

# Doing Right: Connectedness Problem Solving and Negotiation

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## Introduction

We consider problem solving and negotiation to be integral and sometimes use the term problem solving/negotiation, or simply problem solving. Problem solving/negotiation can involve individual and group (multiagent) decision, collaboration, negotiation, and conflict resolution/transformation/reconciliation.

Connectedness Problem Solving and Negotiation (CPSN) is individual and multiagent (group) problem solving and negotiation evolving towards agent connectedness (Section “One, Two, Agent, System, Purpose, Consciousness, Connectedness, Common Ground and Communication”) with a problem system of purposes and their relations that expresses doing right by defining/solving a validated “right” problem/solution. The solution constitutes right action (Section “Doing Right”). Validation means the problem/solution satisfies spiritual (right) rationality (Sections “Rationality to Spiritual (Right) Rationality” and “ESD Spiritual (Right) Rationality Validation Test”). A negotiation agreement requires multiagent agreement on the action to be taken.

CPSN is effected through Evolutionary Systems Design (ESD), a game-theory based, general formal systems-spirituality modeling/design framework for problem solving/negotiation implemented by computer technology. By systems-spirituality here we mean that in systems modeling/design of problem

solving/negotiation, an agent can represent an evolving system of purposes and their relations (the ESD evolving problem representation) from the lowest-level action to the highest purpose as defined by the agent. For some agents that highest purpose could be spirituality, connectedness with One (Section “One, Two, Agent, System, Purpose, Consciousness, Connectedness, Common Ground and Communication”), but not necessarily – a surrogate purpose (Section “Spiritual Rationality and Right problem Solving: Theory and Practice, Surrogates”) could be used. To give recognition to this, we view problem solving/negotiation as systems-spirituality design implemented by computer technology.

In developing CPSN through ESD (CPSN-ESD) we discuss a variety of concepts. This chapter, clarifying aspects of Shakun (2009), is about evolutionary modeling/design and technology, and about experiencing systems and subjective connectedness in problem solving/negotiation. Chapters in this Handbook by Martinovski on emotion in negotiation; Lewis, and Kersten and Lai on computer technology relate to our work here.

## One, Two, Agent, System, Purpose, Consciousness, Connectedness, Common Ground and Communication

Everything is experience. Experience is partially expressible.

One represents all there is, the absolute, the implicate order, the quantum vacuum, emptiness, God, Tao,

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Being, the non-manifested. Two represents the process of all there is, the relative, the explicate order, excitations of the quantum vacuum, the manifested, agents. Two, manifests from One as agents and signifies at least two agents.

An agent constitutes energy/matter/consciousness integrally bound. I am an agent – I experience myself as an agent, a human agent. Beside myself, I experience other agents (the “other”). One, all there is, is distributed so that each agent is One and Two. I am One and Two, and so are you. The human greeting *namaste* – One in me honors One in you – gives recognition to the I-am-One aspect. Agents may be natural or artificial (Shakun, 2003a). Natural agents may be humans, animals, insects, plants or so-called inert matter (as rocks and water). Artificial agents may be robots, softbots (software agents), computers and artifacts in general. Artificial agents are designed by human or other natural or artificial agents. Agents have various degrees of autonomy (freedom from external control). An agent problem solves/negotiates/creates/designs in Two by taking action.

Here we focus mostly on human agents. The ideas are applicable to other agents with lesser (or greater) matter/energy/consciousness capabilities than humans according to their built-in capabilities. This has to be developed further, but for relevant discussion, see Shakun (2001a).

Experientially, a system is a subjective experience of an agent involving physical and non-physical elements and their relations. Physical elements are agents and non-physical elements are purposes in ESD. An agent itself is a system comprising other agents (component systems) and is itself a system (component) in other systems. The term agent/system emphasizes that an agent is a system. Mathematically, a system is a set of elements and their relations with no subset of elements unrelated to any other subset. A relation is a subset of a Cartesian product of sets. A process is a time description of a system, i.e., a dynamical system.

An adaptive agent/system exhibits adaptive behavior – changing behavior (action) to cope with change in its environment or internally to attain adaptive purpose (intended result). Purpose can be apparently purposeless as in play (The National Institute for Play website, <http://www.nifplay.org>). Intelligence of an agent/system is defined as its capacity for adaptive behavior (Section “Intelligence and ESD”). When adaptation includes change through cybernetic positive

feedback/feedforward and self-organization as well as cybernetic negative feedback/feedforward, we say the agent/system is complex. Adaptive systems that can choose their own purposes are purposeful. Hence, we have Purposeful Complex Adaptive Systems (PCAS) engaging in cybernetics/self-organization involving choice of purposes and the means (other purposes) to attain them, i.e., PCAS are capable of purposeful, complex, adaptive systems design/action. The Evolutionary Systems Design (ESD) framework models problem solving and negotiation processes by PCAS engaging in cybernetics/self-organization.

Consciousness of an agent is awareness – constituting self-organizing response capacity – manifesting (as we know at least in humans) inner, subjective, qualitative experience (qualia), i.e., consciousness is awareness/qualia experience. In the evolution of energy/matter/consciousness in natural agents, consciousness evolved cumulatively (each succeeding level including or nesting the preceding ones) and expansively manifesting purpose/conation (response/action via body)/swarm/emotion<sup>1</sup>/social/cognition/system/One consciousness awareness/qualia components, these integrally bound (indicated by the/sign) as a holistic consciousness awareness/qualia experience component. Thus, we have identified nine consciousness components. Human consciousness exhibits all nine of these.

How diverse information is integrally bound to provide a unified, holistic experience is known as the binding problem. Zohar and Marshall (2000, 2004) argue that in humans synchronous neural oscillations in the 40 Hz (cycles per second) range (gamma waves) are the neural basis of consciousness, and that quantum theory explains the coherence of consciousness.<sup>2</sup>

By associating awareness/qualia and their integration with various neural systems in the brain,

<sup>1</sup> Damasio (1999, 2003) distinguishes between emotion and feeling – emotion preceding feeling – with affection a term including both. We do not pursue this here; we use the term emotion with affection, emotion and feeling considered interchangeable.

<sup>2</sup> More generally, perhaps in other natural agents there is a quantum basis for consciousness coherence within individual agents and among agents allowing coherent collective (group, system) behavior (action) that underlies, for example, swarm intelligence studied by Couzin and others in ants, birds, locust, fish and humans, and relatable to robots (see Zimmer, 2007).

neuroscience has added to our understanding of these awareness/qualia. For example, with regard to social consciousness, theory of mind (mindsight) – involving our ability to sense the mind of the “other”, as in empathy, memes and priming – discusses mirror neurons that mirror in us the same neuron activity as in the “other” (Goleman, 2006).

Connectedness is a dynamic subjective relation experience of consciousness of an agent (Shakun, 2001a). An agent can experience connectedness through each of the above nine awareness/qualia – connectedness through: purpose connectedness/conation connectedness as right (perfect, connected) action<sup>3</sup> via body/swarm connectedness through simple-rule agent social interaction/emotion connectedness as love/social connectedness with others/cognition connectedness as oneness/system connectedness – connectedness with a system/spirituality or connectedness with One; and holistic connectedness. When an agent experiences connectedness with One, he experiences connectedness with all awareness/qualia. Connectedness awareness/qualia can be agent purposes with connectedness with One as ultimate purpose (Section “Shared Inherent Purpose”).

With non-connectedness these awareness/qualia become: non-connected purpose/non-connected action/simple-rule social non-interaction/fear/non-connectedness with others/separateness/non-connectedness with a system/non-spirituality or non-connectedness with One; and holistic non-connectedness.

We comment on social, system and One connectedness:

### **Social Connectedness: Connectedness with Others, the “Other” (Other Agents)**

Social connectedness of an individual agent  $i$  is connectedness of agent  $i$  ( $i = 1, 2, \dots$ ) with another

individual agent  $j$  ( $j = 1, 2, \dots$ ) and can be represented as a mathematical relation expressed by a matrix  $Z(i) = [z(i, j, t)]$ . At time  $t$ , if agent  $i$  experiences connectedness with  $j$ ,  $z(i, j, t) = 1$ ;  $z(i, j, t) = 0$  signifies non-connectedness. By definition,  $z(i, i, t) = 1$ . Connectedness of agent  $i$  with  $j$  in  $Z(i)$  reinforces continued connectedness of agent  $i$  with  $j$  in  $Z(i)$ . The set of agents  $j$  with whom agent  $i$  experiences connectedness constitutes agent  $i$ 's social connectedness family. The experience of connectedness with others can be a purpose.

Connectedness (non-connectedness) of agent  $i$  with agent  $j$  in matrix  $Z(i)$  encourages reciprocation – connectedness (or non-) of  $j$  with  $i$  in matrix  $Z(j)$ . Connectedness of  $i$  with  $j$  and  $j$  with  $i$  constitutes mutual or reciprocated social connectedness. Reciprocated connectedness reinforces continued reciprocated connectedness. Since agent  $i$  does not know  $Z(j)$ , he judges (estimates) agent  $j$ 's connectedness (or non-) to him. The set of agents  $j$  with whom agent  $i$  experiences reciprocated (mutual) connectedness constitutes agent  $i$ 's reciprocated social connectedness family which may equal to or be a subset of his connectedness family.

