

# A Study of Collective Entrepreneurship Using Agent-Based Modeling

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The undersigned, appointed by the Dean of the Graduate School, have examined the  
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## Introduction

The impact of entrepreneurship in the United States is legendary. Entrepreneurship makes an impact personally, encouraging businessmen and women that success is possible with hard work and luck. Entrepreneurship makes an impact nationally, creating pop icons that stand as spokespeople for the mystique of creative geniuses (Reich 1987). Although, entrepreneurship makes such a large impact on our nation and globe it still seems that many people believe in the mysterious success of both small entrepreneurial ventures and large publically offered entrepreneurial corporations. The success is no mystery; it is rather a great deal of hard work by a small or large group of people. The reality of entrepreneurship, as proven empirically by Martin Ruef in *The Entrepreneurial Group*, is people work in small demographically similar groups that are isolated in geographic locations and held together by strong collective ties and collective goals (Ruef 2010). The more accurate story of the entrepreneur is one who works closely with a small intimate group of 4 – 5 people tediously over an extended amount of time to dream, create, and produce innovation. The best way to start the story of entrepreneurship is to start in the beginning, entrepreneurial group formation.

Philosophers and sociologists have studied group formation for years and therefore, the literatures are quite extensive. Group formation starts with the study of the individual and their intention to act. Methodological individualists believe that individuals have intentions that are always self-interested and rational. Their

intentions cannot be rolled up to an aggregate group, and any social group formation is present because of large powerful institutions in place. Methodological holists believe that individuals have intentions that are often times self-interested and rational. Their intentions can be rolled up to an aggregate group and form social groups that provide utility to the individual. There are some methodological holists that believe that not only can intentions be rolled up to an aggregate group but that individuals can have intentions that only exist within the context of a group. These intentions are often called 'we-intentions' or 'collective-intentions'. When individuals acting out of collective intentionality form groups, the group, as a representative whole of the individuals, is able to act with group agency. Group agency is a phenomenon that we see in entrepreneurship; a group of people with collective intention and collective action working for a collective good are able to use a spokesperson for their entrepreneurial group.

In this paper I use multiple fields to study group entrepreneurship: philosophy, economics, and ecology. The philosophers contribute to the study of the social ontology of groups. The economists contribute the impact the peculiar behaviors of entrepreneurs have on free market economics. The ecologists provide a method of study to measure and monitor interactions of the individual with the environment. It is the combination of all three fields that allows each field to agree to group entrepreneurship is real in the most simplest of terms: people work together. The dispute arises when each of the fields compare their assumptions of the world they live in. Depending on the 'breed' of philosopher you meet, either methodological

individualists or methodological holists, they are motivated by the individual's own agency to achieve group action. Economists are convinced that all individuals are rational and no group action is rational. The ecologists perceive group action as natural (as in social animals) and have developed a method for studying such action. Can we combine the insights of philosophers, economists, and ecologists to study group entrepreneurship? That is, can we model how latent entrepreneurs search the economic landscape for partners in the economic functions of new venture formation? This work reflects the work in these fields completed to date.

In this paper I defend group entrepreneurship through an extensive literature review of collective intentionality and group agency leading to an agent-based model of group formation. I believe collective intentionality is the motivation for the action of group formation. However, because of the complexity of human nature the philosophers who study intentionality cannot agree on one definition. Michael Bratman, Margaret Gilbert, and Raimo Tuomela all have different mechanisms for how individual we-intentionality leads to group agency. I will systematically break down and compare all three theories finishing my analysis with a comparison in agent-based modeling using NetLogo. Agent-based modeling allows for a model simulation of group behavior and emergent phenomena while accounting for the differences in individuals, local interactions, and adaptive behavior of the individuals. The appeal for agent-based modeling in the study of group entrepreneurship comes from the ability to account for local interactions and monitor group behavior simultaneously.



## Literature Review

A review of literature in support of the agent-based modeling of collective entrepreneurship includes three major areas of prior study: collective entrepreneurship, group agency and intentionality, and agent-based modeling. I will discuss each of these in turn, drawing implication for model development in the next chapter.

### An Introduction to Collective Entrepreneurship

It is difficult to find one clear and concise definition of collective entrepreneurship in the literature. I believe this is because the strong definitions and ongoing debate both ‘collective’ and ‘entrepreneurship’ bring independently. Combining theories of collective action and entrepreneurship can create strong preconceived notions as to who, what, where, when, and how the organizations and firms are formed and operating. To clearly define collective entrepreneurship for the context of this paper I will develop the view of ‘collective’ as this paper is concerned and present the meaningful work done on collective entrepreneurship for the last 20 years.

### Collective Action in the Context of Collective Entrepreneurship

Originally the study of collective action was centered on collectives created for the management of common pool resources. This approach assumes that all individuals are rational actors interested only in their individual payoff, and are only willing to be a part of the collective to receive the highest payoff. Mancur Olson comments to the strong implications of rational action by individuals.

*“Unless the number of individuals is quite small, or unless there is coercion or some other special device to make individuals act in their common interest,*

*rational, self-interested individuals will not act to achieve their common or group interest". (Olson, 1971 p. 5-6)*

Following Olson, Elinor Ostrom (1990) described eight 'special devices' to insure stability of common pool resource institutions; clearly defined boundaries, congruence between appropriation and provision rules and local conditions, collective-choice arrangements, monitoring, graduated sanctions, conflict-resolution mechanisms, minimal recognition of rights to organize, and nested enterprises. Based on Ostrom's work the study of collective action grew dramatically. Many firms, collective by nature of their business structures, used her design principles to study and encourage the creation and management of a collective good (Zajac 1993). To-date Ostrom's approach to collective action has been used to explain institutions governing common resources and large social movements (Zajac 1993).

Traditionally, collective action was not applied to firms within in the private sector because of the absence of a common-pool resource and the presence of a clear-cut structure instituting different mechanisms of motivation for the individuals involved in the firm. However, over time the principles presented by Ostrom have leaked into the study of management of firms, including entrepreneurial firms. Instead, entrepreneurial firms should be considered outside the bounds of the study of collective action and considered its own unique field of study with particular 'special devices' that explain the motivation for entrepreneurs to "have an active interest in recruiting others to work for them, as co-founders, employees, investors,

advisors, or unpaid helpers” (Ruef 2010 p. 7) to form a ‘social group’ pursuing a collective good for the betterment of all individuals involved. Collective entrepreneurship is the study of such a ‘social group’.

Interests and motivations for the study of collective entrepreneurship will differ based on the perspective of entrepreneurship (Buress 2009). Heidi Tuominen (2014) and colleagues identified eight manifestations of collective entrepreneurship:

1. Embedded in a social and institutional scene of market and industry actors and relations
2. Application of social skills the entrepreneur (singular) uses as the mobilizer of actors or resources in network of collaborative processes
3. Joint action guided by social values and aiming at collective outcomes (especially of those of co-operatives)
4. A specific mode of governance of co-operatives that is based on joint ownership and control
5. Market-driven and contractual collaboration in the form of the structure of multiparty alliances, networks, or vertical integration
6. Collaboration between employees in different organizations highlighting occupational identity in advocating a common causes
7. Work and collaboration among employees

8. Teams in established organizations, and the establishment of teams in managing new business ventures.

For the purpose of this thesis I am interested in the study of number eight, the entrepreneurial group as a team.

### Current Work on Collective Entrepreneurship

Martin Ruef is at the forefront of the study of collective entrepreneurship with a team perspective. In his book *The Entrepreneurial Group*, Ruef uses empirical evidence from *The Panel Study of Entrepreneurial Dynamics I & II* covering data from 1998 – 2000 and 2005 – 2006 to provide support for the existence of entrepreneurial groups. For purposes of this literature review we will assume Ruef's conclusion that entrepreneurial groups exist (both as high growth companies and small businesses) to be true and focus on structure of the entrepreneurial groups, most importantly the relationships and identities of individuals involved in entrepreneurial groups.

The entrepreneurial group is not a new phenomenon. In the late 1800s Max Weber identified and studied the start of business groups in medieval commercial partnership in Europe (Weber 1958). Weber's study was for concern of control – how are individuals able to give up control of their firm (profits, benefits, etc.) to work with a partner? Weber started with the Romans. They treated partnerships and the individuals in those partnerships, for concern of law enforcement, as one in the same. However, as trade increased in volume and distance, distinctions between

the individual and business were needed for the advance of the enterprise. To protect their family's personal wealth, separate partnership structures were used to keep the assets of the partnership and the individual separate. Developments in Germanic law allowed the emergence of joint households; followed by the creation of solidary liability (Weber 2003). Joint households allowed for individuals to be held responsible for the debts of other individuals under the same roof. Solidary liability is the acceptance that one individual can be held responsible for the partnership's (or joint households) debts. This example is an indicator of the social power associated with such groups (Ruef 2010).

Over time, the perception of an entrepreneur in the United States morphed to a prime time television star or a rags to riches story featured in the national press for the success of creating a high growth company. Why do we allow the high profile views of a small segment of entrepreneurial stories influence the way we think about what entrepreneurial success looks like? Academic literature has also played a role in perception of entrepreneurial success; business management literature over-romanticizes entrepreneurship while the social science perspective removes the trees from the forest in study of entrepreneurial dynamics, studying details that are often out of context. The overall result in the literature has created a dreamy entrepreneurial experience by highly intelligent people who have the traits and behaviors that produce large economic gains. I believe that aspects of the true entrepreneurship have yet to be uncovered because of the crutches business management and social science, in their study of entrepreneurship, rely upon.

During the 21<sup>st</sup> century, the fields of business management and social science worked to understand and quantify the phenomenon of entrepreneurship. Each discipline took a different approach in understanding the nuances of the entrepreneurial group. In the field of business management Ruef reviewed 16 empirical articles from 1990 – 2007 focusing on entrepreneurial groups (2010, p. 20). All of the articles used high growth companies with high capitalization. Many of the companies were in high profile fields; including health care, high-tech, and academic spin-offs. Eighteen percent of the firms studied were Fortune 500 companies. The overall intent of each article (when considered singularly) was never to give a skewed picture of entrepreneurship. However, the lasting effect of the articles, considered collectively, portrays high profile businesses with extraordinary success. The realities of entrepreneurship in the United States are not as business management literature, or pop culture for that matter, portray it. Rather, the most common entrepreneurial venture in the United States is building construction followed by direct and Internet selling (Ruef 2010 p 23).

Unfortunately, the social science field perspective does not provide a more accurate narrative of the entrepreneurial venture in the United States. Ruef explains:

*While scholars in the interdisciplinary field of business management generally consider a mixture of social psychological, structural, and economic mechanisms driving group composition and its effects on the performance of*

*startup enterprises, social scientists tend to adopt a more myopic view. Economists explaining the distribution of ownership and control rights in new business ventures ignore the relevant effects of kinship, ethnicity, or gender. Sociologist analyzing the recruitment of individuals into entrepreneurial groups overlook the transactions costs that may place some exchange partners within a group and others outside of it boundaries.” (Ruef 2010 p. 31)*

Social science works to quantify a broader group of study than business management. Yet, it continues to ignore too many variables to accurately capture the true phenomenon of entrepreneurship. The study of group entrepreneurship requires a different approach either discipline can accurately provide.

Fortunately for the study of entrepreneurship Martin Ruef is unwilling to accept the business management or social science approach as the single way to interpret the existence of social groups working together in entrepreneurship. Instead Ruef develops a ‘relational demography’ approach to explain the relationships and identities that hold entrepreneurial groups together once group formation has occurred.

1. Ruef’s first mechanism is ecological constraint. Ecological constraint acknowledges the environment proximity while also capturing all systems (contracts, plans, etc.) and resources (availability of critical infrastructure) in the ‘environment’ that can support or inhibit the success group entrepreneurship.

2. The second mechanism, strong ties, allows entrance of the family firm into the discussion of collective entrepreneurship, suggesting that 'entrepreneurial groups are limited by preexisting social networks' (Ruef 2010 p. 25). The strength of social ties allows for embeddedness of the individuals and consequently supporting long-term group success. Although weak ties and structural holes (Burt, 1992) do bring value of new information to groups, they do not support long-term stability of entrepreneurial groups (Ruef 2010).
3. Ruef's third mechanism, homophilous affiliation, describes similar sociodemographic characteristics between individuals. Similarities in the individuals do three things; first, encourage individuals to believe that their common social identity means they think alike (McPherson et al. 2001), second, dispose each individual to higher levels of attraction and trust (Boone et al. 2004), and third, insinuate the existence of loyalty and ultimately highest personal power (Ruef 2010 p. 36).
4. Ruef's final mechanism is the goal orientation of the individual. This is the subjective goal of the individuals and their desired success. In the context of a shared identity, success is defined as ultimate identify fulfillment and not profits.



