Market Research and Prior Art Search

A Crucial Part of Product Development

Sept 11, 2019

Who am I?

- Co-founder & CEO of CodeGuard
  - 0 revenue in 2011, ~$4M 2018
  - CodeGuard acquired July 2018
- 5 years at General Electric in Sales, Sourcing, Ops
- BS Mechanical Engineering
- MBA from Harvard Business School

CodeGuard

We all have marketing experience with products that:

- No one buys
- I don't buy
- I do buy

Group Activity

1:00

- 1 product you buy
- 1 product you don't buy
- 1 product no one buys

Understanding the Customer

- Which products were the easiest to think of?

- Beware when you aren't "eating the dogfood"!

Group Activity

1:00

- Discuss what you think are the two most important functions of a business

- Share the two functions with the class

"Because the purpose of business is to create a customer, the business enterprise has two and only two basic functions:

_____

_____

-*Peter Drucker*

"Because the purpose of business is to create a customer, the business enterprise has two and only two basic functions:

marketing

and

innovation

-*Peter Drucker*

What is marketing?

"Marketing is . . . the whole business seen from the point of view of the final result, that is, from the **customer's point of view**."

Group Activity

<div style="background-color:green; color:white; text-align:center;">

1:00

</div>

- Describe your Senior Design project in 1 sentences

- What are you working on? For whom? Why?

We are working on a new wing design for Boeing because they want to carry more passengers.

Managing Up

- Be able to articulate the value proposition of what you are doing

- Tell it to everyone you meet – after you get to know them

- Double check when interacting with superiors: "Just so I'm sure, we think we will be done with X by Y date. If we accomplish that, you'll be happy, right?"

Group Activity

2:00

- Discuss the potential customers for your product/service (end customer)

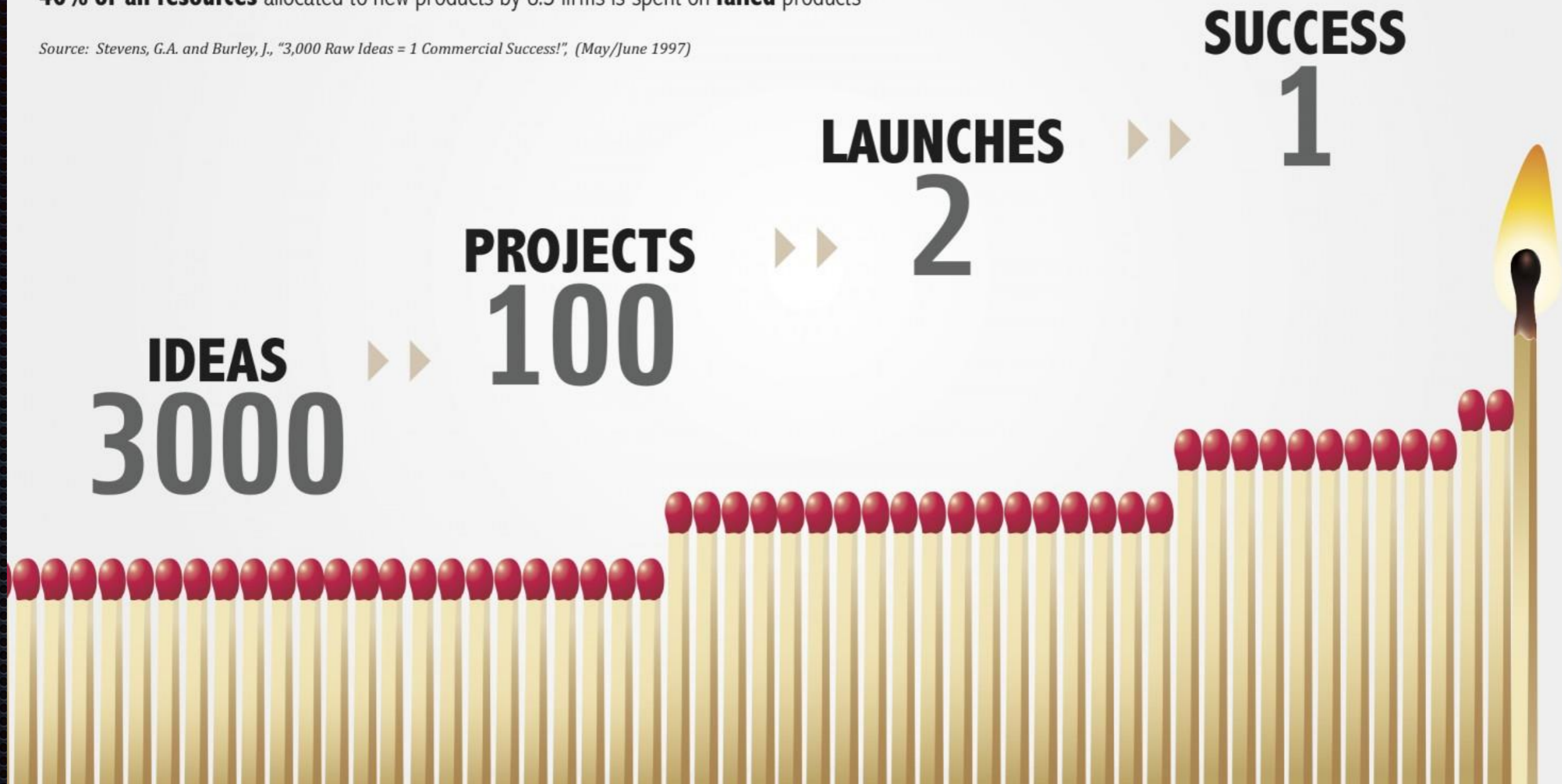- Consumers? Businesses?

- Why would a person or business purchase?

NEW PRODUCT FAILURE RATES

1 of 3 launched products fail despite research and planning

1 out of 4 projects that enter development make it to the market

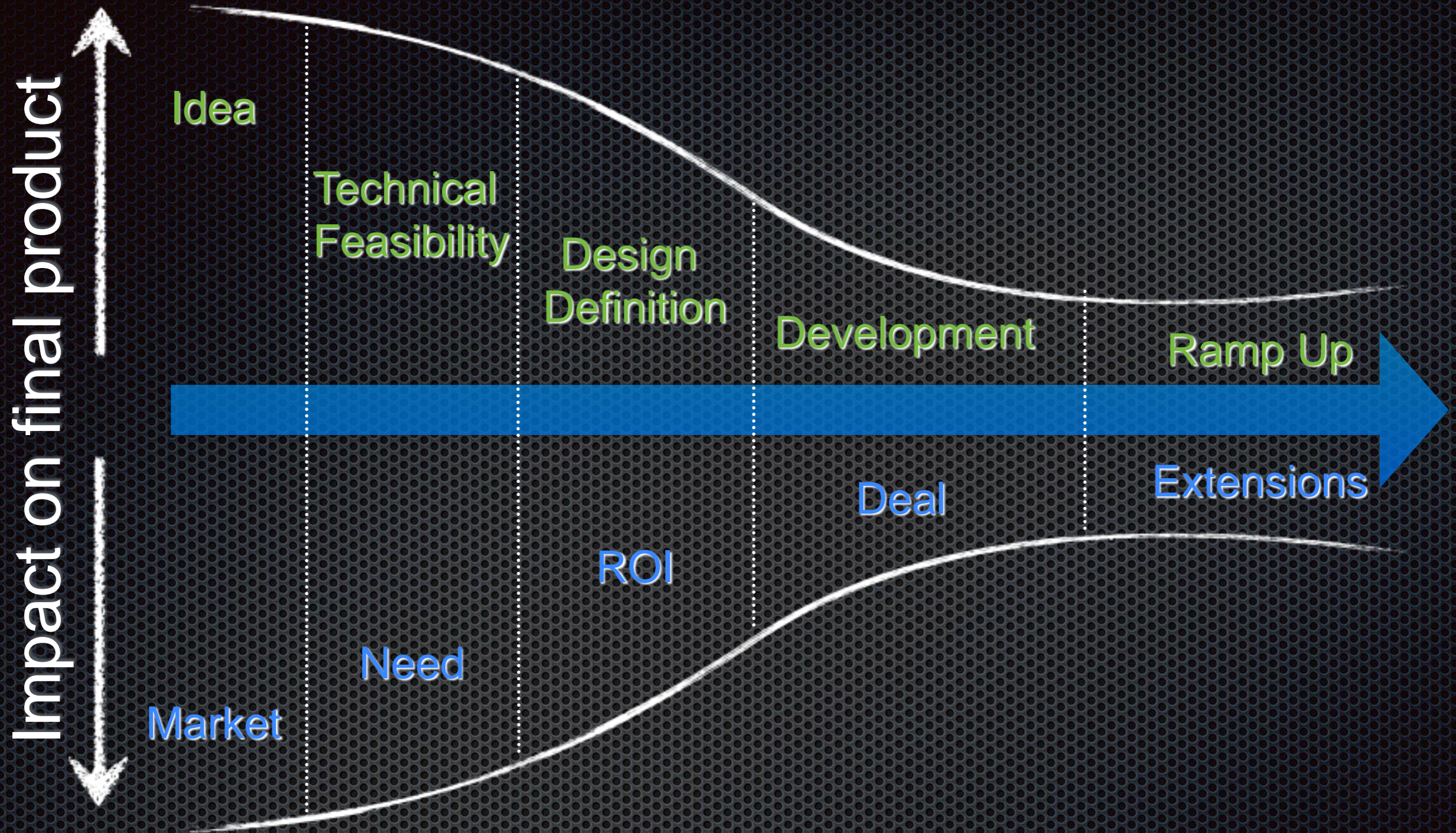**46% of all resources** allocated to new products by U.S firms is spent on **failed** products

Source: Stevens, G.A. and Burley, J., "3,000 Raw Ideas = 1 Commercial Success!", (May/June 1997)

SUCCESS
1

LAUNCHES
2

PROJECTS
100

IDEAS
3000

Group Activity 3

1:00

- Why do you think so many new products fail?