In addition to individual agents  $j$ , agent  $i$  can experience connectedness or non-connectedness collectively with one or more sets  $\underline{J}$  of agents  $j$  and these  $\underline{J}$  can be incorporated as columns in the  $Z(i)$  matrix. Thus, the “other” represents one or more sets  $\underline{J}$  of individual agents  $j$ . Further, individual agent  $i$  can be a member of one or more sets  $\underline{I}$  of individual agents representing “we” and these  $\underline{I}$  can be incorporated as rows in the  $Z(i)$  matrix. In negotiation “we” negotiates with the “other”, the counterpart.

### **Purpose Connectedness; System Connectedness: Problem System Connectedness with the ESD Problem Representation**

Agent  $i$  can experience system connectedness (or non-connectedness) with a system involving physical and non-physical elements and their relations. Physical elements are agents and non-physical elements are purposes in ESD. Connectedness (or non-) with agents can itself be a purpose. Agent  $i$  can

<sup>3</sup> In classical Chinese philosophy (Lau, 1961; Merton, 1969), wu wei (meaning literally “without action”, wu meaning “nothing”) is the name for perfection action/non-action. Wu wei means perfect action for any action (conation) in Two in perfect harmony, i.e., connected with One (Tao), and non-action for any action in Two not connected with One. In our work, “right action” is perfect (connected) action.

experience purpose connectedness with purposes. The Evolutionary Systems Design (ESD) systems-spirituality framework allows agent  $i$  to formally represent his experience in Two<sup>4</sup> in problem solving and negotiation as an evolving problem system of purposes and their relations constituting agent  $i$ 's evolving problem representation, hierarchies 1 and 2 (Section "Connectedness Problem Solving Negotiation (CPSN) and the Evolutionary Systems Design (ESD) Systems-Spirituality Framework"). With an evolved problem representation that represents a problem solution for an agent, the agent experiences problem system connectedness which is a purpose.

### **Spirituality Connectedness: Connectedness with One**

Agent  $i$  can also experience connectedness or non-connectedness with an infinite-element set, experientially equivalent to a one-element set we call One, or "all there is". At time  $t$ , for  $n$  agents  $i$  we represent this experience as an  $n \times 1$  matrix  $Z^*(i) = [z^*(i, t)]$ . At time  $t$ , if agent  $i$  experiences connectedness with One, then  $z^*(i, t) = 1$ ;  $z^*(i, t) = 0$  signifies non-connectedness. Connectedness of agent  $i$  in  $Z^*(i)$  reinforces continued connectedness of agent  $i$  in  $Z^*(i)$ . We define spirituality connectedness or simply *spirituality* as *connectedness with One*, or One connectedness. Connectedness with One is a purpose (ultimate purpose, see Section "Shared Inherent Purpose") that an agent can incorporate into his ESD problem representation.

We can say that connectedness with One is spirituality and other connectedness awareness/qualia, i.e., connected action, swarm connectedness, love, connectedness with others, oneness, connectedness with systems, and holistic connectedness are spiritual. These connectedness awareness/qualia can be surrogate purposes for connectedness with One.

One connectedness while elusive is always there if an agent is open to it since "I am One". One connectedness is the source of wisdom in Two. Problem solving and One connectedness is discussed in Section "Right Problem Solving, Spiritual (Right) Rationality and Right Action".

Connectedness (non-connectedness) of agent  $i$  with One as represented by  $Z^*(i)$  can promote and imply connectedness (non-) of agent  $i$  with others, agents  $j$  in  $Z(i)$ . Connectedness (non-) of agent  $i$  with other agents  $i$  in  $Z(i)$  can be a producer of connectedness (non-) of agent  $i$  with One in  $Z^*(i)$ .

An agent  $i$  knows his own entries in  $Z(i)$  and  $Z^*(i)$ , i.e., knows if he is experiencing connectedness (1) or non-connectedness (0). If an agent  $j$  does not communicate his own entries in these matrices to agent  $i$ , the latter can estimate them.

### **Common Ground**

*Reciprocated purpose connectedness* – commonly perceived/held/shared purpose connectedness across agents – constitutes *common ground* that can facilitate negotiation. Common ground can promote/produce other common ground. Reciprocated connectedness with others is an important example of common ground. *Negotiation* is "a process of potentially opportunistic interaction by which two or more parties (agents), with some apparent conflict, seek to do better through jointly decided action than they could otherwise" (Lax and Sebenius, 1986, p. 11). Negotiation can be viewed as a process of grounding – identification and expansion of common ground leading to a negotiation agreement (Beers et al., 2006). A *negotiation agreement* expresses common ground among agents on at least the jointly-decided action purpose to be taken, but generally not on all purposes in the problem. Agents share an inherent ultimate purpose, connectedness with One inherent in manifesting from One that constitutes ultimate common ground (Section "Shared Inherent Purpose").

The ESD referral process (Sections "Evolutionary Systems Design (ESD)", "High-Level Purposes/Values") can result in a discontinuous change of consciousness generating new values, goals and actions that could provide new common ground.

<sup>4</sup> We note that representing formally, mathematically or talking about experience is not the same as the experience. For discussion of the ESD general mathematical model, see Section "Connectedness Problem Solving Negotiation (CPSN) and the Evolutionary Systems Design (ESD) Systems-Spirituality Framework" and footnote 5.

## **Communication, Dialogue and Negotiation**

*Communication* involves sharing experience from an agent *i* to an agent *j*; fundamentally to produce (maintain) reciprocated connectedness – ultimately, spirituality. A *dialogue* is a two-way process of communication among agents. In their framework, Allwood (1997) and Allwood et al. (2000) discuss aspects of dialogue as cooperation, expressive and evocative functions, and obligations. Negotiation dialogue is fundamental in the negotiation process towards a negotiation agreement.

The nonviolent communication framework (Rosenberg, 2004, 2005) – involving communicating observations, feelings, needs and requests – has connectedness with others, spirituality as purpose.

Communication can involve natural language (written text, speech, non-verbal), data, artificial (computer) language, etc. In addition to face-to-face, physical connectivity for communication may be provided by technology – telephone, internet (data, text, audio and video), wireless mobile, etc. Physical connectivity can affect subjective connectedness and that is where its ultimate value lies (Shakun, 2001b).

## **Frameworks**

A *framework* is an expressed on-going/evolving consciousness experience of an agent for interpreting Two. Agents experience Two differently – have different interpretive frameworks and different purposes. Frameworks include mechanistic (Newtonian) and quantum frameworks in physics for interpreting the physical world that are also applied to the human social world (Zohar and Marshall, 1994); religious/spiritual frameworks as Judaism, Christianity, Islam, Hinduism, Buddhism, Taoism, Humanism, animism, paganism, and atheism; communication frameworks, e.g., Allwood et al. and Rosenberg frameworks (Section “Communication, dialogue and Negotiation”). In a sorcery framework, sorcerers can perceive different worlds resulting from different cognitively-sensed energy data (Castaneda, 1998a, b). Sorcerers see agents as luminous, and physical connectivity between agents as luminous energy filaments. Evolutionary Systems

Design (ESD) – discussed below – is a systems-spirituality modeling/design framework for problem solving and negotiation.

Frameworks are expressions of culture, and so are purposes and their relations within a given framework. As a working definition, Faure and Rubin (1993, p. 3) define culture “as a set of shared and enduring meanings, values, and beliefs that characterize national, ethnic, or other groups and orient their behavior”. Hofstede (1991, p. 260) defines culture as “the collective programming of the mind which distinguishes the members of one group or category of people from another”. Shakun (1999b) discusses an ESD computer culture framework for intercultural problem solving and negotiation.

Differences in frameworks and purposes within frameworks among agents can cause conflicts, but can also provide creative opportunities in problem solving and negotiation. There are possibilities for influence, cross transfer and integration of frameworks, and identification of equivalent elements across frameworks, e.g., see Shakun (2006a). Emergence of new problem elements can occur. Adoption of an ESD computer culture framework (Shakun, 1999b) by a multicultural group can result in emergence of a new common culture with new problem elements (purposes and their relations) for solution of the problem at hand and for future negotiations. Cultural emergence arises in problem solving through the interaction of process and content from the individual multiple cultures involved. With all agent frameworks for Two, connectedness with One is universally involved, at least implicitly.

## **Connectedness Problem Solving and Negotiation (CPSN) and the Evolutionary Systems Design (ESD) Systems-Spirituality Framework**

Connectedness Problem Solving and Negotiation (CPSN) is individual and multiagent problem solving/negotiation evolving towards agent connectedness with a problem system of purposes and their relations that expresses right action (a solution) producing connectedness with One, spirituality (or a surrogate, Section “Spiritual Rationality and Right

problem Solving: Theory and Practice, Surrogates”). CPSN means problem solving/negotiation for connectedness/right action.

