Loran-C receivers: Making the decision

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Loran, an acronym for *LOng RAnge Navigation*, is a radio-navigation system that uses shore-based transmitters and shipboard receivers. Loran-A was developed during World War II to meet wartime navigational needs. Its use for private marine navigation has become widespread since that time.

In 1974 the U.S. Department of Transportation announced that Loran-C, a modified system, will replace the old Loran-A as the government-sponsored radio-navigation system for U.S. coastal waters. This transition is to be completed over a 3-year period, ending in 1980.

Current and potential users of Loran must make decisions about using this new Loran system. For example, if you are a recreational or commercial boat operator, you must decide whether to dispose of your Loran-A set (which will eventually be valueless as a navigation aid) and replace it with Loran-C.

You must also decide on the best time to make this conversion. You must decide among a wide variety of available Loran-C receivers to purchase. You must decide on the method of installation, the method of financing the purchase, and on a number of lesser concerns related to the decision to buy.

This bulletin explains and illustrates how you can make that decision accurately and efficiently. The emphasis is on *how to make* the decision. The actual Loran decision will vary from user to user, depending on the perceived benefits, individual financial situations, and the costs involved.

The decisionmaking process

Decisionmaking is a logical process that we go through every day. Although we seldom think about each of the steps it involves, it is useful to do so occasionally. The decisionmaking process can be divided into these five steps:

1. Make your observations; gather ideas and information.
2. Analyze your information.
3. Make the decision.
4. Take the action your decision indicates.
5. Accept responsibility; evaluate the results.

Loran information (Step 1)

In gathering information for any decision, there are two things to keep in mind: You will never really have "enough" information; your information will probably never be as accurate as you would like it to be.

The cost of obtaining complete and accurate information often exceeds the benefits. This will be especially true

Can you use all the features built into the set? Could you use some that are not included? The right combination of features can add up to savings in search time, meaning more time available at sea for fishing. Photo courtesy of Northwest Instrument Co.

when making decisions about Loran. Information about the *cost* of Loran-C receivers is relatively easy to obtain and is reasonably accurate.

However, information about the *benefits* of using Loran-C receivers is much more difficult to obtain and will probably be much less accurate.

There are currently more than 5,000 Loran-C users and some 12 Loran-C manufacturers worldwide. These manufacturers will readily provide accurate information on acquisition, installation, and operating costs. To obtain equally complete and accurate information on the benefits of using Loran-C receivers might require personal interviews with a sample of manufacturers' representatives and dealers, interviews with experienced users, a study of existing research on the subject, and more. This is time-consuming and expensive, and there will be practical limits as to how much of this kind of investigation you can justify.

Your own experience and records often provide the best source of decisionmaking information. If you are currently a Loran-A user, you should be able to calculate how Loran-A has benefited you in the past. Other Loran-A users can also provide you with information about the benefits of Loran in general.

Remember that a decision about Loran has less impact on your business than a boat-buying decision; therefore, it probably deserves less of your time. Also, it is a decision for which the timing can be somewhat flexible. You can take some additional time to gather needed information, with little added cost. However, Loran may be an important navigational aid in your business and may represent a sizeable investment, so it deserves more than a "seat of the pants" decision.

Analyzing the information (Step 2)

You will need to analyze your decisionmaking so that you can make your decision accurately and efficiently. You also need to analyze this information for accuracy. The Loran-C decision lends itself to two methods of analysis, break-even analysis and partial budgeting.

Break-even analysis. We can illustrate this method by assuming that you are considering the purchase of a Loran-C receiver. Further, assume you have a choice among these three receivers:
1. "Econo Model"—a low-cost, manual, single-pulse receiver; suitable where signals are strong; 6-year estimated life.
2. "Everybody Model"—a medium-priced, automatic-tracking, flexible receiver; 10-year estimated life.
3. "Delux Model"—a fully automatic, full-feature, powerful receiver; 12-year estimated life.

First, make a careful comparison of these three receivers. When you have selected the receiver that is best for you, further analysis will indicate whether you should or should not buy it.