Impact on final product

Idea

Technical
Feasibility

Design
Definition

Development

Ramp Up

Extensions

Deal

ROI

Need

Market

Design Continuum
Customer learning in parallel to product development

# Market research is used to determine idea viability and create marketing plans

- **What?**
  - **Verify need for product**
  - **Determine market size: How big is my idea?**
  - **Choose target customer: Where do we focus first?**
  - **Understand target customer**

- **How?**
  - **Primary**
    - **Methods: Surveys, Focus group**
    - **Risks: Question & facilitator bias**
  - **Secondary**
    - **Methods: Reports and studies**
    - **Risks: Report or study bias**

Potential Market

Available Market

Target Market

Penetrated Market
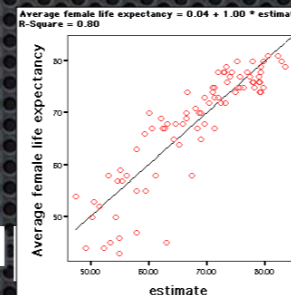
Group Activity 4

2:00

Can primary market research help your team?

Can secondary market research help?

If "yes" to either, how?

The Diffusion of Hybrid Seed Corn In Two Iowa Communities*

By Bryce Ryan and Neal C. Gross†

ABSTRACT

Hybrid seed corn has diffused through the midwest with phenomenal rapidity. In the space of four years, 1936 through 1939, two-thirds of the operators in the two communities studied, changed to the new seed. Relatively few, however, took over hybrid seed for their entire acreage the first year they tried it. This was true even for operators first using the seed at a relatively late date. There appears to be some difference between the diffusion agencies which informed farmers of the new seed and the sources of influence toward adoption. Commercial channels, especially salesmen, were most important as original sources of knowledge, while neighbors were most important as influences leading to acceptance. Although the time pattern of acceptance follows a bell shaped curve, this instance of diffusion cannot be accurately described as following a normal frequency distribution.

RESUMEN

El maíz de semilla híbrido se ha difundido por el Mediano Oeste con extraordinaria rapidez. En el espacio de 4 años, desde el 1936 hasta el 1939, dos tercios de los agricultores de las dos comunidades estudiadas adoptaron la nueva semilla. Sin embargo, relativamente muy pocos de ellos la cultivaron de lleno en el primer año que la conocieron. Ésto fué cierto también con aquellos que la han usado aún más recientemente. Parece que existe alguna diferencia entre las agencias de difusión que informaron a los agricultores sobre la nueva semilla y las fuentes de influjo que los decidieron a su adopción. Las vías comerciales, particularmente los vendedores, fueron las más importantes fuentes de conocimiento, mientras que los vecinos tuvieron más importancia desde el punto de vista de la aceptación de la simiente. Aunque el modelo del tiempo de adopción conforma con el de una campana, este ejemplo de difusión no puede ser descrito como típico de una perfecta distribución normal de frequencias.

The introduction of hybrid seed corn has been the most striking technical advance in midwestern agriculture during the past decade.[1] Although a few experimenters had been acquainted with this new and sturdier seed for many years, only since 1937 has it become a nationally important production factor. It has been estimated that between 1933 and 1939 acreage in hybrid corn increased from 40,000 to 24 million acres (about one-fourth of the nation's corn acreage). In the North Central region the spread was even more rapid. Although hybrid seed was not available until 1928 or 1929, by 1939, 75 per cent of the corn acreage in Iowa was in hybrid.

The very rapidity of its diffusion makes this trait attractive for study. This is true not only because farmers are usually "conservative," but also because its adoption is well within the memory span of current farm operators, and hence amenable to more intensive study than would

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[1] See *Technology and the Farm*, U.S.D.A., 1940, Chapter 5.

Hear about it, then use it

erators dependent upon the two town centers of Grand Junction and Scranton were included, totalling 323 farmers. Since 64 of these had started farming since hybrid corn began its spread, they have been excluded from the analysis. The age bias resulting from this is not as serious as would have been the inclusion of operators having unequal

Diffusion of Knowledge and Practice

Figure 1 shows the comparative percentages of all operators first hearing of hybrid corn in specified years, and the percentages first adopting it. While the curves are generally similar, allowing for a time lag of roughly five years between first knowledge and first adoption,
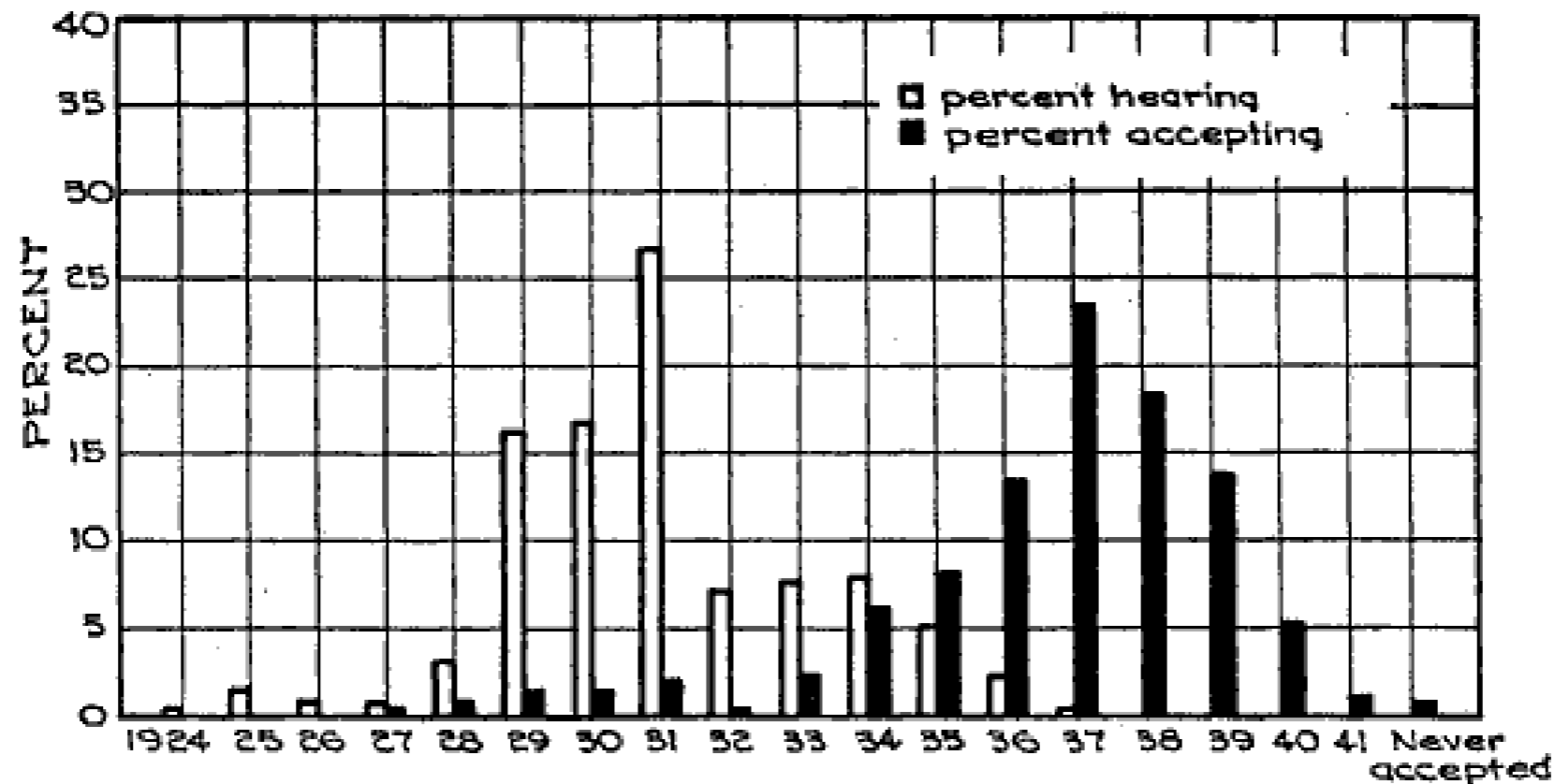

Fig. 1.   Percentages of Farm Operators First Hearing of Hybrid Seed Corn and Per-

