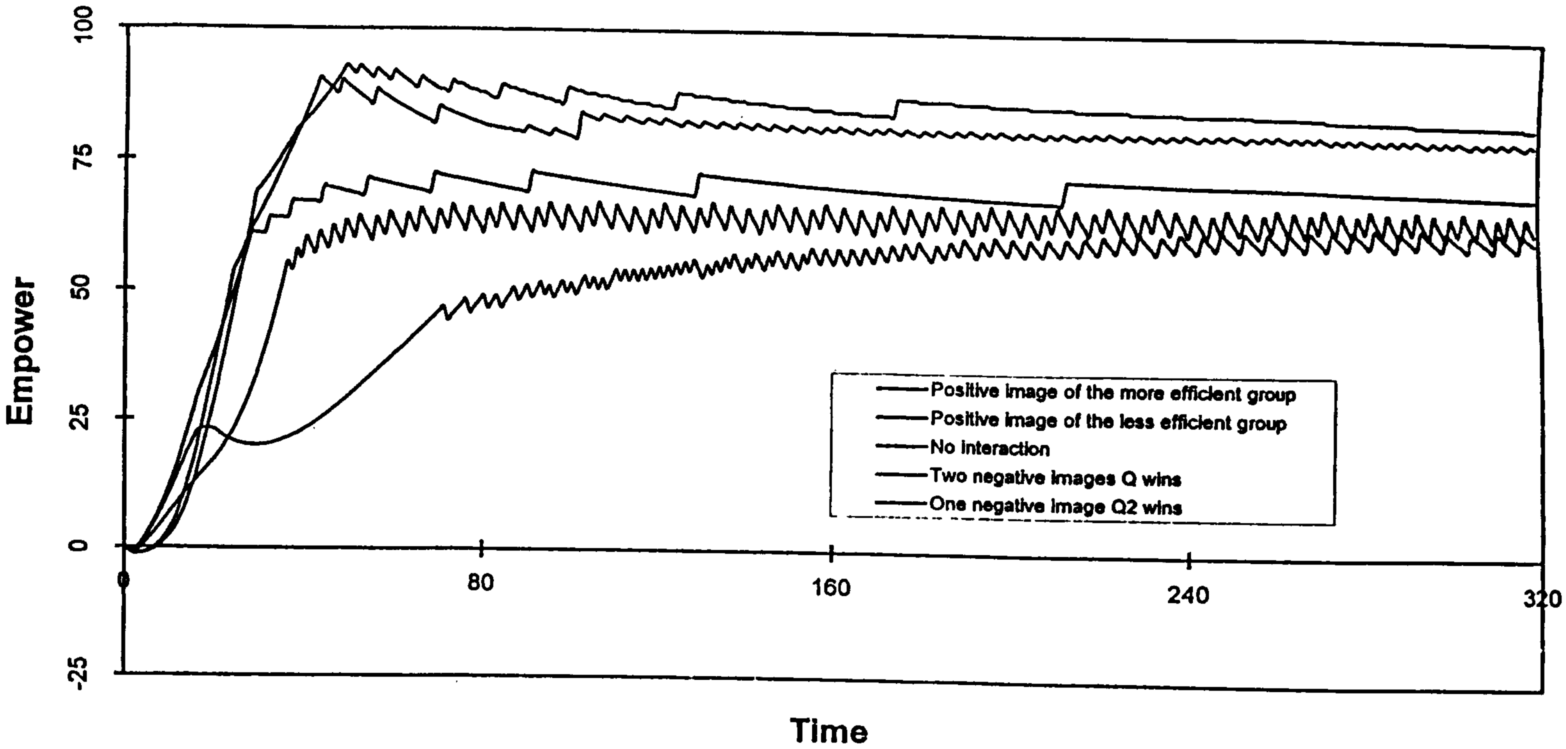


Figure 7(a) The cumulative empower of social groups, Q and Q2, produced by alternative system designs using available resources, I =5. The legend lists model outputs in order of their magnitude at time = 320.