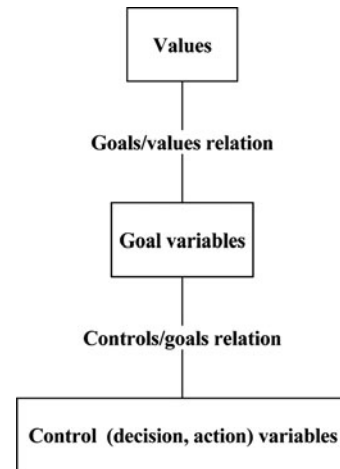
CPSN is effected through the Evolutionary Systems Design (ESD) Systems-Spirituality Framework implemented by computer technology. CPSN-ESD denotes CPSN through ESD.

ESD is a game-theory based, general formal systems-spirituality design framework for PCAS in modeling/designing individual and multiagent problem solving/negotiation. By systems-spirituality here we mean that in systems modeling/design of problem solving/negotiation an agent can model/design an evolving problem system of purposes and their relations (an evolving problem representation, hierarchies 1 and 2 below) from the lowest-level control (decision, action) to the highest purpose, connectedness with One, spirituality (or a surrogate, Section “Spiritual Rationality and Right problem Solving: Theory and Practice, Surrogates”). For an agent, an evolved problem system satisfying spiritual rationality (Sections “Rationality to Spiritual (Right) Rationality” and “ESD Spiritual (Right) Rationality Validation Test”) identifies right action (a solution) producing spirituality, connectedness with One (or a surrogate) for that agent. A negotiation agreement (Section “Common Ground”) requires multiagent agreement on the action to be taken. Thus, CPSN-ESD means problem solving/negotiation for connectedness/right action through systems design with ESD.

### Evolutionary Systems Design (ESD)

The ESD general framework (general problem representation, structure or system) can be applied in defining (designing) and solving specific problems/negotiations. Doing right – taking right action – can be formally validated by ESD.

A problem may be represented by an evolving system involving relations between sets of elements, as (1) players, agents, decision makers or negotiators; (2) values or broadly stated desires; (3) goals or specific expressions of these values; (4) controls (decisions, actions) taken to achieve these goals and values; (5) criteria based on goals for evaluating the effectiveness of decisions; (6) individual preferences defined on criteria; and (7) group or coalition preference defined on

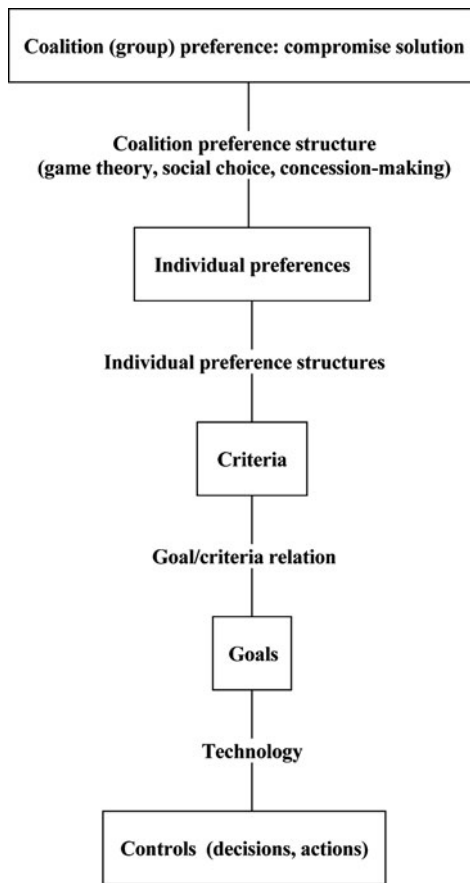


**Fig. 1** Hierarchy 1 relation between control variables, goal variables, and values

individual preferences. Sometimes goals and controls are the same. The ESD system, i.e., general problem representation (system) may be shown as two evolving hierarchies of relations. Hierarchy 1 (see Fig. 1) is a framework for defining (designing) a problem in the general sense of defining values to be delivered in the form of goal variables by exercising control (decision, action) variables. Hierarchy 2 (Fig. 2) is concerned with finding a solution – finding the levels or particular values of the control and goal variables as currently defined in hierarchy 1. The problem representation (hierarchies 1 and 2) may be individual or group (joint).

The setting under consideration involves  $N$  players (agents) in an evolving multiplayer decision problem (game). The number  $N$  and the particular agents can change over time. Drawing on Shakun (1988, 1990, 2006a, b), a subset of the  $N$  players can try to work together and form a group (coalition)  $C$  which can comprise anywhere from one individual player to the grand coalition of all  $N$  players. Group  $C$  may change over time. Other players not in  $C$  can themselves form one or more coalitions designated  $\bar{C}$ .

For example, suppose that five players are not in  $C$ . They could form a coalition  $\bar{C}$  of the five players.  $C$  could negotiate with this coalition. Another possibility is that  $\bar{C}$  could consist of two coalitions each of two players and one individual player (a “coalition” of one). The  $C$  vs.  $\bar{C}$  game could involve  $C$  in three bilateral negotiations; or the  $C$  vs.  $\bar{C}$  game could be a four-coalition multilateral negotiation.



**Fig. 2** Hierarchy 2 relation between controls, goals, criteria, individual preferences, and coalition preference

*Problem Solving is systems design is cybernetics/self-organization.* ESD involves evolution (successive designs) of the group problem representation/system – evolution of the sets of elements and their relations represented in evolving hierarchies 1 and 2 – through *cybernetics/self-organization*: (a) problem adaptation through learning associated with cybernetic negative feedback/feedforward, as through information-sharing and concession-making; and (b) problem restructuring or reframing (evolution) associated with cybernetic positive feedback/feedforward and self-organization. In ESD, cybernetics/self-organization is described by a general mathematical model – as a dynamical system (general problem representation) expressing the evolving hierarchies 1 and 2 as an evolving difference game with a moving present. In working on a specific problem, group (coalition) *C* uses this general mathematical model to develop its evolving problem

representation and choose controls to play against (offer)  $\bar{C}$ . Hierarchies 1 and 2 may be thought of as group *C*'s snapshot of its evolving dynamical system at the current present.<sup>5</sup>

Group *C* plays a noncooperative game against  $\bar{C}$ . The ESD model is prescriptive-descriptive (Raiffa, 2002) – prescriptive for group *C* in making choices based on its descriptive predictions of the behavior of  $\bar{C}$ . Within *C*, players play a within-coalition *C* game whose agreed-upon solution constitutes the control for *C* to play against (offer)  $\bar{C}$ . Within group *C*, the individual agents – in general having different views (problem representations) – can play a cooperative game meaning enforceable agreements are permitted; otherwise the within-coalition *C* game is noncooperative. The formal group *C* (joint) problem representation is based on the union of its formal individual-player problem representations.<sup>6</sup> The latter include estimates (predictions) by the respective individual players of the set of controls (or subjective probabilities on this set) useable by  $\bar{C}$ . These are the basis of *C*'s prediction of the set of  $\bar{C}$ 's useable controls.

If the individual-player problem representations are not fully shared (made public) within group *C* by individuals in that group, the group's public group problem representation will be incomplete. In this case, each player (and others, e.g., a mediator) privately can subjectively estimate missing information; in other words, establish his private group problem representation.

<sup>5</sup> Represented here by hierarchies 1 and 2, the ESD general mathematical model (dynamical system) is given in Shakun (1988, chapter 1), by relations (5), (6), (7), (8), (9) and a goals/criteria relation there. A coalition (group) *C* plays a game in time over a multiperiod planning horizon against the set  $\bar{C}$  of all other players not in *C* who themselves can form one or more coalitions. The game has a moving present and is an evolving difference game. (Dynamical (described in time) systems in discrete (continuous) time with two or more players are called difference (differential) games.) Relation (5) is represented in hierarchy 1 which shows the coalition *C* controls/goals/values relation. Relation (6) is represented in hierarchy 2 as the individual and group (coalition *C*) preference structures. Relations (7), (8), (9) are represented in hierarchy 2 by the technology relation between controls and goals. The goals/criteria relation is also represented in hierarchy 2. The relations (5), (6), (7), (8), (9) and the goals/criteria relation model cybernetics/self organization.

<sup>6</sup> Formal problem relations (always explicit) are expressed by the formal group problem representation (hierarchies 1 and 2). There are always also informal relations, those not expressed in the formal group problem representation that may be explicit or implicit.