Table 1: Summary of Ruef's Relation Demography Approach (2010 p. 34)

	High Visibility	Lower Visibility
Relationship	Ecological Constraint	Strong Tie Constraint
Identities	Homophilous Affiliation	Identity Fulfillment

### Mechanisms of Group Formation

Historically individual action has been the basis of economic research, reducing macro-economic patterns to rational individual action. This approach studied the economic environment during a single snapshot in time while the economy was in an equilibrium state. During equilibrium, the individuals are static and have no motivation for change. However, a majority of the economy operates outside of equilibrium (Arthur 2013) and the study of individuals outside the boundaries of equilibrium can no longer rely upon static models and rational actor theory. Social science has the opportunity to reevaluate the micro-levels inside the larger macro-system to deduce the correct unit of study when it comes to economic activity through entrepreneurship.

Martin Ruef reminds us that entrepreneurial groups spur most entrepreneurial activity (Ruef 2010). But, can social science be based on group action or only individual action? Those that admit the relevance of group process are

methodological holists. Those that require an individual or micro-foundational approach are methodological individualists. The study of group entrepreneurship requires both an individualistic and holistic approach, resulting in a hybrid methodology. We must study the intentions of the individuals to keep sight of the micro picture, while remembering that the groups are the agents active in the macro economy. However if we are to make the leap from individuals to groups we must understand group formation. Philosophers explain group formation by analyzing the individual intentionality of group members. Once individuals begin working together the individuals may no longer be acting on behalf of themselves but also act for the other members of the group, and ultimately the group itself. Such individuals are practicing we-intentionality.

The trigger for group of individuals to change to a group is the study of agency. The achievement of group agency, via we-intentionality, is an indicator for the establishment of collective entrepreneurship. When all group members recognize each other's we-intention (key word: recognize) group agency occurs. Group agency then acts as a vehicle to move social science from the study of individual action to the study of group action. The justification for group action allows a new perspective, outside of rational actor theory (closely tied to methodological individualism) to make a more appealing argument for the study of group entrepreneurship within the context of studying the group in its entirety (include the 'special devices' holding the group together), not just the chosen leader or representative for the group.

To clearly answer the question, of whether social science can be based on group action or only individual action, I will review methodological individualism and methodological holism while constantly acknowledging the hybrid perspective that acts as the theoretical framework for this paper. Then, I will provide an extensive literature review of we-intentionality. Finally, to complete the argument I will present theories of group agency.

### **Theoretical framework**

Group formation starts with the study of the individual and their intention to act collectively. Methodological individualists believe that individuals have intentions that are always self-interested and rational. They also believe intentions cannot be combined to form a group aggregate. (Any social group formation present is because pre-existing institutions.) Methodological holists believe that individuals have intentions that are often times self-interested and rational. Contrary to individualist, holists' believe intentions can be combined to form a group aggregate ultimately forming social groups that provide utility to the individual group members. There are some methodological holists that believe that not only can intentions be combined to form an aggregate group, but that individuals can have intentions that have meaning only in group action (Tuomela 2013 p.15). This paper relies on the fact that individuals exploit utility, value, and worth from group action, and therefore require the rigorous study of group agency, formation, and motivation.

### *Methodological Individualism*

The study of entrepreneurship has been examined with a methodological individualism approach, nearly always assuming a single entrepreneur. Joseph Schumpeter suggested superhero like abilities to single innovative entrepreneurs, with traits of “supernormal qualities of intellect and will” (Raines and Leather 2000: 377; Harper 2008). Max Weber, although a scholar of partnerships and group behavior, noted that a single individual is the first representative of the enterprise. Furthermore, Weber is credited in his work *Protestant Ethic and the Spirit of Capitalism* for taking a methodological individualism approach and tracing the total impact and suggested the future power of entrepreneurial work, at the macro level, to one individual’s actions (Coleman 1986). In these examples, no value is given to the relationships connecting the micro level decisions with the macro level outcomes; instead they are removing the relational aspect from the economical progress discussion.

The study of the individual and the individual’s actions in economics begins with the theory of methodological individualism. Joseph Schumpeter was the first to use the phrase in 1908; however, his definition was much different than the ‘rational choice theory’ associated with methodological individualism today. In the *Value of Self*, Schumpeter presents a method that reduces individual action down to individual intentions that are absent of influences of social systems to effectively investigate microeconomic actions. Although there was some consideration on the absence of social structure it was not a main focus of Schumpeter’s study (Heath 2013).

Methodological individualism was not again discussed in the literature for another

two decades. Friedrich Hayek stated that all action is individual action and under no influence at all by any social structure or institutions (Heath 2013). By the time Hayek was writing, individualism was a defensive move to justify and explain social and macro phenomenon while maintaining the philosophical importance of the individual (Heath 2013). This definition, although definite and not ambiguous, has been analyzed and redefined numerous times. All definitions since Hayek's discussion agree that individuals are the reasons for social phenomena, however the disagreement arises as to whether relations between individuals should be included in the discussion of social phenomena, such as group action (Udehn 2001).

Woven into the fabric of human nature is a desire and ability to interact with other humans. It seems nearly impossible to separate individuals from the influence of these interactions and the social structure humans themselves construct in their daily lives. Joseph Agassi was convinced that social phenomena operate under the influence of the social norms and constructs in society. Agassi suggested that social phenomena occur because of "institutionalistic individualism", not methodological individualism (Agassi 1960). Institutionalistic individualism accepts the influence of the current social structure on individuals as they form new social structure or phenomena. This theory provides the freedom in the theory of the individual to accurately capture the true pressures and influences on individuals as their intentions morph into actions. In contrast, methodological individualism requires a conceptual framework, which does not account for in individual action, to understand the world that individuals act in. Geoffrey Hodgson continues the

argument on the influence of the existence of institutions, institutions as small as existing relationships, in individual action with his 'folk theorem' of social situations. Hodgson suggests, "When explanations are reduced to individuals, interactive relations between individuals are also always involved." (Hodgson 2007)

### *Methodological Holism*

The opposite approach of methodological individualism for the analysis of individual and social action is methodological holism or collectivism. Holism considers the social structures and influences around the individual to be a part of the individual. It goes further and suggests that all individuals are interdependent upon others and the social structures around them currently and in the past (Oyserman 2002). Holism proposes, "the group or society is metaphysically real – and the individual is a mere abstraction, a fiction" (Oyserman 2002) that provides "...demonstrably fallacious inferences about the dynamics of collective action" (Oyserman 2002). In contrast to individualism the measure of value, worth, and independence in holism is placed on the social reality (including social institutions in place that are influencing the individual) instead of the individual. The use of holism in relation to the study of human interaction creates an interesting perspective of entrepreneurial group formation. Individualism put little emphasis on motivations for group behavior. While, holism supports group agency, it forfeits group formation as an emergent quality of individual intentions. Oyserman, Coon, and Kimmelneir identify two consequences of holism that disrupt consideration of the individual in the entrepreneurial group; 1) group membership is a central aspect

of identity and 2) valued personal traits reflect the goals of collectivism (Oyserman 2002).

### *Hybrid Approach to Social Action Theory*

There are some methodological holists that believe that not only can intentions be combined into to an aggregate group but that individuals can also have intentions that only have meaning in group action (Schweikard 2013). These intentions are often called 'we-intentions' or 'collective-intentions'. When individuals acting out of collective intentionality form groups, the group, as a representative of its members, is able to act with group agency. It is valuable to notice that to reach group agency the individual intentions present were necessary to the existence of group agency. The individual action cannot be explained by either methodological individualism or methodological holism. Individualism does not allow the existence of group agency. Holism will not allow individuals to act on their own accord although they are a part of the group. It is important in the study of entrepreneurship to abandon the theory of methodological individualism and adopt a hybrid methodological approach.

My paper is not the first paper to propose a hybrid of methodological individualism and holism when discussing group agency. Raimo Tuomela (2013) came to the same conclusion, methodological individualism does not allow for group agency but holism does not allow for individuals to make individual decisions that result in emergent behavior. The study of entrepreneurial groups and their emergent sociality requires a hybrid approach. I will use Tuomela's approach for the study of group entrepreneurship: "My (Tuomela) weakly collectivistic approach is

nevertheless far from full-blown anti-individualism, because it does not regard groups as intrinsically intentional agents, but rather characterizes individual human beings as the only agentic causal motors in the social world. In a nutshell, groups accordingly can act only through their members activities” (2013 p. 13). Tuomela is an individualist for agency, yet a holist for intention.

### **We - Intentionality**

I accept that neither individuals nor groups have preeminent power over the actions of individuals, but rather the individual’s choice to participate (for the betterment of the individual and the group) in group action is an important force. The focus of study is the individual-level mechanism in place to justify group formation from the individual’s perspective. Through the use of thought experiments, philosophers have been studying the mechanism for individual action for centuries. For the purpose of this paper I will study the individual mechanism for group formation, we-intentionality, from the perspective of social ontology. This provides a unique perspective for social scientists to draw connections in a macro economy that is driven by micro decisions.

Regardless of your belief in methodological individualism or holism, it is a commonly held view that a person is considered an intentional agent, assuming individual agency. For the purpose of this paper I will agree with the assessment of individual intentionality that Raimo Tuomela makes in *Social Ontology*,



*“Intentionality contains the following central elements: intentional agents can have representational mental states such as beliefs, wants, and intentions, and they can also have emotions and feelings with their bodily accompaniments. On the ground of these kinds of states, agents in the full sense are capable of intentional action, which typically is action for a reason. Intentional human agents are also taken to understand normativity and to be capable of obeying norms, for examples the norms involved in promises and agreements and those involved in communal laws and informal social norms. Accordingly, human agents are both causally and morally responsible for their intentional actions.”*  
(2013 p.21)

Social ontology, or the study of shaped mental states (i.e. intentionality and action) provides a unique contrast to individual intention as a basis for group formation discussion. To use social ontology to explain group agency we must first assume two things: 1) that individual action through group behavior is an observer relative observation that is critical to entrepreneurial group formation and 2) we must make provisions in the concept of social ontology to account for small groups that provide similar strength of identify as strong institutions (Searle 2006). Assumption number one recognizes that relationships between individuals only exist if and only if both parties acknowledge the existence of the relationship. This assumption is necessary for most social science studies. Assumption number two states that sociality and social structures (the study of social ontology) are worth studying, no matter the size, and often times exhibit similar characteristics of powerful social institutions.

Through these assumptions we are able to begin discussion around the modes of action, starting with collective intention, of small group formation.

Collective intentionality “is the power of minds to be jointly directed at objects, matters of fact, state of affairs, goals or values” (Schweikard 2013) to achieve group ‘sociality’. Historically intentionality is associated with an individual and it is natural to assume that collective intention is the summation of individual’s intentions at the aggregate level. This is not the case; collective intention is irreducible (Schweikard 2013). Traditionally intentionality is associated with commitment. The intention of an individual morphs into the commitment of the same individual. Again, it seems natural to assume that collective intention becomes the commitment of the group as a whole rather than the commitment of individuals to one common commitment. However, in contrast to the irreducible assumption, individuals retain ownership of their intention and commitment, and therefore their course of action (Schweikard 2013). The behavior observed because of the collective intentionality is a result of a group of individuals, individual collective intention.

Collective intention, the outcome of we-intentionality, acts through the individual in several modes; shared intention, joint intention, shared belief, collective acceptance, and collective emotion (Schweikard 2013).

1. Shared intention removes intention from the individual and places in between individuals to achieve collective goals.

2. Joint intention adapts a view of the world that allows for plurality of agents. It assumes a common ground to facilitate potential cooperation between individuals.
3. Shared belief, which is activated before intention, is the capacity to believe in a common stock of knowledge, or social ontology, paired with the ability to influence information shared with other individuals to have a potential effect of intention, commitment, and action.
4. Collective acceptance is knowledge of and therefore acceptance of the institutions and social norms present in daily life that have influence on our actions.
5. Collective emotion allows groups of people to feel emotions in the aggregate sense, removing the limitation of emotion from one individual and allowing groups to feel, simultaneously and effectively together, a singular emotion.

The study of group formation to form sociality is most interested in shared intention and joint intention. For the purpose of this thesis we will study three mechanisms of collective intentionality, through the mode of shared intention or joint intention: Michael Bratman's shared intention and planning agents, Margaret Gilbert's plural subject or joint commitment, and Raimo Tuomela's shared ethos and we-intentions. Each author is striving toward the common goal "explanations of group phenomena or sociality" but each perspective differs from the others. For the purpose of this paper I will not be working to choose the 'correct' author, rather

I will use all three perspectives as alternative explanations of entrepreneurial behavior.

