

## Selecting optimal targets for change agents: insights from a computer simulation

by Dirk Maienhofer  
School of Information  
University of Michigan  
dirkm@umich.edu

### Extended Abstract

Change agents try to promote concrete change in groups or organizations. For instance, they try to foster the diffusion of innovations by influencing some group members towards innovation adoption. In order to make effective use of limited time and energy resources change agents have to pick the right targets for their efforts. Who are those right targets? Are they the most popular members of the organization or the ones most eager to try out the proposed innovation? To answer this question and to investigate how important the right choice of change agent targets is we developed a diffusion of innovation model – a network threshold model. We implemented the model on a computer to simulate the diffusion of software tools within a part of a larger organization.

The main ingredient of our model is a set of actors who differ in the social ties they have among each other and the way they make decisions to adopt or reject an innovation. At each time step every actor has to "decide" with regard to an innovation if the innovation will be adopted, and if adopted, if use of the innovation will persist. Each actor's decision is based on a) his attitude towards the innovation and b) the adoption behavior of his social network. We chose a threshold model approach ascribing two thresholds for each actor; the first threshold governs adoption, the second threshold is always a fixed fraction of the first and governs the abandonment of the innovation. By providing the actors with a memory our model takes into account that people, especially late adopters, observe how well an innovation is implemented *over a certain amount of time* and how well an innovation is *established*. To take direction and speed of change into account we define an actor  $a$ 's "perceived degree of innovation establishment" as the weighed sum of the average number of adopters in  $a$ 's social net plus the average gain of adopters within  $a$ 's social net over a period of ten time steps. (We only consider those actors who are reported by  $a$  as important contacts).

Realistic data about our actors' social network have been extracted from a survey we administered to a group of 106 employees within a large organization. The overall number of possible ties was limited to 20. Thresholds for the actors were determined from self-reports. We described an innovation that was to be released shortly thereafter and asked directly: "How likely is it you would adopt this innovation?" Individual adoption thresholds were assigned inverse-proportional to this self-reported likelihood estimate. Possible adoption thresholds ranged from 0 (innovator) to the free parameter  $th_{max}$  (the higher  $th_{max}$  the more adopters are needed on average to influence actors to adopt).

To define the initial condition, i.e., which actors are the innovators who adopt at the first time step, we identified the  $n$  % actors with the lowest adoption threshold and determined these to be innovators. This method is justified by the close relation between innovativeness and having a

low threshold for adoption. Persons whose adoption threshold is very high are obviously not innovators.

As expected, we observed in our simulations that diffusion success is increased with a decrease of  $th_{max}$  and with an increase of the rate of innovators. Decreasing the distance between the abandonment and adoption thresholds renders actors more “whimsical” and thereby decreases diffusion success.

Exposure to a change agent in our model renders the targeted actor more positive towards adoption by decreasing his threshold for adoption to 0 (the target becomes an innovator). The efficiency of a target selection S was defined and measured as the extent to which targeting S increased the highest possible value of  $th_{max}$  for which the simulation still results in diffusion success. Every simulation that ended with a portion of adopters greater than 50% was for this purpose defined as diffusion success. For example: For a particular parameter combination diffusion success would only occur until  $th_{max}$  reached the value 100. Selecting group S as a change agent target would then allow an increase of  $th_{max}$  to 130, at which point diffusion would break down. In this case we would consider the target efficiency of S (under this parameter combination) to be 30%.

Computing the above defined efficiency of all possible target selections of size  $n=1,2$  revealed significant differences between the possible selections. Variations of parameters such as the rate of innovators, the weights that determine the perceived degree of innovation establishment or the difference between adoption and abandonment thresholds did not largely impact the findings. The efficiency ranking of single change agent targets remained almost constant under variation of these parameters.

Determining good targets would therefore at least require gathering data about the social network and the attitudes towards innovations. However, the time and resources necessary to do that might be spent more efficiently otherwise. Instead of the costly determination of  $n$  “good” change agent targets a change agent could, for instance, select his target group randomly as long as it was bigger than size  $n$ . Would a strategy that relies in this way on quantity rather than quality be superior? In order to determine how important the selection of good targets is, at least in our simplified setting, we ran trials with randomly selected target groups of different sizes and compared them to a reference group. The reference group was selected solely on the basis of the target selection-efficiency measure defined above. We found that a randomly selected target group has to be on average at least 6 times the size of the reference group in order to achieve a similar level of effectiveness. The following table shows a typical result comparing the average diffusion success of randomly selected target groups of different sizes with the reference target selection of size  $n=3$ . Diffusion success was measured in the percentage of adopters at the end of the simulation. For each group size 10,000 simulations were performed.

<b>Groupsize</b>	3 (ref.)	3 (random)	4 (random)	5 (random)	6 (random)	9 (random)	18 (random)
<b>Success (<math>\emptyset</math>)</b>	53%	6.9%	7.9%	8.2%	8.5%	12.6%	37.5%

Who are the good change agent targets? A social network perspective suggests those actors with a high degree of network centrality. In our model, however, influence towards adoption can

only flow from adopters to actors who consider them important contacts. One should therefore assume that good change agent targets have a high indegree. Indeed, we found the indegree significantly correlated to our measure of target efficiency under most parameter combinations. However, since the correlation coefficient is typically in the order of 0.6 it is fair to say that even the indegree measure is not a perfect predictor of target quality. Some actors have a high indegree but have virtually no impact as change agent targets, whereas other actors have a low indegree but are highly effective change agent targets. This can be analyzed as follows.

We have to expect that the distribution of individual thresholds of adoption and abandonment has an influence on the outcome of our simulations. Assume actor  $x$  adopts at time  $t$ . At time  $t+1$  this might maximally influence  $n$  other actors towards adoption, whereby  $n$  denotes the indegree of  $x$ . Not all  $n$  actors who consider  $x$  an important contact are necessarily influenced in their adoption behavior by  $x$ 's adoption. Having a relation to  $x$  is a necessary but not sufficient condition for being influenced by  $x$ 's adoption. Only certain actors can be pushed towards adoption by  $x$ 's adoption. Who they are depends on *their* individual threshold and the actual number of adopters in *their* network. The impact  $x$  has on  $y$  depends on the number of further adopters in  $y$ 's social net that are needed to reach  $y$ 's threshold. Say  $n-k$  actors are indeed pushed towards adoption by  $x$ 's adoption. At time  $t+2$  the same argument can be made for the impact of each of these  $n-k$  actors on the actors who regard them as important contacts. They will push some but possibly not all of those actors towards adoption, thereby increasing the number of actors (indirectly) influenced by  $x$ 's adoption. In this way  $x$ 's impact spreads step by step through the whole net.

We conclude that the quality of actors as change agent targets depends on the whole network and the distribution of attitudes within that network. Therefore the property of being a good change agent target cannot be a simple network measure like indegree or centrality but should be related to those measures. Our simulation reveals the influence of the interplay between the social network and the distribution of actors' attitudes on the diffusion process. In Granovetter's words, we specified the impact of the social structure and individual preferences on a collective outcome. This might explain why sometimes even promotional efforts that target the most popular actors within a social net fail. Our results outline the circumstances under which targeting less popular actors can be more successful.

### **Literature:**

Granovetter, Mark S. (1978) 'Threshold Models of Collective Behavior', *Journal of Sociology*, 83(6), pp. 1420-1443.

Valente, T. W. (1995). *Network models of the diffusion of innovations*. Cresskill, NJ: Hampton Press.

Valente, T. W. (1996) 'Social Network Thresholds in the Diffusion of Innovation', *Social Networks*, 18, pp. 69-89.