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Resilience for Industries in Unpredictable Environments: You Ought To Be Like Movies

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You Ought To Be Like Movies

By
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Executive Summary

This paper looks at a puzzle facing many industries: How can they survive and thrive in rapidly changing and unpredictable environments? The ideas in the paper are intended to be useful to many industries and firms. The movie industry is used as an example to test the applicability of some new work being done on resilience in unpredictable systems. This new work is being done in many disciplines, including fields as diverse as mathematics, political science, ecology, and business management. It has revealed the possibility that many kinds of complex, unpredictable systems, particularly those that operate as a network, have some things in common. And, while it may not be possible to predict the individual events (success or failure) in these systems, it may be possible to make some predictions about the kinds of strategies that will make them more resilient over the long term. Previous work has already shown that the U.S. movie industry (often referred to as Hollywood) is one of the least predictable industries in the world (in terms of which movies will be big hits) and it suffers some giant failures every year. Yet it is also one of the most successful and stable industries in the world, accounting for a very large share of U.S. exports every year. What works for the movie moguls may work for other organizations that find themselves in unpredictable environments.

The paper examines several years of data on movie revenues and finds a power law distribution in each year. The reasons for this and the implications for strategy in similar environments are examined. Rules of thumb are distilled that may be helpful for other industries and firms. These rules appear to be consistent with several widely accepted management theories, making it appear more likely that the rules from other systems will be relevant in developing resilience in business systems.

Not all businesses have the potential for the big hits that makes the system resilient in the face of many failures. But it will be worth any manager's time to look the ideas presented here in order to discover which ones might work for them. The following ideas are developed in this paper. Business managers will recognize that several things on this list are consistent with well known ideas in management science. This is probably additional evidence that these ideas from other disciplines are not irrelevant to business.

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[1] P.H. Longstaff is a Research Affiliate at Harvard's Program on Information Resources Policy and a member of the Television, Radio and Film Department at Syracuse University; Raja Velu is a Professor at Syracuse University's Whitman School of Management; Jonathan Obar is a graduate student at Syracuse University.

1. Decide if your business (your industry and/or your firm) is unpredictable by nature or if it is just in an unpredictable phase of its development and stability can be expected to return.
2. Acknowledge the unpredictability (either permanent or temporary) and how this changes the definitions of success for the industry, the firms in it, and individuals in those firms. Expand the time scale for measuring success and acknowledge the goal of resilience.
3. Throw many seeds and acknowledge that there will be failures. Either throw many of the same kinds of seed in many environments and see where they grow, or, throw many different kinds of seeds and see which ones thrive in a particular environment.
4. Set up feedback mechanisms that allow you to distinguish success and failures as early as possible. If the system is likely to have tipping points, decide how you will know them and how you will rush resources to (or from) the tipping system. This is especially important if the system is tightly coupled and subject t cascading failure or runaway success.
5. Set up mechanisms that give you maximum adaptability and allow you to invest in success and cut losses on flops. This might include adaptive contracts and contingency compensation.
6. Make sure there are weak links to resources outside your business, ones that can be used when the unpredictable happens. These links should be weak enough that they are not be affected by problems in either business. Strong coupling should be used where efficiency is critical, but acknowledge the trade-off in stability and resilience for that function.
7. Make sure that people who have to deal with the unexpected have links to many resources. These links should be on multiple scales and not require going through a hierarchy in times of opportunity or danger.
8. Make sure that important functions have redundancy, preferably at different scales so that if the function is damaged at one scale it can be picked up at another. This is especially true for any function that acts as a hub.
9. Hubs should have diverse connections that allow the people who use them to access many different types of resources – even ones they don't use very often.
10. Stay in touch with both the slow and fast parts of the business. The part that changes slowly is just as important as the part that responds to every change in the environment. "The Fast proposes but the Slow disposes."

Introduction

Are there any options for managers who find themselves in a business environment where resources or customer demand are truly unpredictable? In these cases it is hard to develop a strategy that is *robust* (capable of withstanding predictable challenges without losses). The option may be to strive for *resilience* (capable of bouncing back from known *and* unknown challenges that result in losses).

Nobody knows unpredictability like Hollywood. So the movie industry seems a good place to test some new work being done on resilience in unpredictable, networked systems. This new work is being done in many disciplines (including such diverse fields as mathematics, political science, ecology, and business management) and has revealed the possibility that complex, unpredictable systems, particularly those that operate as a network, seem to have some things in common. And, while you can't predict the individual events in these systems, you may be able to make some predictions about the kinds of strategies that will make them more resilient to failure. Previous work has already shown that the U.S. movie industry (often referred to as Hollywood) has some of the least predictable products in the world (in terms of which movies will be big hits) and it suffers some giant failures every year.[2] Yet it is also one of the most stable and successful industries in the world, accounting for a very large share of U.S. exports every year.[3] What works for the movie moguls may work for other organizations that find themselves in unpredictable environments.

It's not that people haven't made attempts to find the right formula for success in Hollywood movies, and things like sequels have some predictive power, but even the tried and true can be flops and that goal of predictable investment remains elusive. There are still surprise hits and surprise flops, and there are many more flops than hits. The conventional wisdom in the

[2] See, e.g., Arthur DeVany and W. David Walls, "Bose-Einstein Dynamics and Adaptive Contracting in the Motion Picture Industry," *The Economic Journal*, Vol. 106, No. 439 (Nov. 1996), pp. 1493-1514.
[3] For an overview of how the movie business works, see, e.g., Mark Litwak, *Reel Power: The Struggle for Influence and Success in the New Hollywood*, New York: William Morrow & Co., 1986; Harold L. Vogel, *Entertainment Industry Economics, Fifth Edition*, Cambridge U.K. and New York: Cambridge University Press, 2001.

industry is that only one movie in ten ever makes a profit.[4] Every experienced Hollywood executive can give many examples of projects they did not predict correctly. These executives have been disappointed by many theories about box office success – theories put forward by both the creative people in the business (directors, writers, etc.) and by business analysts with sophisticated statistical analysis tools. Hollywood moguls are likely to roll their eyes and cut off any presentation that tries to posit predictability in their business. It is not easy for them to explain this unpredictability to investors and the corporate boards who now own most studios. But what they know from hard experience can be demonstrated with statistical analysis and some theories being developed in other hard-to-predict systems. Anyone in the movie business will tell you that theirs is a very complex business, and it turns out that they are right in both the technical and the everyday use of that word.

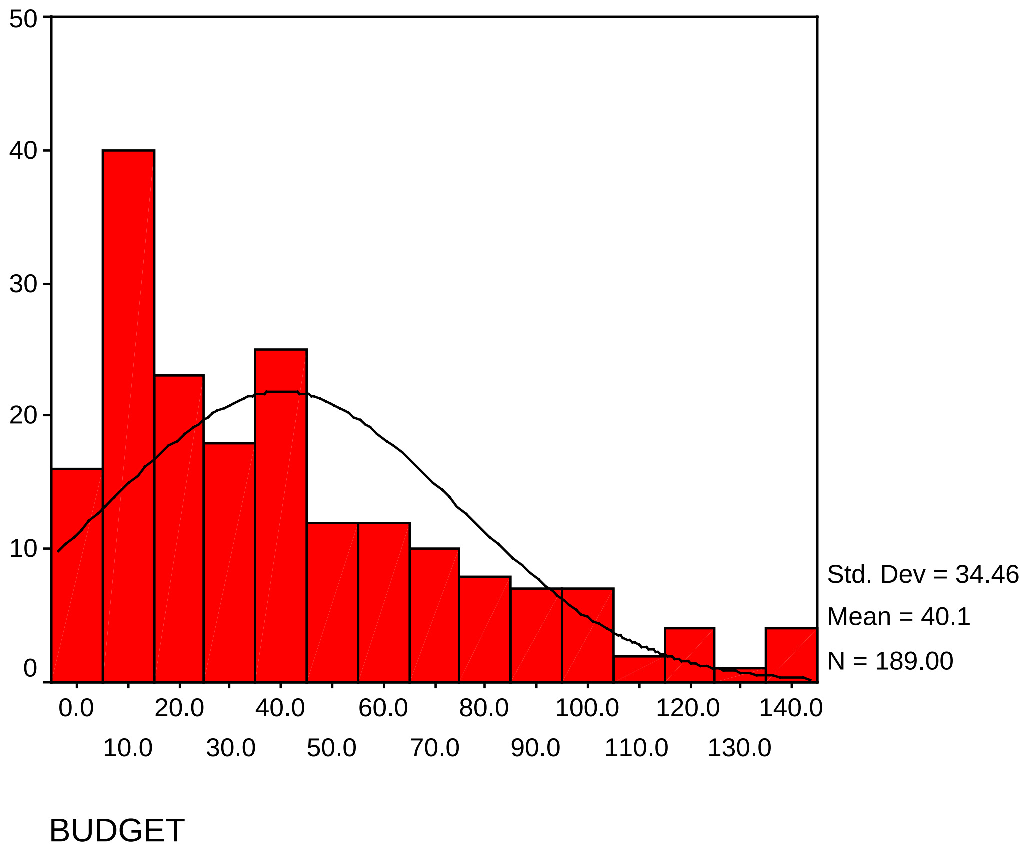
This paper is presented in three parts. Readers not particularly interested in statistical analysis, they may want to skip Parts One and Two and go directly to Part Three.

Part One examines the work that has been done in traditional data analysis of Hollywood success (or lack thereof). Part Two uses data from seven years of Hollywood films, examining the budget, revenue and profit from the 125 top budgeted films for the years 1996-2002. It confirms initial work (examining more limited data)[5] that blockbuster movies follow a power law distribution in all years studied. Unlike a "normal" distribution, where there are a few events at the high and low end, with most events in the middle, a power law distribution indicates that extreme events are happening in a very few cases (blockbusters) but there are many more events (other movies) that are not successful and very few events in the middle range.

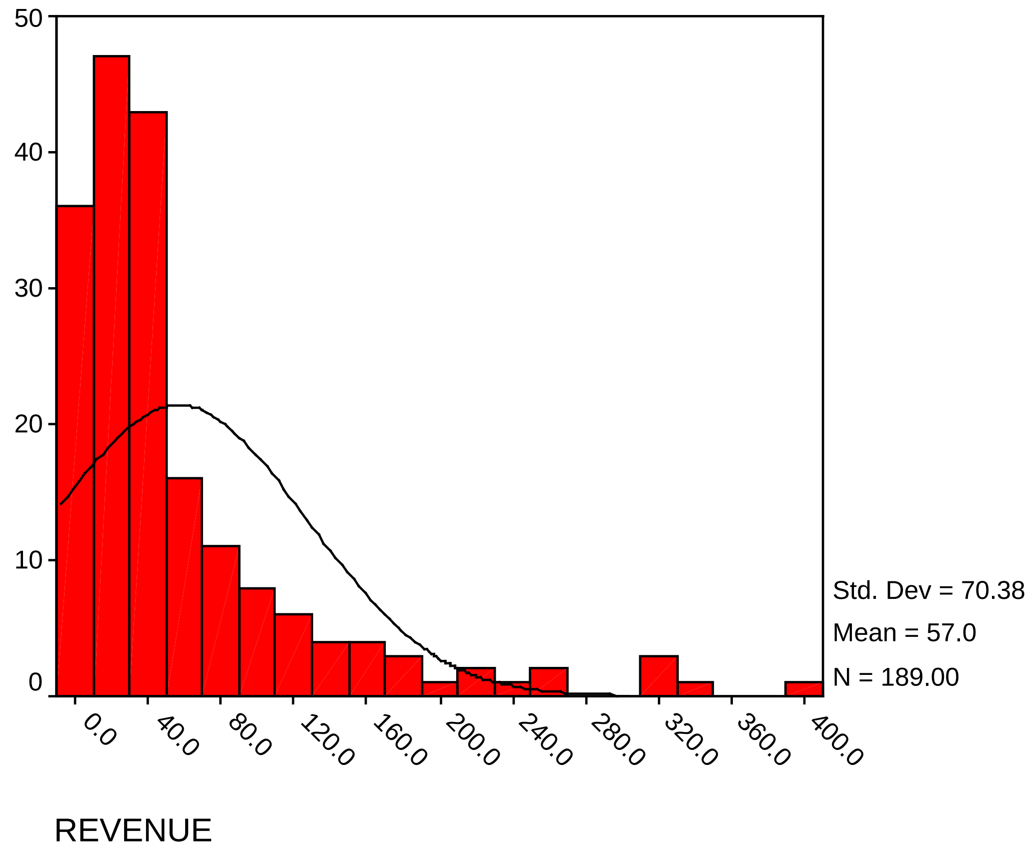
Below are two graphs based on 2002 movie data. The graphs represent the budget and revenue distributions. Both indicate that the distributions are not bell-shaped normal curves but look more like a *power law* distribution. In statistics literature this is also characterized as a Gamma distribution (a power law distribution is part of the family of gamma distribution). A power law distribution is often the signature of a "complex" and unpredictable system. A power law pattern is also said to be "the mathematical face of a special architecture, an architecture that

[4] This ratio is somewhat misleading because Hollywood accounting methods for "profit" are unusual, but the general idea that most films do not make money seems to be correct.
[5] D. Sornette and D. Zajdenweber, "Economic Returns of Research: the Pareto Law and Its Implications," Los Alamos e-print (cond-mat/9809366), September 27, 1998.

is dominated by especially well-connected hubs."[6] These systems are often subject to cascading behavior, where the response of the system is hypersensitive (because of its unstable structure) to individual events that have unpredictable effects on the entire system. This is usually illustrated with the image of a sand pile. Most of the next grains of sand to fall on the pile will stick to the pile, a few may cause a small landslide that collapses part of the structure, and a very few will cause a large landslide that collapses much of the structure.[7] There are some clues from these types of cascading, networked systems that can be useful for managers in an industry subject to a power law distribution – even if these clues do not promise predictability. These clues will be discussed in Part Three.



