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# THE NINNEAPOLIS TORNADOES, MAY 6, 1965
# NOTES ON THE WARNING PROCESS

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The time period prior to the impact of disaster--the warning period--is of crucial importance to the understanding of both impact and post-impact behavior. During this warning period information concerning the nature of the disaster may be received by organizations and individuals and distributed by them to the public or to those particular organizations and individuals likely to be affected by the disaster. In addition to a definition of the threat, this warning information may also include suggestions of appropriate counter-measures which may be taken to reduce the disaster's toll in lives, injuries, and property damage. The importance of this preparation time is implicit in Barton's formulation of a "typology of collective stress situations": the duration of the warning period is one of three basic dimensions along which Barton classifies all disaster situations.[1] The amount of time available between the first indications of possible disaster and the actual impact will help to determine the extent to which organizations and individuals can prepare for disaster contingencies.

When disaster plans for such contingencies already exist, particularly when these plans include specific warning procedures, the duration of the warning period takes on added significance. If the plans for warning those in danger prove to be inefficient these plans will be useless when the warning time is limited--e.g., long lists of telephone calls to be made in a short period of time. On the other hand, if the warning procedures prove ineffective even an extended warning period will be useless--e.g., a city-wide air raid alert that is defined by the population as a test. Because the duration of the warning period is variable and because no long-range predictions can be made for many disasters (explosions, earthquakes, etc.) and only the most general

kind for others (tornadoes, for example, are most frequent in certain areas of the south-central United States during April, May, and June), plans for warning populations of the threat of disaster must be highly flexible. Warning procedures are of practical importance, then, in any plans for disaster operations; of particular concern are the efficiency of these procedures in distributing the warning message and their effectiveness in preparing the population for the impact of the disaster.

The following paper focuses on the warnings given in Minneapolis, St. Paul on the night of May 6, 1965, when a series of destructive tornadoes struck down in the northwestern suburbs of the Twin Cities. The data on which this paper is based were collected by DRC field teams in the course of three trips to the Minneapolis area. This data includes several dozen tape-recorded interviews together with additional written and recorded information from a score or more of Twin Cities organizations, and some 400 letters from residents of the area to the Minnesota State Civil Defense describing the manner in which they were alerted of the tornadoes and their responses to those alerts. Included in the organizational data are a set of logs, schedules and broadcast recordings from a dozen or so radio and TV stations in the Twin Cities metropolitan area.

A useful approach to the study of disaster warning is to see the key organizations involved--the Minneapolis Weather Bureau, Civil Defense, and radio stations for example--less as separate and discrete entities and more as inter-related parts of a <u>system,</u> and to see the matter of warning less as as an act accomplished and more as an on-going <u>process.</u> On this basis the terms <u>warning system</u> and <u>warning process</u> will be employed in the following

discussion. Before considering in some detail the specific organizations and procedures involved in the Minneapolis tornado warnings, a brief note on the stages of the warning process and a quick over-view of the events of May 6th will be presented.

The Warning Process

When conditions suggesting the possibility of disaster are discernible and thus provide for a warning period, as is generally true with tornadoes, floods seismic waves, and similar disasters, this warning period may be seen as falling into at least three stages. These stages are defined by the three major activities which make up the warning process.[2] These are (1) forecast, (2) alert, and (3) confirmation.* First, the forecast activities include the "detection and measurement" of environmental changes and the "collation and evaluation" of these measurements, especially as they indicate the possibility of impending disaster.[3] During this period the Weather Bureau, for example, may issue "forecasts" of severe weather: these indicate that conditions are right for the formation of thunderstorms, hail storms, high winds, and tornadoes over a particular area. The implication of these forecasts is that the public should keep its "weather eye" open for immediate signs of such disturbances.

The second stage in the warning process, the alert, is initiated by the decision to activate the warning system, e.g., air-raid sirens, fire alarms,

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*In order to avoid possible confusion, the term alert has been used to indicate the second stage in the warning process, although the term warning itself--especially as it is employed by the Weather Bureau--would more nearly suggest the kinds of activities associated with this stage, e.g., the activation of the warning system.

church bells, etc. This decision is normally contingent on direct sensual perception of danger, e.g., visual sighting of a tornado or fire, although mechanical sightings are also involved as in the Weather Bureau's use of radar. If the message of the forecast period is to the effect that "it" has a good chance of happening, that of the alert period is, emphatically, "this is it!"