For a proper comparison, we have to calculate what it "costs" each receiver to produce *equal service*, or we have to calculate the difference in services for *equal cost*. Since it is more difficult to calculate Loran receiver services than Loran receiver costs, we will "standardize" the services available among the three different receivers and compare their costs.

One of the services that differ among the three Loran-C receiver models is useful life. We could standardize useful life for the three receivers by using 12 years of service for all three. This means we would buy 2 Econo Models, 1-2/10 Everybody Model, or 1 Delux Model to obtain 12 years of service.

However, the arithmetic will be simpler if we choose 6 years of service and use up the Econo Model, use 6/10 of the Everybody Model, and use 6/12 of the Delux Model in this time period.

There are other service differences among the three models that must be standardized. For example, one model might be faster or more accurate; another might have a greater range. We can standardize these differences by determining the additional boat and crew time required with the Econo Model and Everybody Model that will produce the same service obtained from the Delux Model.

Table 1 illustrates the proper calculations for comparing these differences among the three models.

This analysis indicates that the Delux Model Loran-C receiver will provide equal service for $176 less than the Everybody Model and for $995 less than the Econo Model. The cost difference between the Delux Model and the Everybody Model is less than 2% of the total 6-year cost.

If the information used in this analysis is accurate, the economically correct decision will be to choose the Delux Model over the other two models—*if you finally purchase and install a Loran-C receiver at all.*

However, if our information is suspect or is based on some guesses, the difference between the Everybody Model and the Delux Model is so small that no real choice is possible. The closeness of the results suggests that we should obtain additional information and conduct the analysis again.

Let's assume that *if* we buy a Loran-C receiver, it will be the Delux Model. We now need to make the "to buy or not to buy" decision. To do this, we use the partial budgeting procedure, our second method of analysis.

Partial budgeting. There are three important principles to keep in mind when using partial budgeting:
1. Include in the partial budget only those costs and benefits that will result from the decision (do not complicate the calculation with irrelevant information).