[6] Mark Buchanan, *Nexus: Small Worlds and the Groundbreaking Science of Networks*, New York and London: W.W.Norton & Co. (2002), p. 85.
[7] See, Per Bak, *How Nature Works*, (Oxford: Oxford University Press, 1996).



The results of the data analysis in Part Two indicate that there are a few things that may have some bearing on the slope of the curve in the distribution of movies each year. This section demonstrates that the power law is validated year after year although there is some shift in the cost and revenue over time.[8] Readers who are not interested in the details of this type of analysis may want to skim this section. It must be noted that Hollywood movies are often parts of intellectual property "packages" that seek revenue not only from theatrical release, but from many other uses of the "brand" of the movie, including: home viewing (VHS and DVD), cable, ancillary products, and spin-off books, games, TV shows. In fact, in 2003, Americans spent far more on VHS and DVD rental and sales ($22.5 billion) than they did at the box office ($9.2

[8] Typical distribution Normal and Gamma distribution families are presented in Appendix One. Note that both distributions are constructed to have the same mean and variance, but their shapes are very different. A Gamma distribution does not have the highest part of its curve in the middle, but at or near the beginning of the graph.

billion) and some movies expected to make most of their profits outside the theater.[9] This section looks only at budgets for producing the movie itself and revenue from theaters.

In Part Three, we will see how the work being done in complex, networked systems can be used to analyze the movie business. This section then distills the ideas from the new work on resilience in complex networks to suggest potential strategies for other industries that must operate in unpredictable systems.

[9] "Romancing the Disc," *The Economist*, February 7, 2004, pp.57-58.

Part One

Attempts to Find the Magic Formula for Hollywood Movies

Because the possible rewards for finding the right formula for success in the movie industry are so large, many have tried to find it. Like the medieval chemists who tried to turn lead into gold, they have tried many things – but to no avail. Some have attributed success to "flexible specialization"[10] and others have even tried to create formulas in an attempt to predict the revenue potential of a film before it opens. A recent effort – one might even call it heroic – involved an extremely complicated regression model that incorporated genre, MPAA rating, release date and variables relating to the actors. The method was used to try to predict the revenues for 311 films released domestically in 1998. [11] An example of this method:

> … a PG-rated drama not released during the summer with one best actor and no top dollar actors, … its predicted log gross is: .394 - .408 + .308 - .150 + (1)(.400) + (0)(.712) = .616, and its predicted gross is $10^{.616}$ = $4.13 million.[12]

Unfortunately, this model was unable to come even close to predicting actual domestic grosses for most movies. Some of the extreme examples: *There's Something About Mary* was predicted to make $1.8 million, and it actually made $176 million; *Godzilla* was predicted to make $18 million and made $136 million; and *Saving Private Ryan* was predicted to make $14 million and made $216 million. The inability of the model to predict the success of *The Horse Whisperer* was attributed to the inability to incorporate the fact that the film was based on a best-selling novel. The model overestimated the success of *Hurly-Burly* because of the bad reviews that it received; again, something the model could not incorporate. Other predictive failures were attributed to a number of factors: the films were "sleepers," they had positive word-of-mouth feedback, and some were nominated for Oscars.

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[10] See, Susan Christopherson and Michael Storper, "The City as Studio; The World as Back Lot: The Impact of Vertical Disintegration on the Location of the Motion Picture Industry," in *Studying Culture: An Introductory Reader*, Ed. Ann Gray and Jim McGuigan, new York: Oxford University Press, Second Edition, 1997, pp. 256-275.

[11] Simonoff, J.S.& Sparrow, I.R. (2000). Predicting movie grosses: Winners and losers, blockbusters and sleepers. *Chance, 13(3)*, pp. 15-24.

[12] Ibid. p. 9.

Clearly, there are many forces at work in the making of a hit movie and any model that attempts to incorporate all of them would be almost impossibly complex, with no assurance that it had included all of the potential variables. Some who have studied the industry believe that, "There are just so many things that can affect how a movie does, … Everything from the weather to who is in the NBA finals on Friday night can make a movie go in the tank." [13]

Many studies have focused on the effects of individual variables. For example, Krider and Weinberg[14] examined the effects of release timing on revenue; Ainslie, Drèze and Zufryden[15] examined how competition and choice of actors/directors leads to particular levels of success. Though these studies, and many others like them, have successfully contributed quantitative analyses regarding the specific variables in question, the relationship between the variety of variables involved and the immense collaborative effort that is the Hollywood production, distribution and exhibition process remains a mystery. None of these studies could explain why hundreds of films made each year (many with huge budgets and massive marketing support) fail to become hits, while films with minuscule budgets and unknown actors such as *The Blair Witch Project* (1999 release, budget $35 thousand) and *My Big Fat Greek Wedding* (2002 release, budget $5 million) made $140 million and $241 million (respectively) domestically.

DeVany and Walls brought an economics perspective to their analysis of the "stark uncertainty facing the motion picture industry." Their 1996 analysis of 50 Hollywood films exhibited in 1985-86 resulted in this conclusion:

> The space of outcomes in which the 50 films vying for audiences in our sample can evolve, is of staggering dimension and the dynamics evolve unpredictably. Star vehicles may have higher initial expectations, but booking patterns and information dynamics produce highly unpredictable distributional dynamics and uneven revenues. The brief tenure of studio heads and the wide use of artist participation contracts is consistent with the profound uncertainty implied by our empirical findings. [16]

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[13] Tom Gruca, University of Iowa Business School, in interview with Justin Lahart. "Bagged at the box office," *CNN/Money*, June 23, 2003. Online at: money.cnn.com/2003/06/23/markets/movies

[14] Krider, R.E. & Weinberg, C.B. (1998). Competitive Dynamics and the Introduction of new products: The motion picture timing game. *Journal of marketing research*, *35*, pp.1-15.

[15] Ainslie, A, Drèze, X & Zufryden, F. (2003). "Modeling movie choice" Available at: http://www.anderson.ucla.edu/research/entmedia/moviechoice.pdf

[16] DeVany and Walls, note 2, p. 1513.

Sornette and Zajdenweber[17] also examined this issue and found that a power law distribution existed when applied to the grosses of the top films from 1993. This paper has expanded the number of films studied by DeVany and Walls and looked at a longer time period than that used by Sornette and Zajdenweber. It includes 125 films from the years 1996 to 2002. With this larger data set, we have been able to confirm the previous conclusions about the existence of unpredictability and power law distributions and to establish that the data examined in previous studies did not represent anomalies in the movie business. In Part Three, we look at ways that managers can make use of this information.

[17] Sornette and Zajdenweber, note 5.

Part Two

Analysis of Multiple Years Data

In order to make the pattern over the years studied comparable, we consider only top 125 budgeted movies in each year. This subset although smaller in number covers a wide range of budget, from 1ml to 100ml. Table One shows *median* values for each year (half of the sample is higher and half are lower) because, in this kind of data set, the median is considered to be a more robust measure than the *average* because of the spikes in the numbers.

Table One: Median Values for Budget, Revenue and Profits for Each Year Studied

Year	Budget (ml)	Revenue (ml)	Profit (%)
1996	30	30	20.0
1997	32	38	5.0
1998	35	38	7.0
1999	40	41	1.5
2000	45	45	1.8
2001	45	51	10.0
2002	48	43	13.0

Table One demonstrates what is common knowledge in the industry: budgets for making a film have steadily increased and so have the total revenues. But the budgets have increased at much faster pace. In fact, the median budget for a movie has gone up by 60% in the seven year period. The growth of median profits for the top 125 films each year has been erratic.

While the summary statistics in Table One are informative, they do not tell us if there is any change in the overall distribution during those seven years. As demonstrated in the Introduction of this paper, the year 2002 clearly indicates a distribution that follows a power law. Similar patterns can be seen for all the years. (See Appendix Two.) In statistics literature a Gamma distribution (a power law distribution is part of the family of gamma distribution) allows for the possibility of delayed peaks in revenue. It is typically characterized by two parameters;

one called the "shape" and the other is the "scale." If the shape parameter is closer to one, it implies the exponential power law which results in a distribution that peaks at the beginning and then falls rapidly. The scale parameter indicates size of any peak. When a Gamma analysis is performed on the data set used here, the shape parameter seems to oscillate around one and the change in the scale parameter appears to be rather marginal. This analysis indicates that in spite of chaos in the industry the pattern of revenues is that most of the movies make modest revenues, and the movies with high revenues are generally few in number.

Table Two: Parameter Values for Gamma Power Law

Year	shape	Scale
1996	0.869	0.019
1997	0.942	0.020
1998	1.261	0.024
1999	1.001	0.016
2000	1.231	0.019
2001	1.100	0.015
2002	0.946	0.013

The above analysis does not help to predict which movies will fall in the tail of the power law distribution. To see if this is possible, we have attempted a different regression analysis than those done in the past. In most previous research, the various factors examined were used to predict movie *revenue*. We consider, instead, the *profit percentage* which is a bottom line measure. The following factors were examined to see if what impact they had on profit percentage:

Season: The release time of a movie thought to be an important variable in the success of a movie. For this analysis we lump holiday seasons such as summer and Christmas together and the rest are treated as nonseasons.

Opening weekend revenue: It is strongly believed in the industry, this is a strong predictor of the success or failure of the movie. Resources (e.g., marketing) are added to or taken away from the project based on the first week numbers. We also compute a more revealing financial ratio of this revenue as a percentage of the total budget.

Number of Screens: The number of screens the movie is released in during the first week is often a sign of the predicted popularity of the film and the marketing that has been put behind it.

Number of weeks: How long the movie stays in theaters depends on not only its own success but on the success of competing movies currently being screened.

Budget: We added this variable to the model to see if big budgeted films necessarily provide higher return for the investment.

Recovery ratio: In this variable we consider the ratio of first week revenue to the total domestic revenue.

Before we get to the regression results, it is instructive to see if there is any difference in how these variable play out in movies that make profit and movies that do not. For this we look at the "winners" (made profit) and "losers" (no profit) from 2002 and examine each of variables listed above.

Table 3: Summary Statistics for 2002 Winners and Losers

	Winner (117)	Loser (72)
Budget	$ 36.3 ml	$46.3 ml
Season	45%	35%
Opening Week Revenue	18.7ml	$6.6ml
Number of Screens	1915	1835
Number of weeks	17	12
Financial Ratio	55%	13%
Recovery Ratio	23%	29%

In general, it appears that losers average bigger budgets; the seasons do matter; a greater percentage of winners are released during the two seasons we identified earlier. There is almost 3:1 ratio in the opening weekend revenue. The number of screens did not matter. The financial ratio which is based on the first week revenue is quite telling. Successful movies recover more than 50% of their budget in the first week. The recovery ratio is almost the same for both winners and losers, indicating that this may not be as predictive as some have assumed.

While the above analysis indicates there may be some usefulness for each factor individually, their joint effect is what is important in the real world. This can only be measured through a regression analysis.

Table 4: Regression of Profit percentage on other factors

	2000(N=191)	2001(N=183)	2002(N=189)
Season	13.3*	9.32*	12.4
Opening $	3.1*	2.72*	2.78
# of screens	-0.002	0.00	-0.017
# of weeks	2.07*	2.12*	17.9*
Budget	-0.87*	-0.78*	-3.9*
Recovery Ratio	72.8%	76.2%	17.0%

* Significant at 5% level

The results indicate that certain factors that are within producer and/or distributor control are likely to affect the profit rate: season of release and how long the film stays in theaters. The number of screens does not appear to matter in the profit rate. Usually higher budgeted movies do not generate a higher profit rate. The recovery ratio (first week revenue to total revenue) indicates the strength of this relationship is lower for the year 2002, mainly because there were several outliers that seem to deviate from the model. In particular the movie “My Big Fat Greek Wedding” which started as a sleeper did very well in the box office eventually.

To conclude, the power law distribution holds for the movie revenues at the aggregate level for all the years studied even though the budget and revenue numbers are increasing. Profits follow a similar power law distribution (see Appendix Two). But the prediction of success of individual movies still is an elusive task, especially for any variables that can be manipulated before releasing the movie.

Part Three

What if It's Really Not Predictable?
The Movie Business As a Resilient Complex Network

What if the experienced Hollywood executives are right? What if managers in unpredictable environments let go of the idea that there is some magic management bullet or magic formula that means consistent success? Instead, these managers could assume that their businesses operate in an environment that is so complex that nobody can predict in all cases which product or strategy will be a blockbuster or even make a profit.