**Table 1**  
Cybernetics/self-organization  
in group problem  
restructuring

Problem representation	Selection of Problem Structure at Bifurcation by:	
Driven to Bifurcation by:	Cybernetic control	Self-organization
Cybernetic control	Cybernetics (description 1)	Cybernetic self-organization (description 2)
Self-organization	Self-organizing cybernetics (description 4)	Self-organization (description 3)

The control alternatives available to  $C$  to play in the  $C$  vs.  $\bar{C}$  game are analyzed. Playing against its prediction of the set of  $\bar{C}$ 's useable controls and using a particular available control alternative,  $C$  can control to a predicted feasible output goal set using its group technology (hierarchy 2). Similarly, for each of its other control alternatives,  $C$  can predict its feasible output goal set. This  $C$  vs.  $\bar{C}$  predicted output analysis is incorporated in the individual private group problem representations of the players in  $C$ . Then the within coalition  $C$  game is played either cooperatively or noncooperatively to arrive at an agreed-upon compromise solution (control alternative) for  $C$  to play against (offer)  $\bar{C}$  (Shakun, 1990). After  $C$  and  $\bar{C}$  actually play<sup>7</sup> their present time period controls,  $C$  determines what goal levels have been reached and so does  $\bar{C}$ . Negotiation may continue one time period later.  $C$  and  $\bar{C}$  may consider problem restructuring leading to an evolved problem system (see below). Then each solves its evolved problem to determine its control (concession) to now play. Thus, negotiation may continue through concession making between  $C$  and  $\bar{C}$  leading to either a compromise solution (agreement) or negotiation break-off.

As described above, agreement between  $C$  and  $\bar{C}$  is a compromise solution reached by concession making. In addition to concession making, various game theory and social choice approaches are available for finding compromise solutions (Shakun, 1988, 1990). For the use of case-based reasoning to find compromises, see Sycara (1990) and for rule-based techniques, see Kersten et al. (1988).

If coalition  $C$  comprises the grand coalition of all  $N$  players, then  $\bar{C}$  is empty, and an agreed-upon compromise solution of the within coalition  $C$  game can simply be implemented.

With difficult problems, i.e., when a solution to a problem is not forthcoming, problem system redesign by problem restructuring (reframing) is a key approach in cybernetics/self-organization. Associated with discontinuous change in consciousness, problem restructuring involves redefining (redesigning) the structure (sets of elements and their relations) in hierarchies 1 and 2. Regarding restructuring, a group problem representation can have bifurcation points at which there is a choice of branch (problem structure). Shakun (1996) describes four possibilities for restructuring (reframing) involving cybernetic control and self-organization (Table 1).

For descriptions 1, 2, and 4 in Table 1, restructuring may be supported using the ESD referral process (described below) and other domain-independent methodological knowledge (Shakun, 1991).<sup>8</sup> With description 3, self-organization both drives the problem representation to bifurcation and selects the new problem structure.

An interesting example of restructuring with description 3, self-organization is provided by Martinovski (2007). Using linguistic analysis and drawing on theory of mind, she considers a plea bargaining negotiation involving a judge, a defense attorney and a prosecutor in which unexpected reframing occurs bringing common ground and a compromise agreement.

The ESD heuristic controls/goals/values referral process is based on the idea that values, goal variables and control variables can serve as reference, referral or focal points for generating other values, goal variables, and control variables in restructuring the controls/goals/values relation in hierarchy 1.

In hierarchy 1, consider the goals/values relation as a matrix which shows which values (rows) are

<sup>7</sup> We are describing simultaneous play here. Sequential play where players alternate playing present time period controls may also be used.

<sup>8</sup> Sycara (1991) uses case-based reasoning and related procedures, and Kersten et al. (1991) uses rule-based techniques for restructuring.



delivered by which goal variables (columns) for individual players in a group. For a given player, an entry of 1 as an element of the matrix indicates that the player is “for” the row value being delivered by the column goal variable (the column variable being a producer of the row variable, and promoted and implied by the row variable), i.e., he/she favors both the value and the goal variable as an operational expression of the value. An entry of 0 indicates the player is against the value being delivered by the goal variable. An entry of \* indicates the player is neutral or does not perceive the value as being delivered by the goal variable. The entries for a given player can change, and the sets of values and goal variables can evolve using the goals/values referral process.

In other words, we are relating two sets (lists), values (rows) and goal variables (columns). ESD makes use of heuristics (rules of thumb) for changing the two sets and their relation in problem restructuring.

Some heuristics for the referral process stated for values and goal variables (control variables can also be used) are as follows (Shakun, 1988, chapter 13):

1. Given a particular value (row) and looking at the goal variables (columns), is there any other new goal variable that also delivers the value, or should an existing goal variable be dropped?
2. Given a particular goal variable (column) and looking at the values (rows), is there any other new value that is also delivered by the goal variable, or should an existing value be dropped?
3. Given a particular value (row), is there any other new value (more general or less general) that also expresses this value?
4. Is there any other additional value that is important in this problem or should an existing value be dropped?
5. Given a particular goal variable (column), is there any other goal variable that is suggested by this goal variable?
6. Is there any other additional goal variable that is important in this problem or should an existing one be dropped?
7. Is there any other additional player who should now be included in the group goals/values relation or should one be dropped?

Faure et al. (1990) discuss social-emotional aspects of ESD. It is possible to include social-emotional aspects as well as task aspects in the problem representation.

Regarding coalitions, once a coalition  $C$  forms ESD provides negotiation support for it. The ESD model can also support coalition formation itself. ESD can be used prescriptively by any player, player group, or others in simulating a coalition  $C$  – try it out to see if coalition  $C$  is worthwhile forming. Formal modeling of coalition formation is an active research topic – see, for example the Coalition Theory Network website, hosted by Fondazione Eni Enrico Mattai (FEEM), <http://feem.it/web/attiv/ctn.html>. Various cooperative and noncooperative approaches in game theory are noted. Some promising directions, e.g., network formation theory as a generalization of coalition theory, are included.

ESD supports consensus-seeking, i.e., moving towards the same preferred (desired) solution for all players, through sharing of views constituting exchange of information. Of course, in practice if consensus is not achieved, compromise can provide a solution.

The ESD general formal mathematical model is an evolving difference game (footnote 5). However, in working with the evolving problem representations (hierarchies 1 and 2) for specific problems, mathematical symbols are not normally used by players, relations between sets of elements being expressed by tables (matrices).

For further discussion on cybernetics/self-organization, the ESD general framework, the referral process, and applications to specific problems/negotiations, see Shakun (1988, 1990, 1991, 1995, 1996, 2003a, b, 2005, 2006a, b).

### ***Purpose in Hierarchies 1 and 2***

A *purpose* of an agent is an intended result. Hierarchies 1 and 2 are hierarchies of agent purpose in Two. In hierarchies 1 and 2, we note that the sets – values, goals, controls, criteria, individual preferences and group preference – are all purposes of agents. More general purposes are higher in the hierarchies. Higher purposes may be characterized as ends, and lower purposes that deliver (produce) these ends as means to

ends. For example, in hierarchy 1, control (decision, action) variables produce goal variables that produce values; they are all purposes. Relation among these purposes defines a system (structure), and constitutes meaning. With ESD, problem solving as systems-spirituality design means the design of purposes and their relations in hierarchies 1 and 2 from the lowest level control (decision, action) to the highest purpose – connectedness with One, spirituality or a surrogate for it. As desired intended results, all of these purposes in hierarchies 1 and 2 may be loosely called “values”, i.e., purposes/values.

### ***Shared Inherent Purpose***

Our core axiom: Human (and other natural) agents have a shared inherent purpose – an ultimate purpose in Two inherent in manifesting from One that they hold in common constituting ultimate common ground. This ultimate purpose (most general, highest purpose/value in hierarchy 1) is to experience spirituality, connectedness with One, i.e., to live Two as One – ultimate purpose connectedness – to hang out in connectedness with One as a way of life in Two. As ultimate common ground, connectedness with One as shared inherent purpose can help agents work through substantive conflict in values, goals and actions.

Nonetheless, an agent can use a surrogate purpose in lieu of connectedness with One as highest purpose in hierarchy 1 (Section “Spiritual Rationality and Right problem Solving: Theory and Practice, Surrogates”).

### ***High-Level Purposes/Values***

Higher purposes in hierarchy 1 can promote and imply lower purposes, and lower purposes can be producers of higher purposes. The ESD referral process (Section “Evolutionary Systems Design (ESD)”) can support this.

For example, just below the highest value, connectedness with One, in hierarchy 1 an agent could place at the second highest level the value (purpose) connectedness with others (other agents, mathematically represented by  $Z(i)$  – Section “Social Connectedness: Connectedness with Others, the “Other” (Other

Agents)”). Connectedness with One can promote and imply connectedness with others. Connectedness with others can be a producer of connectedness with One. Connectedness with others is a widely shared purpose that can help agents work through substantive conflict.<sup>9</sup>

An agent could place the value freedom at the third highest level just below connectedness with others. Connectedness with One and with others can promote and imply freedom. Freedom can be a producer of connectedness with others and with One. If by freedom we mean freedom for an agent and other agents to fully engage in cybernetics/self-organization for right problem solving producing connectedness with One (Section “Right Problem Solving, Spiritual (Right) Rationality and Right Action”), connectedness with One does indeed imply freedom. Love is the affection component of connectedness with One (Section “One, Two, Agent, System, Purpose, Consciousness, Connectedness, Common Ground and Communication”). We could say that connectedness with One (and with others) is love – along with connectedness with others, love is also placed at the second highest level – is freedom.<sup>10</sup> In principle, this can provide support rooted in spiritual systems design (ESD) for freedom and democracy (Sharansky, 2004).