Table 1.—Break-even analysis of three hypothetical Loran-C receivers

Model	Life	Total purchase and installation cost	Interest on investment @ 12%	Maintenance and operation	Additional crew time required to produce the same services as the Delux Model	Additional boat time chargeable to differences between this model and the Delux Model	Summary
Econo	6 years	$1,000	During the first year of ownership, $1,000 is "tied up" in this receiver; therefore, it is not available for another investment that might yield a 12% return, for example. Therefore, we will give up as much as 12% of $1,000 in income for the first year by owning the receiver: $.12 \times \$1,000 = \$120$. The average investment during the second year is $1,000 less $167, the amount of depreciation.[a] The interest charge for the second year of the 6-year life is, therefore, $(\$1,000 - \$167) \times .12 = \$99.96$. The interest charge for the third year is $[\$1,000 - (2 \times \$167)] \times .12 = \$79.92$. If we do this for all 6 years, we will obtain the total interest income given up by investing in the Loran receiver. The arithmetic looks like this: Year 1: $\$1,000 \times .12$ = $120.00 Year 2: $(\$1,000 - \$167) \times .12$ = 99.96 Year 3: $[\$1,000 - (2 \times \$167)] \times .12$ = 79.92 Year 4: $[\$1,000 - (3 \times \$167)] \times .12$ = 59.88 Year 5: $[\$1,000 - (4 \times \$167)] \times .12$ = 39.84 Year 6: $[\$1,000 - (5 \times \$167)] \times .12$ = 19.80 Total $419.40	We can base these projections on personal experience with Loran-A receivers, others' experience with Loran-C receivers, and manufacturers' information. Assume the projected annual maintenance and operating costs are as follows: Year 1 $ 15 Year 2 15 Year 3 35 Year 4 100 Year 5 150 Year 6 180 $495	This would include the additional boat time (since the crew is on the boat) and the additional time required to tune, adjust, interpret, etc., the Econo Model relative to the Delux Model. For example, if the Econo Model takes 5 minutes to produce a reading that we could obtain instantaneously from the Delux Model, 5 minutes times the number of readings per year represents the additional crew time chargeable to differences in receiver performance. If an average of 150 readings are taken per year, the total time difference between the Econo and Delux Models is 150×5 minutes = 12.5 hours. If the Loran operator's time is worth $8.00 per hour, the additional crew cost to match the services of the Delux Model is: 12.5 hrs./year × $8.00/hour = $100/year $100/year × 6 years = $600	After working out the additional boat time required to obtain readings (12.5 hours/year, from the column at the left), there is also the extra time used because of less accurate readings. A commercial fisher may have to make two or three passes to find a particular piece of fixed gear or fishing area; a charter boat operator may have to make several attempts to find home port in the fog.[b] The boat's log may be a good source for this type of information. Assume that the Econo Model would result in 15 additional hours of boat time per year (12.5 from readings that take extra time—from the column at the left—and 2.5 from faulty readings). Furthermore, assume it costs $96 per hour to operate the boat, exclusive of crew costs. The cost chargeable to increased boat time from using the Econo Model versus the Delux Model would then be: 15 hrs./year × $96/hr. × 6 yrs. = $8,640	Investment consumed $ 1,000 Interest on investment 419 Maintenance 495 Additional crew time 600 Additional boat time 8,640 **6-year cost** **$11,154**
Everybody	10 years	$3,000	Year 1: $\$3,000 \times .12$ = $ 360 Year 2: $(\$3,000 - \$300) \times .12$ = 324 Year 3: $[\$3,000 - (2 \times \$300)] \times .12$ = 288 Year 4: $[\$3,000 - (3 \times \$300)] \times .12$ = 252 Year 5: $[\$3,000 - (4 \times \$300)] \times .12$ = 216 Year 6: $[\$3,000 - (5 \times \$300)] \times .12$ = 180 Total $1,620	Year 1 $ 15 Year 2 15 Year 3 45 Year 4 150 Year 5 210 Year 6 240 $675	10 hrs./year × $8/hour × 6 years = $480	10 hrs./year × $96/hr. × 6 yrs. = $5,760	Investment consumed (6/10 of $3,000) $ 1,800 Interest on investment 1,620 Maintenance 675 Additional crew time 480 Additional boat time 5,760 **6-year cost** **$10,335**
Delux	12 years	$8,000	Year 1: $\$8,000 \times .12$ = $ 960.00 Year 2: $(\$8,000 - \$667) \times .12$ = 879.96 Year 3: $[\$8,000 - (2 \times \$667)] \times .12$ = 799.92 Year 4: $[\$8,000 - (3 \times \$667)] \times .12$ = 719.88 Year 5: $[\$8,000 - (4 \times \$667)] \times .12$ = 639.84 Year 6: $[\$8,000 - (5 \times \$667)] \times .12$ = 559.80 Total $4,559.40	Year 1 $ 25 Year 2 25 Year 3 100 Year 4 300 Year 5 450 Year 6 700 $1,600	None	None	Investment consumed (6/12 of $8,000) $ 4,000 Interest on investment 4,559 Maintenance 1,600 Additional crew time 0 Additional boat time 0 **6-year cost** **$10,159**

[a] Depreciation is the original investment divided by the life: $1,000/6 yrs. = $167.

[b] The Econo Model may not be able to provide some of the services that we could obtain from the Everybody or Delux Models. For example, there may be large areas where the Econo Model will not receive any Loran-C signal. To the extent that this adds to boat and crew time or restricts the boat's operation, greater costs can be charged to the Econo Model compared with the Everybody or Delux Models.

The purchase price is not the whole story. A model that sells for more may still cost less over its total useful life. See table 1 for details on how to compare total costs for different receivers. Photo courtesy of Progress Electronics Co.

2. Consider the nonmonetary factors after the partial budget is completed (do not make the decision before completing the analysis).
3. Evaluate the accuracy of your partial budgeting information.

Our challenge: To buy or not to buy the Delux Model Loran-C receiver. First, list the information you *need*:

1. *Increased costs.* If you buy the Delux Model, what will be the increased annual costs chargeable to that Loran receiver?
2. *Decreased receipts.* If you buy the Delux Model, will receipts or income decrease? If so, how much decrease can be charged to the Loran-C receiver?
3. *Decreased costs.* If you buy the Delux Model, will any costs of your operation decrease? If so, how much can be credited to the Loran-C receiver?
4. *Increased receipts.* If you buy the Delux Model, will receipts or income increase? If so, how much can be credited to the Loran-C receiver?