This does *not* mean that there are no incompetent business executives – their actions will always be one of the things that make this an unpredictable system. But it may be wise to change a strategy that assumes that successful blockbusters can be "engineered" in advance by omniscient leadership. If the predictability is impossible, then resilience in the face of failure seems imperative. And that is exactly what the movie industry seems to have achieved. In this section we look at how the movie industry fits current ideas about complex, unpredictable systems, but readers from other industries will want to compare the movie business to their own to see where the similarities will offer important insights.

A. Complex Systems

Systems are said to become "complex" when they have intricate interdependencies among their various parts and many variables operating at the same time. Examples of complex systems include the weather and the spread of disease in a population. Complex systems are also generally nonlinear. The effect of adding something to the system (an infected person or the air disturbed by a butterfly flapping its wings) may diffuse unevenly throughout the system because the other components of the system are not evenly distributed, or the force doing the distribution is not equally strong throughout the system. Think of throwing a handful of buttons on the floor and then connecting them in various ways: some are connected by heavy string, magnets connect some, and others are connected only by dotted lines on the floor. All the red buttons are connected to each other and some of the red buttons are connected to blue buttons. Most (but not all) of the blue buttons are connected to one yellow button while all of the red buttons are connected to another yellow button. The group of buttons is sitting on top of an active earthquake area. Could you predict what will happen to any one of the blue buttons if an earthquake hit its vicinity or someone pulled the string at one of the yellow buttons?[18]

Complex systems have another surprising property: adding an element that can be duplicated to the system may cause a shift in the total system that is much greater than the amount added. For example, sending a rumor about a company via e-mail to a friend in that company adds only one piece of information to that company's information system. But, because many agents (employees) in the company are connected via e-mail, the piece of information multiplies in the system as each employee sends it to many others. The phenomenon is typical in systems that are interconnected in a network.

Some complex systems are *adaptive* or are said to *evolve* when individual agents operate independently in response to forces in their environments via feedback. In some systems the agents can "learn" from one another when some agents obtain more resources and their actions are copied by other agents. In systems where the change is not learnable in the current generation by other agents (for example, the change is a mutation in an organism's genetic structure) it can become prevalent in succeeding generations if the change makes agents who have it more successful, enabling them to leave more offspring (this is evolution by natural selection). For example, a mouse with better hearing is more likely to survive the presence of foxes in her environment and will leave more offspring than other mice. Over many generations these better-hearing offspring will also leave more offspring and gradually the number of mice without the acute hearing will decline.

Management theorists have begun to use these ideas about complexity and unpredictability[19] although theorists like Alfred Chandler have been thinking about firms in turbulent times for quite a while.[20] In what would become one of the more influential business

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[18] This is an adaptation of the "Buttons and Strings" metaphor used by Stuart Kaufman to explain complex systems in *At Home in the Universe: The Search for the Laws of Self Organization and Complexity*, New York: Oxford University Press (1995), pp. 55-58.

[19] Robert Axelrod and Michael D. Cohen, Harnessing Complexity: Organizational Implications of a Scientific Frontier, New York: The Free Press (1999); Ralph D. Stacey, Douglas Griffin and Patricia Shaw, Complexity and Management: Fad or Radical Challenge to Systems Thinking? London and New York: Routledge (2000); Peter Schwartz, Inevitable Surprises: Thinking Ahead in a Time of Turbulence, New York: Gotham Books (2003)

[20] See, e.g., Alfred Chandler, *Strategies and Structure: Chapters in the istory of American Industrial Enterprise*, Cambridge MA: MIT Press, 1962; Charles Perrow, *Normal Accidents: Living with High-Risk Technologies*, Princeton NJ: Princeton University Press, 1984.

books of the late twentieth century, Peter Senge suggested that businesses must learn to adapt to change by creating "learning organizations." [21] But he knew it wouldn't be easy.

> Business and other human endeavors are also systems. They, too, are bound by invisible fabrics of interrelated actions, which often take years to fully play out their effects on each other. Since we are part of that lacework ourselves, it's doubly hard to see the whole pattern of change.[22]

Senge set out to destroy "the illusion" that the world is created by separate, unrelated forces and to develop understanding of *dynamic complexity* where cause and effect "are not close in time and space and obvious interventions do not produce the expected outcome."[23] Subsequent writers, such as Robert Louis Flood, have expanded on this idea, expanded the evidence against predictability in complex business situations, and warned of the consequences for assuming that these processes are capable of being controlled.

> An 'A caused B' rationality is a source of much frustration and torment in people's lives. If a difficult situation arises at work, then an "A causes B' mentality sets up a witch-hunt for the person or people who caused the problem.[24]

And yet, many people in organizations that operate in complex systems continue to operate with this mentality. They believe that if they just look harder they will find the right formula for success. If their situation is truly complex and unpredictable, this quest will be doomed in many cases and it will take energy away from finding a strategy for resilience in the face of inevitable failures.

B. The Movie Business as a Complex System

It is certainly true that all industries are becoming more complex as they become more interconnected and the forces working on them become more global than local, but the movie industry exhibits the classic characteristics of complex systems more than most.[25] What makes the movie business complex? It has intricate interdependencies, many variables, nonlinear inputs, and adaptation.

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[21] Peter Senge, *The Fifth Discipline: The Art and Practice of Learning Organizations*. Doubleday: New York (1990), p. 7. For earlier work in the same vein, see, Chris Argyris, *Integrating the Individual and the Organization.* Wiley: New York (1964).
[22] Ibid. p. 364.
[23] Ibid. p. 364.
[24] Robert Louis Flood, Rethinking The Fifth Discipline: Learning Within the Unknowable, Routledge: London and New York (1999), p. 84. See, also, Scott Snook, Friendly Fire: The Accidental Shootdown of U.S. Black Hawks Over Northern Iraq, Princeton, NJ: Princeton University Press (2000).
[25] For a discussion of the communications sector as a complex system, see, Longstaff, P., *The Puzzle of Competition in the Communications Sector: Can Complex Systems be Regulated or Managed?*" Program for Information Resources Policy, Harvard University, July, 2003.

Intricate Interdependencies

Like the button system described above, some of the connections in the movie business are strong and generally ongoing (directors and stars to their agents, producers to distributors) but most of the connections are weak because movies (at least since the demise of the studio system) are made as individual projects with people and firms attaching themselves to a project for a limited period of time. During the project's life all the players depend on one another and failure of one will affect the entire project. Many of these projects are connected to other projects where the participants are working simultaneously, have worked, or will work soon. Innovations or problems in one can spread to all of them rather quickly. At the level of the communications sector, all the communications industries (movies, cable, TV, print, etc) are increasingly linked together by their need to compete for several scarce resources, principally the time, attention and money of consumers. Indeed, some have predicted that they will all "converge" into one industry.[26] Thus any new movie will not just compete with other movies but with all the other options that potential moviegoers have for their free time. On the other hand, movie producers depend on other media to distribute advertising and marketing.

Wide Variety of Variables

The success of any particular firm or particular industry depends on a wide variety of variables, a few of which the firms or industries have some control over but many of which they have little or no control over. In the last twenty years the movie business has been buffeted by changes in the technologies they depend on for both production and distribution. Globalization and changes in U.S. demographics have made their audience much more diverse and increased the variables that operate on each film. Other uncontrollable variables for film producers include: the other movies in theaters at the same time, the "mood" of the public (if they are nervous about the economy or a terrorist attack they may not go to see movies that are not uplifting), and the weather on opening weekend (good weather may make more people choose to be outdoors). Some variables can be controlled (stars, budget, release date, etc.) but, as the research noted

[26] Although convergence is not *a fait accompli*, it is undeniable that increased competition has made all the formerly distinct industries look hungrily at each other's customers and in that sense they are now "linked" in ways they were not before. At the same time, each firm is linked to many other systems such as equipment and content suppliers as well as many layers of government. In addition, globalization links many more of these industries and firms to each other, making the system even more complex. For the forces pushing the industry together and pulling it apart, see P.H. Longstaff, *The Communications Toolkit*: *How To Build Or Regulate Any Communications Industry.* MIT Press: Cambridge MA (2002). Chapters 7 and 8.

above and the experience of many producers show, manipulation of these variables does not give consistently predictable results.

Nonlinear Effects and Cascades

When forces changing the system do not add up in a simple systemwide manner, we say they are nonlinear. Adding something to the system may mean it changes by more than the amount added. This is particularly true for the success of a particular film since it depends heavily on recommendations of critics and "word of mouth" marketing. One popular national critic can have a great impact on the number of people who decide to see a movie, as can many well-connected local moviegoers.[27]

There is a growing body of work that looks at systems that *cascade* at unpredictable points. Things such as epidemics and fads are examples of cascades in a system. In some systems, a cascade is the *tipping point* of the system – something that moves it from one state into another.[28] In fact there may be two tipping points in many networked systems. The first is when a system develops enough connections so that local islands of connections merge into a larger network where large cascades are possible. As the network increases, the cascades become larger and more likely until the *second* tipping point where the cascades become smaller and rarer because there is *too much connectivity*. The second tipping point is said to be a dilution effect and it happens when the individuals in the network are connected to so many people that any one of the connections does not have a great enough influence. Each individual is said to "tip" (decide to see a movie, for example) when a certain *fraction* of its neighbors makes this choice, not a certain *number* of them. If I have more people to whom I look for clues on movies or fads, it will take more of them to get me to join the bandwagon.[29]

At first glance, this information about the operation of these cascading networked systems seems to indicate that there may be some way to figure out the best place to nudge them in order to make them tip your way – to make your movie the one that beats the odds to become a

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[27] This was noted by DeVany and Walls, see note 3.

[28] For a discussion of how this works in marketing, see, Malcolm Gladwell, *The Tipping Point: How Little Things Can Make a Big Difference*, Boston: Little, Brown and Company (2000).

[29] There are a number of accessible books on this idea. See, e.g., Duncan J. Watts, *Six Degrees: The Science of a Connected Age*, New York and London: W.W. Norton & Co., 2003; Steven Strogatz, *Sync: The Emerging Science of Spontaneous Order*, New York: Hyperion (2003) esp, Chapter 10; Mark Buchanan, *Nexus: Small Worlds and the Groundbreaking Science of Networks*, New York and London: W.W.Norton & Co. (2002); Mark Buchanan, *Ubiquity: The Science of History …Or Why the World is Simpler Than We Think*, New York: Crown Publishers (2001).

hit. But, while it may be important to know the amount of connectivity of a simple system in order to predict the likelihood of tipping, it is important to remember that if the system is adaptive and has many variables working on it, the likelihood of predicting a cascade that will tip the system is not high. This is true particularly when other people also have this information and are trying to nudge the system their way.

Multiple-directional and multi-velocity trajectories

The environment into which any particular film is born is complex at both the macro and micro levels. At the level of the communications sector, the growth rates or velocity of growth for the various industries that compete with movies are clearly not the same. The movie business (like print and broadcast) shows some signs of being a "mature" business that cannot look forward to much growth in its current markets. But it competes (for customer time and attention) with much faster-growing industries in cable, satellite, and gaming. This does not mean that these more mature industries will die, but it means that any financial opportunities that depend on rapid growth will be less available to them – even as they feel compelled to compete with the faster-growing industries. The system is made even more complex by a divergence in time frames: as the industries in the communication sector evolve faster to keep up with changes in their environments, other processes (policy making, business formation) move relatively more slowly and have difficulty keeping up with the changes.

Adaptation

Movie projects exist in a highly competitive environment with individual films living and dying in a relatively short period of time. Since the people working on films are highly interconnected, the ideas about why certain projects died early (or were never born) travel quickly through the system and others adapt their strategies based on their view of what works and what doesn't. The fact that there is often disagreement about what made a project fail means that this adaptation is not uniform and not predictable. DeVany and Walls note that "contingency rich" contracts help the movie business to maintain an ability to adapt to changing demand conditions, particularly contracts between distributors and exhibitors that allow everyone to take advantage of a movie that is becoming a hit while limiting the exposure of distributors who have signed up for a flop.[30]

[30] DeVany and Walls, note 3 at p. 1497.

So how does the movie industry manage to thrive and prosper when it is so unpredictable? The answer seems to be that this industry has (without anybody planning it) developed a resilience to the failures it deals with every day.

C. Dealing With Unpredictability Through Resilience

When confronted with a danger, the best strategy may be to develop a *robust* system that will keep the danger out or act as a buffer to keep the system from being affected by it. This is a good strategy if you know the nature of the danger(s) you are likely to face. If you are likely to be threatened by an army with spears and swords, building a wall around your city will act as a buffer and stop harm to those within. While there will be some temporary defensive measures put in place in case of attack, sooner or later the city will return to normal. But building a wall (literally or figuratively) may also keep out other things (like water and food to the besieged city) and keep those who are protected from taking advantage of opportunities outside the protected area.

When an individual or group (species, business organization) must operate in an environment where resources and dangers are unpredictable, one strategy for survival is to develop *resilience*.[31] Since they don't know what dangers are out there, they can't develop a single strategy for robustness – walls would not be appropriate because they would deprive the individuals of access to other resources they might need for unknown dangers. If a system with unpredictable danger/opportunities is attacked or deprived of resources, it must be able to bounce back to its previous state. Since they don't know what the dangers will be, they often don't know what will work to make the danger go away. In these cases adaptability and access to a variety of resources seem to be key for developing resilience.