In addition to freedom, an agent could place the value justice at the third highest level. Connectedness with others (and with One) can promote and imply justice. Justice can be a producer of connectedness with others (and with One).

In terms of the ESD referral process (Section “Evolutionary Systems Design (ESD)”), we can think of connectedness with others (and with One) as a higher purpose that generates first freedom and then justice as lower purposes when the question in heuristic 1 below is twice asked. We may think of higher purposes, connectedness with One and connectedness with others as being rows and lower purposes, freedom and justice as columns in a lower purpose/higher purpose matrix. Restating heuristic 1

<sup>9</sup> In addition to connectedness with others, an agent could also place other connectedness awareness/qualia purposes (Section “One, Two, Agent, System, Purpose, Consciousness, Connectedness, Common Ground and Communication”) at the second highest level.

<sup>10</sup> Walsch (2000, p. 204) simply says “love is freedom”.

(Section “Evolutionary Systems Design (ESD)”) we have:

Heuristic 1 (restated): Given a particular higher purpose (row) and looking at the lower purposes (columns), is there any other lower purpose (column) that is promoted and implied by the higher purpose and can be a producer of the higher purpose?

We give another example of the referral process. In declaring “We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the pursuit of Happiness,” this portion of the U.S. Declaration of Independence can be viewed as a heuristic 1 referral process between higher purpose connectedness with One and lower values equality, life, liberty and the pursuit of happiness. In Bhutan, the government emphasizes the purpose “maximize gross national happiness” and there is an on-going transition from their historic monarchy to democracy.

ESD cybernetics/self-organization in general and the referral process in particular can contribute to declaration and constitution development/amendment and constitutional law viewed as problems in systems-spirituality design.

Restating heuristic 2 (Section “High-Level Purposes/Values”), we can start with a particular lower purpose (column) to generate higher purposes (rows). In general, with the ESD referral process, we can start with a purpose at any level and generate purposes at the same or other levels. We can also ask whether there is any other additional player (agent) who should be included in the problem.

## Doing Right

For doing right, an agent  $i$  defines/solves a validated “right” problem/solution. The solution constitutes right action. Validation means the problem/solution satisfies spiritual (right) rationality (Section “Rationality to Spiritual (Right) Rationality” and “ESD Spiritual (Right) Rationality Validation Test”) – the action is reasonable (satisfies generalized rationality) and is a producer of connectedness with One or connectedness with a surrogate purpose (Section “Spiritual Rationality and Right problem Solving: Theory and Practice, Surrogates”). Examples of surrogate

purposes for connectedness with One are connectedness with others; freedom; the vector purpose (freedom, justice); the vector purpose (connectedness with others, freedom, justice). The whole ESD problem representation can be a surrogate purpose.

## Recapitulation: CPSN Through ESD (CPSN-ESD)

With CPSN-ESD, CPSN uses the ESD Systems-Spirituality Framework implemented by computer technology (Section “Technology: Computer Implementation of ESD and Applications”) for evolutionary problem solving/negotiation. This involves designing an evolving problem system of agent purposes and their relations in hierarchies 1 and 2 (an evolving problem representation). For an agent, an evolved problem system satisfying spiritual rationality (Sections “Rationality to Spiritual (Right) Rationality” and “ESD Spiritual (Right) Rationality Validation Test”) identifies right action (a solution) producing spirituality, connectedness with One or a surrogate (Section “Spiritual Rationality and Right problem Solving: Theory and Practice, Surrogates”) for that agent. A negotiation agreement (Section “Common Ground”) requires multiagent agreement on the action to be taken.

With CPSN, action in Two designated as right action is intended to produce/renew/maintain connectedness with One (or a surrogate). Complementarily, connectedness with One (or a surrogate) promotes taking right action (doing right).

## Intelligence and ESD

Intelligence can be viewed and defined in various ways (Pfeifer and Bongard, 2007). With the ESD framework for problem solving and negotiation, we define *intelligence* of an agent/system as its capacity for adaptive behavior, changing behavior (action) to cope with change in the environment or internally to attain adaptive purpose comprising connectedness awareness/qualia purpose (Section “One, Two, Agent, System, Purpose,

Consciousness, Connectedness, Common Ground and Communication”) and related values (purposes) in the ESD problem representation. In other words, with ESD the interest is on actualizing connectedness intelligence for evolving the ESD problem representation to spiritual rationality (Section “Rationality to Spiritual (Right) Rationality”) through purpose, conation (body), swarm, emotional, social, cognitive, systems, spirituality, and holistic intelligence.<sup>11</sup> Humans, at the top of the evolutionary intelligence chain, exhibit all these intelligence, surpassing animals in intelligence while retaining animalistic behavior characteristics.<sup>12</sup> For intelligence in robots, see Pfeifer and Scheier (1999), Pfeifer and Bongard (2007), Kennedy and Eberhart (2001) and Zimmer (2007).

Regarding intelligence in virtual agents, Swarouth et al. (2006) describe a virtual human who negotiates with a real human in a training exercise. The virtual human, appearing on a large screen, has integrated capabilities in task representation and reasoning, natural language dialogue, emotion, and action and body movements including gaze, facial expressions and body gestures. Some negotiation training sessions with the virtual agent indicate continuing functionality with problem restructuring.

## Rationality to Spiritual (Right) Rationality

Drawing on Shakun (2003a, b, 2006a), we discuss rationality, cognitive rationality, generalized rational-

<sup>11</sup> For discussion of one or more of these intelligence types and their relations see: For body intelligence, see Pfeifer and Scheier (1999), Pfeifer and Bongard (2007); for swarm intelligence, see Kennedy and Eberhart (2001), Zimmer (2007); for emotional intelligence, see Goleman (1995); for social intelligence, see Goleman (2006); for systems intelligence, see Hamalainen and Saarinen (2007); for spirituality, spiritual and holistic intelligence, see Zohar and Marshall (2000, 2004); cognitive intelligence is considered by all these references; Rosenberg (2004) considers purposes (values, needs) basic to purpose intelligence.

<sup>12</sup> The triune brain model of MacLean (1990) involves three evolutionary formations –R-complex (reptilian complex), limbic system, and neocortex associated with reptilian behavior (reptiles), emotion (early mammals), and cognition (late mammals), respectively. Reptilian behaviors observed in humans are described by MacLean, e.g., establishment of territory, challenge displays, submissive displays, courtship behavior, etc.

ity, and spiritual rationality. For an agent, if a purpose 1 is reasonable (based on reason – in science, empirically verifiable) with regard to producing a purpose 2, purpose 1 is said to be rational for producing purpose 2, i.e., the purpose 1/purpose 2 binary relation is *reasonable* or *rational* for that agent. For *n*-ary relations, rationality means production among purposes in the *n*-ary relation is reasonable. Rationality is normally associated with cognition; hence, the term cognitive rationality, rationality validated by cognition. We extend rationality to generalized rationality where reasonableness (rationality) of a purpose relation is validated by an agent (1) using one or more of seven consciousness components selected by him from (conation/swarm/emotion/social/cognition/systems/One) and holistic,<sup>13</sup> or (2) holistic alone. Thus, the agent selects the consciousness components used in the validation test.

We further extend rationality to spiritual (right) rationality where the purpose 1/purpose 2 relation or an *n*-ary relation satisfies generalized rationality and is a producer of connectedness with One, spirituality. The latter, spirituality for an *n*-ary relation is validated using the same consciousness components as selected in the test for generalized rationality by verifying connectedness as a subjective experience for each of these components. See Section “ESD Spiritual (Right) Rationality Validation Test” for further details on validation for generalized rationality and spiritual rationality. Other rationalities are possible, e.g., affective rationality where reasonableness is validated only by affection (emotion). After discussing “problems” in Section “Problems”, and “right problem solving, spiritual (right) rationality and right action” in Section “Right Problem Solving, Spiritual (Right) Rationality and Right Action”, we present a subjective validation test for spiritual rationality in Section “ESD Spiritual (Right) Rationality Validation Test”.

## Problems

Problems are in Two, not in One. *Problem consciousness* of an agent means awareness of a problem.

<sup>13</sup> In Shakun (2006a) the consciousness components used in generalized rationality are conation, emotion, cognition and holistic.

*Problem connectedness* means connectedness of an agent with a problem. *Shared* or *reciprocated problem consciousness* means awareness of a problem shared by at least two agents. Following Shakun (2006a), problem consciousness reveals two problem types: problem type (1) arises with the breaking of an agent's connectedness with One (or a surrogate, Section "Spiritual Rationality and Right problem Solving: Theory and Practice, Surrogates"); problem type (2) arises from an agent wanting to manifest in Two his continuing connectedness with One (or a surrogate). Regarding problem type (1), when relationships in Two break the continuity of connectedness with One, the agent has a problem so engages in problem solving to take right action (see next paragraph) to produce re-connectedness with One. Regarding problem type (2), connectedness with One is there and the agent's problem is how to manifest it in Two through right action which produces continuing connectedness with One. In either case, the agent engages in problem solving to take right action to maintain connectedness with One (or a surrogate) as the agent's way of life manifesting One in Two.