### *Michael Bratman*

Michael Bratman's explanation for group activity is referred to as shared agency (Bratman 2013). Bratman views planning structures as 'basic to our individual agency', and uses the existence of individual planning structures to develop a thesis for modest sociality via intentionality. Planning structures are the internal forces in place to execute plans of action (Bratman 2013, p. 51). By using the planning structure Bratman develops the sufficient conditions of intentionality of sociality, while keeping the unit of study focused on the individual. According to Bratman, individuals in the social group must follow six axioms and a dependency principle (assuming agents A and B have a shared intention to do R if and only if):

1. Intentions on the part of each in favor of activity R (intentions concerning the joint activity)
2. Agent A knows that agent B has the intention to R (and vice versa)  
(Interlocking intentions)
3. Both have intentions in favor of meshing sub plans to achieve R (Intended and actual mutual responsiveness and mesh)
4. Belief about the joint efficacy of the relevant intentions
5. Belief about interpersonal intention (Interdependence of intentions)
6. (Dependency Principle) Agent A continues to intend to R if and only if agent B continues to intend to R (and vice versa)

7. Common knowledge of 1 -5 and dependency principal. (Bratman 2015, p. 85 - 86)
8. The connection between the shared intention and the joint action involves public mutual responsiveness in sub-intentions and action that tracks the end intended by each of the joint activity by way of the intentions of each in favor of the joint activity. (The Basic Thesis)

I will review six points of his thesis; planning theory of individual agency, intentions concerning the joint activity, interlocking intentions, creation of master plan, interdependence of intentions, and intended and actual mutual responsiveness and meshing.

Intentions of individuals are plan states that guide, coordinate, and organize thought and action to accomplish goals across time as well as at a point in time. According to Bratman's planning theory, these intentions are embedded in the planning that is central to "internally organized temporally extended agency" of individuals (Bratman 2014). Such agency is present at all times. These intentions are subject to adherence of the norms of intentional rationality consistency (internally consistent and consistent with one's belief), agglomeration (the sum of the parts is equal to the whole), means-end coherence (intentions working toward a goal and demand an outcome), and stability (stability over time) (Bratman 2014, p. 15). These norms provide a standard explanation of how the plan states (or intentions) play out in

planning agency and provide a measure of significance of the force present in the existence of norms.

For a group to exhibit sociality it must first share an intention, which qualifies under plan states, from the listed norms above. Bratman, determines that (because of the planning theory) each individual can and will choose an activity, of which all group members agree upon. The plan state then morphs from the individual intending that they go alone to the group intending that they go together (Bratman 2014, p. 43). It is an important nuance for the defense of joint activity that the individuals together intend *that* they X instead of the individuals together intending *to* X. It is here that each individual can 'count' on joint action and 'need not anticipate experiencing, from the perspective of he who is acting, our X-ing" (Bratman 2014 p 64). For this, and ultimately planning theory, to hold true we must assume that all of the participants agree upon the activity and the outcome of that activity.

For intentions to be interlocking the individual intentions must be connected to the joint activity (agreed upon in number one listed above), showing a semantic interconnection between intentions in favor of the joint activity. For intentions to be interlocking each individual's intention must include references to the intention of other individuals in the group and the role of their intention in the joint action and vice versa (Bratman 2014, p 50). However, it cannot be forgotten that the intention itself is the intention of an individual, and therefore the nature of the intention is itself reflexive in that the individual intention is for the individual to meet their own

plan for themselves (Bratman 2015, p. 52). The interlocking and reflexive property is contained in “I intend that we X and you intend that we X”.

The creation of a ‘master plan’ (Although Bratman does not refer to a ‘master plan’ I believe it helps illustrate his intended description for meshing of sub-plans) through the ‘meshing’ together of individual sub-plans is necessary to achieve the intended joint activity. All the sub-plans together must ‘successfully execute’ the joint action of the individuals in order for the intended meshing to be achieved (Bratman 2015 p. 53). The construction of sociality via a master plan for the means of group action “can ensure that each is committed to, and so appropriately responsive to, the consistent, coherent, and effective interweaving of the planning agency of one another in a way that tracks the intended joint action” (Bratman 2015 p. 53 – 54).

Interdependent intentions are important because it is necessary for individuals to believe that their personal intention can determine whether or not the joint action occurs. However if I believe that we can achieve the joint action on my own accord (within the master plan) and you believe that we can achieve the joint action on your own accord, we negate each other. Instead we must assume that there is interdependence between the individual actor’s intentions. Interdependence binds each intention of the individual together so that each individual knows whether the other continues to intend and if they have the ability to adjust the sub-plan to achieve the joint action (Bratman 2014 p. 71).

The outcome of Bratman's basic thesis is modest sociality – or group agency by individuals working with others to achieve individual goals. This is important for the overall goal of this thesis, but will be addressed more explicitly in the next section of this chapter. Bratman's thesis does provide a strong central role for the intentions of the individuals, which keeps a hybrid theoretical approach to group agency. Bratman allows for individuals to share intentions, create a plan and policies (without convergence in beliefs), and complete a joint action (Bratman 2014, p. 156).

### *Margaret Gilbert*

Margaret Gilbert's joint intention of groups is explained as a new relational definition of groups. Gilbert proposes a plural subject approach, defining intention as part of a new body of people that creates a single entity, where all intentions are shared and then acted upon by the group (Gilbert 2014). Contrary to Bratman, Gilbert's approach is non-reductive; the intentions are more representative of the group as a whole. However, it could be considered reductionist thinking because of the inability to allow the emergence of we-intentions. (This is an important aspect to the modeling of entrepreneurial group formation). Gilbert does share the use of 'shared intention' with Bratman. Gilbert, contrary to Bratman, allows shared intention to simply be present when 'we' is used to explain who is to do an activity, "we intend to A". Gilbert, using a plural subject approach, proposes connection via prior commitment, to drive intention (we-intentionality). This commitment or mutual obligation is the glue that holds together the plural subjects via shared intention, the commitment is adequate in the presence of three criteria: disjunction,



concurrence, and obligation. It is important to note that Gilbert requires a plural subject approach, removing emphasis from the individuals and placing it on group (Gilbert 2009).

The disjunction criterion suggests that personal intentions are not necessary for the existence of shared intention. Gilbert presents her argument to create “individually necessary and jointly sufficient conditions” for shared intention. In the case of the disjunction criterion she suggests that, unlike Bratman, shared intention can be present between individuals in the presence of only shared intention at the aggregate level, and not at the personal level. Gilbert states, “When two or more people share an intention, none of them need have a personal contributory intention” (Gilbert 2009, p. 171). Gilbert argues that when shared intention is defended on the accounts of correlative personal intentions it does not meet the necessary condition of shared intention, although it could prove to be sufficient. Unfortunately, the sufficiency of personal intentions creates hindrance in the creation of necessary and sufficient conditions of shared intention.

The concurrence condition supersedes the sufficiency of correlative personal intentions in shared intention, requiring concurrence of all parties for a change in the shared intention of the group. All of Gilbert’s work assumes the “we” are doing X; therefore the concurrence condition speaks to the ability of the shared intention to survive the action of individuals and come to fruition. The concurrence condition states that when individuals are interested in changing the shared intention all

parties must agree to the change, “absent special background understandings”. Gilbert adds a qualifier (special backgrounds) to the concurrence condition, allowing for the existence of prior agreements to the shared intention that could ultimately change the shared intention in the middle of the execution. The concurrence condition provides partial framework to release personal intention from the sufficiency of shared intention because of the inability to simply release oneself from the shared intention without the concurrence of the other members involved in the ‘we’ action (Gilbert 2009 p 174).

What if members of the group change the plans and one member disagrees and rejects the shared intention? The obligation criterion of shared intention requires that each member is “obligated to each to act as appropriate to the shared intention in conjunction with the rest” (Gilbert 2009 p. 175). Gilbert discusses the ‘obligation’ and the requirement of that obligation; this paper is not concerned with the argument of obligation rather only the implication. Gilbert concludes that:

*“...One who has a right to someone’s future action already owns that action in some intuitive sense of “own”. Until the action is performed he is owed that action by the person concerned, thus being in a position to demand it of him prior to its being performed and to rebuke him if it is not performed. If it is performed, it has finally come into the possession of the right-holder, in the only way that it can.” (Gilbert 2009 p. 176).*

The obligation criterion, Gilbert argues, further explains the sufficiency of correlative personal intentions for shared intention.

Gilbert's defense of shared intention concludes with an explanation of joint commitment, in the presence of plural subjects. Gilbert suggests that shared intention is not the sum of individual intention, rather "members of some population P share an intention to do A if and only if they are jointly committed to intend as a body to do A". It is important to understand the nuance of 'jointly committed', as it is the differentiation of Gilbert's theory and other philosophers of social ontology. For Gilbert, commitment does not occur until common knowledge is held within the group and all members agree. Each member may be ready for such a commitment but individual commitment is never present, rather only joint commitment. The commitment of the individual to the joint action must occur prior to the shared intention (Gilbert 2009).

### **Raimo Tuomela**

Bratman and Gilbert could not find room for both the individual's intention and the group's intention inside a social group. However, Raimo Tuomela justifies group action through the view of both the individual's intentionality and the group's intentionality. Tuomela presents 'we-mode' and 'I-mode' collective intentionality in *Social Ontology*. We-mode and I-mode are presented as two different modes to achieve group action, although both modes produce a different type of working group, using different motivations and intentions. I will present both We-mode and

I-mode for reason of comparison. However, I will only focus on we-mode for the purpose of application in entrepreneurial group formation modeling.

The type of intention determines “the function roles in thinking and acting in virtue of their different satisfaction conditions, which also entail different commitments and action recommendations” (Tuomela 2013, p. 70). Tuomela has identified three types of I motivated intentions: I-mode intention (IMI), Private I-Mode Intention (PIMI), & Pro-group I-mode (PROGIMI).

*“(PIMI) Agent A has the intention that P in the purely private I-mode if and only if A is privately committed to satisfying P (or participating in the satisfaction of P) and he intends to satisfy if only for himself qua private person.*

*(IMI) Agent A has the intention that P in the I-mode if and only if A is privately committed to satisfying P (or participating in the satisfaction of P) and he intends to satisfy P (or participate in its satisfaction) at least in part for himself qua private person (rather than qua group members).*

*(PROGIMI) Agent A has the intention that P in the pro-group I –mode in group g if and only if A is functioning qua member of g (in a weak sense), is privately committed to participating in the satisfaction of P and intends to do it in part for (the members of) group g but in part for himself qua private person. “*

*(Tuomela 2013 p.70).*

Private I-mode intention (PIMI) has no need to be discussed for the purpose of group agency and entrepreneurial groups. I-mode intention (IMI) and Pro-group I-mode intention (PROGIMI) are both means to group formation, although both entirely different motivations than present in we-mode intentions. IMI facilitates group action in where the members of the group are only acting on behalf of their individual interest, although other members may benefit from the action of the intention. However, PROGIMI describes a person, acting as an individual (not with individual goals only), to achieve a satisfaction that is desired jointly by group members. The group is not required to have agency, or a joint-intention and the individual may act alone to achieve the satisfaction that is desired jointly by the group members. It seems reasonable that because of the lack of commitment from the group that the individual must be motivated enough to achieve the intention for only the good of the individual, therefore it stays an “I-mode” mechanism. We-mode must have a joint-intention on behalf of all members in the group. Tuomela as describes I-mode compared to we-mode, “We-thinking involves the notion of group viewed from the “inside”, from its members’ point of view, as a “we” for them.” (Tuomela 2013, p. 23).

To thoroughly present we-mode I will step through with commentary for each of the 10 qualifiers of we-mode intention, drawing comparisons to I-mode intention and the implications of group formation as related directly to the specific we-mode qualifier. Tuomela’s unique theories resulting from the below listed qualifiers are

group reason, collectivity, and collective commitment serving to unify the group around “constitutive goals, values, and purposes to which the group life is dedicated” also known as shared ethos (Tuomela 2013, p 15).

1. Intentional action requires intention toward a relevant action – presently the action is regarded as a goal, for simplicity’s sake.
2. A group agent  $g$  intends to achieve a goal if and only if its members (at least the operative ones) intend jointly, as a group, to achieve it.
3. Intention involves at least instrumental commitment.
4. If group agent  $g$  is committed to an action-goal  $X$ , its members  $A_1, \dots, A_m$  must be collectively committed to it as a group as well as to their part performances.
5. Group action  $X$  here requires the members’  $A_1, \dots, A_m$  participation in  $X$  in terms of their respective part actions  $X_1, \dots, X_m$ , and it is here (simplifying) assumed that the latter either factually bring about or conceptually constitute  $X$ . (Analysis of group action in terms of members’ actions; recall (2).)
6. If the members of  $g$  have intentionally satisfied their joint intention by performing  $X$  as a group, they have acted for a group reason (viz., a group reason for the members’ part performance), the reason here being group agents  $g$ ’s having the intention to bring about  $X$  or a further goal to which the members’ bringing about  $X$  contributes.