In systems with unpredictable environments the members of the group try many things and hope that some of them will be able to survive whatever challenges or surprises they encounter. For example, birds often lay many eggs, but only a few hatch and fewer still survive to maturity. Businesses often develop many products in prototype form but abandon them if they do not meet

[31] There is a growing body of work that looks at resilience. See, e.g., Lance H. Gunderson, "Adaptive Dancing: Interactions Between Social Resilience and Ecological Crises," *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change*, Cambridge UK and New York: Cambridge University Press, 2003; C. Folke, F. Berkes, and J. Colding, "Ecological Practices and Social Mechanisms for Building Resilience and Sustainability," *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*, ed. Berkes and Folke, Cambridge: Cambridge University Press, 1998.

specific targets. Thus, both *a limited investment in large numbers of the same thing* and *diversity in the things tried* can be tools for resilience. It should be noted at the outset that survival using these strategies does not necessarily involve anything even close to *stability* in the short-term fortunes of the individuals of that species or firms in that industrial sector.[32] This strategy requires a willingness to accept many failures and/or to deal with the same challenge in different ways. This *should not* be interpreted to mean that some of the many eggs laid or the many different products developed are somehow inherently “fitter” than the others. All of the eggs were alike and all of the products had many unknowns in their development. A few eggs and a few products survive because they were lucky enough to find themselves in exactly the right environment for them to thrive. No one could have predicted which eggs or which products would be so lucky. In a more predictable environment, it may be possible to select the fittest eggs or products for extra support (as animals in more predictable or less dangerous environments often do by giving extra care to the healthiest infants).

The movie business would seem to be a perfect example of resilience in action. As noted above, movie producers operate in an environment with many unpredictable variables. The production part of the industry is not concentrated into large or permanent organizations, but consists of many independent operators who come together for specific movies and then move on to the next project. The industry is constantly experimenting with new ideas, looking for the next hit. And for every movie that is released there are many more projects that did not reach maturity. They were shelved or abandoned when it became clear that it was impossible to put together the right resources. Other movies were made but never released in theaters because it was determined that this would not be profitable, and they are released in secondary markets such as DVD or sold to cable. Instability at the level of the individual movie does not mean that there is instability at the level of the industry. Even though there are many failures, the industry survives because of a few big successes. This is made possible, in part by the adaptive contracts noted above and by the industry practice of *contingent compensation*. The people in the business (actors, directors, suppliers) make some money for their contributions and may be entitled to more (sometimes *much* more) if the movie becomes a hit. If the movie does not turn a profit it is only the investors who gambled on net profits who walk away with nothing. But, like those who bet on other

[32] There remains a serious debate in biological science about the relationship between diversity and stability. Some argue that diversity enables stability because it acts as insurance: if there is a danger it is more likely that a system will recover if it contains species with various strategies or tolerances. On the other hand, some experiments have indicated that low diversity systems recover more biomass faster. See, Shahid Naeem, “Biodiversity: Biodiversity Equals Instability?” *Nature*, Vol. 416, (2002) pp. 23-24.

unpredictable events such as horse races (or who lay many eggs or develop many projects), these investors take their losses as just one try in a bigger game and wait for a big hit.

In recent years, many businesses have been told that they can build resilience by developing "a broad portfolio of breakout experiments with the necessary capital and talent"[33] from which there will be winners and losers. "Most experiments *will* fail. The issue is not how many times you fail, but the value of your successes when compared with your failures."[34] The movie industry seems to be a good example of this advice in action, but a view of resiliency on a larger time scale is often difficult for investors and executives from more traditional businesses where profits and losses are calculated on a quarterly basis.

Resilience Through Scales of Operation

In systems that operate at more than one scale, resiliency may operate at each scale and across the scales. There might be different time scales or different size scales at work in the same system. For example, in the human body, the immune system acts first at a local scale to confront an infection by sending a variety of forms of immune cells (within-scale resiliency through diversity or redundancy). But if this response is not successful, the system responds by "scaling up" its response and inducing fever. When similar *functions* (even if not similar *mechanisms*) operate across-scales it makes the system more resilient because they are redundant – if one fails the other will go into action.

In the movie business, most challenges are dealt with first at the individual film level. If the challenge is too big for that level or persists in spite of attempts at that level, the industry scales up through several organizations that represent the interests of types of players (producers, directors, actors, technicians, etc.) and if a challenge that threatens the industry cannot be dealt with at that level, the industry comes together in temporary coalitions of these organizations.

Resilience Through Loose Coupling and Slow Scales

Many authors have noted that slower parts of systems act as resilience mechanisms for the faster parts because they can "remember" how to handle certain surprises. In return the faster parts of the system give the slower parts information about changes taking place and allow it to

[33] Gary Hamel and Lisa Valikangas, "The Quest for Resilience," *Harvard Business Review, September 2003,* pp. 52-63, at p.54.
[34] Id. at p.60.

adapt at its own time scale. In some cases, when the slower parts do not have this information they are liable to drastic, cascading change when the changes reach a critical level, particularly when the system has become tightly coupled. The very connectedness or sameness that makes it efficient can amplify internal weaknesses or external shocks. This has been seen in many systems.

> When the system is reaching the limits to its conservative growth, it becomes increasingly brittle and its accumulated capital is ready to fuel rapid structural changes. The system is very stable, but that stability derives from a web of interacting connections. When this tightly connected system is disrupted, the disruption can spread quickly, destabilizing the entire system. The specific nature and timing of the collapse-initiating disturbance determines, within some bounds, the future trajectory of the system. Therefore, this brittle state presents the opportunity for a change at a small scale to cascade rapidly through a system and bring about its rapid transformation. This is the "revolt of the slave variable." (Citing Diener and Poston 1984)[35]

In the movie business, this cascading change at the slow level was seen in the relatively abrupt collapse of the studio system. Under this system, individual players were bound by contract (tightly coupled) to particular studios. A variety of surprises caused the highly connected studio system to collapse and break into the loosely coupled industry organization we see today.

The importance of the relative *strength* of the connections in a system is increasingly seen as critical to the analysis of the system's behavior. In fact, it is a fairly good predictor of the stability and resilience of any group. Strong coupling within or between organizations would be predicted if there is a high level of resources reliably available, the system changes rapidly, and influence spreads quickly in the system.[36] The movie business appears to be both loosely coupled in some respects and tightly coupled in others. The level of resources (the audiences) is not high or reliable and the major parts of the system change slowly. But information can spread rapidly due to the connected nature of the business.

If the individuals are truly *tightly coupled*, any disturbance in the system will affect them all and if any of them fails, there is a much greater likelihood that others will fail with them. Think of a team of horses that is hitched to a wagon. This aspect of tight coupling has very interesting implications for organizations seeking efficiency through developing economies of scale. One of the seldom-acknowledged tradeoffs for doing the same thing many times in a highly

[35] Gunderson, at note 25, pp.12-13.
[36] See, Karl E. Weick and Kathleen M. Sutcliffe, *Managing the Unexpected: Assuring High Performance in an Age of Complexity*, Jossey-Bass: San Francisco CA (2001); Longstaff, note 20.

connected way is that this tight coupling will inevitably create an unstable situation if redundancy is taken out of the system to lower costs. For example, we all know that you can produce individual widgets cheaper if you build a lot of them in the same way, using processes that are very closely tied to the processes of suppliers and customers. This kind of efficiency remains the Holy Grail for many firms that must compete with firms that have cheaper factors of production (e.g., lower labor costs). As attractive as this goal is, it comes with a dark side. If a critical supplier, customer, or piece of technology is removed, with no redundant source, the entire system is vulnerable to collapse. Loosely connected systems with built-in redundancy seem to be the most secure from this type of danger.

Loosely coupled systems are those where the components have weak enough links that they can ignore small perturbations in the system. The components of a loosely coupled system are said to have more independence from the system than tightly coupled components since they can maintain their equilibrium or stability even when other parts of the system are affected by a change in the environment. The components of loosely coupled systems are also better at responding to local changes in the environment since any change they make does not require the whole system to respond. Thus, if innovation or localized response to particular problems or opportunities in an unpredictable environment were the goal, then loosely coupled systems would have the best chance to find new answers and to develop resilience. A more tightly coupled system could lead to premature convergence on a solution since all the components would be responding more or less in unison.

Once again, when we look at the movie business through this lens, we see resilience in both the tight and loose coupling. This industry is made up of many small firms and individuals with loose ties when they are not working on a project but very strong ties once they begin a project. They must coordinate schedules and work together closely to meet the budget and the production schedule. At the level of the project, anything that affects the contributions of one will affect everyone. But outside of a particular project, a failure of one has almost no effect on the others. If one of them finds a good solution to a problem several others may try it, but it will not be adopted by the entire industry unless it has shown that it works in many situations OR unless there is a need for uniformity.

When tight coupling is needed in the movie business, the individuals and firms look to the higher level of organization provided by the professional organizations such as the Motion Picture Producers Association of America (MPAA). The relative weakness of these organizations has implications for the adaptations of the larger industry because this process can take place only as fast as the most loosely coupled component can (or is willing to) move. The temporary or partial independence of one or more components in the movie business will slow down (or change) the process. This is an important insight for executives who must make predictions about the ability of a merged organization to develop "synergies" that result in higher profits or lower costs. For example, if one unit of the newly merged company is a film production company (they are famous for being loosely coupled internally) and it must be coupled with a telephone company (they are equally famous for tight internal coupling) the result may be a slower adaptation process than the telephone culture is accustomed to. If the telephone firm becomes unstable after it has become more tightly coupled to the film company, the latter will become unstable as well. At this point the film company is likely to seek a more loosely coupled relationship – or even a break in the relationship.

The movie business may have been able to survive many failing movies because of its ability to organize many weak links into a network of influence. Networks have become the subject of much study in the search for resilience.

Networks, Power Laws, and Resilience

Note: Readers who are familiar with network theories may want to skip this section, but readers who have little or no knowledge of these relatively new ideas are urged read on because the conclusions of the paper rely, in part, on this section.

There is a new (and growing) body of work that looks at the connections between things that function as a network. Network Science gained popularity as the "small world" problem and, more recently, the "Kevin Bacon game." The former is the puzzle of why most people on the earth seem to be separated from one another by only six other people, or six degrees of separation. The latter uses movie actor Kevin Bacon and his connection to other people in the film industry to test the degrees of separation between them. The game proves that Hollywood is a very connected place and that every actor is connected to every other one by about four steps. If the game counted connections to agents and producers the connections might be even smaller.[37]

This new research on networked systems was originally done in a branch of mathematics known as graph theory. It is now being examined by many disciplines including political science, biology, sociology, and computer science. In some of the networks studied, the distribution of things in the network (e.g., wealth, Web links) follows a power law and the place of any particular thing in that distribution was difficult to predict. As noted above, networks that exhibit a power law distribution are characterized by a continuously decreasing curve, showing many small things existing with a few large ones (many people with small amounts of money and a few with a large amount, many Web sites with a few links and a few with many links). This is in contrast to systems where the distribution follows the typical bell curve with a few things at either end of the spectrum (a few small things at one end and a few large things at the other) but most of the things clustered in the middle. We have demonstrated in this paper that each year successful movies follow a power law distribution and it is quite clear that the business has many characteristics of networking.

There is some indication that networks following a power law develop differently from other systems. They seem to grow one node at a time (as in one Web page at a time, one person at a time) and some nodes will have preferential connections because the more connections they have the more they will get. These superconnected nodes are called “keystones” or “hubs.” For example, some nodes become hubs when they are connected to more often by others because they were the first to fill a connection role or because they have more resources to devote to connections. Thus, if you are the first Ebay-type connection Web site, or you are a very large company such as Microsoft (with perceived resources to devote to connection) you are more likely to become superconnected. In these systems the connected tend to get more connected, not necessarily because they are better but because they were first or bigger to start with.[38]

Some networks have what is known as a “scale-free” topology. That is, there are many small nodes that connect to a few larger nodes that in turn connect to still larger nodes in a

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[37] For a more comprehensive discussion of the game and why it is important even outside of Hollywood, see, e.g., Duncan J. Watts, *Six Degrees: The Science of a Connected Age*, New York and London: W.W. Norton & Co., 2003, pp. 92-100.
[38] See, e.g., Albert-Laszlo Barabasi, *Linked: The New Science of Networks*, Cambridge MA: Perseus Press (2002), Chapter Six.

hierarchical configuration. The lower level nodes have no way to connect to other nodes in the system except through their local hub. Imagine the telephone network. You cannot connect directly to anyone except through your local exchange, which acts as a hub for your area. Unfortunately, we are now discovering that this type of network will often

> …perform terribly under conditions of failure. For the same reason they are vulnerable to congestion-related failure (because they are too centralized), if any of the hierarchy's top nodes do fail, they will isolate large chunks of the network from each other. It is here that connectivity at all scales really comes into its own, for in multiscale networks there is no longer any "critical" nodes whose loss would disable the network by disconnecting it. And because they are designed to be decentralized not only at the level of teams but also at larger scales, they can survive bigger failures.[39]

Multiscale networks allow nodes to connect across scales, without requiring them to go through a hierarchical routing system. While this may not be the most efficient configuration, it does make the network *robust*, that is, allows it to survive failures because taking out the one hub that you connect to (or those that it connects to) will not deny you access to the whole system. The movie business shows many attributes of a multiscale network because there is no formal hierarchy and most people have connections to people in many parts of the business. An actor will have connections to producers, directors, technicians, and just about everyone else. And all of them will have similar connections. Thus, if one of a person's connections to the business fails they will not be separated from the business and will still have access to the resources of the network of people and resources that they need.