Thus, a problem follows from unrealized purpose in Two, the problem being modeled by using the evolving ESD general problem representation, hierarchies 1 and 2. Connectedness with One in humans is tenuous and frequently lost so problems are ubiquitous. While they can be painful reflecting non-connectedness with One, problems are opportunities for re-identifying right action sustaining the One experience. The discussion that follows is applicable to an agent involved with group (multiagent) problem solving, as well as to the case of individual problem solving.

## Right Problem Solving, Spiritual (Right) Rationality and Right Action

Problem solving is systems design is cybernetics/self-organization (Section "Evolutionary Systems Design (ESD)"). This involves an agent in designing procedures (process) and using them – engaging in cybernetics/self-organization to design the problem/solution system. Right (spiritual) problem solving is right (spiritual) systems design is right (spiritual) cybernetics/self-organization. In right problem solving/negotiation, the agent works with other agents

in a group to design procedures (process), preferably right procedures, that are used to design a right problem/solution where right means the problem/solution or system of procedures satisfies spiritual rationality as validated by the agent using a spiritual (right) rationality validation test (Section "ESD Spiritual (Right) Rationality Validation Test"). A validated solution or procedure constitutes right action – action that is generalized rational and produces spirituality (connectedness with One) for the agent. Spirituality for an agent can require that an action also bring spirituality to some or all other agents in the problem/negotiation, as individually judged by them.

In other words, as judged individually by him, an agent can validate a right problem/solution by a subjective test for spiritual rationality presented in Section "ESD Spiritual (Right) Rationality Validation Test". If validated, we say there is *right problem rationality* meaning the problem/solution is rational and produces spirituality. In any case, whatever the solution obtained by problem solving, it is the result of using problem solving/negotiation procedures (procedural process). A system of procedures can also be validated as being right, i.e., for rationality and spirituality by the same subjective test used for right problem rationality. If validated, we say there is *right procedural rationality*. This is desirable since right procedures promote a right problem/solution producing spirituality. At the same time, spirituality promotes right procedural rationality. Problem solving with spirituality promotes freedom to fully engage in cybernetics/self-organization favoring a right problem/solution.

Simply put, *spirituality (connectedness with One) by actualizing agent intelligence, promotes right problem solving/negotiation that in turn produces spirituality*. Therefore, in beginning/continuing right problem solving/negotiation if he is not already there, an agent is advised to access (return, transit to) spirituality, connectedness with One (Shakun, 2006a).

One is always there ("I am One"). *Inner stillness* (awareness with quiet mind) is a key to connectedness with One. If an agent loses connectedness with One, inner stillness brings re-connectedness. Connectedness with One is the default state and always returns if the agent is open<sup>14</sup> to it – turns off thought, lets

<sup>14</sup> We note that in Buddhism, openness or emptiness means not fixating or holding on to any thought.

the problem go. Focusing on the now (the present moment) by focusing attention on (sensing) anything without thought – accepting the moment as it is – lets the problem go, bringing inner stillness and connectedness with One. One is always in the now, the present moment (in Shakun, 2001a). The power of now, Tolle (1999, 2003), is the power of connectedness with Being (One). Tolle suggests various signposts or portals to One, for example, focusing attention on (sensing) the inner body. Focusing on the breath as in mediation is well known. Lowest in the cumulative evolutionary chain of emergence of Two from One, the body provides direct access to inner stillness and connectedness with One. Shakun (2001a) discusses some techniques for letting the problem go and transiting to connectedness with One. In religion prayer is a key to connectedness with One. Play (The National Institute of Play website, <http://www.nifplay.org>) can bring connectedness with One.

Hence, an agent begins right problem solving by (1) accepting the problem, (2) accessing spirituality (connectedness with One) if not already there, and staying there as much as possible while (3) developing/designing (preferably right, sometimes ad hoc) procedures (process, means) and using them in defining/designing a right problem/solution (product, end).<sup>15</sup> This involves the agent (1) judging (validating, testing) whether a suggested system of procedures for designing (defining/solving) the problem is right rational, i.e., whether there is right procedural rationality, and (2) validating (testing) whether the resulting defined problem/solution (represented in hierarchies 1 and 2) is right rational, whether there is right problem rationality. A validation test for both right procedural rationality and right problem rationality is presented in Section “ESD Spiritual (Right) Rationality Validation Test”. As noted, since right procedural rationality promotes right problem rationality, right procedural rationality is desirable. Failing the latter, next preferable is validation of generalized procedural rationality. Here

reasonableness is validated by generalized rationality but spirituality is not validated. Otherwise, validation of cognitive procedural rationality or of other procedural rationalities, e.g., affective procedural rationality is possible. Thus, whether regarding his own suggested procedures, those of other agents, or procedures actually adopted by the group, each agent can judge (test) whether for him/her procedural rationality is right, generalized, cognitive, affective, ad hoc or a mix of these over time. Whatever the rationality of the problem solving procedure (process) used, an agent can test whether for him/her a group problem problem/solution that evolves is right rational or test a problem/solution for other rationalities.

### **ESD Spiritual (Right) Rationality Validation Test**

For an agent, we present an ESD subjective validation test for spiritual (right) rationality applicable to particular procedures and problem relations as  $n$ -ary relations (systems) drawing on Shakun (2003a, 2006a). The test applies to binary and higher  $n$ -ary relations up to and including the whole system of procedures or the whole problem representation/solution (hierarchies 1 and 2). With CPSN-ESD, validation of the whole problem representation/solution for spiritual rationality affirms rationality and agent connectedness with an evolved problem and a right solution (action). Tests for other rationalities are similar, less comprehensive versions omitting those aspects of spiritual rationality that do not apply.

With spiritual (right) rationality validation, an agent tests whether for him spiritual rationality is confirmed, i.e., whether generalized rationality and connectedness with One (or a surrogate, Section “Spiritual Rationality and Right problem Solving: Theory and Practice, Surrogates”) are validated using a test involving consciousness awareness/qualia components selected by the agent (1) from (conation/swarm/emotion/social/cognition/systems/One) and holistic or (2) holistic alone. The test for generalized rationality tests reasonableness (rationality) and omits testing for connectedness with One; the test for spiritual rationality includes both. Thus, validation for spiritual rationality affirms ESD problem system connectedness for an agent.

<sup>15</sup> Procedures and the problem/solution are each systems. Designing a system involves the use of procedures (procedural process, means) to deliver products (ends). The procedures for defining the problem/solution product are themselves the product of procedures for developing procedures. Group agreement on procedures (preferably right procedures) is a negotiated agreement on the way to another negotiated agreement (preferably right) – the solution to the problem/negotiation.

To clarify with an example, Shakun (2006a) presents a spiritual (right) rationality validation test where the agent selects validation by cognition, emotion, conation, and holistic. For the agent, this involves subjective testing by (1) cognition – is this  $n$ -ary procedure or problem relation cognitively reasonable (rational) and is it cognitively a control or intermediate producer of oneness,<sup>16</sup> (2) emotion – is this  $n$ -ary procedure or problem relation emotionally reasonable (rational) and is it emotionally a control or intermediate producer of love, does it feel right, and (3) conation – is this  $n$ -ary procedure or problem relation conatively (body) reasonable (rational) and is it conatively a control or intermediate producer of perfect (connected) action with commitment to implementation, (4) holistic – is this  $n$ -ary procedure or problem relation holistically reasonable (rational) and is it holistically a control or intermediate producer of connectedness with One (spirituality)? Spiritual (right) rationality requires “yes” answers to all of these questions. When the  $n$ -ary relation is the whole problem representation, then the words “control or intermediate” in the questions are omitted – the whole problem representation itself is or is not the producer.

As consciousness components are integrally bound and can be experienced holistically, an agent may in practice prefer a simpler holistic-alone test that is the same as part (4) of the test above. The *holistic-alone spiritual (right) rationality validation test* for a particular  $n$ -ary procedure relation or problem relation involves subjective testing holistically – is this  $n$ -ary procedure or problem relation holistically reasonable (rational) and is it holistically a control or intermediate producer of connectedness with One (spirituality)? Spiritual (right) rationality requires a “yes” answer. Spiritual rationality of the problem/solution for an agent means that the solution (control, decision or action to be implemented) is right – is rational and produces spirituality, connectedness with One for that

agent, and that is the agent’s inherent purpose, the agent’s highest value.

## Spiritual Rationality and Right Problem Solving: Theory and Practice, Surrogates

Following Shakun (2003, 2004, 2006a), in the general case of not-fully-shared-information among agents in a group, each individual agent in group  $C$  – employing, as may be useful, the incomplete public group problem representation – can judge (test, Section “ESD Spiritual (Right) Rationality Validation Test”) whether his own private group problem representation (Section “Evolutionary Systems Design (ESD)”) with an agreed-upon compromise solution found by group  $C$  is right for him. If all individual agents so judge rightness, then the group  $C$  has defined and solved a right problem (as represented by the private group representations of its members), although publicly it is incompletely represented. A right private group problem representation/agreed-upon compromise solution for all agents in group  $C$  is the ideal result – the solution constitutes right action whose implementation produces spirituality for all agents in the group. For case of fully-shared information – a special case of not-fully-shared information – the public and all the private group representations are the same and publicly completely represented within group  $C$ .