7. If the members collectively act for a group reason as a group, they necessarily satisfy the collectivity condition with respect to X and its parts: Necessarily due to acting as a group, if the group reason is satisfied (fulfilled) for any one of them, it is satisfied (fulfilled) for all of them and the group.
8. Group acts intentionally as a group to bring about X. (Categorical premise instantiating the antecedent of (6) and (7).)
9. The members of A act intentionally as a group for that group reason, being collectively committed to doing so, and satisfying the collectivity condition (Form (2) – (8).)
10. The members of A acted cooperatively in the we-mode (From (9) and the three central criteria of the we-mode (viz., the group reason, collectivity, and collective commitment criteria.) (Tuomela 2013 p. 35 – 36)

An intentional agent can only conduct the intentional action. Intentional agents have representational mental states, emotions, feelings, understand normativity, and are capable of obeying norms. Their individual agency provides the framework for each individual to perform intentional action, or action for a reason for their own behalf (Tuomela 2013 p. 21) Qualifier number one places importance of both intentional action and therefore the agents being intentional agents. Any individual working to accomplish any action, both individual and group action is under the first qualifier. However in statement number two above the group members are incorporated into the intentional action. This does not distinguish between I-mode and we-mode group action, rather individual action from group action. Qualifier number three

again does not provide reason for separation from we-mode or I-mode group action; instead it places a requirement for commitment to be present when achieving any type of intention. Qualifier number four begins the separation of we-mode and I-mode.

As described above the largest difference in Pro-Group I-Mode (PROGIMI) and we-mode is the group membership. An individual functioning in PROGIMI is acting as a private person, where we-modes employ we-thinking and we-reasoning to achieve collectivity. Collectivity is a condition of we-mode presented by Tuomela. It makes 'togetherness' of a group (not necessarily group membership but rather knowledge and acceptance of group members) a necessary condition for the presence of we-mode group action. Individuals must complete their responsible action to achieve to group action to continue to qualifier number five. If the action is complete the remaining qualifiers are in place and therefore the existence of collectivity. It is important to note that collectivity, according to Tuomela, only requires the appropriate actions to be completed by group members. In addition to collectivity Tuomela requires that two other criteria: group reason and collective commitment culminating in 'shared ethos' (Tuomela 2013).

Tuomela is concerned by the motivating factors to achieve group action. He places much time explaining the nuances of how individuals can be motivated to work together. His second criteria continues much like collectivity and is concerned with the motivation of the individual on behalf of the group, "We-mode action is based on



a group reason and is thus performed for the reason of promoting the group's interest." (Tuomela 2013, p.38). Group reason or group motives is the driving force behind the desired action. When considering the 10 we-mode qualifiers listed above group reason was in place at number two. Again, to participate in group-reason, group membership is not a necessary condition (this time Tuomela suggests that "wholehearted identification" via group membership shows "genuine" commitment to we-mode) (Tuomela 2013, p. 39).

If group reason motivates individuals to act together and collectivity embodies the desire to act together, then collective commitment is the glue. Collective commitment acts through joint-intention. "Group members' joint intention to see to it that something (group ethos – the accumulation of group reason and collectivity) is or will be the case even on conceptual groups generates collective commitment for the member to see to it that 'p'" (Tuomela 2013, p. 45). All three criteria are concerned with the motivations on the individual level. Because Tuomela distinguishes group action at such a level it is then easy to determine whether individuals are acting in pro-group I-mode or we-mode to achieve group action. The cornerstone of we-mode is shared ethos. Individuals acting to achieve group action without group motivation, commitment, or intention individuals are operating in I-mode, however when the strength of shared ethos is present it provides the framework to motivate individuals act inside the group reason, collectivity, and collective commitment.

## Group Agency

The concept of group agency resembles we-intentionality, in that both are representative of a group of people and their interaction. Group agency is specific to the group interaction with its environment. We-intentionality is specific to the interaction of individuals that make up the group. “The main argument for employing the notion of group agent (or that of a group capable of action) is that it has indispensable explanatory, predictive, and descriptive usefulness for theorizing about the social world, especially in the case of large groups.” (Tuomela 2013, p. 46). Although Tuomela continues to focus on the size and group reason as further reason for studying group agency he communicates a point that is important for the study of group agency for the small entrepreneurial group – understanding how small entrepreneurial groups interact with their environment provides explanatory, predictive, and descriptive usefulness in the study of entrepreneurship.

Several different doctrines prevail for the conditions of agency. I will focus on one thesis presented by Christian List and Philip Pettit in *Group Agency: The possibility, design, and status of corporate agents*. List and Pettit present three features of an agent:

1. (The agent) has representational states that depict how things are in the environment
2. (The agent) has motivational states that specify how it requires things to be in the environment

3. (The agent) has the capacity to process its representational and motivational states, leading it to intervene suitably in the environment whenever that environment fails to match a motivation specification (List 2011 p. 20 - 22)

Representational and motivational states are, or intentional states, are arrangements in the personality of the individual that interact with other states to produce action. The representational states depict the world and the motivational states motivate action. List and Pettit are not concerned with the physical nature of such states, only that the state initiates the action of the agent. It is the combination of both the representation of the environment perceived by the agent and the motivation of agent to change the environment that initiates action by the agent (List 2011, p. 20 – 22).

A simple analogy of agency as a robot provides an example lacking complexity. A robot uses its representative states to observe an environment and motivated by one driving force changes its environment based on its motivational state. The robot in this scenario may observe many environmental changes, however if the change is not 'represented' within the scope of the robots concern no action will be taken. However, when the same three conditions of agency are applied to complex human beings an enhanced scope is required. Consider the inverse approach to determining the intentional states of an agent. In the robot example an observer would be able to identify both the representational and motivational states of the robots through consideration of what the cues for the robot to preform action are.

Add multiple intentional states and a diverse environment; the identification of intentional states then becomes difficult to the observer (List 2011, p 23). Because the environment and motivations of entrepreneurial projects are so complex for the purpose of modeling group agency via collective intentional it is critical to have a strong understanding the ontology in the background.

List and Pettit go on to defend group agency within their own framework of joint-intentionality. The purpose of this paper is to explore different modes of we-intentionality, or different ontological perspectives. I will take the necessary condition of we-intentionality to group agency as proposed by List and Pettit and test the three different mechanisms (Bratman, Gilbert, and Tuomela) proposed above. Group agency is the fulfillment of the three necessary conditions, proposed above for individual agency, only applied to a group that exhibits we-intentionality and therefore individuals with joint intention to accomplish specific goals.

In addition to List and Pettit, John Searle has an ontological approach to group agency. Searle acknowledges the individual as methodological individualism does, and makes the assumption, as made by many social scientists, of the existence of a collective world and all influences of the collective world (social norms, social structures, etc.) to effect and be a part of the individual. Therefore Searle argues that we-intentions are a sort of social structure in place to morph and influence I-intention. Natalie Gold describes Searle's approach to collective intentions with I-intentions being the derivative form of we-intentions with the thought process as

follows, “We intend to we-intention by me I-intention. “ (Searle 2006). This method of describing group actions separates we-intentions from I-intentions and requires the unit of analysis be different for both types of intentions during the study of group behavior. (Searle, similar to List and Pettit, present a theory for we-intentions, of which we are not concerned. Searle’s approach requires imposition from a third party of the implementation of we-intentions. This paper is interested in group formation that is created from the members and not directed by a leader.) Searle extends individual intentionality to a system of multiple agents working under a defined social norm to represent collective intentionality, and therefore group agency. Searle confirms the need to for collective intentionality to morph into group agency, although he does not spend adequate time describing the properties of agency. Searle does go on to say “ ... Assigns action through powers, duties, rights, and responsibilities. Collective intention is achieved through the acceptance of status and authorization of power” ...even in the entrepreneurial group (Searle 2006). Searle requires obligations, rights, and responsibilities for institutions to be recognized, or ‘sociality’ to be recognized, or (further refined) the group agency of a small entrepreneurial group to come to fruition and therefore complete group action (Searle 2006).

### **Agent-based Modeling for Social Sciences**

In the literature review above, I describe the significant elements of the current literature on social ontology. By taking a we-intentionality approach to the study of entrepreneurial group formation, I adapted individualism and holism to a hybrid perspective. That view allowed for consideration of philosophers’ take on group

formation to achieve group agency. To prove their theories Bratman, Gilbert, and Tuomela relied on thought experiments to prove the existence, necessity, and sufficiency of all conditions. Such a method is not sufficient for the study of entrepreneurship in economics. Traditional economic methods would suggest I study entrepreneurial group formation under econometrics or equilibrium modeling. However, because of my hybrid theoretical approach I am unable to justify or support such a methodology. Instead I am interested in using a method of study that allows the management of individual behaviors and the observance of emergent group behavior. How can social ontology be linked to the study of collective entrepreneurship? Since group agency (action) is the outcome of purposeful group intentionality, it is necessary to have a modeling technique that allows for the demonstration of the individual and group mental states and their resultant behaviors. Agent-based modeling explicitly allows for the modeling of individual behaviors and the interactions between individuals (note in biology ABM is called Individual-based modeling or IBM).

Agent-based modeling is a model structure that first, allows individuals and the environment to be given specific individual traits; second, allows the two to interact while maintaining individuality; and finally, allows the modeler to observe the change of the individuals and subsequent emergent group behavior. The essence of the agent-based modeling is the ability for emergence of group and system level behaviors from the individual's interaction with the environment. This research uses agent-based modeling (ABM) to illustrate the relationship between individuals,

we-intentionality, and group agency in the founding of collective entrepreneurial ventures (i.e. the accounts of Bratman, Gilbert, and Tuomela). The use of ABM allows me to examine the outcomes of alternative decision-making rules for individuals (multiple philosophers within one model) and alternative interaction behaviors among individuals (the progression of group agency within an individual). Agent-based Modeling allows for a model simulation of group behavior and emergent phenomena while accounting for the differences in individuals, local interactions, and adaptive behavior of the individuals. The appeal for Agent-based modeling in the study of group entrepreneurship comes from the ability to account for local interactions and monitor group behavior simultaneously.

This section of the literature review will present the use of agent-based modeling for the study of collective entrepreneurship. This section will maintain a literature review approach and not divulge the details of the model itself.

### **An Agent-based Modeling (ABM) Approach to Collective Entrepreneurship**

*“Agent-based models are computational representations of autonomous agents who interact with each other at a micro level leading to broader-level patterns” (Poteete et al. 2011, p; 171).*

The use of Agent-based modeling (ABM) in the study of social ontology is in its infancy. ABM is widely used in ecology today (often referred to as Individual-based modeling, IBM). Similar logic used for the justification of ABMs in ecology can be used for ABMs in social ontology.

*"...In ecology, the individuals are not atoms but living organisms. Individual organisms have properties an atom does not have. Individuals grow and develop, changing in many ways over their life cycle. Individuals reproduce and die, typically persisting for much less time than the systems to which they belong. Because individuals need resources, they modify their environment, Individuals differ from each other, even within the same species, and age, so each interacts with its environment in unique ways. Most important, individuals are adaptive: all that an individual does – grow, develop, acquire resources, reproduce, interact – depends on its internal and external environments. Individual organisms are adaptive because, in contrast to atoms, organisms have an objective, which is the great master plan of life: they must seek fitness, that is, attempt to pass their genes on to future generations. As products of evolution, individuals have traits allowing them to adapt to changes in themselves and their environment in ways that increase fitness."*

*(Grimm & Railsback, 2005 p. 3)*

Social ontologists agree that individuals are different, able to grow and develop, capable of modifying their environment, and adaptive. Indeed, ecology and ontology are different perspectives on behavior. I am not here to compare the two -- explicitly how fitness of an individual in a social group compares to the fitness of animals. However, without little explanation it is evident that an individual (in a social sense) is more concerned with their livelihood than the livelihood of the group (Grimm &



Railsback 2005). Therefore, the individual will be adapting, sensing, and changing to the environment it is presented, with the intention of success – whether it be the success for the good of the individual alone or the success of the individual inside a social group. In order to monitor both the status of the individual and the existence of groups I need a research method that can monitor the ‘interrelations between individual traits and system dynamics’ (Grimm & Railsback 2005, p. 4).

ABMs are used when there are differences in individuals, local interactions are present, emergent qualities are expected, and individuals exercise their ability to make adaptive decisions (DeAngelis 2005). The system dynamics of concern during group formation is the group mental state and resultant behavior (group agency). The achievement of group agency is the result of the formation of a group. Once agency is formed the model is over, a simple counting of groups is sufficient to measure the activity that occurred. However, because of ABM we have an additional lever that allows the monitoring of the formation process for each individual.

Although the resultant behavior is the trigger of completion of the purpose of this study, without the ability to analyze the individuals the research is lacking. This study then is able to defend the four qualifiers for ABM (differences in individuals, local interactions, emergent qualities, and individual exercising their ability to make adaptive decisions). Social ontology supports that individuals are different. Local interactions are present of individuals are present during the group formation process. Emergent qualities are expected to arise from group agency. Individuals

exercise their ability to make adaptive decisions to determine their status of group agency.

## The Model

It is the purpose of this section to describe the conceptual frameworks for creation of, and detail the logic behind, four working models; each designed to increase understanding of the social ontology present in small entrepreneurial group formation. This section is not the ODD (a strict protocol required for Agent-based Modeling), but rather supplemental information to make clear the ability Agent-based modeling has to test and analyze social ontological puzzles. First, I will step through each model's logic, citing the literature review. Second, I will elaborate on the two mechanisms for group formation that dominate: individual based and group based, and the impact that has on modeling. Finally, I will emphasize the unique perspective created by viewing social ontology through Agent-based modeling.