Use it a little, then a lot

TABLE I. MEDIAN PER CENT OF CORN ACREAGE IN HYBRID FOR INDIVIDUAL YEARS BY YEAR IN WHICH OPERATOR FIRST USED HYBRID SEED

Year first used hybrid	1933	1934	1935	1936	1937	1938	1939	1940	1941	No. of cases
Before 1934	38.0*	50.0	67.0	100.0	100.0	100.0	100.0	100.0	100.0	24
1934		20.0	29.0	42.0	67.0	95.0	100.0	100.0	100.0	16
1935			18.0	44.0	75.0	100.0	100.0	100.0	100.0	21
1936				20.0	41.0	62.5	100.0	100.0	100.0	36
1937					19.0	55.0	100.0	100.0	100.0	61
1938						25.0	79.0	100.0	100.0	46
1939							30.0	91.5	100.0	36
1940								69.5	100.0	14
1941									54.0	3
Total										257
Never accepted										2
Total Sample										259

* The median hybrid planting for this group in first year of acceptance was 12 per cent of total corn acreage.

time-consuming self-demonstration was required even after visible evidence and objective comparisons were readily available to all.[9]

Original Source of Knowledge[10]

Almost one-half of the farmers cited personal contact with salesmen as their earliest source of informa- lustrates the sharp fluctuations in the importance assigned these various media, depending upon the year in which the trait was first made known to the farmer. Thus, salesmen were of major significance before 1933. Nearly 70 per cent of the operators learning of hybrid in the

Awareness vs influence & time

	20.0	29.0	42.0	67.0	95.0	100.0	100.0	100
	18.0	44.0	75.0	100.0	100.0	100.0	100.0	100
		20.0	41.0	62.5	100.0	100.0	100.0	100
		19.0	55.0	100.0	100.0	100.0		100
			25.0	79.0	100.0	100.0		100
			30.0	91.5	100.0			100
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					54			

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acreage.

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0.7 per cent "farm
ther sources were of
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the importance assigned t
ious media, depending upon
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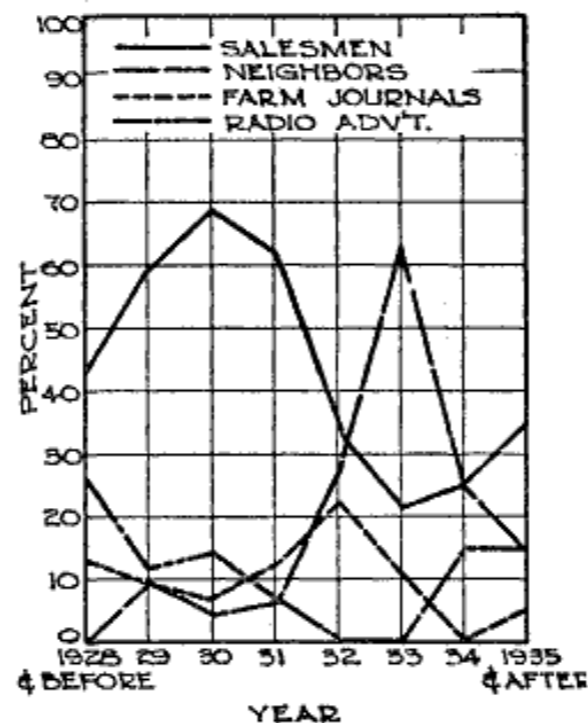operators learning of hybr

Fig. 2. Percentages of Farm Operators First Hearing of Hybrid Seed Corn Through Various Channels, by Year First Heard.

year 1930 named salesmen as their initial source; three years later only 21 per cent learned of the trait through salesmen. On the other hand, as salesmen declined in importance "neighbors" notably increased. In 1931 only 6 per cent named neighbors, but in 1933 more than 60 per cent named them. In the final years during which the most isolated operators were being reached, these two sources were about equal. There

able to use a time scale by year of adoption of the trait, rather than by year of first information. Two-thirds of the early adoptors credited salesmen with influencing them most, while two-thirds of the latest adoptors credited their neighbors as being primary motivators (figure 3).

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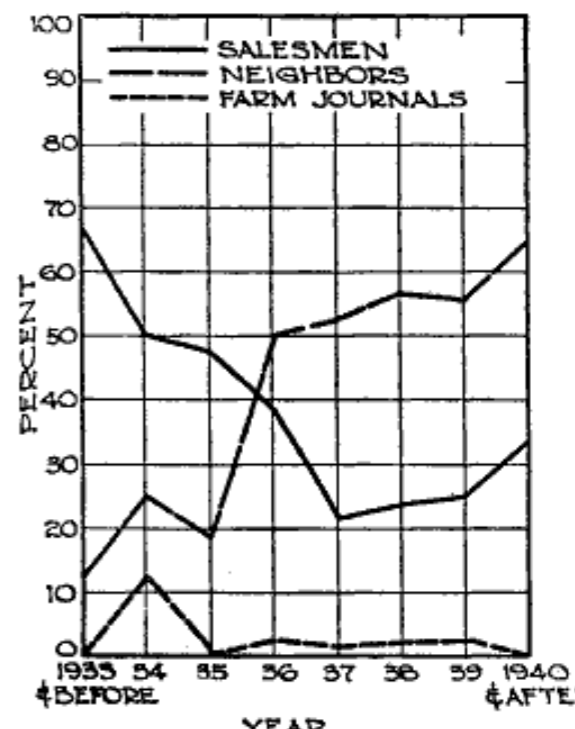tance as
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influenced

Fig. 3. Percentages of Farm Operators Accepting Hybrid Seed Corn In Different Years Assigning Major Influence to Various Sources.

With the passing years neighbors gained almost consistently in importance and salesmen lost. The bulk of the operators fall in the later years— hence, the much greater neighbor influence in the total sample.

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TABLE 2. PERCENTAGES OF ALL
CITING SPECIFIC ORIGINAL
KNOWLEDGE OF HYBRID SEED
INFLUENTIAL SOURCES

Source	Origina knowle
Neighbors	14.6
Salesmen	49.0
Farm Journal	10.7

ege began publishing and
orts on comparative corn

Group Activity 5

1:00

What could seed manufacturers have done to speed up adoption?

Diffusion of Innovations
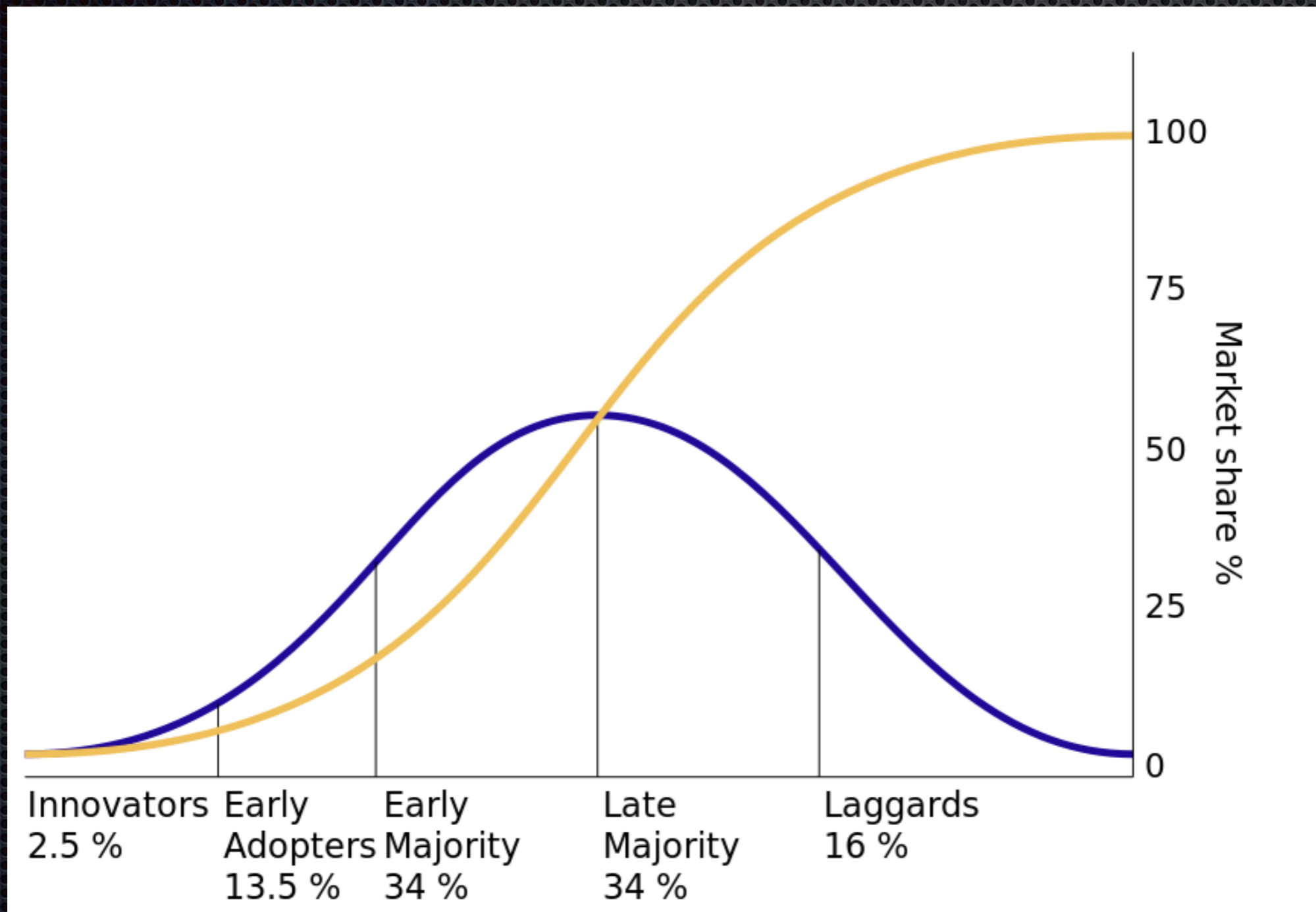
Bass Model

Model formulation [edit]

$$\frac{f(t)}{1 - F(t)} = p + qF(t) \ [2]$$

Where:

- $f(t)$ is the change of the installed base fraction
- $F(t)$ is the installed base fraction
- p is the coefficient of innovation
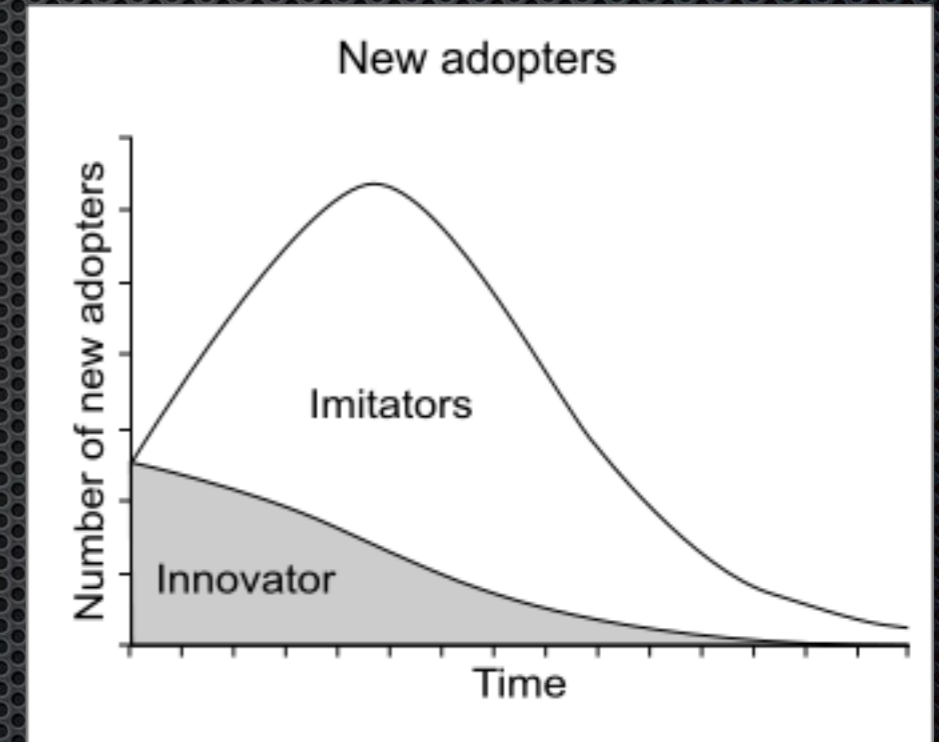- q is the coefficient of imitation

Sales $S(t)$ is the rate of change of installed base (i.e. adoption) $f(t)$ multiplied by the ultimate market potential m:

$$S(t) = mf(t)$$

$$S(t) = m\frac{(p+q)^2}{p}\frac{e^{-(p+q)t}}{(1 + \frac{q}{p}e^{-(p+q)t})^2} \ [2]$$

The time of peak sales t^*

$$t^* = \frac{\ln q - \ln p}{p + q} \ [2]$$

New adopters

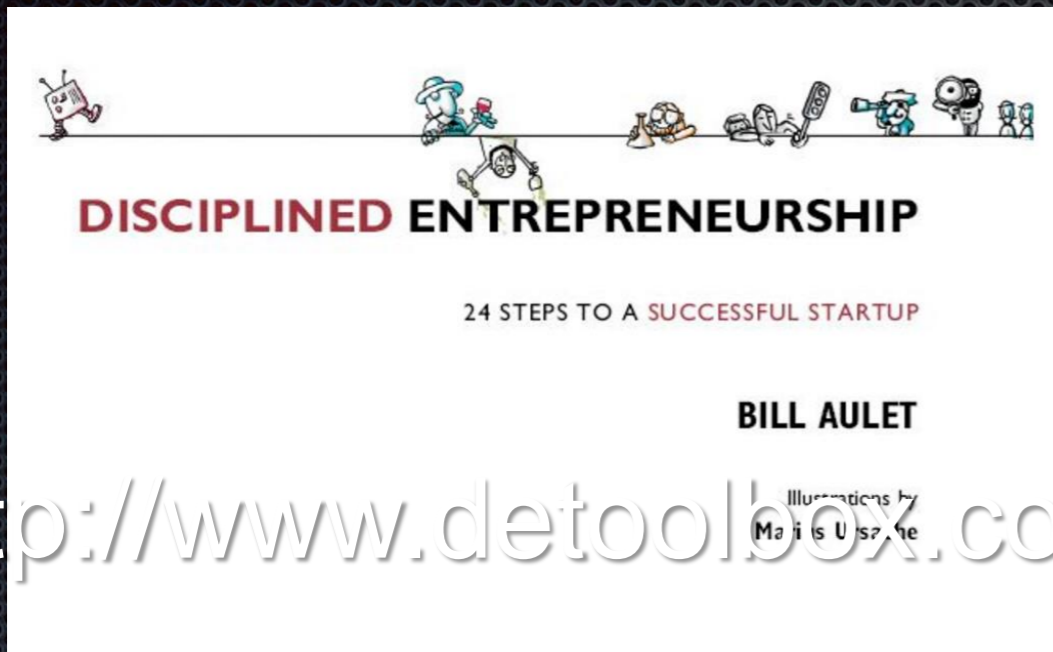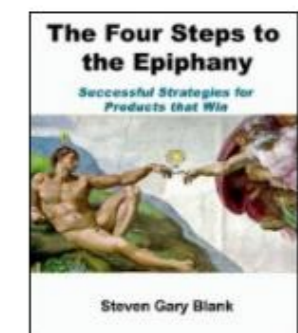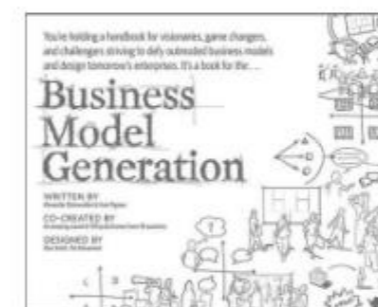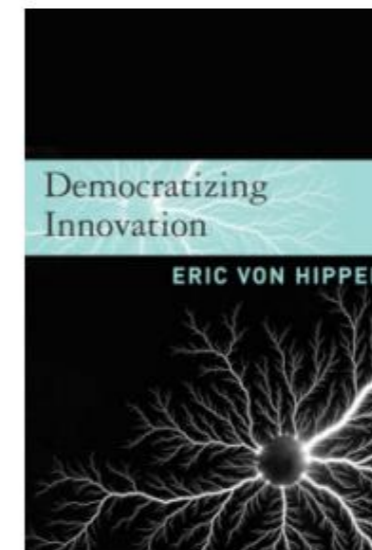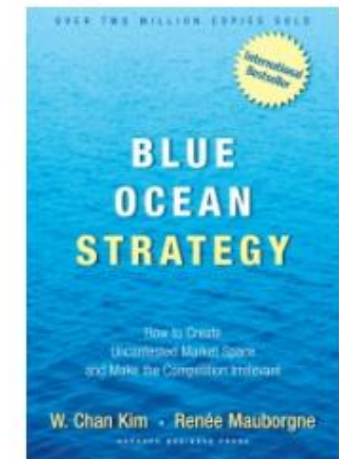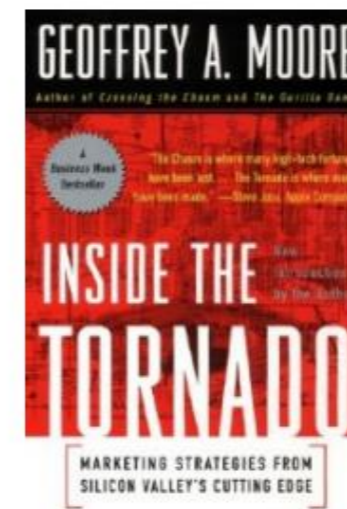Number of new adopters — Time

Imitators

Innovator

The End

Questions?