In some networks the "winner takes all" when one node has all the connections and there is one giant hub with many nodes.[40] This happens when nodes can choose which hub they will use to connect to the system and they will choose the hub that gives them the most connections. The more connections a hub has the more likely it will be chosen and eventually the system will tip and all will choose the most connected hub.[41] In fact, there is strong evidence that the Internet is a winner-take-all network and only a few sites will have superconnections.[42] Any time you add a hub to a *random* network of individuals or groups (they are not connected except at random) you are likely to get this "aristocratic" (the rich get richer) configuration where power and scarce

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[39] Duncan Watts, note 25, at p. 285.
[40] Id., Chapter Eight.
[41] A similar thing happens when people must choose a technology to connect to the system. They will choose the one that gives them the most connections to things in the system. The battle between VHS and Betamax was an example of this. The system tipped to VHS when consumers perceived that it gave them access to more movies.
[42] See, e.g., Barabasi, note 34, Chapter Eleven.

resources are drawn to the spot with the most resources.[43] These networks where superconnected hubs form are often very efficient and robust at lower levels because destroying any of the less connected nodes will have little impact on the system. But this strength is also their Achilles' heel because destroying a superconnected hub can destroy the entire network. Any firm that becomes a superconnected hub for the sector becomes both an opportunity for efficiency and a danger because it can bring everyone down with it. The movie business would seem not to be this type of network because there are many people who serve as connectors and a "winner" that controls all the connections in the business has not emerged.

As in other complex systems, the work being done on networks also indicates that the strength of the ties between things is critical for understanding (if not always predicting) the operation of the networked systems. There is good evidence that weak ties (or loose couplings) are often more important than strong ones when dealing with a new opportunity or problem. If two firms are strongly linked (or tightly coupled) to each other they are probably also strongly linked to each other's links so what happens to one will affect all of them. Strong links work very efficiently as long as the firms (individually or collectively) don't face unique challenges or encounter new opportunities. If something unexpected happens, it will be the weaker links of each firm that will be bridges to other systems with other resources or ideas that can be used when they face a new problem.[44] Thus, the long-term stability of a system (or a firm) may actually increase if it has many weak ties – even if this means it is less predictable or less efficient in the short term. This has led to speculation that a balance between the need for stability and diversity is called for and the appropriate strength will depend on the number of connections available. "…the superconnected few should be linked to others mostly by weak links, while those with few links to others should be connected by strong links."[45]

Resilience in networks

Resilience in networks is also increased by diversity and redundancy. A variety of weak links for the superconnected hubs requires some diversity in the system because if everyone is the

[43] This "rich get richer" phenomenon is observable even in physical systems with no "choice." For example, snowflake growth is often governed by this rule. If one of the plates of a developing snow crystal is a bit longer than the other it will pick up more of the scarce water vapor and grow faster. The longer it gets, the more water vapor it gets and eventually one plate will "win" over the other. See, Kenneth Libbrecht, *The Snowflake: Winter's Secret Beauty*, Stillwater MN: Voyageur Press (2003), p.78.
[44] See, e.g., Mark Buchanan, *Nexus: Small Worlds and the Groundbreaking Science of Networks*, New York and London: W.W. Norton & Co. (2002), Chapter Two, "The Strength of Weak Ties."
[45] Id. At p. 149.

same it will be difficult to develop the variety of links that would be useful in case something unpredicted happens. Thus, a loss of too many of these weak links will have serious implications for the resilience of the system. As we have noted, the movie business is made up of many different types of people who are connected to one another through weak links to highly connected individuals. If these hub individuals connected to only certain types of people they would not be able to pull together all the resources needed to put a project together, and they would require connections to other hubs. The diversity of their links also makes them more likely to be able to take advantage of unexpected opportunities or deal with potential disasters.

Resilience is also improved in a network if hubs have some functional redundancy. If they are unexpectedly removed from the system there is something or some function that will perform their role in the system. In Hollywood this redundancy of hubs is accomplished by allowing many different professionals to serve as connectors: producers, agents and lawyers all often perform the task of putting people and deals together.

While this work on resilience in complex networked systems is still in the formative stages, Duncan Watts, one of the original researchers in this area, has this to say:

> Already we can understand that connected, distributed systems, from power grids to business firms to even entire economies, are *both* more vulnerable and more robust than populations of isolated entities. If two individuals are connected by a short chain of influences, then what happens to one *may* affect the other even if they are completely unaware of each other. If the influence is damaging, then each is more vulnerable than they would be if they were alone. On the other hand, if they can find each other through that same chain, or if they are both embedded in some mutually reinforcing web of relations with other individuals, then each may be capable of weathering a greater storm than they would be by themselves.[46]

Most people with experience in the movie business would probably agree with these sentiments, even if they don't understand the science behind them. People who make movies must work in an environment that is complex, ever changing, and where what worked last year will not work next year. The causes of success and failure remain elusive. And yet the movie business is clearly successful. It may be an example to all industries that must operate in similar situations. It is possible that the goal for managers in complex, networked systems that exhibit a power law distribution may not be better predictions, but more loose connections across all scales

[46] Duncan Watts, note 25, at p. 303.

of the business. In this kind of unpredictable environment, resilience may be the greatest (or only) success.

Conclusions

What does all this mean for business strategy? Can this information be used to make better decisions? Yes. As long as "better" does not mean "predictable" – particularly in a business with unreliable access to resources, intricate interdependencies, many variables, nonlinear inputs, and adaptation. If a business does not have these attributes of complexity, it is possible that better does mean more predictable.

Even if they can't predict the forces working on their organizations, managers may be able to make their organizations more resilient. But beware! The insight provided by the study of these systems seems to indicate that if resilience is the goal, bigger is not better and increased efficiency (by eliminating redundancy or tight coupling with customers/suppliers) has serious consequences. These are not always welcome ideas.

Previous attempts at improving complex systems have met with some spectacular failures. James Scott has documented some of these well intended but disastrous policies and believes they argue for smaller, more diverse and more flexible institutions or strategies that can adapt with the system they are trying to improve.

> The intervention of scientific forestry, freehold tenure, planned cities, collective farms, ujamaa villages, and industrial agriculture, for all their ingeniousness, represented fairly simple interventions into enormously complex natural and social systems. After being abstracted from systems whose interactions defied a total accounting, a few elements were made the basis for an imposed order. At best, the new order was fragile and vulnerable, sustained by improvisations not foreseen by its originators. At worst, it wreaked untold damage in shattered lives, a damaged ecosystem, and fractured or impoverished societies.
>
> ...we gain in ease of appropriation and in immediate productivity [with increased economies of scale], but at the cost of more maintenance expenses and less "redundancy, resiliency, and stability." If the environmental challenges faced by such a system are both modest and predictable, then certain simplification might also be relatively stable.
>
> …Even in huge organizations, diversity pays dividends in stability and resilience…. Much has been made of the rather complex family firms in Emilia-Romagna, Italy, which have thrived for generations in an extremely competitive world textile market by virtue of mutuality, adaptability, and a highly skilled and committed workforce…. These firms and the dense, diverse societies upon which they depend, have increasingly seemed less like archaic survivals and more like forms of enterprise ideally suited to postindustrial capitalism.[47]

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[47] James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed*, Yale University Press: New Haven and London, 1998, pp. 352-354.

Does the movie business fit the pattern that is beginning to emerge in the study of other complex networked systems that must operate in unpredictable environments? In all of the ways examined here, the answer is yes. While acknowledging that this work is only in its infant stages, it is possible to formulate some ideas that warrant much closer attention and some possible strategies for organizations that can't wait until the definitive votes are cast. Many organizations in unpredictable environments may find that they accomplish their goals not by building organizations (and the rules that govern them) based on predictions, but based on adapting to the unpredictable and remaining resilient in the face of multiple failures. It is acknowledged that this will be a tough sell to those who have come to believe in the inevitability of finding the right formula for success. But sooner or later we may have to give up on trying to turn lead into gold and get down to the business of watching the world change while we change with it. Organizations looking for a model could do worse than studying the movie business.

Since all businesses live in different environments there is no one-size-fits-all plan for developing resilience. Not all businesses have the potential for the big hits that makes the system resilient in the face of many failures. But it will be worth any manager's time to look the ideas presented here in order to discover which ones might work for them. The following ideas are developed in this paper. Business managers will recognize that several things on this list are consistent with well known ideas in management science. This is probably additional evidence that these ideas from other disciplines are not irrelevant to business.

1. Decide if your business (your industry and/or your firm) is unpredictable by nature or if it is just in an unpredictable phase of its development and stability can be expected to return. There may be a temporary unpredictability in resource availability or customer demand due to recession. You would then want a resilience strategy that allows you to bounce back when things return to normal and won't burden the enterprise with some complex coping mechanism that is no longer needed. If their has been a fundamental (or structural) change in the environment so that this unpredictability will be with you for the foreseeable future you will want to examine fundamental processes, particularly those that are tightly coupled with unpredictable resources.

2. Acknowledge the unpredictability (either permanent or temporary) and how this changes the definitions of success for the industry, the firms in it, and individuals in those firms. Expand the time scale for measuring success and acknowledge the goal of resilience. This may be the most difficult thing to do. It involves changing the expectations of all stakeholders, particularly investors and employees. It means acknowledging risk in specific terms and not punishing failure that is caused by unpredictable complexity.

3. Throw many seeds and acknowledge that there will be failures. Either throw many of the same kinds of seed in many environments and see where they grow, or, throw many different kinds of seeds and see which ones thrive in a particular environment. Once again, this means acknowledging risk and making failure part of the cost of doing business, not a personal and professional death knell for those involved with the seeds that do not grow.

4. Set up feedback mechanisms that allow you to distinguish success and failures as early as possible. If the system is likely to have tipping points, decide how you will know them and how you will rush resources to (or from) the tipping system. This is especially important if the system is tightly coupled and subject t cascading failure or runaway success. For many companies (and government organizations) this is very difficult because their cultures punish anything that looks like failure. It's not surprising that nobody signals that things are failing (or not growing) because to do so would be professional suicide and jeopardize one's bonus.

5. Set up mechanisms that give you maximum adaptability and allow you to invest in success and cut losses on flops. This might include adaptive contracts and contingency compensation. This may mean fewer long-term contracts (for both employment and other resources) in "seedling" enterprises or products. It will also mean having resources ready to throw at any seedling that looks like it's about to take off. This may mean keeping a resource reserve for this purpose (but they will not be making maximum return while waiting in reserve) or having resources that can be quickly redeployed from other projects (those without long-term commitments).

6. Make sure there are weak links to resources outside your business, ones that can be used when the unpredictable happens. These links should be weak enough that they are not be affected by problems in either business. You might consider using a variety of suppliers or paying a supplier to be on "standby." Strong coupling should be used where efficiency is critical, but acknowledge the trade-off in stability and resilience for that function – strong coupling to resources prone to surprise would be limited to functions that have redundancy (back-up that will take over the function). If you need electric power to perform critical functions (cooling, running computers, etc.) you might have a strong link to an electric power supplier that gives you quantity discounts, but only if you have auxiliary generators or standby power suppliers that can step in to perform the function if the power is cut off by a terrorist attack.

7. Make sure that people who have to deal with the unexpected have links to many resources. These links should be on multiple scales and not require going through a hierarchy in times of opportunity or danger. If the person running your plant needs to get electric power quickly they should not have to go up the chain of command to get permission and they should have direct access to the persons who can deliver what they need, regardless of whether they are at similar levels of the organizations chart. If the night supervisor has to call the VP at the standby supplier the considerations of hierarchy should not get in the way.

8. Make sure that important functions have redundancy, preferably at different scales so that if the function is damaged at one scale it can be picked up at another. This is especially true for any function that acts as a hub. If communication services are centralized there should be redundant communication services at the local level.

9. Hubs should have diverse connections that allow the people who use them to access many different types of resources – even ones they don't use very often. People and functions where things come together (such as manufacturing) need to have access to many things that they *might need* and even to things that nobody thinks they will ever need. This allows them to fix the problem without having to fix the supply chain first.

10. Stay in touch with both the slow and fast parts of the business. The part that changes slowly is just as important as the part that responds to every change in the environment. “The Fast proposes but the Slow disposes.” There is great value in the people who have been performing a function for many years. They should never be treated as failures. Likewise, new ideas should not be dismissed without real consideration – particularly in light of feedback mechanisms set up to alert the organization about changes in the environment. Many of us do not notice changes in the environment until it is too late to respond with considerable effort, slowing down resilience.