### Model Logic

The models presented represent an ontological approach to better understanding entrepreneurial groups. Although Bratman, Gilbert, and Tuomela give little concern to the type of people acting in group formation, the study of entrepreneurial groups places great weight on this point. The members of an entrepreneurial group cannot be homophilous for the success of the group, rather it is important to have different roles and attributes represented. Fritz Redlich separates active roles in entrepreneurial groups into the innovator, capitalist, and manager. The innovator, in the most traditional sense, is the 'entrepreneur' or the 'dreamer'. The capitalist, brings the money and know-how to finance the project. The manager does all the hard dirty work of details to bring to fruition the dreamers dreams (Redlich 1951). In some real-life circumstances this approach will not fit, roles may be combined

into one person and additional roles filled through other people. However, the exercise is more for the benefit of adding diversity to the required mix of an entrepreneurial group, not the roles they are considered to be for this study.

Although, the formation mechanism proposed by each social ontologist is distinctly different, the inner workings of the codes operate quite similarly. When group formation is achieved it is not of model importance as to whether an individual lead the group design or the group presence forced the group design, and therefore each model operates quite similarly. I mention these specifics as a pre-cursor to the presentation of the model to provide the correct lenses to view the model logic.

### Bratman

Bratman views planning structures as 'basic to our individual agency', and uses the existence of individual planning structures to develop a thesis for modest sociality via intentionality. Planning structure are the internal forces in place to execute plans of action (Bratman 2013, p. 51). According to Bratman, individuals in the social group must follow six axioms and a dependency principal (assuming agents A and B have a shared intention to do R if and only if):

1. Intentions on the part of each in favor of activity R. (intentions concerning the joint activity)
2. Agent A knows that agent B has the intention to R (and vice versa).  
(Interlocking intentions)

3. Both have intentions in favor of meshing sub plans to achieve R. (Intended and actual mutual responsiveness and mesh)
4. Belief about the joint efficacy of the relevant intentions
5. Belief about interpersonal intention (Interdependence of intentions)
6. (Dependency Principal) Agent A continues to intend to R if and only if agent B continues to intend to R (and vice versa)
7. Common knowledge of 1 -5 and dependency principal. (Bratman 2015, p. 85 - 86)
8. The connection between the shared intention and the joint action involves public mutual responsiveness in sub-intentions and action that tracks the end intended by each of the joint activity by way of the intentions of each in favor of the joint activity. (The Basic Thesis)

For a group to exhibit sociality it must first share an intention. Bratman, determines that (because of the planning theory) each individual can and will choose an activity, of which all group members agree upon. The plan state then morphs from the individual intending that they go alone to the group intending that they go together (Bratman 2014, p 43). The creation of a 'master plan' through the 'meshing' together of individual sub-plans is sufficient to achieve the intended joint activity. All the sub-plans together must 'successfully execute' the joint action of the individuals in order for the intended meshing to be achieved (Bratman 2015, p. 53). The outcome of Bratman's basic thesis is modest sociality – or group agency. In the modeling for Bratman group formation, formation begins when agents unite based on intentions,

agents can only link with agents that are not like them in 'entrepreneurial role'. If each of the agents has the same type of intention then the agents begin to 'mesh' their sub-plans. If the incorrect type of meshing occurs the group dissolves. The formation of the 'master plan' is the indication of group agency.

### **Gilbert**

In Margaret Gilbert's ontology of groups she uses a plural subject approach to propose connection via prior commitment, to drive we-intentionality. This commitment or mutual obligation is the glue that holds together the plural subjects via shared intention. The commitment present is adequate in the presence of three criteria: disjunction, concurrence, and obligation (Gilbert 2009). The two key factors in representing Gilbert's approach are commitment and intention. In Gilbert's literature she proposes that prior commitment is present first, before intention. It is the obligation imposed by the commitment that forces concurrence on the intention to be completed. In the modeling of Gilbert group formation, formation begins when agents unite based on prior commitments in place, agents can only link with agents that are not like them (adding diversity to the entrepreneurial group). The group then brings intention to a consensus. The sign of intention then triggers group agency.

### **Tuomela**

Bratman and Gilbert could not find room for both the individual's intention and the group's intention inside a social group. However, Raimo Tuomela can only justify group action through the view of both the individual's intentionality and the group's intentionality. Tuomela's unique theories resulting from the below listed qualifiers

are group reason, collectivity, and collective commitment serving to unify the group around “constitutive goals, values, and purposes to which the group life is dedicated” also known as shared ethos (Tuomela 2013, p 15).

1. Intentional action requires intention toward a relevant action – presently the action is regarded as a goal, for simplicity’s sake.
2. A group agent  $g$  intends to achieve a goal if and only if its members (at least the operative ones) intend jointly, as a group, to achieve it.
3. Intention involves at least instrumental commitment.
4. If group agent  $g$  is committed to an action-goal  $X$ , its members  $A_1, \dots, A_m$  must be collectively committed to it as a group as well as to their part performances.
5. Group action  $X$  here requires the members’  $A_1, \dots, A_m$  participation in  $X$  in terms of their respective part actions  $X_1, \dots, X_m$ , and it is here (simplifying) assumed that the latter either factually bring about or conceptually constitute  $X$ . (Analysis of group action in terms of members’ actions; recall (2).)
6. If the members of  $g$  have intentionally satisfied their joint intention by performing  $X$  as a group, they have acted for a group reason (viz., a group reason for the members’ part performance), the reason here being group agents  $g$ ’s having the intention to bring about  $X$  or a further goal to which the members’ bringing about  $X$  contributes.

7. If the members collectively act for a group reason as a group, they necessarily satisfy the collectivity condition with respect to X and its parts: Necessarily due to acting as a group, if the group reason is satisfied (fulfilled) for any one of them, it is satisfied (fulfilled) for all of them and the group.
8. Group acts intentionally as a group to bring about X. (Categorical premise instantiating the antecedent of (6) and (7).)
9. The members of A act intentionally as a group for that group reason, being collectively committed to doing so, and satisfying the collectivity condition (Form (2) – (8).)
10. The members of A acted cooperatively in the we-mode (From (9) and the three central criteria of the we-mode (viz., the group reason, collectivity, and collective commitment criteria.) (Tuomela 2013, p. 35 – 36)

An individual's agency provides the framework for each individual to perform intentional action, or action for a reason for their own behalf (Tuomela 2013, p. 21)

Tuomela is concerned by the motivating factors to achieve group action. If group reason motivates individuals to act together and collectivity embodies the desire to act together, then collective commitment is the glue. Collective commitment acts through joint-intention. The cornerstone of we-mode is shared ethos. Individuals acting to achieve group action without group motivation, commitment, or intention individuals are operating in I-mode, however when the strength of shared ethos is present it provides the framework to motivate individuals act inside the group reason, collectivity, and collective commitment. In the modeling of Tuomela group



formation, the presence of we-intention is the driving trait that spurs group formation. Agents are only allowed to form groups with agents that are in different roles than themselves and but share the same ethos, intention, and believe that each member will contribute to the success of the share ethos (represented as belief in the model). For Tuomela it is the existence of the shared belief that the accumulation of all parameters will accomplish the we-intention that trigger group formation.

### **Real World**

Each social ontologist makes underlying assumptions about the environment in which group formation is occurring. Therefore each perspective is tied to specific circumstances and it is highly probable that depending on the motivating goal, perspective of the individual, and parameters of the environment the type of formation will differ. The motivating factor for Bratman is the presence of I-intention and for Gilbert & Tuomela it is the presence of we-intention. However, the motivations that follow for each perspective differ in order, execution, and formation. Outside of these factors, the model has external influences that impact the type of group formation to occur. To complete the experimentation of how the three models described above interact, a model that incorporates all three group formation methods was developed. This model is a demonstration of how different formation mechanisms execute when present amongst each other. This model is necessarily more complete than the models of the three individual accounts.

The power of the agent-based modeling tool is revealed through this real world model demonstration. The real world agent-based model of potential group formation structures is a first-of-kind, regimented validation of the three proposed approaches (Bratman, Gilbert, and Tuomela) individuals use when completing group formation to achieve group agency. Although the sophistication of each model, from an agent-based Modeling and NetLogo perspective does not seem revolutionary, the application of such a regimented discipline to a field that typically uses thought experiments is impactful. This approach allows for a qualitative analysis of the group agency while systematically analyzing the potential formation efforts of the individuals.

### **Mechanisms for Group Formation**

The mechanisms described by Bratman, Gilbert, and Tuomela can be summarized in two categories: 1) individual-based and 2) group-based. Bratman relies upon the intentions of individuals to motivate group formation. Gilbert and Tuomela perceive the existence of we-intention (or at least the awareness of we-intention) as the beginning of the pathway to group formation. Each model has an agent attribute that prompts the action to search for potential group members within a specific search radius. Then agents access the surrounding environment in search of potential group members based on specific attributes. For each model the order attributes are searched for differs, this coding difference is the illustration for the different social ontological views. For the purpose of this section, I will describe the motivating factors behind the programming of each group formation category.

### Individual-Based

For Michael Bratman the agent characteristic that prompts modest sociality (and therefore the search process) is I-intention to achieve a specific action. All group action is driven by the individual's motivation via planning to complete a task in congruence with others that share the same I-intention. Bratman allows for individuals to share intentions, create a plan and policies (without convergence in beliefs), and complete a joint action (Bratman 2014 p. 156). In this model individuals must have share the same intention and the ability to mesh sub-plans. Bratman relies upon planning structures to achieve group formation and therefore it is necessary that all potential group members are willing and able to mesh sub-plans to achieve the agreed upon action. Modest sociality, an equivalent to group agency, is Bratman's proposed outcome.

### Group-Based

For Margaret Gilbert the agent characteristic that prompts joint intention (and therefore the search process) is prior commitment with other agents. Gilbert's approach is non-reductive; intentions are not motivated by the I-intention of the individual but rather the shared intention present in the prior commitments. We-intentions are only formed after the formation of the group and consensus of the group objective is reached within the group. Gilbert does share the use of 'shared intention' with Bratman. However, in the Gilbert model this is not represented as a qualifier to group formation, but rather the intention is transformed to a shared intention in the presence of prior commitment. Although the attribute intention is used all of the models, each approach uses the attribute differently. Gilbert, contrary to Bratman, allows shared intention to simply be present when 'we' is used to

explain who is to do an activity, “we intend to A”. For modeling this nuance of the attribute is not captured, rather the existence of intention is screened for and if present the model continues to proceed in the action of group formation (Gilbert 2009), relying that intentions will converge upon group formation. The Gilbert model is simplest of the models, relying on the prior-commitments to be the connection for group initialization and the motivation to agree upon a we-intention to achieve group agency.

For Raimo Tuomela the agent characteristic that prompts we-mode group formation (and therefore the search process) is the existence of we-intention within the individual. His second criteria is concerned with the motivation of the individual on behalf of the group, “We-mode action is based on a group reason and is thus performed for the reason of promoting the group’s interest.” (Tuomela 2013, p.38). Group reason is the driving force behind the desired action and illustrated in two attributes in the model. In order for group formation to occur the intention, the ethos (or group reason), and the beliefs (presence of collectivity) of the potential group members must be the same as the intention, ethos, and beliefs of searching agent. The group reason (represented as ethos in the model) is the motivation for individuals to act together and collectivity (represented as belief in the model) and therefore embodies the desire to act together. Collective commitment, the achievement of group agency, acts through joint-intention that is formed in the presence of shared intentions, a shared ethos, and shared beliefs. ‘Group members’ joint intention to see to it that something (group ethos – the accumulation of group

reason and collectivity) is or will be the case even on conceptual groups generates collective commitment for the member to see to it that 'p'" (Tuomela 2013, p. 45). All three criteria are concerned with the motivations on the individual level to act for the good of the group. The cornerstone of we-mode is shared ethos.

### **Social Ontology Through an Agent-based Modeling Perspective**

Complex systems are systems that include individuals acting with no central decision maker. Often a behavior that was not intended by the individuals, emerges from the micro-behaviors in the system. I apply complex system techniques to entrepreneurial behavior, specifically entrepreneurial group behavior. There are quite a few entrepreneurial stories that their success seemed to emerge from a set of unexplainable circumstances that seem to be hard to recreate. Many people analyze and dissect the stories to be able to study and reify their actions and behaviors. However, after many years of analysis and case studies there is not a clear-cut how to list of steps to become a successful entrepreneur. If for a moment we step back and think about the possibility that individual entrepreneurs, represented as agents that act as individuals, are motivated by a certain set of shared beliefs and group together, a new vantage point for a different perspective of study has been established. Once grouped together they are still operating as individuals but begin to identify as a group, to form group agency. There is no central decision maker, although there may be decision maker figure (a.k.a. 'the boss'). Because of the nature of entrepreneurship, the single decision maker is there as a representation of a need and not necessarily the central diving figure (this is

necessary for group agency). The group acts overtime and creates emergent success, culture, or change.