The third stage would appear to be the most important, at least in terms of the success of the warning process if that success is measured by overt response. Whether those in danger of fire evacuate the building or those in the path of a tornado take refuge in their basements is greatly dependent on their belief in the validity of the warning. In turn, this belief is most often dependent on the results of their attempts to confirm the meaning of the alert. Immediate and automatic response to a danger signal is relatively rare, the best example being the response of school children to a fire alarm. In most other situations persons aware of a warning usually seek to validate their own initial interpretation of its meaning (which is usually that "it doesn't mean anything") by observing the reactions of those around them, by watching the sky, by telephoning significant persons, by listening to the radio, or by other similar attempts to further define the situation. The implementation of protective measures must await the outcome of these attempts at confirmation. To assume that the warning has been accomplished once the alarm has been sounded is, to the extent that confirmation is a typical process, a very dubious assumption indeed.

Subsequent portions of this paper will discuss in greater detail each of these three processes.

The Events of May 6, 1965

At 5:45 p.m. CST the Severe Local Storm Unit of the Weather Bureau in Kansas City (SELS) issued the following tornado forecast based on its collection and evaluation of meterological data:

> U. S. WEATHER BUREAU TORNADO FORECAST FOR A PORTION OF EXTREME NORTH CENTRAL IOWA MOST OF SOUTHWEST SOUTH CENTRAL AND PORTIONS OF EASTERN MINNESOTA AND A PORTION OF NORTHWEST AND WEST CENTRAL WISCONSIN. SCATTERED SEVERE THUNDERSTORMS WITH LARGE HAIL LOCALLY DAMAGING WINDS AND THE POSSIBILITY OF AN ISOLATED TORNADO ARE EXPECTED TO OCCUR THIS THURSDAY EVENING FROM 6 P.M. CST UNTIL 10 P.M. CST WITHIN AN AREA ALONG AND SIXTY MILES EITHER SIDE OF A LINE FROM THIRTY MILES NORTHWEST OF SPENCER, IOWA, TO 40 MILES EAST OF GRANTSBURG, WISCONSIN.
>
> IN MINNESOTA THIS INCLUDES AN AREA SOUTHEAST OF A LINE FROM HENDRICKS ON THE MINNESOTA-SOUTH DAKOTA BORDER NORTHEASTWARD TO 20 MILES SOUTHWEST OF DULUTH AND NORTH OF A LINE FROM AUTIN TO 20 MILES NORTHWEST OF WINONA. THIS INCLUDES THE TWIN CITIES AND VICINITY.[4]

The forecast was received by the Minneapolis Weather Bureau and forwarded by teletype to local press and radio and television stations at 5:30 p.m. CST. This action took place at the end of a pleasant afternoon during which weather conditions had betrayed no threat of storms: skies were fair with scattered clouds, winds were gentle and from the south, temperatures prevailed in the seventies. Fortunately, however, the forecast was issued in time to be included in most of the Twin Cities' 6:00 p.m. regular radio and television news programs. By 6:15 p.m. the radar scope at the Weather Bureau indicated very "suspicious" weather patterns. A telephone message from an FAA employee at Flying Cloud Airport at 6:20 indicating visual sighting of a funnel cloud, a report of a tornado touch down at Chanhassen, fifteen miles southwest of the Twin Cities, together with hook echoes picked

up by the radar led to a decision to activate the Civil Defense bell-light system and air raid siren "Take Cover" signal. This was done at 6:34 from the warning-system installation at the Weather Bureau. At the same time a precut tape was sent over the teletype loop to local press, radio and television in the form of a general tornado warning announcing the activation of the air raid sirens and promising additional information within five minutes.

Between 6:27 p. m., the time of the first tornado touch down at Chanhassen, and 8:40 p. m. when the final tornado dipped down in Golden Valley, six separate tornadoes battered the northwestern suburbs of the Twin Cities. From the time of the "red alert" and continuing on until midnight when the all-clear was issued at least half a dozen radio stations in Minneapolis, St. Paul went on "Tornado Watch". They broadcasted warnings from the Weather Bureau as well as relayed telephone messages from residents who had spotted funnels or suspicious clouds. In addition, the stations issued information on protective measures and gave descriptions of the damage suffered. The tornadoes left thirteen dead, some 500 injured, and property damage approaching fifty million dollars.