While these ideas are applicable both to established firms and to startups, each group will have special advantages when building resilience. Startups have the advantage of being able to build hubs, establish links of various strengths, and create “ramp up” and “get out” trigger points from the outset, thereby avoiding any legacy networks and locked-in systems that will be difficult to adapt quickly enough to meet important surprises. Established firms and industries have the advantage of deeper understanding of the slow scales for their systems and the resources for building in redundancy. But all firms must get better at surviving surprises in an ever more connected and complex world.

Further Reading

(All are appropriate for nonspecialists)

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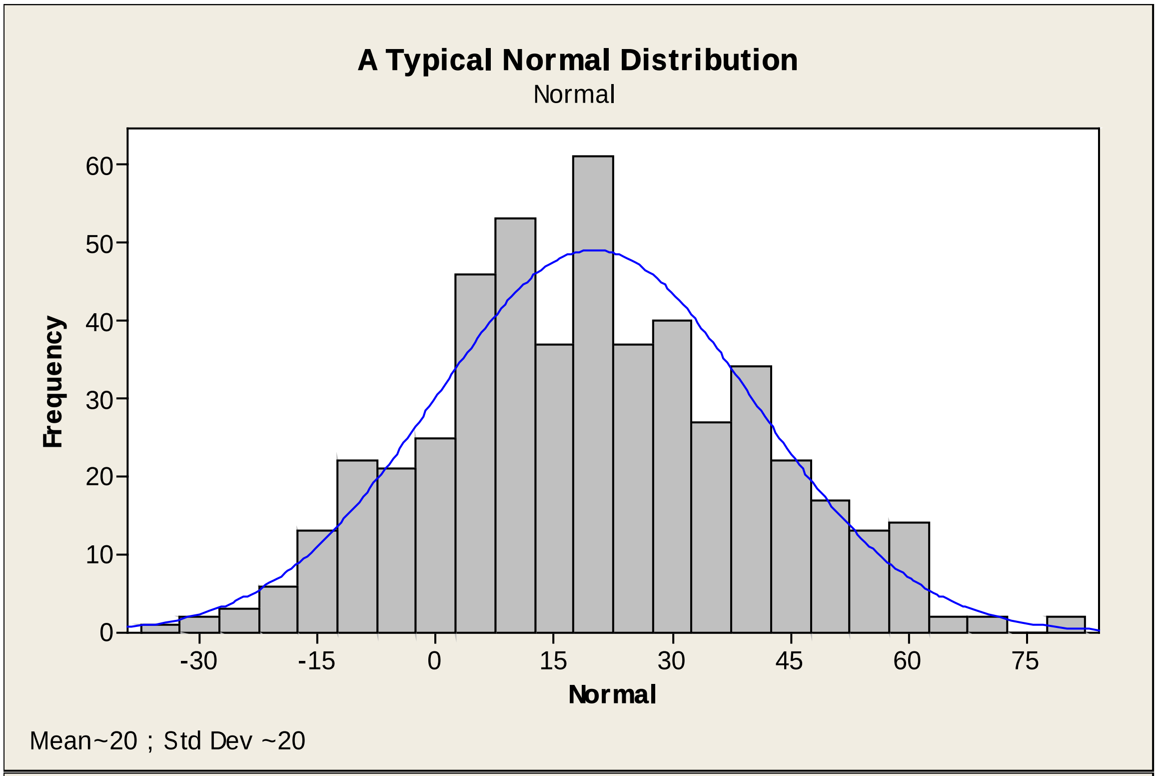
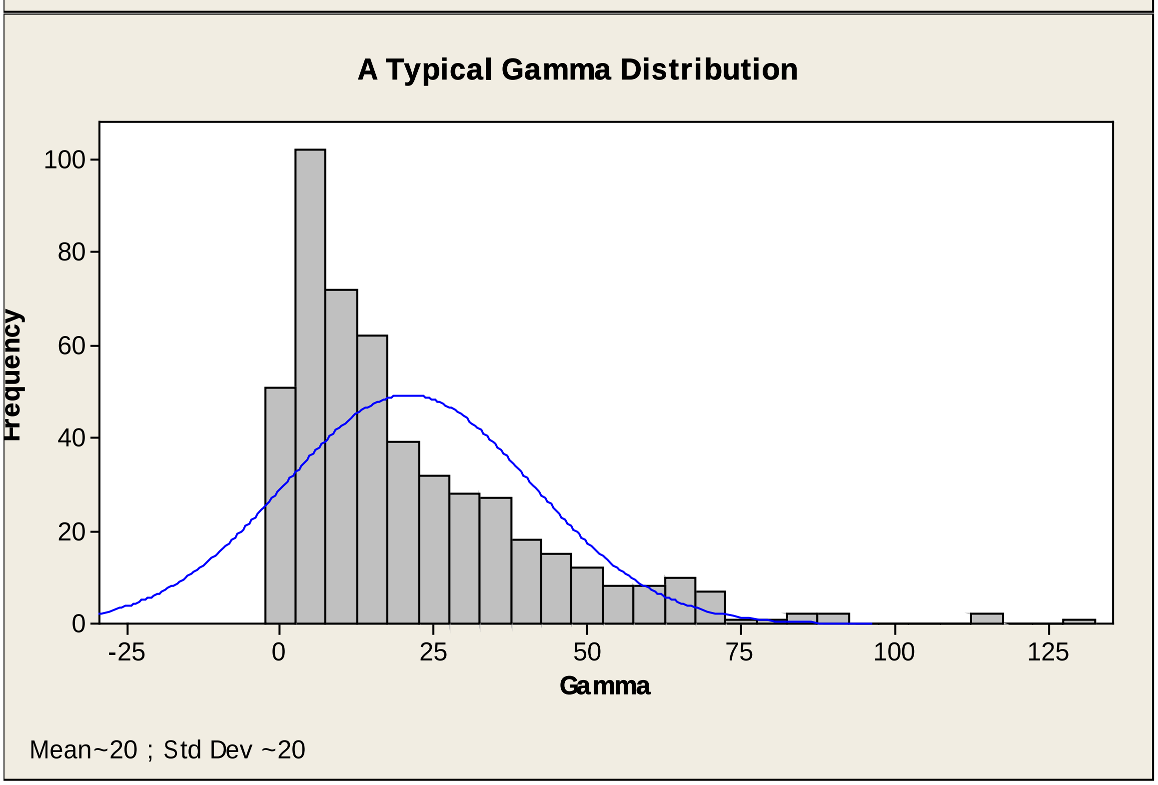
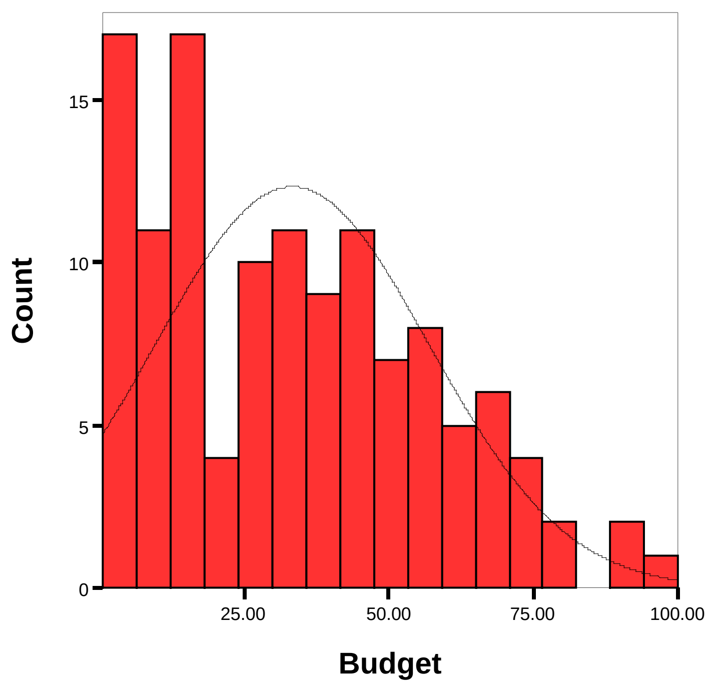
Appendix 1: Graphs of Normal and Gamma Distributions