Scott Page suggests that diversity in groups creates a larger predictability of success. He also suggests that individuals use a certain set of heuristics for their decision making process, the heuristics have more to do with their perception of reality and things they choose to accept as true. When combining this idea on perception with the behavior rules from group agency and we-intentionality from Gilbert, Tuomela, and others it changes the how the forming rules are executed. It suggests that based on pre-conceived notions (which Ruef starts to talk about – preconceived notions of entrepreneurs based on demographics) people make decisions, decisions on what to believe and why to believe it. This would have a great influence on the group that they choose, what do they choose to see as most important? How do they choose this? Ruef suggests that the group that an entrepreneur chooses to work with has an impact on the formation time of the business (Ruef 2010 p. 195).

The meshing of social ontology and agent-based modeling within the boundaries of entrepreneurship opens the door for unique discussion, as illustrated above.

However, it is the regimen of agent-based modeling that allows such theoretical discussion to abound. Inside the boundaries of agent-based modeling different thought tests are able to be experimented with to illustrate the processes individuals take to form groups. Additional complexity can be added to the models by adding an environment in which entrepreneurial activity and impact can occur.

The flexibility of agent-based modeling to provide a framework to support individual attributes, and therefore the social ontological perspective, a global environment, the economic environment in which entrepreneurial groups act, and the all of the possible interactions (agents with agents and agents with the environment) makes it the perfect mechanisms to complete foundational research relating to entrepreneurship.

## **ODD (Overview, Design Concepts, Description) of Agent-based Model**

The ODD is a standardized design approach to building and describing agent-based models. It was created by a large group of modelers in 2006 (Grimm, et. al. 2006) and updated in 2010 so as to make model review more efficient. The standard design includes seven elements: purpose, state variables and scales, process overview, design concepts, initialization, input data, and sub models. The design concepts section is the most complex and requires description of agent behaviors in eleven categories (not all of which appear in a given agent-based model).

1. Basic Principles
2. Emergent Behavior
3. Adaption by Agents
4. Learning
5. Prediction by Agents
6. Sensing by Agents of Other Agents and Patches
7. Interaction Rules
8. Stochasticity of Variables
9. Formation of Collectives
10. Observation (output creation)

The ODD for my model follows below.



## Overview

*Purpose:* To increase understanding of the theories of Bratman, Gilbert, & Tuomela's approach on collective or group intentionality using Agent-based modeling. To date the Agent-based modeling approach has not been used in the study of social ontology theories. These models do not exist to prove or disprove the mechanisms of action in the social ontological approach, rather they simply provide a novel mechanism to provide scientific structure to their study.

In addition, this model acts to display group agency using the conceptual approach proposed by Bratman, Gilbert, & Tuomela using agent-based modeling. These social ontologists have only tested their theories using thought experiments, and have not used a qualitative protocol to systematically prove or disprove their assumptions and theories. The display of group agency is critical for the existence of entrepreneurial groups. The models in this ODD are working to provide qualitative proof behind the existence of we-intentionality to ultimately further the study of collective entrepreneurship.

*State Variables:*

**Turtles (NetLogo's generic agents):** Entrepreneurial minded individuals:

State variables include:

- Role: 1, 2, or 3. Fritz Redlich separates active roles in entrepreneurial groups into the innovator, capitalist, and manager. The innovator, in the most traditional sense, is the 'entrepreneur' or the 'dreamer'. The capitalist, brings the money and know-how to finance the project. The manager does all the

hard dirty work of details to bring to fruition the dreamers dreams (Redlich 1951). Each agent can be only one of these. The distinction of the three agent types is set in the initial conditions.

- Search Radius: 1 – 20 patches. The search radius is the distance each turtle can ‘see’ or ‘sense’ other potential turtles to determine if they are eligible to form a group. The search radius is measure from the center of a patch to the center of a different patch.

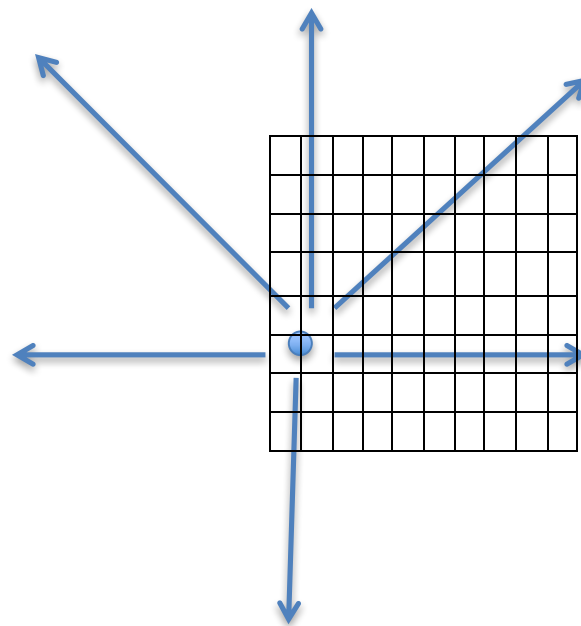


Figure 1: Illustration of Search Radius in Agent-based Models

- Bratman
  - I-Intention: Binary, Present or Absent. I-intention is basis of Bratman’s approach on we-intentionality. In the Bratman model, I-intention must be present to participate in the group search.
  - Intention: Binary, Present or Absent. After the search process has begun the agent searches for other agents with intention that is the same as theirs.

- Mesh: Binary, Present or Absent. Agents search for agents that are able to mesh their sub-plans together.
- Gilbert
  - Prior Commitment: Binary, Present or Absent. Prior commitment is the first step of we-intentionality for Gilbert. In the Gilbert model prior commitment must be present to participate in the group search.
  - Intention: Binary, Present or Absent. After group formation has occurred the intention of the group comes to a consensus.
- Tuomela
  - We-intention: Binary, Present or Absent. We-intention is the first step of we-intentionality for Tuomela. In the Tuomela model we-intention must be present to participate in the group search.
  - Ethos: Binary, Present or Absent. In order for we-mode group action to occur agents must share the same 'ethos'.
  - Intention: Binary, Present or Absent. After the search process has begun the agent searches for other agents with intention that is the same as theirs.
  - Belief: Binary, Present or Absent. Belief in the ability for the group to complete the collective intention is necessary for we-intentionality.
- Real-World
  - I-Intention: Binary, Present or Absent. I-intention is representative of the Bratman model.
  - Intention: Binary, Present or Absent. After the search process has begun the agent searches for other agents with intention that is the

same as theirs, or the intention comes to congruence. Intention is present in all proposed models.

- Mesh: Binary, Present or Absent. Mesh is representative of the Bratman model.
- Prior Commitment: Binary, Present or Absent. Prior commitment is representative of the Gilbert model.
- We-intention: Binary, Present or Absent. We-intention is representative of the Tuomela model.
- Ethos: Binary, Present or Absent. Ethos is representative of the Tuomela model.
- Belief: Binary, Present or Absent. Belief is representative of the Tuomela model.

**Patches (NetLogo's cells in spatial array):** The landscape is a 99 x 99 square grid. Each patch represents a specific latent opportunity. The agents are placed on a particular patch through stochastic placement. Agents are placed on patches one at a time as part of the initial conditions. At the onset of the group search process multiple agents are able to occupy one patch. The search process for the agents is primarily focused on the search for other eligible agents for group formation. However, each agent is only able to see a limited number of patches based on their search-radius, and therefore a limited sub-section of their world. As agents find suitable group members the patch that the group is formed becomes the new 'home'

of the group, this patch is the opportunity the entrepreneurial group is acting collectively to pursue.

**Global Environment:** None

*Scales:*

State variables will either be scaled from 1 – 10 or binary (present or absent). Each state variable is described above.

*Process Overview:*

Multiple philosophers of social ontology have developed theories as to how and why people share we-intentionality. These models test each philosopher's theory using the rigor of Agent-based modeling. Each author will first be tested individually and then all three theories for group formation will be allowed to exercise at the same time. The models work in time steps, each time step is not representative of a specific amount of time. Proximity to each agent does determine the speed at which interaction will occur however it does not represent additional variables.

Bratman:

- At each time step individuals search for other individuals or existing collectives to establish membership. The individual will observe possible targets within its search radius, and then move toward the target. *Targets for each experiment are described in sub-model below.*

- If an encounter is completed within the time step, the agent senses the attributes of the other agent (individual or collective) that co-locates on the patch to see if they are compatible collective partners. (In the case of an existing collective, this will be governed by membership size limitations and by the class of agent and its background).
- If membership criteria are met, then the agent stays for the next time step.
- If membership is not met, the agent restarts the search process in the next time step.
- If an incipient collective exists on the same patch (unaffiliated individuals), begin negotiation over obligations and claims. If a plan is created within bounds, complete firm (collective formation). *Details in relation to plan in Bratman sub-plan below.*
- If an existing collective and a potential-member individual exist on the same patch in a given time step and membership criteria were established in a prior time step, new member intentionality is assessed by collective. Individual accepts or refuses.
- If accepts, then the collective membership is updated in the time step.
- If no acceptance occurs, Individual re-initiates search.
- If all members' aspiration levels are met, the collective remains.
- If aspiration levels of all members will not be met on current patch the collective dissolves. In the next time step, each individual begins search process to find new collective partners.

- At the end of each time step, individual state variables are updated: membership with collective and location.
- At the end of each time step, collectives update membership, location, and status of duties and claims.

Gilbert:

- At each time step individuals search for other individuals or existing collectives to establish membership. The individual will observe possible targets within its search radius, and then move toward the target. *Targets for each experiment are described in sub-model below.*
- If an encounter is completed within the time step, the agent senses the attributes of the other agent (individual or collective) that co-locates on the patch to see if they are compatible collective partners. (In the case of an existing collective, this will be governed by membership size limitations and by the class of agent and its background).
- If membership criteria are met, then the agent stays for the next time step.
- If membership is not met, the agent restarts the search process in the next time step.
- If an incipient collective exists on the same patch (unaffiliated individuals), begin negotiation over obligations and claims. If a plan is created within bounds, complete firm (collective formation). *Details in relation to plan in Gilbert sub-plan below.*

- If an existing collective and a potential-member individual exist on the same patch in a given time step and membership criteria were established in a prior time step, new member intentionality is assessed by collective. Individual accepts or refuses.
- If accepts, then the collective membership is updated in the time step.
- If no acceptance occurs, Individual re-initiates search.
- If all members' aspiration levels are met, the collective remains.
- If aspiration levels of all members will not be met on current patch the collective dissolves. In the next time step, each individual begins search process to find new collective partners.
- At the end of each time step, individual state variables are updated: membership with collective and location.
- At the end of each time step, collectives update membership, location, and status of duties and claims.

Tuomela:

- At each time step individuals search for other individuals or existing collectives to establish membership. The individual will observe possible targets within its search radius, and then move toward the target. *Targets for each experiment are described in sub-model below.*
- If an encounter is completed within the time step, the agent senses the attributes of the other agent (individual or collective) that co-locates on the patch to see if they are compatible collective partners. (In the case of an existing collective, this



will be governed by membership size limitations and by the class of agent and its background).

- If membership criteria are met, then the agent stays for the next time step.
- If membership is not met, the agent restarts the search process in the next time step.
- If an incipient collective exists on the same patch (unaffiliated individuals), begin negotiation over obligations and claims. If a plan is created within bounds, complete firm (collective formation). *Details in relation to plan in Tuomela sub-plan below.*
- If an existing collective and a potential-member individual exist on the same patch in a given time step and membership criteria were established in a prior time step, new member intentionality is assessed by collective. Individual accepts or refuses.
- If accepts, then the collective membership is updated in the time step.
- If no acceptance occurs, Individual re-initiates search.
- If all members' aspiration levels are met, the collective remains.
- If aspiration levels of all members will not be met on current patch the collective dissolves. In the next time step, each individual begins search process to find new collective partners.
- At the end of each time step, individual state variables are updated: membership with collective and location.
- At the end of each time step, collectives update membership, location, and status of duties and claims.

## Real World:

- At each time step individuals search for other individuals or existing collectives to establish membership. The individual will observe possible targets within its search radius, and then move toward the target. *Targets for each experiment are described in sub-model below.*
- If an encounter is completed within the time step, the agent senses the attributes of the other agent (individual or collective) that co-locates on the patch to see if they are compatible collective partners. (In the case of an existing collective, this will be governed by membership size limitations and by the class of agent and its background).
- If membership criteria are met, then the agent stays for the next time step.
- If membership is not met, the agent restarts the search process in the next time step.
- If an incipient collective exists on the same patch (unaffiliated individuals), begin negotiation over obligations and claims. If a plan is created within bounds, complete firm (collective formation). *Details in relation to plan in Real-World sub-plan below.*
- If an existing collective and a potential-member individual exist on the same patch in a given time step and membership criteria were established in a prior time step, new member intentionality is assessed by collective. Individual accepts or refuses.
- If accepts, then the collective membership is updated in the time step.