The Forecast

The Severe Local Storm Unit of the Weather Bureau (SELS) is charged with the responsibility of forecasting severe thunderstorm activity for all parts of the nation. Particular attention is paid to those meterological patterns which suggest the possibility of tornadoes. Thus each morning SELS issues an "outlook" which covers the subsequent twenty-four hour period. In addition SELS continues its watch of these conditions. When weather data and radar information suggest more definite evidence for the build-up of such storms, severe

weather forecasts are issued to local Weather Bureaus in areas likely to be affected by these storms. SELS attempts to allow approximately six hours of lead time for such forecasts. The average lead time is one and a half hours. The areas normally included in these forecasts vary in size from 20, 000 to 30, 000 square miles.[5]

The SELS tornado forecast of May 6, 1965, which included the area of the Twin Cities, was issued from Kansas City at 5:45 p. m. CST--a little less than forty-five minutes before the first of the tornadoes touched down in Chanhassen. Although this forecast was included in virtually all the local 6:00 p. m., newscasts, it is important to note that this was only a forecast, and not a warning. Given the somewhat vague nature of tornado warnings, at least from the point of view of the uninitiated layman--e. g., "...an area southeast of a line from Hendricks on the Minnesota-South Dakota border northeastward to 20 miles south west of Duluth..."--and given the apparent tendency of most persons to discount potential threats as not likely to affect them (e. g., Martha Wolfenstein hypothesizes that denial of remote threats is psychologically "normal")[6] --to conclude that the dissemination of this forecast probably made very little impact on the general population seems reasonable. Indeed, the experience of the Weather Bureau in the Palm Sunday Indiana tornados (April, 1965) would suggest the same conclusion:

> Very few of those interviewed in the tornado affected areas were aware of the difference between a tornado forecast and a tornado warning. Accordingly, there was no real feeling of urgency even among most of those who actually heard the warnings on radio and TV. The "warning" was generally interpreted as just an up-dated statement of the tornado forecast.[7]

In the context of the present report, however, this conclusion must re-

main conjectural, since no systematic data relating to public response to the forecast were obtained by the DRC.

Standard procedure in the Minneapolis Weather Bureau includes the relaying of weather bulletins to all local press, radio and television stations on the organization's teletype loop. But, if the mass media's broadcast of the 5:45 tornado forecast accomplished little in the way of sensitizing the public to possible danger, the forecast immediately suggested that possibility to the staff of the Weather Bureau. Danger cues contained in the SELS forecast which were not apparent to the "average" listener or were simply ignored were picked up by those professionally trained in the language of meterology. Thus radar indications of a possible storm which had been noted as early as 4:34 p. m., but which had not been associated with the possibility of tornadoes became, at the time of the SELS forecast, retrospective grounds for suspicion of severe weather.

By 6:15 p. m. additional and more contemporaneous information had been accumulated which suggested the strong possibility of tornado activity in the Twin Cities area. The Weather Bureau has a system of ground observers in the suburbs around Minneapolis-St. Paul but received no calls from them of visual sightings prior to the first touchdown.[8] The bureau did receive a call at 6:20 p. m. from Flying Cloud Airport, some four miles east of Chanhassen, reporting the sighting of several funnel clouds apparently touching ground. It was also advised shortly thereafter of a reported touchdown in Chanhassen at 6:27 p. m. This information verified hook echoes located in that vicinity by the bureau's radar scope. According to the Weather Bureau,

such visual verification is normally required before actual tornado warnings are released since radar echoes by themselves are subject to somewhat ambiguous interpretations: the same radar patterns may simply indicate rain clouds or they may signify tornado activity. Similarly, no certain means of determining whether the funnel is actually touching ground is available using only radar information. Thus the visual sighting is necessary to verify radar echoes (the process may also be reversed, i.e., radar echoes may be employed to verify visual sightings.) This later procedure was subsequently employed that evening. In like manner a tornado forecast from SELS will provide some evidence for one interpretation of radar data as against the other. One member of the Minneapolis Weather Bureau put it this way:

> But the thing is that...if you weren't in a severe weather area, warned from Kansas City, then, you know, you might not pay any particular attention to the radar echoes. If you are in such an area, you really sit up and take notice...As long as you have an area where you expect them, and one shows up, it's pretty hard to discount it.

While a SELS forecast may not, under "normal" conditions, have much effect on the public, it does have a very important effect on the staff of local Weather Bureaus. Such a forecast, together with additional data--radar echoes and reports of visual sightings--may serve as the precipitants of a tornado alert.