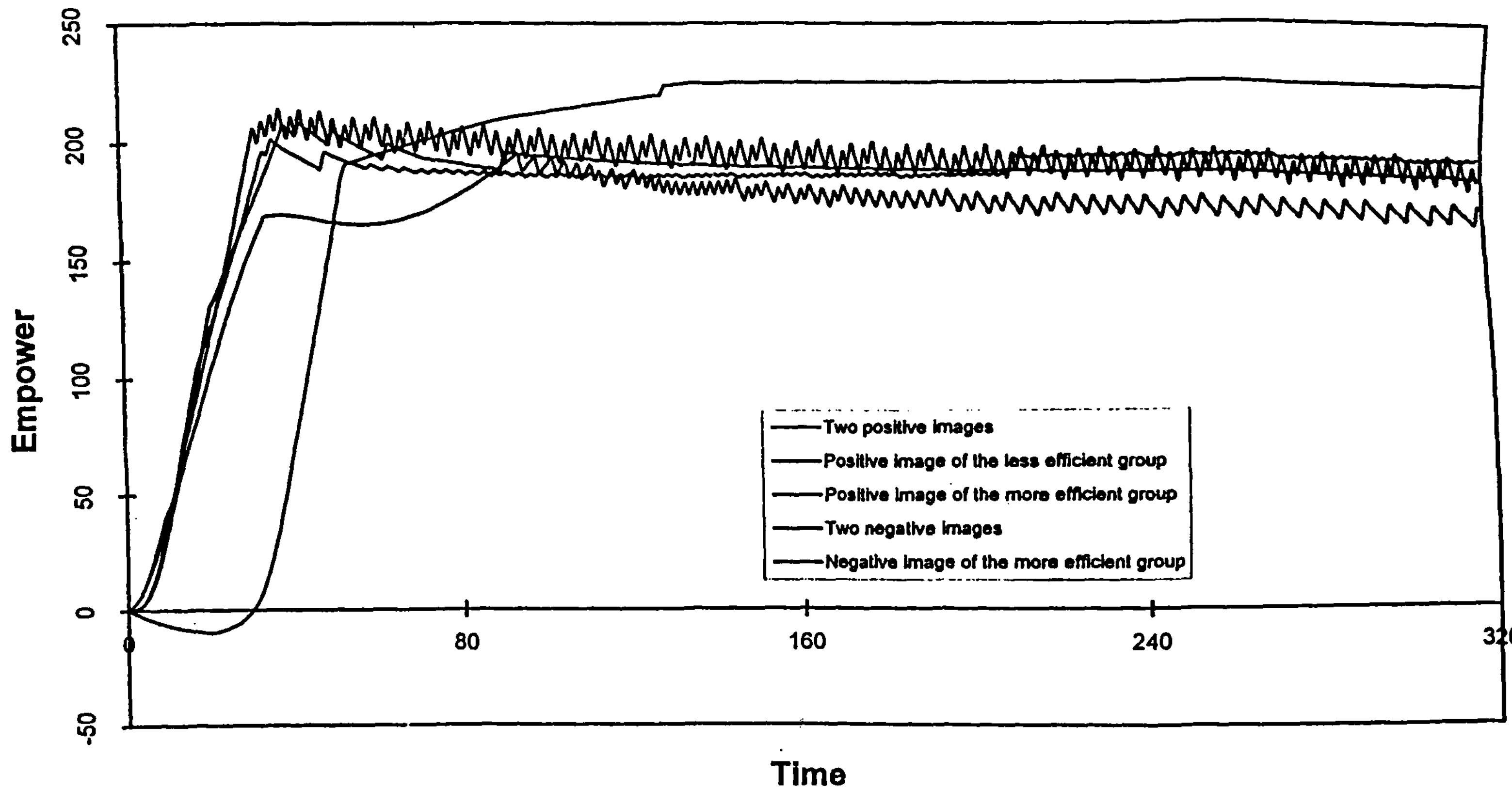


Figure 7(b) The cumulative empower of social groups and their images produced by alternative system designs when available resources are doubled. The legend lists model outputs in order of their magnitude at time = 320.

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16. ABSTRACT

Appreciative inquiry explains social change by identifying mechanisms for collective action which establish a normative vision that guides the evolution of the social system or group. In its essence this theory suggests that social systems evolve toward the highest ideals held by the social group. Systems that develop positive images of the other and heliotropic, or positive, reinforcement loops show how social change can be guided by affirmative images. Change in social systems must also follow success in competition during an evolutionary process which is guided by the Maximum Empower Principle. This principle states that system designs which maximize empower (emergy per unit time) production for the whole system are the ones that survive. Emergy normalizes the many kinds of energy flows in a hierarchical system so that they are expressed in equivalent units. We designed a simple experiment to determine if social systems with heliotropic loops generated more empower than systems without such interactions. We determined the empower production of six possible modes of interaction between two social groups competing for the same resource base by simulating six Energy Systems models, each representing a mode of social interaction. The cumulative empower produced by these models was compared to rank the interaction modes in order of their expected competitiveness in the evolutionary process. A path for the evolution of social systems where two groups compete for the same resources was proposed based on our simulation results. In general the three designs containing heliotropic loops generated more empower than the design with no social interaction and the two designs with negative social interactions.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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