- If no acceptance occurs, Individual re-initiates search.
- If all members' aspiration levels are met, the collective remains.
- If aspiration levels of all members will not be met on current patch the collective dissolves. In the next time step, each individual begins search process to find new collective partners.
- At the end of each time step, individual state variables are updated: membership with collective and location.
- At the end of each time step, collectives update membership, location, and status of duties and claims.

### Design Concepts

Design Concepts: Philosophers have contemplated why people come together; what force is the motivation for an individual to release control and be willing to work together with others?

Group work facilitated by we-intentionality is present in our everyday life. Some examples include: 1) making hollandaise sauce with a friend, 2) cleaning the house with your roommate, or 3) completing a paper with a group member. However, without careful consideration to the task it is easy for two individuals to work on separate goals, which happen to have the same outcome. According to the literature there are specific guidelines as to when we-intentionality is present. Michael Bratman believes we-intentionality is present when two or more individuals have a shared plan to accomplish a single intention.

Margaret Gilbert relies upon prior commitments to form the structural glue that motivates individuals to act together to achieve group agency. Raimo Tuomela relies upon the existence of shared ethos (or inner motivating belief system) of individuals to support group formation. To-date we-intentionality has only been written and thought about conceptually. It is the intention of these Agent-based models to model group formation, with special consideration taken to group formation of entrepreneurs.

The basic principles of the model derive from individual-based entrepreneurial behaviors (e.g. search for opportunities in the business environment) and from the design principle that entrepreneurial organizations must consist of three primary entrepreneurial functions, represented by three different agents: innovation, uncertainty-bearing, and firm formation. The foregoing design principle derives from heterodox economics and the history of entrepreneurship. Thus, the model will not allow for the instantiation of an entrepreneurial firm unless all three functions/agents exist in the same location in the landscape. The formation of the collective requires the establishment of we-intentionality for group action upon the joint outcomes (income) of the collective. This comes from social ontology and follows a number of possible paths from I-intentionality of the individual agents to we-intentionality of the group members to active joint agency (and economic action as a collective entity). The collective entity “harvests” earnings from the landscape patch and periodically assesses the landscape to see if higher-outcome patches are

available for exploitation. Eventually, collectives may disband if the earnings cannot meet the aspirations of individual agents and the individual claims upon them.

The sections below consider the specific behaviors and other design elements from the ODD protocol outlined above (page 32).

*Emergence:* Individual behaviors are primarily dependent upon individual state variables and interaction rules defined for collective formation and membership. After groups of agents form the group will be the representative agent for the opportunity. Agents have as part of their attributes intentionality and we-intentionality. When agents are close enough to form a group the formation of the group implies that the individuals' we-intentionality is into morphed to group-agency so that the active agent is now the group and no longer the individuals. The emergent behavior of the model is the action of the new agent, as an agglomeration of the individuals.

*Adaptation:* Not present in this model. In future models agents could adapt their level of intention, belief, and cooperation after experience with group formation.

*Fitness:* Not present in this model. In future models agents could react to their environment based on their adaption of intention, belief, and cooperation to become more attractive group members for the search process.

*Objectives:* Although adaption and fitness are not present in this early model and therefore it is not necessary for the objectives of the individuals to be explicitly listed, I believe it to be beneficial to mention that in this model individuals are guided by the interaction rules in place that operate under a hierarchy of objectives of each individual dependent upon the model in operation.

*Prediction:* Each agent will predict the expected payoffs of each opportunity. This will help determine if they move toward an opportunity. Each agent will predict 1) the value of opportunity as the individual and 2) the capacity each agent has working together and still receive a high payoff as an individual. The required payoff will be stochastically distributed.

*Sensing:* Currently all individuals can see others levels of intention, belief, cooperation and willingness to write a plan. Agents also are able to sense if they have shared connections with agents or share an 'ethos'. Special sensing abilities will be given to certain opportunities because of different business types. The state variable 'trust' will also determine how much each agent is able to sense.

*Interactions:* All agents interact together. Each agent 'meets' to gain knowledge of other agents' behaviors. From there each experiment is different for Bratman, Gilbert, & Tuomela.

*Stochasticity:* As mentioned earlier, required payoff will be an endowed initial condition and is deterministic.

*Collectives:* Collectives are formed through emergent behavior. Once collectives have been formed the group will then act on behalf of the opportunity. Breeds of each type of group we-intentionality will then act as the agent.

*Observation:* The world display shows the location of each agent on the opportunity landscape. Additional outputs will be counters for those in group formation and those grouped and exploiting opportunities.

## Details

*Initialization:* For each model, agents are given individual attributes determined by the social ontological perspective of the model. Each model is described in detail below as sub-models. The initialization of each model is the same. Each model has 30 turtles (agents) of each agent role (role 1, 2, and 3) for a total of 90 agents that can form a maximum of 30 groups. Within each role agents are given all individual attributes randomly, except for intention. The absence of intention is received by exactly 15 of each role type, and the presence of intention is received by exactly 15 of each role type.

*Input:* The environment is assumed to be constant, no input data is necessary.

*Sub-models:* All model parameters for the environment are the same for all models represented. A model was designed to represent each ontological view as well as a model designed to represent an environment with all views operating at once. In the process overview I eluded to each model's targets for group members and the negotiation necessary to complete group formation. I will describe in detail, using code as explanation, each of the models targets and negotiation requirements.

- Bratman
  - Target: The target attribute for group formation in the Bratman model is I-intention. I-intention is representative of an agent's intention to complete a group-task on an individual level. All group members must have I-intention to form a Bratman group. I-intention must equal 1.

```

to go
ask turtles [
  if (gr = 0) [
    if (I-intention = 1) [
      rt random 360
      fd 1
      set myrole role
      set myid who
      set myint intention
      if (role = 1) [
        ask turtles with [I-intention = 1 and gr = 0] in-radius sr [

```

- Negotiation: Once the group search has begun, agents search for agents with different roles than themselves, the presence of intention, and the ability to mesh sub-plans.

```

ask turtles with [I-intention = 1 and gr = 0] in-radius sr [
  if (role = 2) and (intention = myint) and (mesh = 1) [
    set pot1 1
  ]
  if (role = 3) and (intention = myint) and (mesh = 1) [
    set pot2 1
  ]

```



- Completion of model: The model is complete once any agents with a given role do not remain with I-intention present.

```
set i1r1 count turtles with [ I-intention = 1 and role = 1 and gr = 0]
set i1r2 count turtles with [ I-intention = 1 and role = 2 and gr = 0]
set i1r3 count turtles with [ I-intention = 1 and role = 3 and gr = 0]

if (i1r1 = 0 or i1r2 = 0 or i1r3 = 0) [stop]
```

- Gilbert

- Target: The target attribute for group formation in the Gilbert model is prior commitments. Prior commitments are representative of an agent's relationship with agents prior to group search. All group members must share a prior commitment to form a group in the Gilbert model. Prior commitment must equal 1.

```
to go
  ask turtles [
    if (gr = 0) [
      if (PC = 1) [
        rt random 360
        fd 1
        set myrole role
        set myid who
        set myint intention
        if (role = 1) [
          ask turtles with [PC = 1 and gr = 0] in-radius sr [
```

- Negotiation: Once the group search has begun, agents search for agents with different roles and prior commitments to form groups. Intention of the agent is a state variable, however the intention of the agent is morphed to be like all group members once paired with group agents of prior commitments.

```

if (role = 1) [
  ask turtles with [PC = 1 and gr = 0] in-radius sr [
    if (role = 2) [
      set pot1 1
    ]
    if (role = 3) [
      set pot2 1
    ]
  ]
]

```

- Completion of model: The model is complete once any agents with a given role do not remain with prior commitments present.

```

set ng (count turtles with [gr = 1] / 3)
set p1r1 count turtles with [PC = 1 and role = 1 and gr = 0]
set p1r2 count turtles with [PC = 1 and role = 2 and gr = 0]
set p1r3 count turtles with [PC = 1 and role = 3 and gr = 0]

```

- if (p1r1 = 0 or p1r2 = 0 or p1r3 = 0) [stop]
- Tuomela
  - Target: The target attribute for group formation in the Tuomela model is we-intention. We-intention is representative of an agent's desire to complete a group-task on an individual level, taking a holism approach to intention. All group members must have we-intention to form a Tuomela group. We-intention must equal 1.

```

to go
  ask turtles [
    if (gr = 0) [
      if (we-intention = 1) [
        rt random 360
        fd 1
        set myrole role
        set myid who
        set myint intention
        set myethos ethos
        set mybelief belief
        if (role = 1) [
          ask turtles with [we-intention = 1 and gr = 0] in-radius sr [

```

- Negotiation: Once the group search has begun, agents search for agents with different roles than themselves, the presence of intention, the presence of ethos, and the presence of belief.

```
if (role = 1) [
  ask turtles with [we-intention = 1 and gr = 0] in-radius sr [
    if (role = 2) and (ethos = myethos) and (intention = myint) and (belief = mybelief) |
    set pot1 1
  ]
  if (role = 3) and (ethos = myethos) and (intention = myint) and (belief = mybelief) |
  set pot2 1
]
```

- Completion of model: The model is complete once any agents with a particular role do not remain with we-intention present.

```
set ng (count turtles with [gr = 1] / 3)
set w1r1 count turtles with [ we-intention = 1 and role = 1 and gr = 0]
set w1r2 count turtles with [ we-intention = 1 and role = 2 and gr = 0]
set w1r3 count turtles with [ we-intention = 1 and role = 3 and gr = 0]

if (w1r1 = 0 or w1r2 = 0 or w1r3 = 0) [stop]
```

- Real-World (a world where all three ontological accounts are possible)
  - Target: The target attribute for group formation in the real-world model is dependent upon the sub-model being processed at the time. Bratman, Gilbert, and Tuomela are all represented in the real-world model. All of the targets for these models are described above.

```
to go
  ask turtles [
    bratman
    gilbert
    tuomela
  ]
]
```

- Negotiation: Once the group search has begun agents search for agents with different roles than themselves that qualify to the particular sub-model being processed at the time. All of the negotiation requirements for the sub-models are described above.

- Completion of model: This model runs indefinitely in the current design.

## Model Results

Four models are displayed for the purpose of demonstration of group formation using agent-based modeling. It is expected that each model will simply represent the agents ability to participate in a search process to find group members and then achieve group agency via necessary conditions for we-intentionality. Inside each model the search radius will be tested to confirm that the larger an area an agent can search for potential group members the quicker group formation is completed. In some of the models it takes many steps to form all groups, in these models restrictions were added to the model testing to begin performing the next test after 5000 time steps. In these models I expect the average number of time steps for group formation to decrease from 5000 as search radius increases.

NetLogo was used for the agent-based modeling of the group formation (Railsback 2012). Figure 1 depicts the home screen for all models.

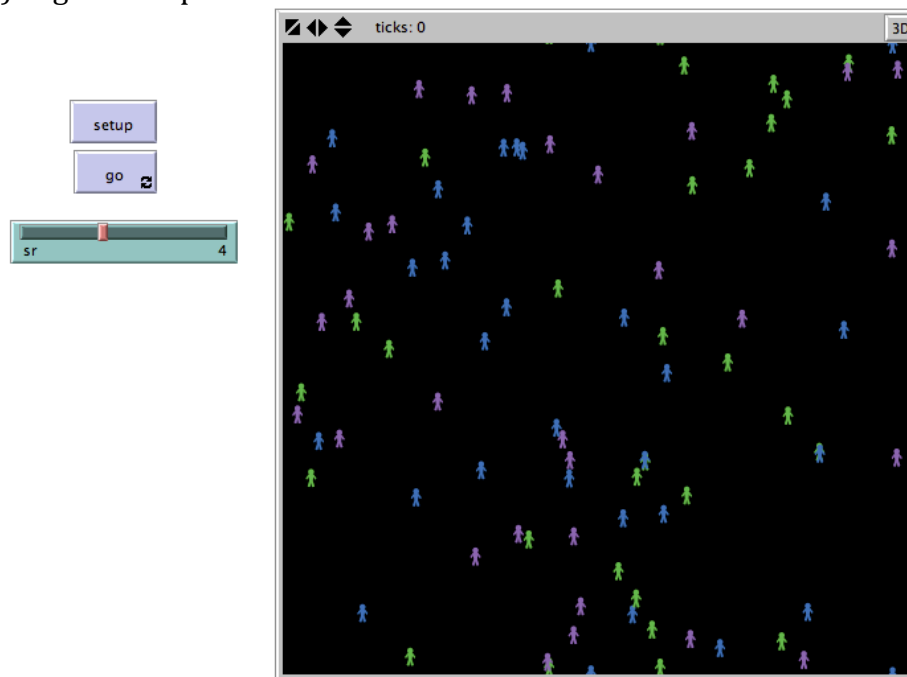


Figure 2: NetLogo home screen for all models depicted in this thesis

The setup button is the trigger for the creation of all of the agents on the screen. The go button prompts the agents to act according to their individual attributes and interact with other surrounding agents. The 'sr' button, is a slider, allowing for the search radius (Search radius is represented by 'sr' within the model coding. The search radius is the area each agent can sense other agents and access their individual attributes) of each individual agent to be modified quickly from the home screen. Three different agents roles are represented in the model and depicted by the different color of agents (i.e. 1 = innovator, 2 = capitalist, and 3 = manager). The three roles are necessary to insure that groups are made up of different types of individuals.