Appendix

Resources

http://www.detoolbox.com/
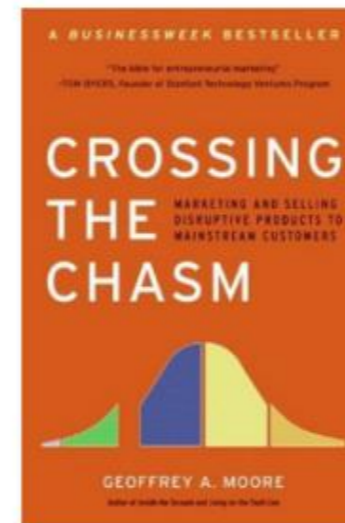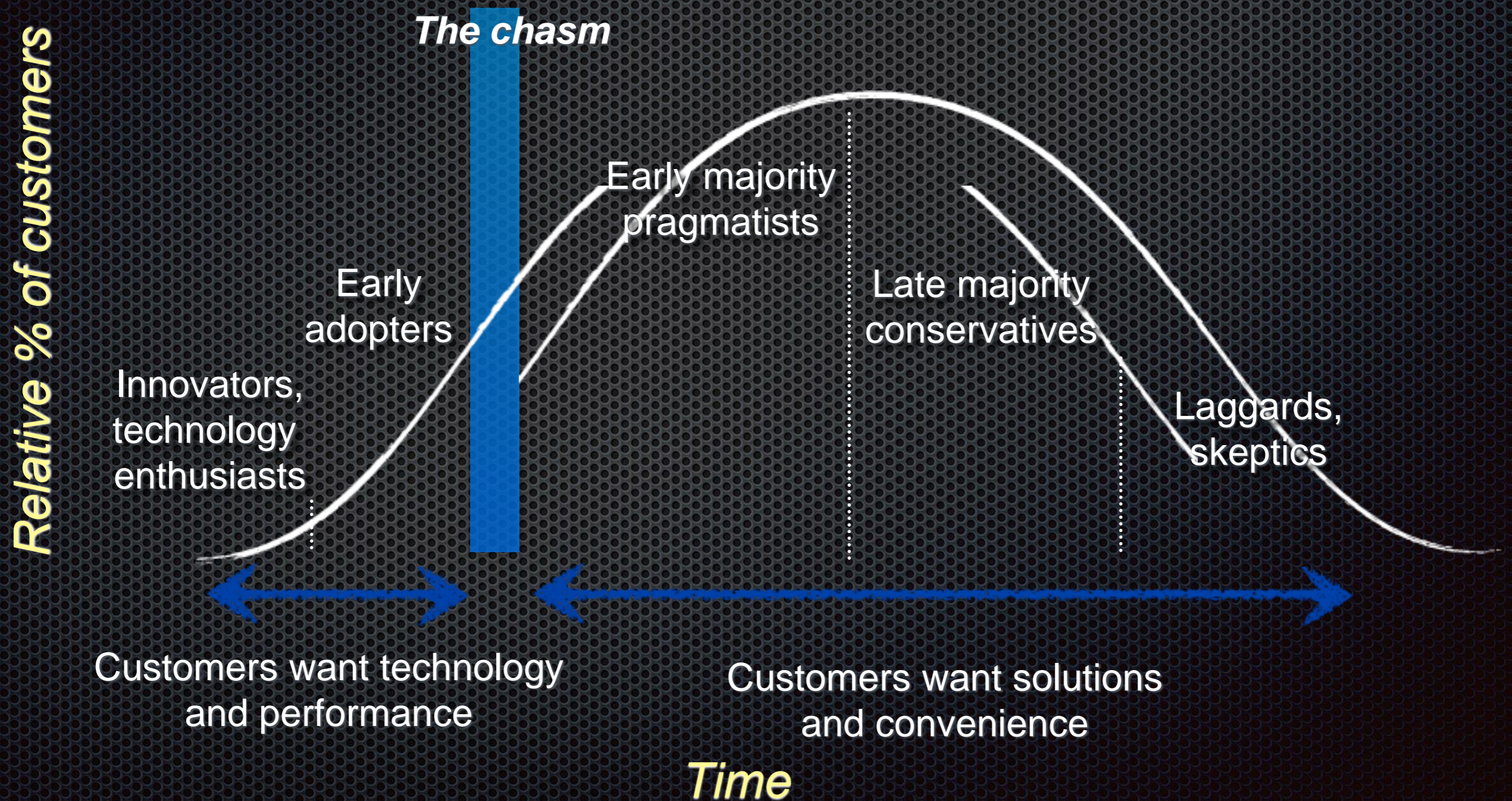
Technology Adoption Lifecycle
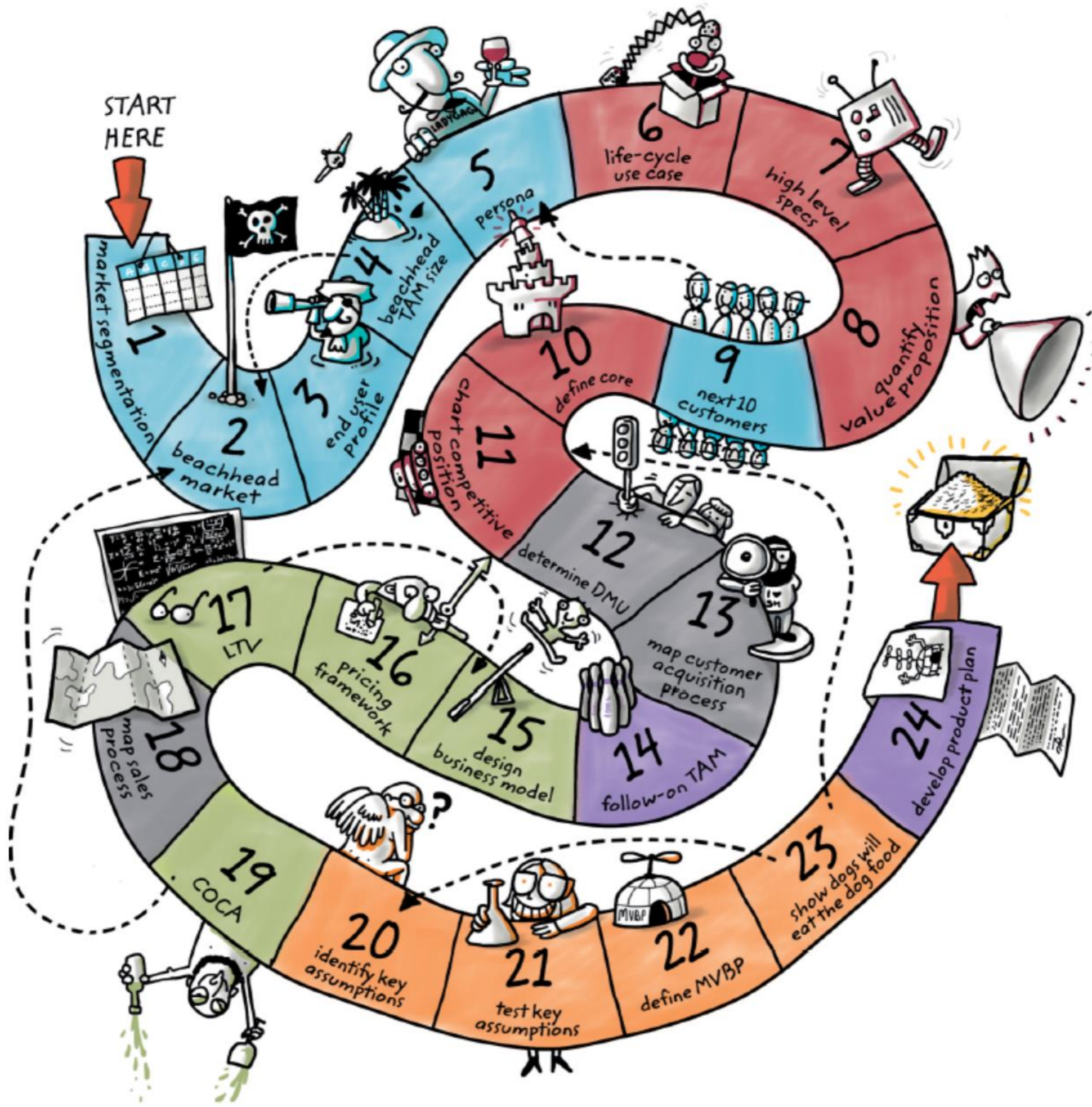
WHO IS YOUR CUSTOMER?

1 Market Segmentation

2 Select a Beachhead Market

3 Build an End User Profile

4 Calculate the TAM Size for the Beachhead Market

5 Profile the Persona for the Beachhead Market

9 Identify Your Next 10 Customers

WHAT CAN YOU DO FOR YOUR CUSTOMER?

6 Full Life Cycle Use Case

7 High-Level Product Specification

8 Quantify the Value Proposition

10 Define Your Core

11 Chart Your Competitive Position

HOW DOES YOUR CUSTOMER ACQUIRE YOUR PRODUCT?

12 Determine the Customer's Decision-Making Unit (DMU)

13 Map The Process to Acquire a Paying Customer

18 Map the Sales Process to Acquire a Customer

HOW DO YOU MAKE MONEY OFF YOUR PRODUCT?

15 Design a Business Model

16 Set Your Pricing Framework

17 Calculate the Lifetime Value (LTV) of an Acquired Customer

19 Calculate the Cost of Customer Acquisition (COCA)

HOW DO YOU DESIGN & BUILD YOUR PRODUCT?

20 Identify Key Assumptions

21 Test Key Assumptions

22 Define the Minimum Viable Business Product (MVBP)

23 Show That "The Dogs Will Eat the Dog Food"

HOW DO YOU SCALE YOUR BUSINESS?