Next, list the information that is *available* for the partial-budget analysis:

Purchase and installation cost, $8,000.

Life, 12 years.

Interest on investment, 12%.

Repairs and operation:

Year 1	$ 25	Year 7	$500
Year 2	25	Year 8	500
Year 3	100	Year 9	700
Year 4	300	Year 10	500
Year 5	450	Year 11	700
Year 6	700	Year 12	700

Savings in gear search time, 5 to 10% (you can obtain estimates from experienced operators, dealers, and manufacturers).
Current search time, 25 days (from boat's log).

Savings in running time, 3 to 5% (you can obtain estimates from experienced operators, dealers, and manufacturers).
Current running time, 14 days (from boat's log).

Average gross per day when on the grounds, $260 (from financial records).

Reduction in gear loss, 8% (you can obtain estimates from experienced operators).
Normal gear loss, $1,800/year (from ship's log and financial records).

Now, apply the available information to the categories of information you need; this is the *analysis* part of partial budgeting:

Increased costs
Depreciation
($8,000 investment/12-yr. life) $667
Interest (1st year)
12% × $8,000   960
Repairs and operation, sum of
12 yrs./12   433

Total increased costs $2,060

Decreased receipts   0
Total decreased receipts   0

Decreased costs
Reduced gear loss, 8% × $1,800 $144

Total decreased costs $144

Increased receipts (assuming saved gear search and running time is used on the grounds to increase production as follows)
(5 to 10%) × 25 days × $260 =
from $325 to $650
(3 to 5%) × 14 days × $260 =
from $109 to $182

Total increased receipts
from $434 to $832

To summarize:
To obtain the negative (detrimental) side, add increased costs to decreased receipts:

Increased costs $2,060
Decreased receipts   0

Negative side $2,060

To obtain the positive (beneficial) side, add decreased costs to increased receipts:

Decreased costs $144
Increased receipts   from $432 to $832

Positive side   from $576 to $976

From this we can see that the negative side outweighs the positive side by as little as $1,084 or as much as $1,484.

$576 − $2,060 = −$1,484
$976 − $2,060 = −$1,084

The partial-budget analysis indicates you would be worse off in the first year by $1,084 to $1,484 if you purchase and use the Delux Model Loran-C receiver. Should you buy it? This brings us to the third step in the decisionmaking process.

Making the decision (Step 3)
Making the decision is simple in one sense, difficult in another. It is simple in that you have only to do it. It is difficult because you must accept the risk and uncertainty that is inherent in any decision and be prepared for the consequences.

We have reduced some of the uncertainties of our Loran-C decision by going through the foregoing break-even and partial-budget exercises. However, some of the information we have used may not be accurate, and there are other considerations that cannot be readily included in the partial-budget analysis.

For example, where are the safety benefits of a Loran-C receiver? Will these benefits outweigh the cost disadvantage that our partial-budget analysis reveals?

You, the decisionmaker, must weigh these factors in your mind, accept the risk and uncertainty inherent in the decision, and *decide*. To put off the decision can be costly, unless you are confident that more and improved decisionmaking information is forthcoming.

Take action and accept responsibility (Steps 4 and 5)
A decision is not a decision until you implement it. If you decide against a Loran-C installation, you have implemented that decision when you no longer allocate your scarce management time thinking about Loran-C. If you decide in favor of Loran-C, you have implemented that decision when you have the receiver installed and functioning.

If the results of your decision are different than anticipated, it is important to know where you made errors in the decisionmaking process. Even though you may feel that other people provided you with false or misleading information, the decision responsibility is yours and yours alone. Figure out how you could have avoided the use of false or misleading information—and do not make the same mistake again!

For more information

Dugan, Robert F., and Daniel A. Panshin, *How to Get the Most out of Loran-C*, Oregon State University Extension Service, Sea Grant Marine Advisory Program Publication SG 54 (in press).

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