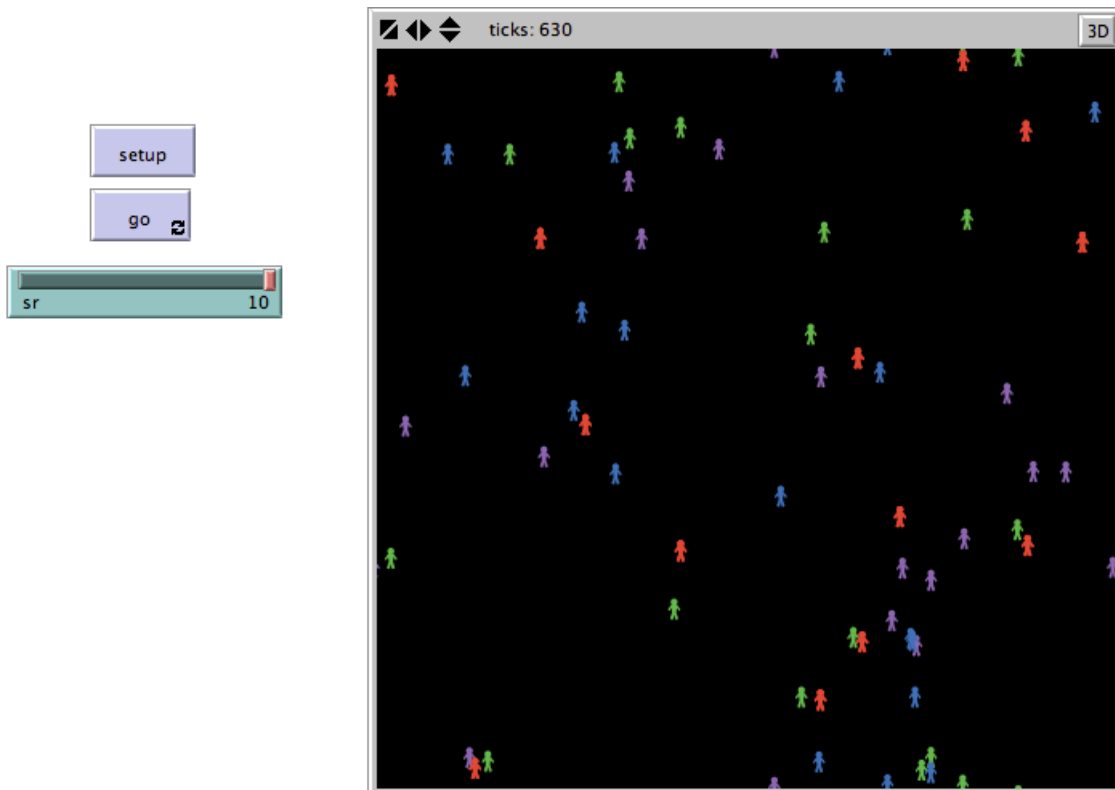


Figure 3: NetLogo completed model

When agents identify possible other agents to form a group with the agents relocate and access the qualities of the other agents. If agents are suitable for group formation then all agents change color to red (or some other predetermined color) and stop participating in the group search. The red color indicates the achievement of group agency. Each agent-based model has 90 turtles with 30 turtles in each role, for a possibility of the formation of 30 three-agent groups during each experiment. For each model I will present the numbers of groups formed and the amount of time it took for all possible groups to form, dependent upon the search radius. Each experiment is the average of 25 model trials.

### Bratman

The Bratman model requires I-intention to participate in the search process.

Expected results were found during the Bratman model exercise. Roughly 15% of total potential groups formed at search radius five, 20% of total potential groups formed at search radius ten, 23% of total potential groups formed at search radius fifteen, and 24% of total potential groups formed at search radius twenty. As the search radius increased agents were able to form groups at a quicker rate. The Bratman model was limited to 5000 time steps.

Search Radius	Average # of Groups Formed	Average # of Time Steps for all Agents to Form Groups
5	4.69	5,000.00
10	6.04	4,884.84
15	6.97	4,881.60
20	7.40	3,866.84

Table 2: Bratman Agent-based Modeling Results

### Gilbert

The Gilbert model requires prior-commitment to participate in the search process.

Expected results were found during the Gilbert model exercise. Roughly 40% of total potential groups formed, as the search radius increased agents were able to form groups at a quicker rate.

Search Radius	Average # of Groups Formed	Average # of Time Steps for all Agents to Form Groups
5	11.6	15,739.18
10	11.96	6,541.10
15	11.78	2,445.22
20	11.58	1,186.18

Table 3: Gilbert Agent-based Modeling Results

### Tuomela

The Tuomela model requires we-intention to participate in the search process.

Expected results were found during the Tuomela model exercise. Roughly 8% of total potential groups formed at search radius five, 16% of total potential groups formed at search radius ten, 18.5% of total potential groups formed at search radius fifteen, and 19% of total potential groups formed at search radius twenty. As the search radius increased agents were able to form groups at a quicker rate, because of the increased number of groups formed. The Tuomela model was limited to 5000 times steps.

Search Radius	Average # of Groups Formed	Average # of Time Steps for all Agents to Form Groups
5	2.4	5,000.00
10	4.84	5,000.00
15	5.56	5,000.00
20	5.68	5,000.00

Table 4: Tuomela Agent-based Modeling Results



## Real-World

The real-world model tests the interaction that occurs when multiple methods of group formation are present. This model is important in its testing to simply illustrate the ability for all three techniques to be present in one environment and all three sub-models continue to operate. The Bratman method for group formation formed the most groups with a search radius of 5 or 10. The Gilbert method formed the most groups with a search radius of 15 or 20. This is expected because of the lack of agent requirements for group formation for both Bratman and Gilbert. With a smaller search radius Bratman formed more groups because his search process was the first sub-model to proceed, followed by Gilbert and then Tuomela. Tuomela had the fewest groups formed because of the high number of qualifiers necessary for group formation. Figure three below shows a NetLogo model screen with all three group formations occurring (represented by the red, orange, and yellow agents).

Search Radius	Average # of Groups Formed	Bratman Groups	Gilbert Groups	Tuomela Groups	Avg. # of Times Steps for All Agents to Form Groups
5	3.68	1.80	1.24	0.63	5,000.00
10	4.64	1.94	1.91	0.79	5,000.00
15	5.36	1.99	2.17	1.19	5,000.00
20	4.97	2.03	2.23	0.71	5,000.00

Table 5: Real-World Agent-based Modeling Results

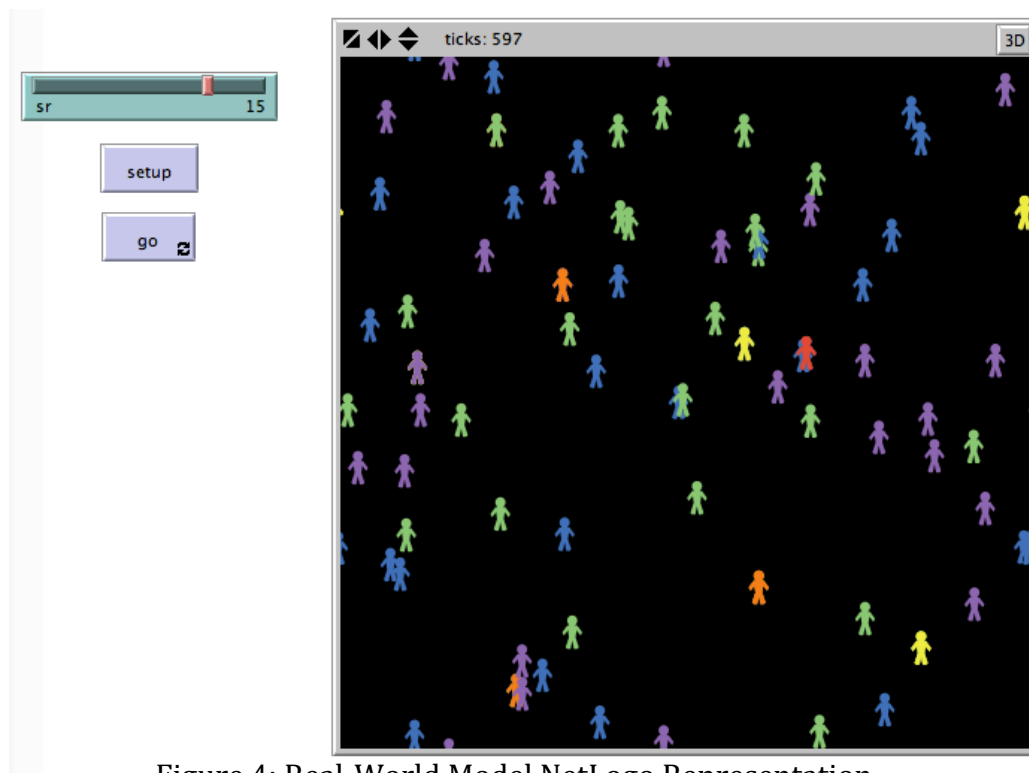


Figure 4: Real-World Model NetLogo Representation

### Further Study

The exercise of completing agent-based models for the illustration of social ontology present in group formation was the purpose of this thesis. That is, these models examine the dynamics of team formation under three specific ontological accounts. It is designed with incipient flexibility to change the distribution of agent types, size of the landscape, and the mobility of agents. Additional research needs to be completed using the backbone created here, to study, in-depth, the impact a particular ontology has on group formation. The models can then be further expanded to represent a specific economic environment in which the groups formed can then exploit opportunities.

Contrary to the current model, in which I assume occupation of the same patch indicates group agency, a model needs to be developed in which the collective group formed then interacts with the environment as one agent. Economic measures can then be monitored. For example, earnings of the collective could emerge from interaction between the collective and the landscape patch (harvest) according to landscape-level rules, competitive effects that arise from the juxtaposition of other collectives, and the speed at which different collectives form on the landscape. It will be interesting to explicitly model the potential economic payoffs from landscape patches, so as to see how the collectives compete with each other as group agents (in the list and Pettit sense).

## Conclusion

This study of group entrepreneurship is completely reliant upon understanding the social ontology of the individuals comprising the group. Contrary to the business management or social science approach to entrepreneurship, the best way to study entrepreneurship is a hybrid individual – group perspective. The individual's attributes will define the method to which group formation occurs, and therefore influence the structure and governance of the entrepreneurial group. The governance is the dominant force in the implementation of group agency at a human level.

Group agency was easily achieved in a computer model simulation. In further development of the model, individuals could have the opportunity to defect from the formed group and act outside of group agency. However, to best understand the governance necessary to force group agency, it is critical to trace and understand the social ontology of the individuals that caused the group formation. That is the purpose of this thesis. I defend group entrepreneurship through an extensive literature review of collective intentionality and group agency leading to an agent-based model of group formation. I believe collective intentionality is the motivation for the action of group formation. However, because of the complexity of human nature the philosophers who study intentionality cannot agree on one definition. Michael Bratman, Margaret Gilbert, and Raimo Tuomela all have different mechanisms for how individual we-intentionality leads to group agency. I systematically broke down and compared all three theories finishing my analysis

with a comparison in agent-based modeling using NetLogo. Agent-based modeling allows for a model simulation of group behavior and emergent phenomena while accounting for the differences in individuals, local interactions, and adaptive behavior of the individuals.

The immediate implication of the models presented is the inter-disciplinary proposition of a new framework for group formation. The group formation itself is not the focus; rather it is the approach to the study of the group formation. Group formation studied only under the umbrella of ontology provides no framework to quantitatively analyze the impact changes to the ontology has on groups. Economics rarely studies the group formation, but only the consequences of groups. With the use of ecological methods I was able to draw a connection between the study of the individual in ontology and the study of the group in economics. This connection builds a valuable framework for further work to grow from and increase the understanding of the impact individuals have on the macro-environment.

Further reaching implications of this work expand into the increased knowledge of entrepreneurial groups to help support the study of entrepreneurial success. By adding sophistication to the agent-based models presented in this thesis substantial work can be done to begin to test variables that lead to entrepreneurial success. By reducing the subject of study down to the intention of the individual the field of entrepreneurship now has a vehicle to test and begin to understand why some entrepreneurial ventures thrive. In addition, once the individual attributes have

been identified the flexibility to add environmental factors is now present. It becomes possible to ask questions as poignant as, “What type of entrepreneurial group survived and thrived during the economic environment of the American Great Depression?”. Although, this approach cannot predict future success it can be a tool to provide increased understanding to the mysterious success of entrepreneurs.

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