14 Calculate the TAM Size for Follow-on Markets

24 Develop a Product Plan

The Diffusion of Hybrid Seed Corn In Two Iowa Communities*

By Bryce Ryan and Neal C. Gross†

ABSTRACT

Hybrid seed corn has diffused through the midwest with phenomenal rapidity. In the space of four years, 1936 through 1939, two-thirds of the operators in the two communities studied, changed to the new seed. Relatively few, however, took over hybrid seed for their entire acreage the first year they tried it. This was true even for operators first using the seed at a relatively late date. There appears to be some difference between the diffusion agencies which informed farmers of the new seed and the sources of influence toward adoption. Commercial channels, especially salesmen, were most important as original sources of knowledge, while neighbors were most important as influences leading to acceptance. Although the time pattern of acceptance follows a bell shaped curve, this instance of diffusion cannot be accurately described as following a normal frequency distribution.

RESUMEN

El maíz de semilla híbrido se ha difundido por el Mediano Oeste con extraordinaria rapidez. En el espacio de 4 años, desde el 1936 hasta el 1939, dos tercios de los agricultores de las dos comunidades estudiadas adoptaron la nueva semilla. Sin embargo, relativamente muy pocos de ellos la cultivaron de lleno en el primero año que la conocieron. Ésto fué cierto también con aquellos que la han usado aún más recientemente. Parece que existe alguna diferencia entre las agencias de difusión que informaron a los agricultores sobre la nueva semilla y las fuentes de influjo que los decidieron a su adopción. Las vías comerciales, particularmente los vendedores, fueron las más importantes fuentes de conocimiento, mientras que los vecinos tuvieron más importancia desde el punto de vista de la aceptación de la simiente. Aunque el modelo del tiempo de adopción conforma con el de una campana, este ejemplo de difusión no puede ser descrito como típico de una perfecta distribución normal de frequencias.

The introduction of hybrid seed corn has been the most striking technical advance in midwestern agriculture during the past decade.[1] Although a few experimenters had been acquainted with this new and sturdier seed for many years, only since 1937 has it become a nationally important production factor. It has been estimated that between 1933 and 1939 acreage in hybrid corn increased from 40,000 to 24 million acres (about one-fourth of the nation's corn acreage). In the North Central region the spread was even more rapid. Although hybrid seed was not available until 1928 or 1929, by 1939, 75 per cent of the corn acreage in Iowa was in hybrid.

The very rapidity of its diffusion makes this trait attractive for study. This is true not only because farmers are usually "conservative," but also because its adoption is well within the memory span of current farm operators, and hence amenable to more intensive study than would

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[1] See *Technology and the Farm*, U.S.D.A., 1940, Chapter 5.

otherwise be possible. Analysis of this diffusion has a special significance in that it represents a farm trait which can almost unqualifiedly be termed a "good (economic) farm practice." The study of its spread may offer some factual knowledge of conditions attendant to the eminently successful diffusion of a rational technique.[2]

The 1930's provide a curiously complex background to the diffusion of a new, hardier, and more productive breed of corn. On the whole the peculiar circumstances of this decade should have favored the more rapid spread of the trait rather than its retardation, but this assumption cannot be accepted unequivocally. From a rational standpoint the period of economic distress should have given added incentive to the acceptance of a more efficient practice, but the new seed demanded cash outlay at a time when farmers were loath to use either cash or credit. Although none of the farmers studied attributed delay in adoption to lack of credit, the general restriction of cash expenditures in the depths of depression was undoubtedly a limiting factor.[3] Balanced against the negative effects of depression were two conditions stimulating adoption. The first of these

was the AAA starting in 1933, and the second was the severe droughts especially in 1934 and 1936. The reduction of corn acreage associated with a "pegged price" was certainly favorable to the more productive type of seed and the superior performance of hybrid corn under drought conditions offered objective demonstrations of its hardiness.

Even with this conspiracy of circumstances, it still might be wondered that hybrid spread so rapidly, in view of the slowness with which many sound economic practices are accepted.[4] Aside from the obvious superiority of the new breed (except where improper seed was used in a particular locality) it was a trait which could be and was promoted profitably by lively commercial interests. Further, its advantages were visible not only in account books; they showed up tangibly to every drought-wearied farmer who passed by. In Iowa, at least, the Extension Service aided the movement in a number of ways, but notably through the publication of comparative corn yield tests, and the certification of commercial seeds. Also of importance was the very ease by which the new practice could be adopted. Its use required few changes in routine or equipment.

To ascertain the process through which hybrid seed was absorbed into the technicways of the Corn Belt, two communities in central Iowa were se-

lected for study in the summer of 1941.[5] Practically all of the farm operators dependent upon the two town centers of Grand Junction and Scranton were included, totalling 323 farmers. Since 64 of these had started farming since hybrid corn began its spread, they have been excluded from the analysis. The age bias resulting from this is not as serious as would have been the inclusion of operators having unequal

opportunity of adopting the trait in any given year.

Diffusion of Knowledge and Practice

Figure 1 shows the comparative percentages of all operators first hearing of hybrid corn in specified years, and the percentages first adopting it. While the curves are generally similar, allowing for a time lag of roughly five years between first knowledge and first adoption,
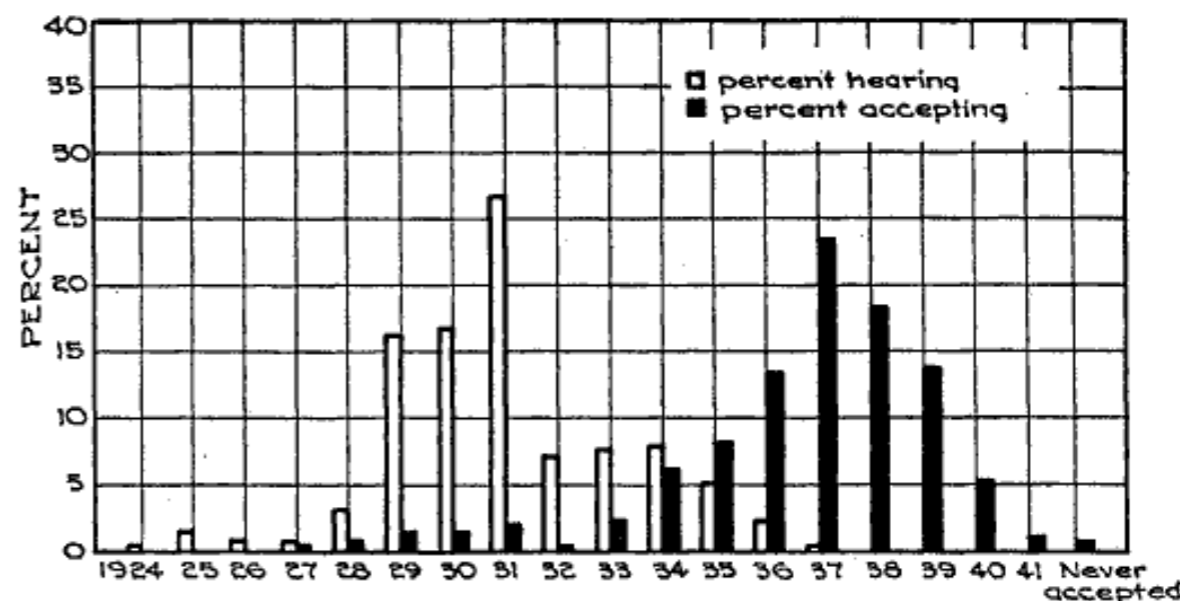
Fig. 1. Percentages of Farm Operators First Hearing of Hybrid Seed Corn and Percentages First Accepting It, by Years.

some differences are worth noting. Whereas the modal frequency in knowledge came 7 years after the first operator heard of the seed, the modal frequency in adoption occurred 10 years after the trait was first accepted. The preliminary stages of diffusion were somewhat slower in terms of adoption than in knowledge; once the wave of adoption

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[2] This paper represents a part of a longer study now in progress in which factors affecting rapidity of spread are also being analyzed.

[3] Too much emphasis should not be placed on this essentially psychological assumption. The use of hybrid seed would have been profitable in every separate year of the depression. See Neal C. Gross, "The Diffusion of a Culture Trait in Two Iowa Townships," M.S. Thesis, Iowa State College, 1942 (unpublished).

[4] For example: hog sanitation, liming, systematic accounts, and many more which have been promoted by the Extension Service for years.

[5] These communities are situated in Greene County 15 miles apart, equidistant from urban centers and on a main east-west highway. They are not typical of Iowa but probably are typical of the intensive grain producing, high income, and highly commercialized central area of the state. They are typically rurban; practically all operators have radios, newspapers, farm journals, and telephones. It should be recognized that some of the operators were not members of these communities at the time they adopted hybrid seed, but there is no reason to believe that this offers any serious bias for the present problem.

swelled, hybrid practically "took the field" in the space of four years (1936-1939 inclusive). Almost all had heard of the new trait before more than a handful were planting it.[6]

Increasing Acceptance

As might be expected, few operators turned their corn acreage completely to hybrid seed in the early years (See table I). In fact, this tentative pattern of acceptance characterized the majority who began using the seed even in 1940 and 1941. While the very late operators generally took up the new seed immediately for a larger share of their acreage, the median planting for those first using hybrid in 1939 amounted to only 30 per cent of their total corn acreage for that year. More surprising than the increase in the size of first plantings as time went on is the fact that the more conservative operators, with several years of community experience to guide them, were so "experimental" in their acceptance.