If an individual agent in a group  $C$  judges that with regard to his own private group problem representation that the group agreed-upon compromise solution is not right for him, he can try to continue problem solving/negotiation (cybernetics/self-organization search) with the other group members to arrive a right solution for him/her. If this does not happen, leaving the group is always an option for the agent. In practice, solutions that are not right for at least some agents in the group, as judged respectively by them, are not infrequently implemented. Still, later problem solving that could deliver connectedness for all agents is possible.

Particularly prevalent in large groups, a group-designated or undesignated subset of agents of the group  $C$  may collectively evaluate solution rightness for the group. Clearly, in this case, it may not be right for all individuals in the group.

<sup>16</sup> With respect to cognitive rightness for a problem relation, Shakun (1992, 1999a, 2001a) suggests validation by specified cybernetic/self-organization procedures – evolutionary heuristics or generating procedures – for examining, changing (evolving) and retaining the relation. These include the heuristic controls/goal/values referral process considered in the Section “Evolutionary Systems Design (ESD)” of the present chapter.

The above discussion of rightness in the general case of not-fully-shared information applies to both agreed-upon compromise solutions for group  $C$  agents to the within- $C$  game and to the  $C$  vs.  $\bar{C}$  game. A negotiation agreement to the  $C$  vs.  $\bar{C}$  problem (game) requires agreement by  $C$  and  $\bar{C}$  on the action to be taken.

*In theory*, with regard to the problem relations in hierarchies 1 and 2, not only the binary relations (e.g., goals/values relation, controls/goals relation, controls/values relation, technology relation, goals/criteria relation, individual and coalition preference structures, and, of course, controls/spirituality relation, spirituality being the highest value), but all  $n$ -ary relations should be tested for spiritual (right) rationality. This includes the whole problem representation (hierarchies 1 and 2) which itself is an  $n$ -ary relation. In practice, if an agent's validation test shows that key binary relations and the whole problem representation are right, then the problem representation/solution could be taken as right producing spirituality (connectedness with One), and would be the present result of problem solving. Similarly, in practice for procedures, testing for right (spiritual) rationality could be limited to key binary procedure relations and the whole system of procedures.

In theory, spirituality promotes right problem solving and right problem solving produces spirituality for an agent. In practice, if problem solving does not produce spirituality for an agent and/or if he so chooses, the agent can use another purpose at a lower level than spirituality as a surrogate purpose for spirituality. In this case, the spiritual (right) rationality validation test (Section "ESD Spiritual (Right) Rationality Validation Test") becomes a test for surrogate spiritual rationality where connectedness with One is replaced by connectedness with a surrogate purpose. The validation test asks whether an  $n$ -ary procedure or problem relation is reasonable and is a control or intermediate producer of the surrogate.

For example, just below the highest value, connectedness with One, in hierarchy 1 an agent  $i$  could place the value (purpose) connectedness with others (other agents) at the second highest level. Agent  $i$  could use connectedness with others as a surrogate for connectedness with One (spirituality) if problem solving does not produce spirituality for agent  $i$  and/or if he so chooses.

A surrogate can also be a vector of purposes. For example, the surrogate purpose vector with components connectedness with others, freedom, and justice can be a surrogate for connectedness with One. The whole ESD problem representation can be a surrogate.

In theory, there may in the problem representation be any number of levels in hierarchy 1, and control, goal and value purpose vectors may have any number of components. In practice, a small problem representation – relatively few levels in hierarchy 1 and low-dimensional purpose vectors – that satisfies the spiritual rationality test for a right problem/solution (producing connectedness with One) is recommended. When there is no problem, hierarchy 1 has only the highest value/purpose, connectedness with One (signifying the agent hanging out there). Problems are in Two, not in One, and are of two types (Section "Problems"). To begin right problem solving, if he is not already there the agent is advised return to connectedness with One by letting the problem go (Section "Right Problem Solving, Spiritual (Right) Rationality and Right Action"). Solving the problem with the absolutely smallest problem representation means a hierarchy 1 (and associated hierarchy 2) having, as a group agreed-upon problem solution, only one control level with a one-dimensional control vector, and the highest value, connectedness with One. If this absolutely smallest problem representation satisfies the agent's validation test for a right problem/solution, the problem has rightly been solved, the solution producing spirituality for the agent. In practice, additional purposes – values, goals, controls – normally are added.

Adding additional purposes can be helpful and frequently necessary in judging by the spiritual rationality validation test that rightness (spirituality) is satisfied. However, in adding these it is important to remember that the rightness of a problem representation/solution comes fundamentally from its lowest level control vector – the practical action or control implemented – delivering connectedness with One. Other-level purposes – both lower-level purposes (often called practical results) and higher-level ideal values – are intermediates in producing connectedness with One. Nevertheless, intermediates can be important and necessary for an agent in judging rightness with the validation test and in explaining the problem and choice of controls among agents. For



example, for agent  $i$ , connectedness with others represented by  $Z(i)$  can be an important in judging whether connectedness with One is produced, i.e., whether  $z^*(i) = 1$ . The purpose vector (freedom, justice) can be necessary intermediates in judging whether connectedness with others and with One is produced by a control vector. These other-level purpose intermediates can also serve as surrogates (see above in the Section “Spiritual Rationality and Right problem Solving: Theory and Practice, Surrogates”) for connectedness with One.

### **Beginning/Continuing Negotiation: Accessing Connectedness with One, Surrogates and Intermediates**

In Section “Spiritual Rationality and Right problem Solving: Theory and Practice, Surrogates”, we discussed use of a surrogates and intermediate purposes – e.g., connectedness with others – for connectedness with One in problem/solution validation. Here, we consider use of surrogates and intermediates in beginning/continuing negotiation having discussed accessing connectedness with One itself in Section “Right Problem Solving, Spiritual (Right) Rationality and Right Action”.

In beginning/continuing negotiation, an agent is advised to access connectedness with One to promote right problem solving/negotiation (Section “Right Problem Solving, Spiritual (Right) Rationality and Right Action”). If he has difficulty in accessing spirituality and staying there, the agent can access a surrogate purpose instead, such as connectedness with others and/or freedom. Even if he can access connectedness with One so that a surrogate is not necessary, an agent may consciously access other purposes – intermediates – that he feels are helpful for him in beginning/continuing negotiation. The agent may include intermediates in his own problem representation, and may or may not communicate these to other agents.

To illustrate, in beginning his speech to what he sensed was a chilly Israeli Knesset (parliament), Egyptian President Anwar Sadat said that we are all religious brothers; religious brotherhood was for him a surrogate or intermediate to spirituality in communicating with the Knesset members.

### **Beginning/Continuing Negotiation: Connectedness with Others**

In addition to connectedness with One (or if he cannot access it, instead as a surrogate), an agent can access the purpose, connectedness with others in beginning/continuing negotiation. In matrix  $Z(i)$ , agent  $i$  can represent whether he is experiencing connectedness (or non-) with a specified set of agents  $j$  that he intends as his connectedness family, agent  $i$ 's intended connectedness family. Thus, for agent  $i$  connectedness with this set (family) can be a purpose.

If an agent  $i$  chooses connectedness with others as a surrogate for or addition to connectedness with One in beginning/continuing negotiation, he takes action to try to produce and maintain connectedness with his intended connectedness family, and encourage reciprocated connectedness by this family or as large a subset of it as possible, which then constitutes his reciprocated connectedness family. Agent  $i$  may re-specify/re-identify these families over time. Sometimes connectedness with others can work better as a surrogate or addition if agent  $i$  can increase the size of his connectedness and reciprocated connectedness families.

Adopting this connectedness-with-others action approach – where in beginning/continuing negotiation an agent takes action to try to produce/maintain connectedness with his intended connectedness and reciprocated connectedness families – does not guarantee current conflict resolution. However, the connectedness with others/connectedness with One relation suggests promise for the connectedness-with-others action approach for problem solving in the long-run.

For example, in the continuing fragile negotiations between Israel and the Palestinians, in continuing economic connection (action) Israeli farmers sell agricultural produce to Palestinians in Gaza and this action can produce connectedness with others. In effect, Palestinians could be thought of in terms of intended connectedness and reciprocated connectedness families. In South Africa, connectedness with others has been promoted by the truth and reconciliation process (action).

Connectedness-with-others action may be thought of as occurring within a communication process between an agent and the “other”, and guided

and interpreted using Rosenberg's observations-feelings-needs-requests nonviolent communication framework (Section "Communication, Dialogue And Negotiation").