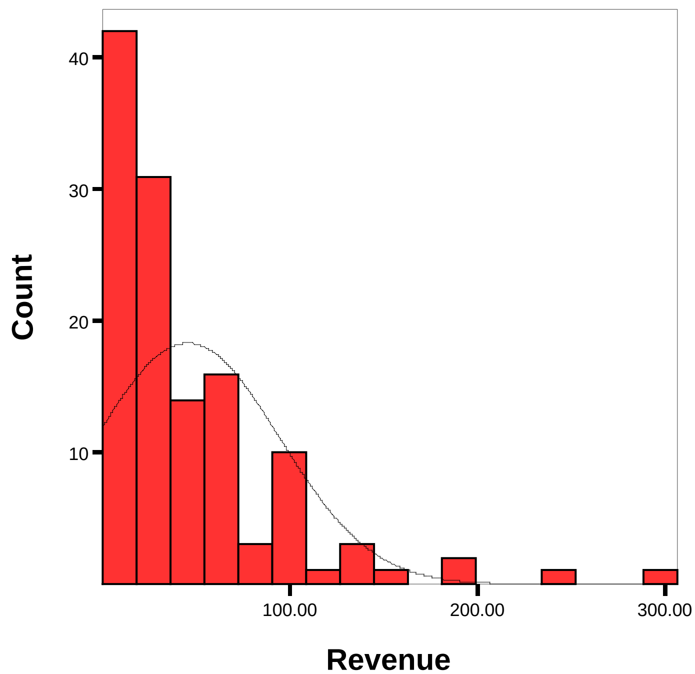
Appendix II

Budget:1996



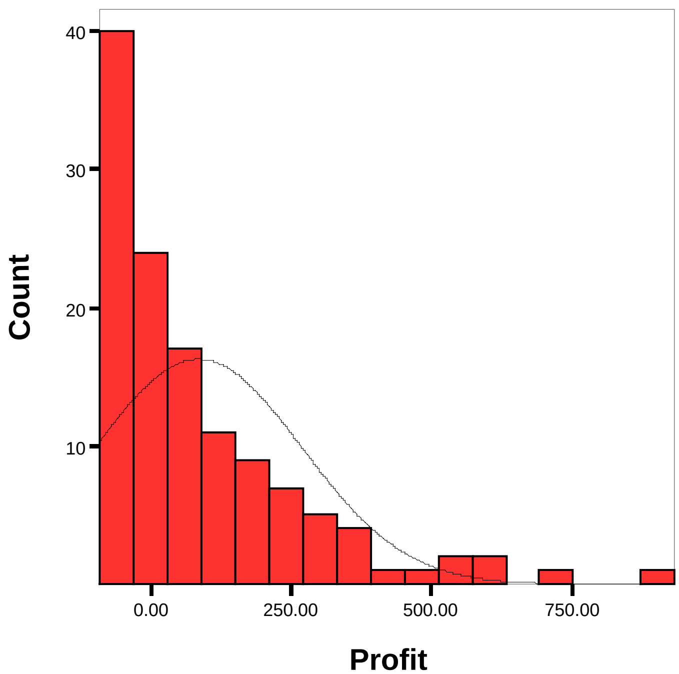
Mean~ 33.4ml

Revenue:1996



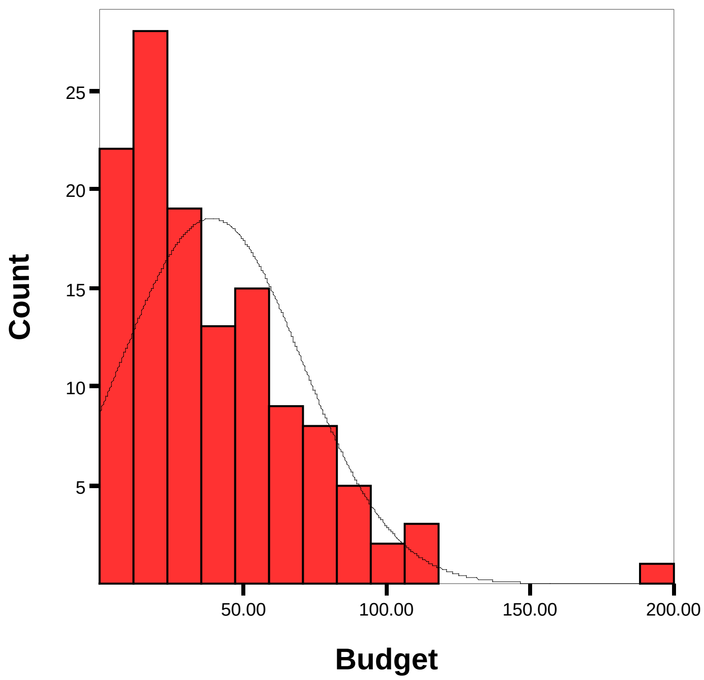
Mean~ 45.6ml

Profit:1996



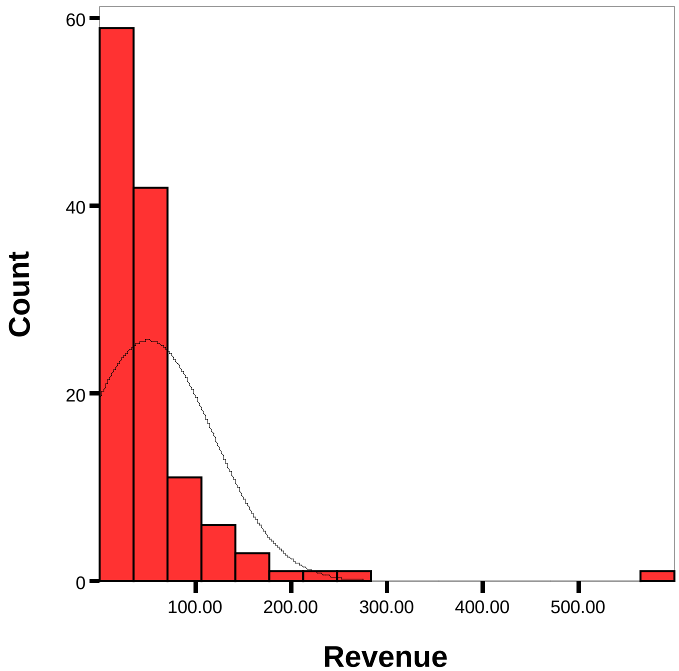
Mean~ 83%

Budget:1997



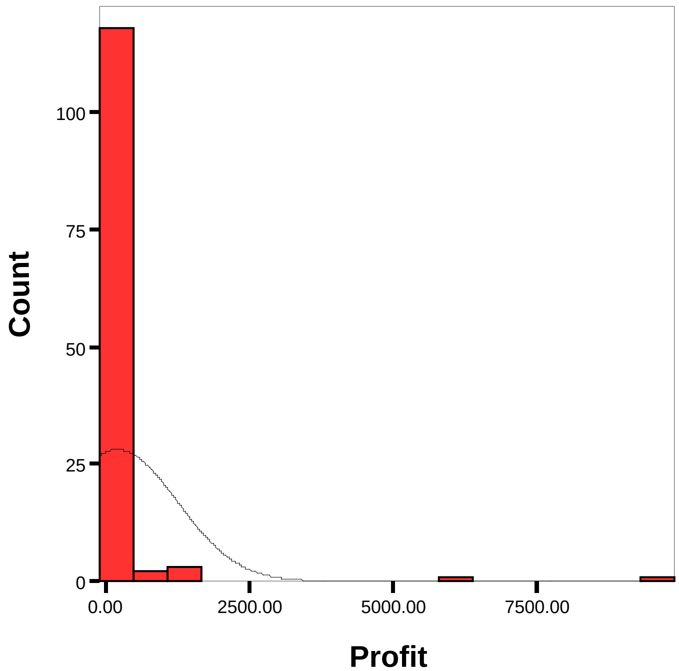
Mean~ 38.8ml

Revenue:1997



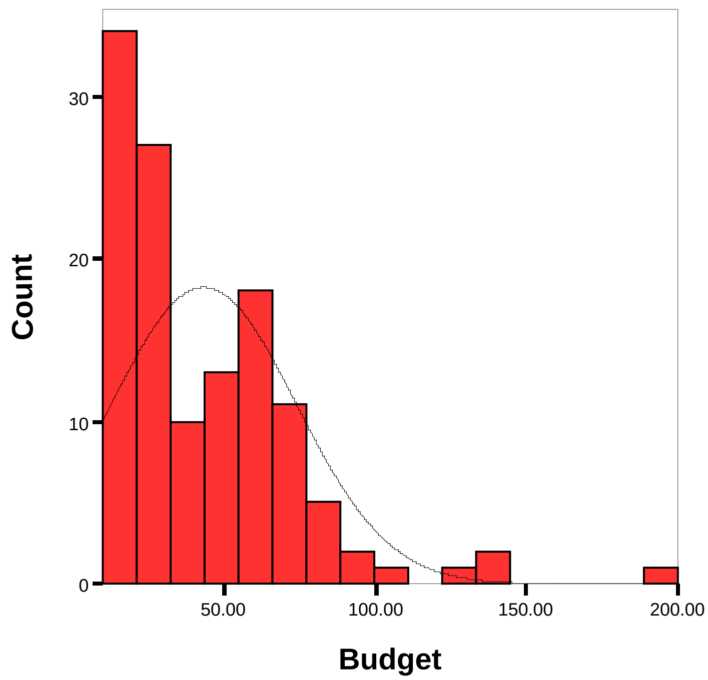
Mean~ 50.4ml

Profit:1997



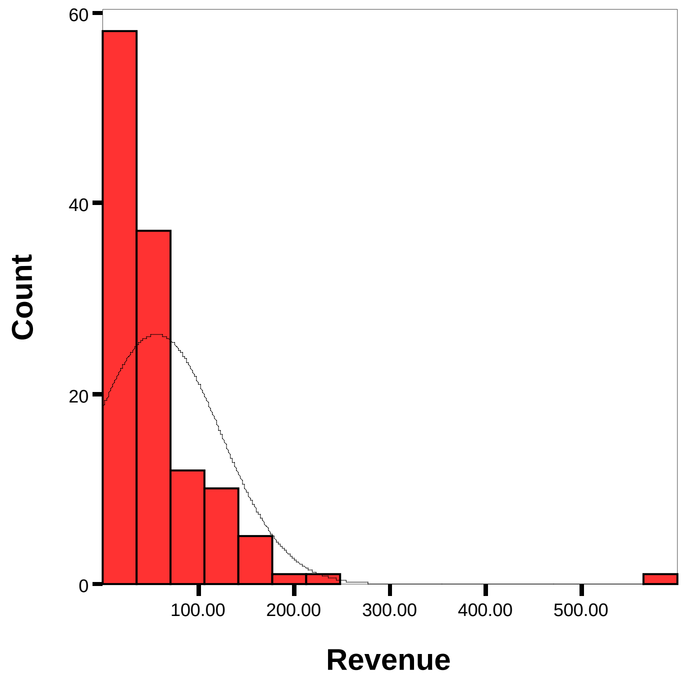
Mean~ 200%

Budget:1998



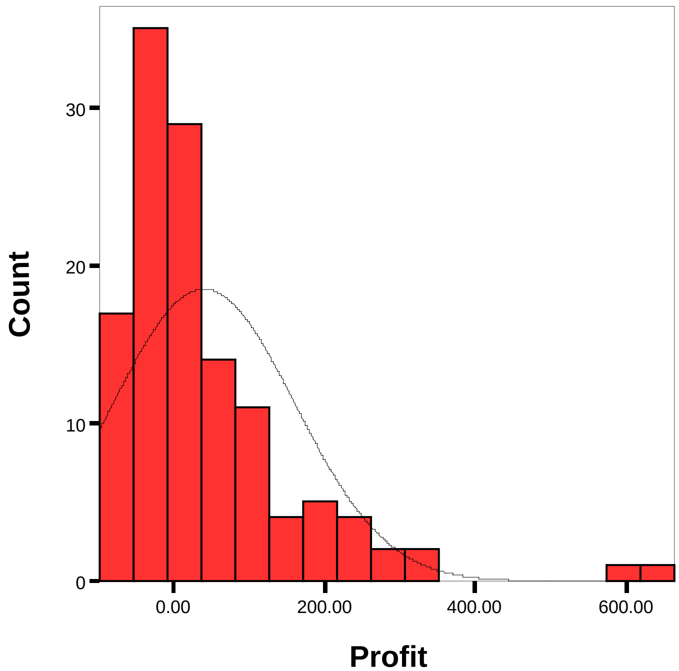
Mean~ 43.2ml

Revenue:1998



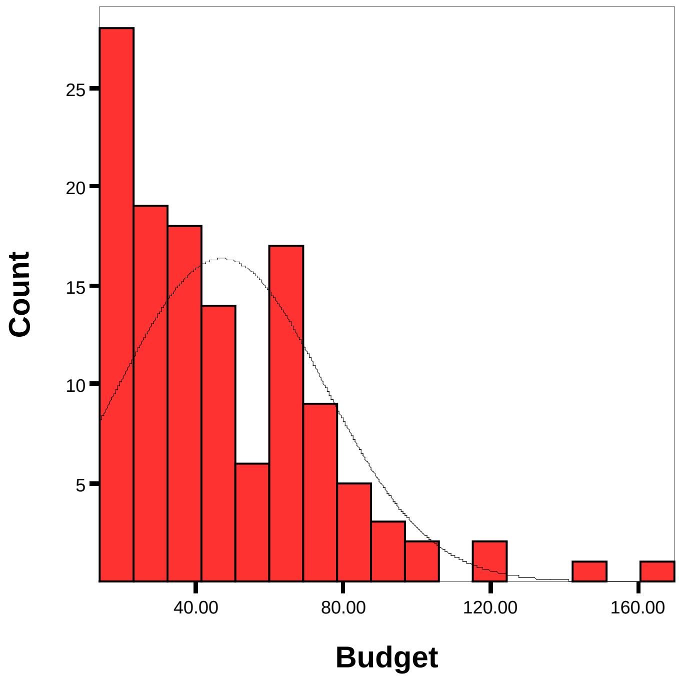
Mean~ 56ml

Profit:1998



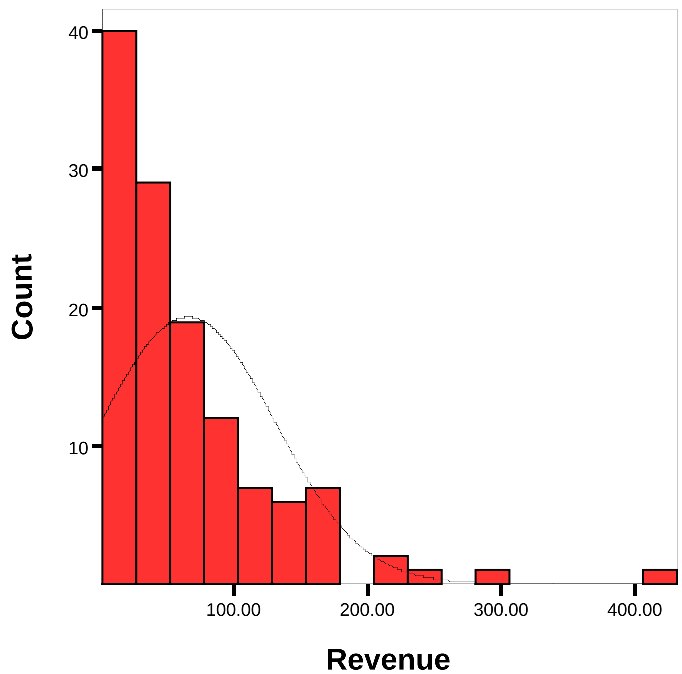
Mean~ 40%

Budget: 1999



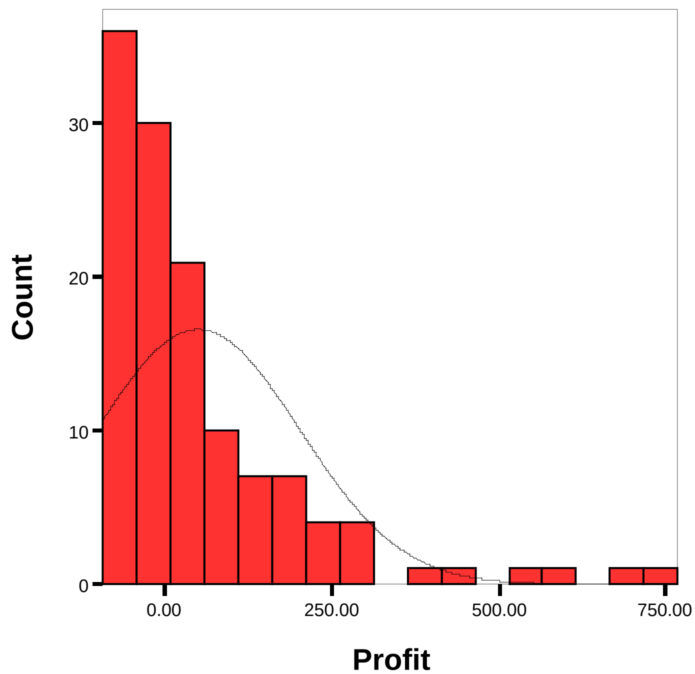
Mean~ 47ml