Although the size of first plantings increased very little with the passing years, until about 1939, the later acceptors took a shorter time to reach practically complete adoption of the new seed. Thus, for example, the operators starting to plant hybrid in the respective years, 1934, 1936, and 1937, all reached a 100 per cent median planting for the first time in 1939.[7] However, in most years prior to 1939 the earlier the operators had started using hybrid, the larger was the percentage of crop in the new seed. Although some exceptions to this arise, notably among operators starting in 1935, in general, the later acceptors did not "catch up with" the earlier ones until the point of practically complete adoption had been reached.

In a sense the early acceptors provided a community laboratory from which neighbors could gain some vicarious experience with the new seed over a period of some years. The importance of this local laboratory has been attested by the weight given "neighbors" as influences toward acceptance.[8] But at the same time it is evident that the more conservative operators would not accept other farmers' experience at full face value. This offers a suggestive slant on the learning process in farm practice. It would seem that whatever the advantages demonstrated by community experience in hybrid, the bulk of the operators insisted upon personal experimentation b e f o r e complete acceptance. As we have seen, the experimentation period was shortened for the late ones, but very few were willing to start at the point already reached by earlier adoptors. The acceptance of hybrid was far from a conversion; individual and

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[6]This would be much more striking if adoption of the trait meant 100 per cent of corn acreage in hybrid. Here we have considered acceptance of the seed in any degree as adoption.

[7]The mean percentages of corn land in hybrid for each of these groups in 1939 were: 1934—97.2; 1936—82.1; 1937—86.6. Means have not been used generally because of the skewed distributions especially in early and late phases of the acceptance process.

[8]See below.

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Total Sample										259

* The median hybrid planting for this group in first year of acceptance was 12 per cent of total corn acreage.

time - consuming self - demonstration was required even after visible evidence and objective comparisons were readily available to all.[9]

Original Source of Knowledge[10]

Almost one-half of the farmers cited personal contact with salesmen as their earliest source of information on hybrid seed, while an additional tenth named radio sales talks (See table 2). Only 14.6 per cent named neighbors as original informants and 10.7 per cent "farm journals." All other sources were of minor importance. Figure 2 illustrates the sharp fluctuations in the importance assigned these various media, depending upon the year in which the trait was first made known to the farmer. Thus, salesmen were of major significance before 1933. Nearly 70 per cent of the operators learning of hybrid in the

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[9]Iowa State College began publishing and distributing its reports on comparative corn yields in 1921.

[10]The study of diffusion sources is of course based upon highly subjective data, i.e., dependent upon the farmer's recall and evaluation. However, the most feasible way of approaching the problem is on the question-answer basis, and in the comparison of early and late acceptors at least there is no reason for the existence of great differences in sources on the strength of recall bias.

TABLE 2. PERCENTAGES OF ALL OPERATORS CITING SPECIFIC ORIGINAL SOURCES OF KNOWLEDGE OF HYBRID SEED AND MOST INFLUENTIAL SOURCES

Source	Per Cent	
	Original knowledge	Most Influential
Neighbors	14.6	45.5
Salesmen	49.0	32.0
Farm Journal	10.7	2.3
Radio advertising	10.3	. .
Extension Service*	2.8	2.4
Relatives	3.5	4.2
Personal experimentation	.	6.6
All others**	9.1	7.0
Total	100.0	100.0

* Including County Agent, bulletins, etc.
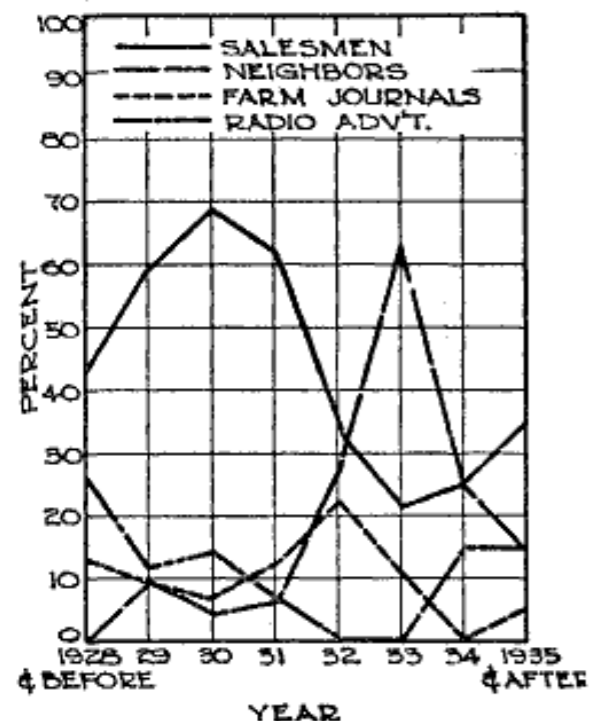** Including unknown.

Fig. 2. Percentages of Farm Operators First Hearing of Hybrid Seed Corn Through Various Channels, by Year First Heard.

year 1930 named salesmen as their initial source; three years later only 21 per cent learned of the trait through salesmen. On the other hand, as salesmen declined in importance "neighbors" notably increased. In 1931 only 6 per cent named neighbors, but in 1933 more than 60 per cent named them. In the final years during which the most isolated operators were being reached, these two sources were about equal. There are sharp fluctuations also for the minor sources of diffusion. Farm journals were of significance mainly in 1932 while radio advertising was of some importance for the very early and the very late operators.

It is evident that some of these observations have been based on very few cases, since about two-thirds of the operators heard of hybrid seed in 1929, 1930, and 1931. All of these were years in which salesmen were important. Hence, it was mainly a group of stragglers who were reached through other farmers. The speed with which knowledge of the new trait spread through the communities is probably in fact, as well as in farmer opinion, a tribute to the initiative of hybrid seed dealers. The unimportance of neighbors prior to 1932 is consistent with the earlier finding that only 5 per cent of the operators were using the seed prior to that date. Observation of neighboring fields would probably not have become important until after that time.

Most Influential Sources of Knowledge

When the farmers were asked to evaluate their various sources of information on hybrid as to relative influence in leading them to take up the practice, neighbors were cited more frequently than any other medium (by 45.5%). While salesmen were also accorded considerable importance as influences, as well as original informants, only 32.0 per cent felt that their judgment was influenced most significantly by such commercial representatives. Nearly 7 per cent believed that their personal experience was the only strong motivator.[11]

In analyzing the time pattern in

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[11] This was an evasion of the real issue since the desired information was as to influence leading to personal use of the seed.

the comparative influences of neighbors and salesmen, it is more reasonable to use a time scale by year of adoption of the trait, rather than by year of first information. Two-thirds of the early adoptors credited salesmen with influencing them most, while two-thirds of the latest adoptors credited their neighbors as being primary motivators (figure 3).
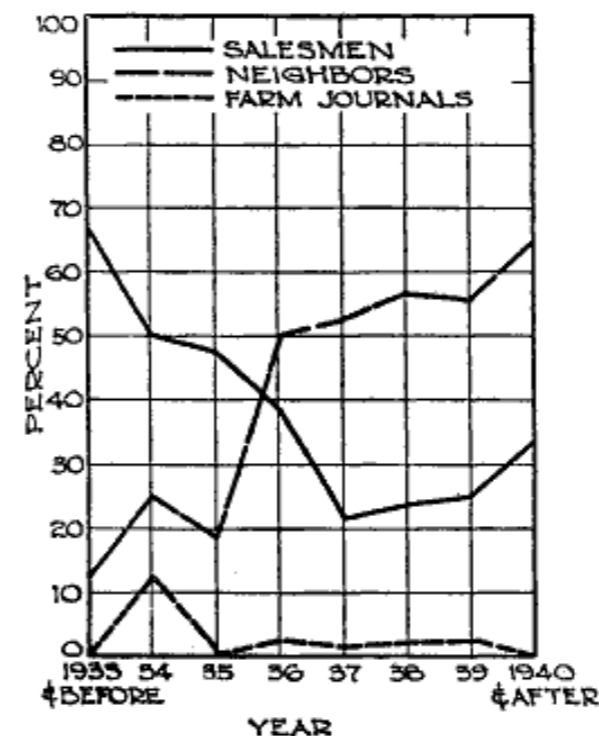

Fig. 3. Percentages of Farm Operators Accepting Hybrid Seed Corn In Different Years Assigning Major Influence to Various Sources.

With the passing years neighbors gained almost consistently in importance and salesmen lost. The bulk of the operators fall in the later years—hence, the much greater neighbor influence in the total sample.

Insofar as the farmers' evaluations are accurate, it may be suggested that the diffusion agencies are divisible into two moderately distinct types, namely, those important as introductory mechanisms and those important as activating agents. Thus salesmen were credited with informing the majority of the operators but neighbors were credited with convincing them. This is consistent with the earlier observation regarding the extreme caution with which individual farmers took up the new trait. Salesmen no doubt were in fact the major sources of introductory knowledge, but experience within the community counted for more in terms of action. This stands out also in the almost complete lack of influence assigned to other impersonal agencies. While this hypothesis demands further testing, the functional distinction between diffusion agencies is a problem warranting much greater attention both from scholars and from extension service administrators. The spread of knowledge and the spread of "conviction" are, analytically at least, distinct processes, and in this case have appeared to operate in part through different although complementary channels.