## Technology: Computer Implementation of ESD and Applications

Shakun (2001a, 2004), drawing on Shakun (1999b) and Lewis and Shakun (1996), discusses computer implementation of the ESD general framework for designing/evolving, defining/solving specific problems using a computer group support system. With the help of a facilitator, group C may create and execute a procedural process meeting script for the problem. The meeting script can involve both electronic and non-electronic activities. The meeting script is the detailed agenda or procedural sequence (hopefully, judged by all individuals in group C as following right procedural rationality, but not necessarily – see Section "Right Problem Solving, Spiritual (Right) Rationality and Right Action") that group C chooses in developing the ESD group problem representation (formally, hierarchies 1 and 2). Script management can be dynamic including adjustments of meeting scripts "on the fly" during meetings (Kelman et al., 1993). Lewis (1995) discusses a general purpose group support system, MeetingWorks for Windows, that has a set of software tools (generate, organize, cross-impact, etc.) for group meeting support. Lewis and Shakun (1996) create and execute an illustrative group meeting script and demonstrate how a ESD group problem representation and solution can be developed using MeetingWorks.<sup>17</sup> Originally for same-place/same-time work, MeetingWorks has been extended to group at-a-distance telework that can be performed on the Internet.

Regarding online dispute resolution (ODR), present-to-future CPSN-ESD work includes computer joint implementation of CPSN-ESD and the

negotiation software, Smartsettle developed by Ernest Thiessen ([www.smartsettle.com](http://www.smartsettle.com)), and studies of CPSN-ESD/Smartsettle/Meetingworks integration.

Shakun (2001b) considers some aspects of mobile technology, connectedness and ESD. He discusses physical connectivity – promoted by advances in communication (internet, mobile technology, etc.) and transportation (airplane travel, etc.) – and subjective connectedness. The leap in physical connectivity increases the number of interacting agents in systems of people and technology. This creates opportunities for subjective connectedness or non-connectedness in groups local to global with consequences for international negotiation involving globalization including e-business, terrorism, etc.

## Applications

The initial real world experience in applying ESD was for group problem solving/negotiation within a major European automobile company. Cultural differences between players were largely professional cultural differences, e.g., as between marketing, engineering and finance. In Shakun (1988), chapters 11 and 12 are based on this experience for new product design and negotiation. Chapter 10 discusses ESD group decision and negotiation support for car buying, the approach being strongly influenced by this experience.

ESD is applied to airline buyout in Shakun (1991). ESD is discussed in the context of e-commerce system design involving multi-bilateral, multi-issue e-negotiation with a tit-for-tat computer agent (Shakun, 2005).

ESD is developed for international negotiation in Shakun (2006b). Some international applications include the multiplayer Arab-Israeli conflict (Shakun, 1988, chapter 3), and negotiation between a multinational corporation and a host (India) government (Shakun, 1988, chapter 6). Intercultural negotiation illustrated by Japanese-American negotiation is considered in Shakun (1999b). An example involving an on-going crisis negotiation – the April 2000 United States–China plane collision – is developed in Shakun (2003b). Faure and Shakun (1988) discuss a case involving international negotiation to free hostages.

<sup>17</sup> Of course, other general-purpose group support systems, e.g., GroupSystems, can be used with ESD. Bui and Shakun (1996) discuss more specialized negotiation capability provided by NEGOTIATOR for implementing ESD.

## Concluding Remarks

CPSN-ESD represents Connectedness Problem Solving and Negotiation (CPSN) through Evolutionary Systems Design (ESD) for doing right meaning defining/solving a validated “right” problem/solution. The solution constitutes right action. This is problem solving and negotiation for connectedness/right action through systems-spirituality design with ESD implemented by computer technology. Problems evolve towards a validated right problem/solution expressing agent problem system spiritual (right) rationality – rationality and connectedness with a problem system of purposes and their relations (the ESD problem representation) that expresses right action (a solution) producing connectedness with One, spirituality or a surrogate purpose. While CPSN-ESD emphasizes connectedness with One as shared ultimate common ground, an agent may use connectedness with others and other purposes as surrogates and intermediates for connectedness with One. In brief, CPSN-ESD means problem solving and negotiation for connectedness/right action – for doing right.

Difficult polarizing problems/conflicts are pervasive. For finding solutions to these, full or partial use of the computer-implemented formal CPSN-ESD framework is particularly indicated, although informal use as a guide can also be valuable. Using this framework in multiagent problem solving/negotiation itself provides common ground for agents. For simple problem solving and negotiation, we also can, of course, use the computer-implemented formal CPSN-ESD framework, but here we may be more inclined to employ CPSN-ESD informally and in a more limited way.

Experience reflected in the Shakun references cited suggests that agents using full or partial, computer-implemented formal CPSN-ESD or using CPSN-ESD informally as a guide achieve more and better (suitably defined) negotiation agreements. A mediator/facilitator can support agents in this. In addition laboratory negotiation experiments – in which negotiators are primed or not for connectedness and spiritual rationality – can be run with CPSN-ESD for controlled verification that primed negotiators achieve more and better negotiation agreements.

For an agent following CPSN, connectedness with others – as a key high-level surrogate/intermediate purpose for connectedness with One – can promote

choices/actions by the agent that are themselves producers of connectedness with others and that encourage reciprocated connectedness. Nonetheless, negotiation power is important for a CPSN agent. A CPSN agent may not feel confident that the “other” likewise is/becomes CPSN oriented and remains so during the negotiation. A CPSN agent may indeed feel that the “other”/counterpart does not follow CPSN – or a compatible framework like that of principled negotiation (Fisher et al., 1991) – but is a hard-power negotiator. Thus, a CPSN agent may have to negotiate in a non-CPSN environment. That is why CPSN agent intelligence recognizes that negotiation power is desirable to have, and use constructively in pursuing CPSN.

In game theory a negotiator’s power is related to his conflict payoff (associated with BATNA – Best Alternative To Negotiated Agreement) and his propensity for risk-taking as reflected in the shape of his utility function, as these relate to those of the “other.” Conflict payoffs and utility functions are not necessarily fixed. These may be changed by an agent and the “other” and are subject to influence from the other side. Fisher et al. (1991) discuss how an agent can enhance his negotiating power. It is also true that negotiation power is inherent in the very use of CPSN-ESD.

## Present-to-Future Work

Regarding present-to-future work, in Section “Technology: Computer Implementation of ESD and Applications” we have already mentioned joint implementation of CPSN-ESD and the Smartsettle negotiation software, and studies of CPSN-ESD/Smartsettle/Meetingworks integration.

In developing CPSN-ESD, we have focused primarily on humans whose evolving consciousness, connectedness, intelligence and rationalities is at present the most advanced and comprehensive. The CPSN-ESD approach is applicable to other agents with lesser (or greater) matter/energy/consciousness capabilities than humans according to their built-in capabilities. For preliminary discussion see Shakun (2001a).

Multiagent systems with human and computer agents are of special interest. With CPSN-ESD, modeling/system design means not only defining, evolving and solving problems/negotiations involving

human/natural and computer/artificial agents in given multiagent systems, but modeling/designing the agents and multiagent systems themselves. Present-to-future work includes furthering support of human agents in actualizing spiritual rationality in CPSN-ESD; designing spiritual artificial agents; designing multiagent systems for connectedness capitalism based on CPSN-ESD – see related research by Zohar and Marshall (2004) on spiritual capital; developing connectedness democracy; further research and applications on intercultural and international negotiation; work on the world connected.

### **To Live Two as One**

One represents all there is, the absolute, the imprecise order, the quantum vacuum, emptiness, God, Tao, Being, the non-manifested. Two represents the process of all there is, the relative, the explicate order, excitations of the quantum vacuum, the manifested, agents. Two, manifests from One as agents and signifies at least two agents. An agent constitutes energy/matter/consciousness integrally bound. Agents may be natural or artificial. This is our core axiom (Section “Shared Inherent Purpose”): Human and other natural agents have a shared inherent purpose – inherent in emerging from One – that they share in common. Such an agent’s inherent purpose – its ultimate purpose in Two (highest purpose/value in hierarchy 1) – is to experience spirituality, connectedness with One, i.e., to live Two as One. Nonetheless, an agent can use a surrogate purpose in lieu of connectedness with One as highest purpose in hierarchy 1 (Section “Spiritual Rationality and Right problem Solving: Theory and Practice, Surrogates”). In this chapter the main agent-focus is on human agents.

To live Two as One, i.e., to be One in Two, involves an agent accessing and staying as much as possible in spirituality, connectedness with One or a surrogate purpose as a way of life manifesting One in Two; and when a problem occurs the agent engaging in individual and multiagent (group) problem solving/negotiation to find right action – confirmed by validation of agent spiritual rationality (generalized rationality and problem system connectedness) – to produce (renew, continue) connectedness with One or

a surrogate. A negotiation agreement requires multiagent agreement on the right action to be taken.

The world connected – what does it mean? It signifies physical connectivity, but more fundamentally, it means subjective connectedness – especially, with “the other”; communicating, sharing and innovating ideas; engaging in problem solving and negotiation to find right-action solutions to problems.

Simply put, CPSN-ESD – Connectedness Problem Solving and Negotiation (CPSN) through Evolutionary systems Design (ESD) implemented by computer technology – is dedicated towards spiritual rationality/connectedness problem solving, manifesting One in Two.

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