Revenue: 1999



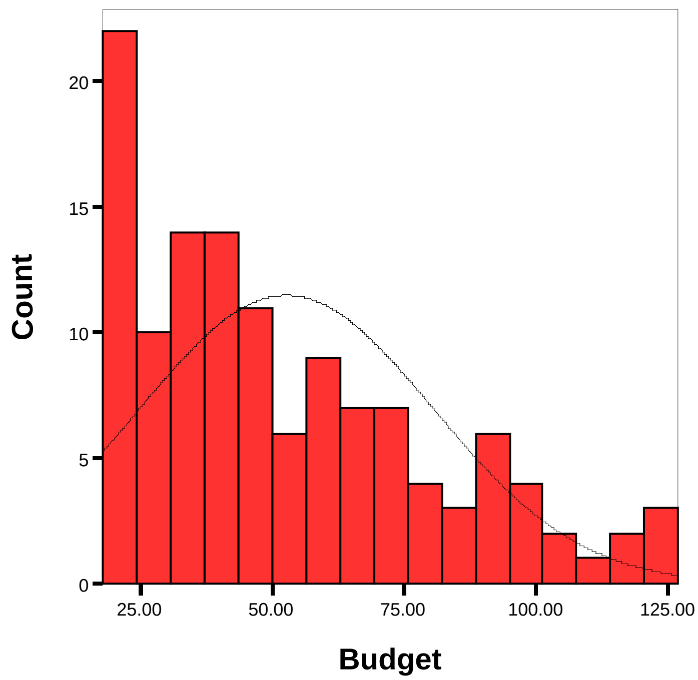
Mean~ 65.4ml

Profit: 1999



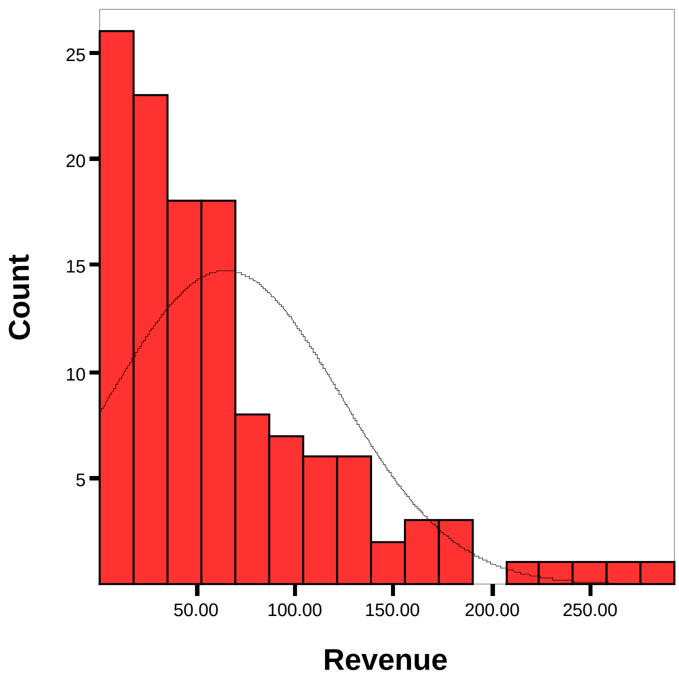
Mean~ 51%

Budget: 2000



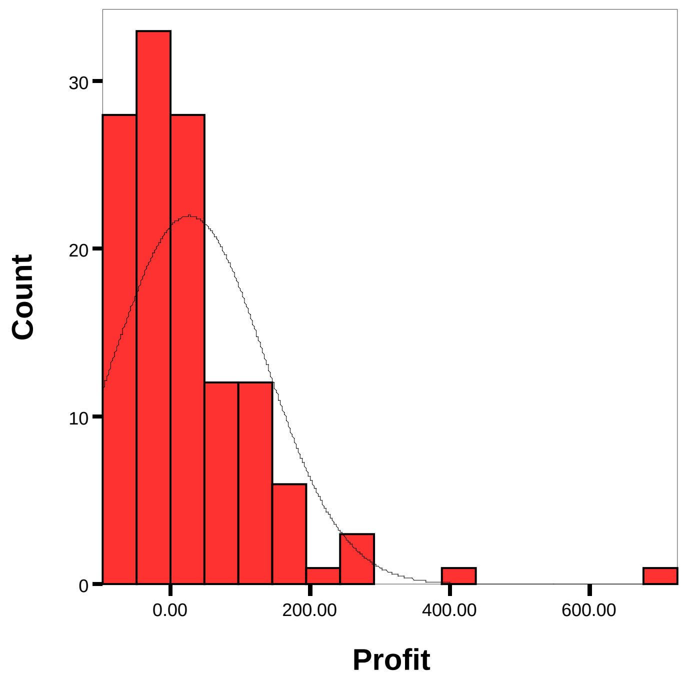
Mean~ 52.7ml

Revenue: 2000



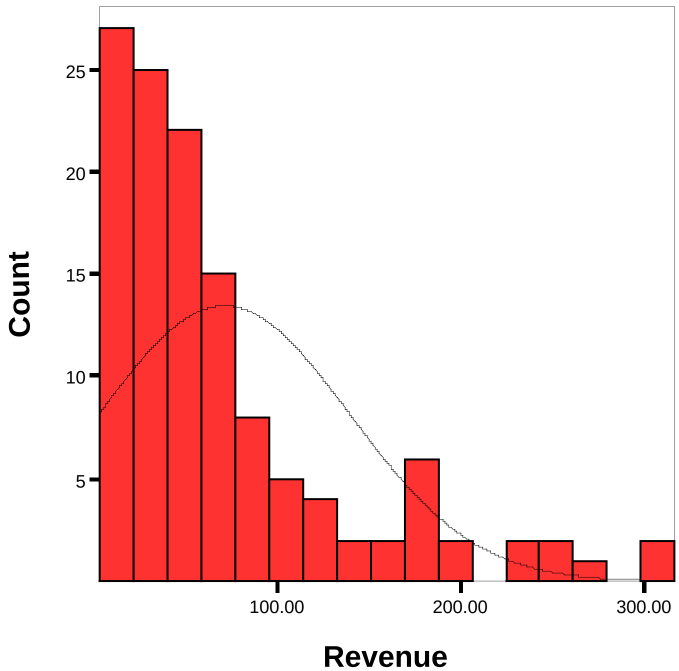
Mean~ 64.5ml

Profit: 2000



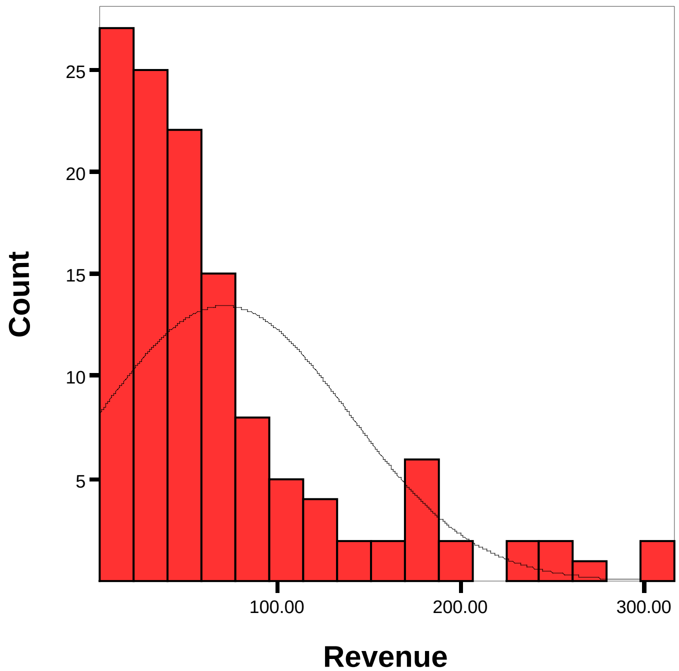
Mean~ 27%

Budget: 2001



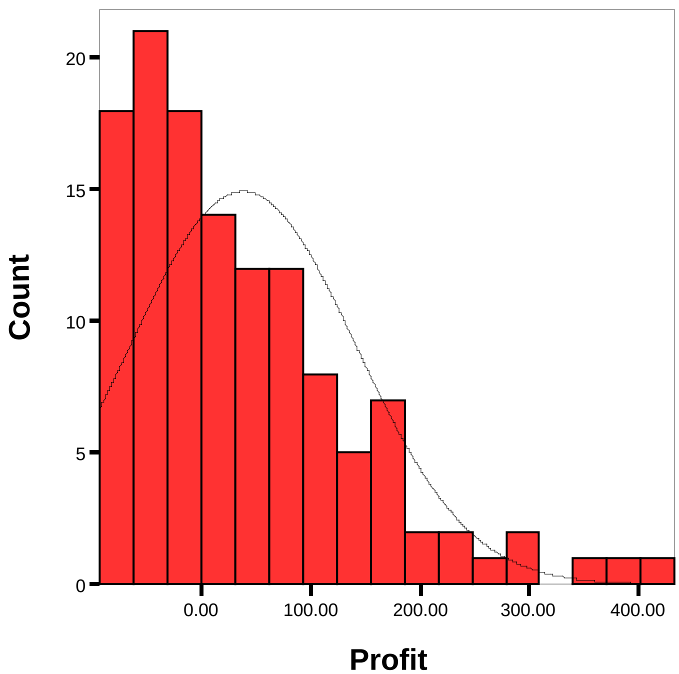
Mean~ 52.9ml

Revenue: 2001



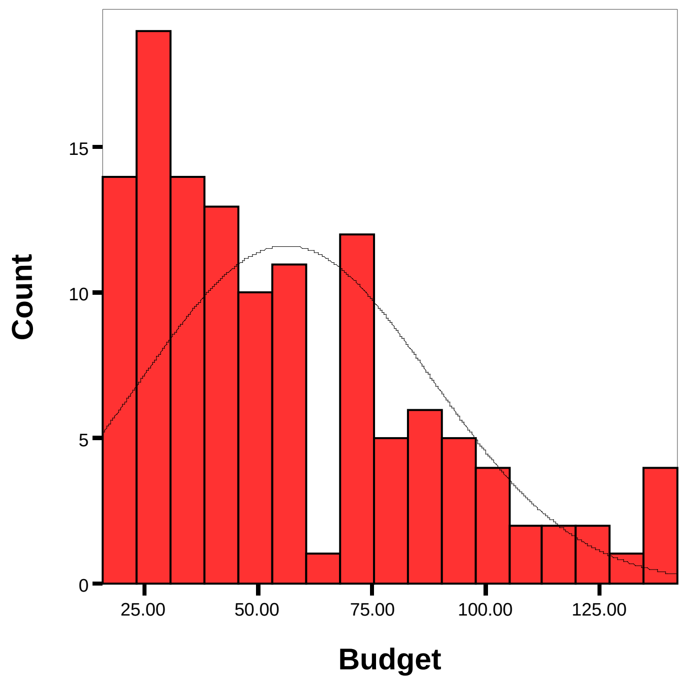
Mean~ 71.6ml

Profit: 2001



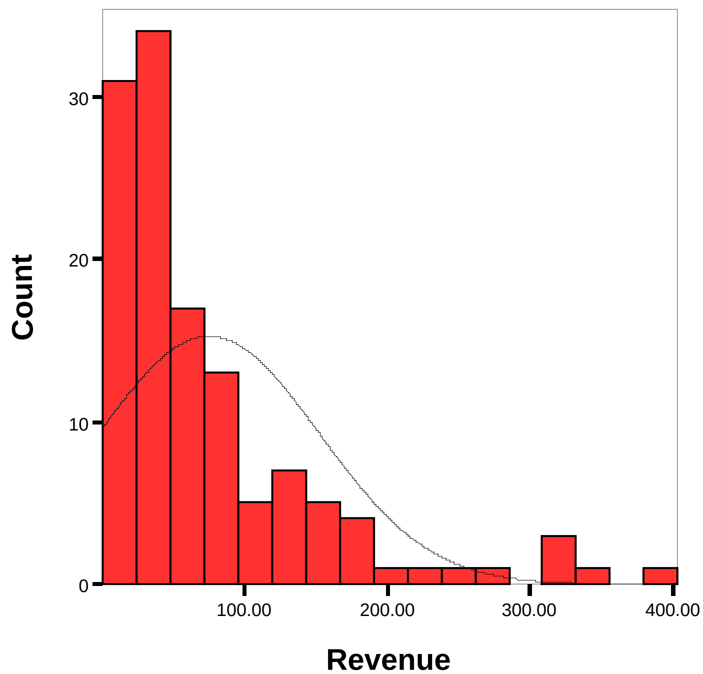
Mean~ 38%

Budget: 2002



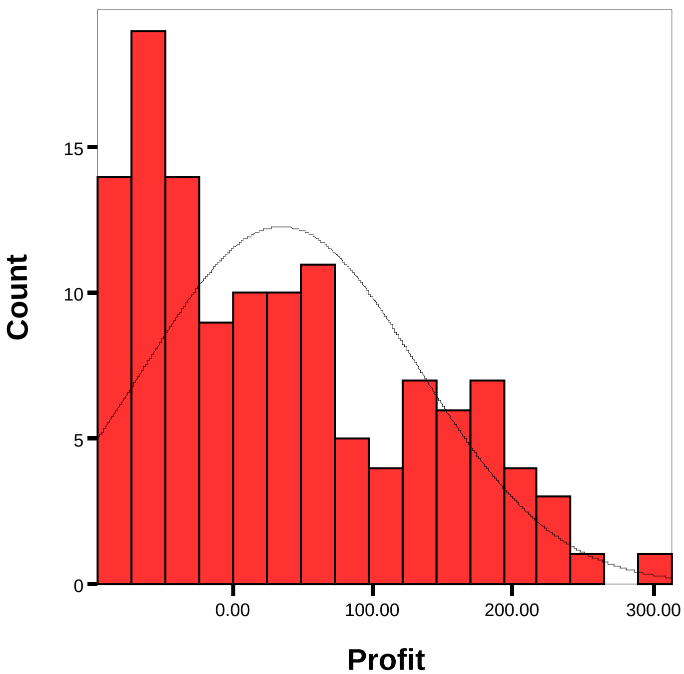
Mean~ 56.3ml

Revenue: 2002



Mean~ 75.3ml

Profit: 2002



Mean~ 35%

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