Diffusion and the Normal Frequency Curve

It has been evident that the acceptance sequence of hybrid seed in these communities has followed a bell shaped pattern. Certainly the cumulated frequency curve of acceptance would appear similar to the S curve familiar to students of growth phenomena.[12] Pemberton has attempted to give a precise mathematical statement of this, arguing that diffusion

may be expected to follow a normal frequency distribution unless upset by crisis conditions. It seems worth while to test the applicability of a normal frequency hypothesis to the present data.[13]

Figure 4 demonstrates wide differences between our data and their

from the normal frequency is statistically highly significant. (Chi square =21.67, d.f. 9.) Specifically, the observed frequencies differ from the normal curve fitted to them in the following ways:

1. The total time span was four years less than expected, although

Note: By the end of 1941 only 2 farmers remained who had not yet accepted.
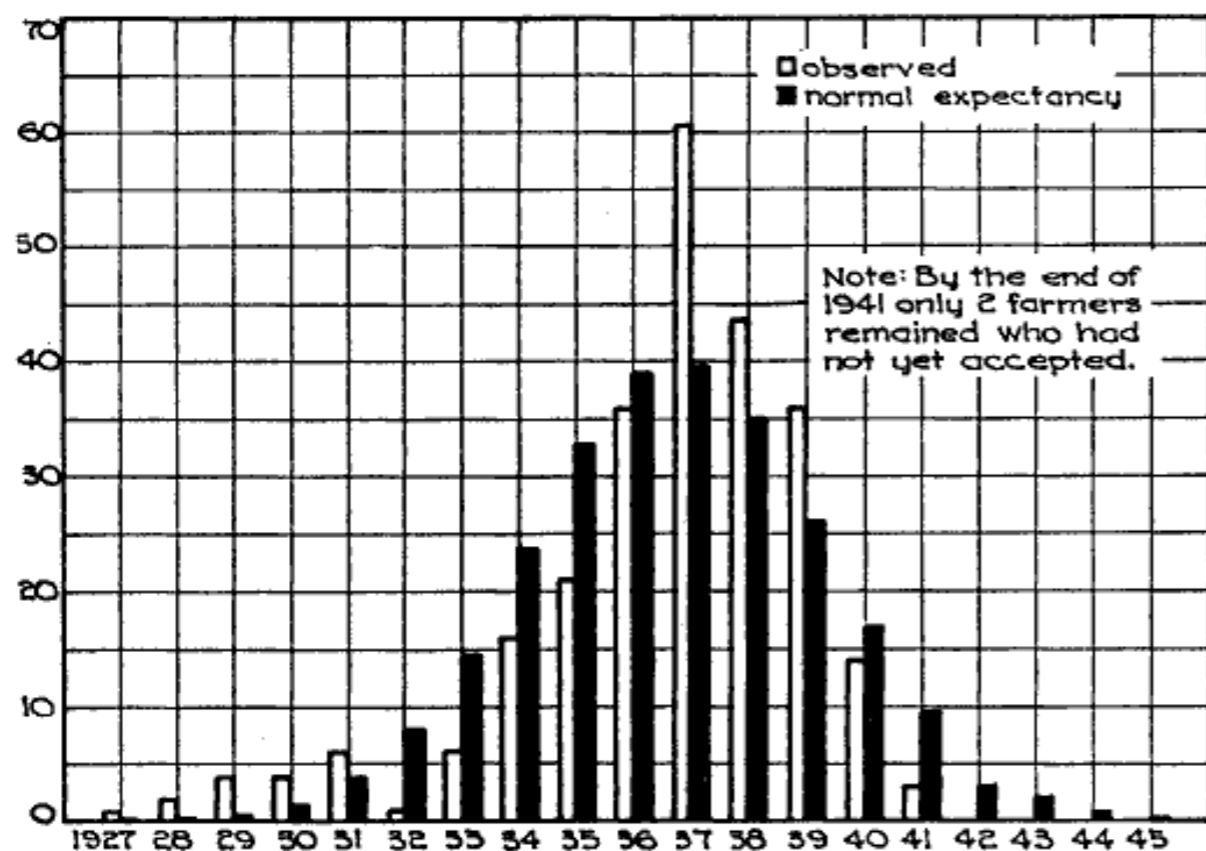
□ observed
■ normal expectancy

Fig. 4. Observed and Expected (normal) Distributions of Farm Operators According to Year Hybrid Seed Corn Was Accepted for Planting.

computed values in a normal frequency distribution. This deviation

only two operators remained without hybrid corn at the time of study.

2. The expected frequencies are

greater than the observed in the final years of acceptance and less in the very early years.

3. The observed cases are greatly concentrated at the mode and in the two years following it.

Obviously any reference to the observed distribution as a normal one would be quite misleading, and attributing deviations from normal to "crisis" is to explain away rather than to explain.[14] This failure to conform to a popular hypothesis leads to the consideration of the theoretic applicability of the normal curve to such diffusion data.

It is perhaps true that a normal frequency distribution would describe our sample in reference to some general measure of degree of resistance to change. Granting such an assumption, it would not necessarily postulate a normal frequency distribution in terms of actual trait adoption. There is no doubt but that the behavior of one individual in an interacting population affects the behavior of his fellows. Thus the demonstrated success of hybrid seed on a few farms offers a changed situation to those who have not been so experimental. The very fact of acceptance by one or more farmers offers new stimulus to the remaining ones.[15] The decision to adopt the new practice is a product not only of the operator's position in respect to some pre-existing conditions, but also of the in-

fluences and incentives brought to bear. The intensity of the latter is affected by knowledge of previous acceptances, especially when the various acceptors are competitors and the trait raises the general productivity level.

This situation is quite different from that presented by the measurement of heights in a population. Normal frequency does not appear to be a concept closely adapted to this condition where pressures, or reasons, for adoption become increasingly acute with passing time. If we would find mathematical expressions of diffusion, or diffusion rates, it seems reasonable that they be sought in formulae resting upon adequate p r o c e s s u a l assumptions. Consequently the acceptance pattern demonstrated by these data might with greater methodological exactitude be expressed as a logistic curve. However, it is difficult to see anything beyond an interesting analogy even if we should find a close fit to a logistic curve computed from the data. We see no reason for assuming that a formula developed mainly within the framework of population analysis should conform to diffusion data. The twisting of sociological phenomena into the analytical frameworks of other fields is not only sterile but may actually retard the development of useful sociological tools. If there is indeed an expected diffusion curve, its contours must be derived from comparative inductive researches.[16]

As yet there is no justification for identifying any mathematical formu-

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[13]The application of the S curve to diffusion was popularized by F. Stuart Chapin in *Cultural Change*, published in 1928. This obvious result of cumulating frequencies in a bell-shaped distribution has been refined by later students, notably Earl Pemberton whose hypotheses will be discussed in the light of our data. See Earl Pemberton, "The Curve of Culture Diffusion Rate," *Am. Soc. Rev.* (Aug. 1936), and "The Effect of a Social Crisis on the Curve of Diffusion," *ibid* (Feb. 1937).

[13]Pemberton, *op. cit.* (Aug. 1936), states that "the time of trait acceptance in any given case is determined by the chance combination of factors for and against adoption." This he believes is analogous to the distribution of heights in a population, *i.e.*, where the probability of predominance of plus or of minus determinants is less than the probability of mixed determinants.

[14]See Pemberton, *op. cit.* (Feb. 1937).

[15]Obviously there must be a decline in frequency of acceptance after the modal year, *simulating* a normal curve, since fewer operators remain who may yet accept the trait.

la with the diffusion process *per se* but this is a challenge rather than a confession of defeat. It may indeed be that for some classes of diffusion the normal frequency or logistic may be found to be more than interesting analogies, but at best this could be true only of limited types of diffusion, *i.e.*, where the methodical assumptions underlying those curves are identical with conditions of social interaction basic to the trait's spread. It is quite possible that dif-

ferent types of diffusion occur with different temporal patterns. The "tidal wave" process we have noted may indeed be typical of intra-community diffusion, or further research may show it to be a product of special circumstances, *i.e.*, commercial incentives, competition, etc. Surely there is neither empirical nor theoretical foundation for identifying the diffusion curves of fads and fashions with those of postage stamps, bath tubs, or hybrid seed corn. The formulation of ideal diffusion curves must wait upon analysis of vastly more material than has yet been done, but it seems doubtful if any theoretic pattern can adequately conform to situations involving all degrees of interaction and isolation; to economic practices as well as styles; to intra- as well as to inter-societal diffusion.

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[16] There is no implication here that fitting mathematical curves to sociological data is entirely useless. Mathematical curves may be extremely useful for comparative analysis at least. Raymond Jessen, of the Iowa State College Statistical Laboratory, suggests that the Orthogonal Polynomial may have possibilities in the comparative analysis of diffusion data. For a provocative utilization of logistic and Gompertz curves in diffusion research, see Alice Davis, "Technicways in American Civilization," *Social Forces* (March, 1940).