The Alert

The Twin Cities and the majority of their immediate suburbs are served by an air raid siren, bell-light warning system. This system can be activated by either the Weather Bureau or the Civil Defense from a telephone installation located in each of their headquarters. Once in motion, the system sets

off some 150 air raid sirens in Minneapolis and St. Paul and 270 bell-light signals located in schools and hospitals, municipal offices, police and fire stations, in a number of private industrial and office buildings, and in the homes of local officials. The established procedure for sounding a general tornado warning over the system involves two steps: first, the "take-cover" alarm is dialed from the Weather Bureau's installation, and second, a pre-cut tornado tape is sent by teletype to all the local press, radio and television stations. This tape indicates the reason for the sirens and the bell-lights and promises additional and more specific information within five minutes. In the interim the mass media supposedly broadcast the warning and, ideally, directions on appropriate countermeasures. The system had never been used in an actual emergency until the May 6th tornadoes. However, tests of the sirens were regularly conducted at 1:00 p. m. on the first Wednesday of every month. Bell-lights were tested once a week.

The Minneapolis Weather Bureau is also responsible for issuing severe weather alerts to some thirty Minnesota counties around the Twin Cities. The procedure normally followed in alerting these areas not served by the siren and bell-light system is to call the sky wave key station--the former CONELRAD radio station in the Civil Defense network--and provide that station with the relevant information for the area. Other smaller and less powerful stations in the immediate vicinity monitor that station's frequency and are alerted to the danger by the standard emergency action notification signal (EANS) followed by the information put out by the Minneapolis Weather Bureau. They in turn are broadcast the same EANS and the Weather Bureau's

information. Although the Minneapolis Weather Bureau serves this larger area, its staff does not make any major decisions concerning the actual sounding of alarms or dissemination of warning information for any jurisdiction outside the Twin Cities area--Minneapolis and St. Paul and their immediate suburbs. Some of the factors involved in the making of the May 6th decision for the Twin Cities will now be considered.

The weather station radar at Minneapolis first indicated the approach of rainstorms at 4:35 p. m. At that time one was located approximately fifty-five (nautical) miles from the city. By 5:00 p. m. this same disturbance had moved within forty-two miles of Minneapolis and was associated with other light showers farther out from the city. The intensities of all these were given as increasing. More than routine attention was not paid to these environmental changes, however, until the SELS severe weather forecast had been received at 5:45 p. m. During the next half an hour the meaning of these earlier developments became clearer. Observations that might have indicated only the approach of thunder and rain under "normal" conditions, in the context of the SELS forecast and in the light of additional observations distinctly suggested the probability of at least hail, winds, and heavy thunderstorms, and the possibility of tornadoes. Thus the following bulletin, based on continued observations, was released at 6:15 p. m.:

> AT 6:00 P.M. THIS EVENING WEATHER BUREAU RADAR AT TWIN CITIES AIRPORT SHOWS AN AREA OF HEAVY THUNDERSTORMS WITH HEAVY RAIN AND UP TO ONE HALF INCH HAIL FROM JUST WEST OF THE TWIN CITIES TO APPROXIMATELY 100 MILES WEST OF THE TWIN CITIES MOVING NORTHEASTWARD. ONLY LIGHT WINDS HAVE BEEN REPORTED IN THE THUNDERSTORMS WHICH PASSED THE METROPOLITAN AREA TO THE WEST IN THE PAST HOUR WITH ONE HALF INCH HAIL AT BUFFALO ABOUT 35 MILES NORTHWEST OF THE TWIN CITIES AND ONE QUARTER TO ONE

HALF INCH HAIL IN EXCELSIOR.

In ten minutes telephone messages from Flying Cloud Airport and Chanhassen reporting tornado touchdowns had provided verification of suspicions raised by hook echoes in the area. As already noted, radar observations and visual sightings complement each other, each making up for the deficiencies of the other: both radar echoes and direct sighting are liable to misinterpretations. The "take cover" signal would not be sounded unless both sources were present. Had unsolicited calls not been made to the Weather Bureau, members of the bureau staff probably would have telephoned one of the ground observers in the Chanhassen area to verify the radar echoes. This process is described in the following statement from a staff member:

> We have a network of ground observers out to the west, southwest, and northwest of here which is tight enough...[so that] if we locate where we think this suspicious-looking echo is on the radar scope, we can pin-point it by putting a map overlay in front of that scope and find out right away what community that suspicious echo is located in. Then go to our list of observers that are located in that community and select one who we would call... and ask what he can see--whether or not there was anything suspicious looking.

(Again, this process can also be reversed, i.e., telephone messages of visual sightings can be verified by checking the radar scope.)

The necessary conditions for a decision to sound the alarm were present. All that was required was the decision. The formal organization of the Weather Bureau staff provides that the watch supervisor (usually a public forecaster) has the final responsibility for making such a decision. However, DRC data suggest that these kinds of decisions are probably made less on the basis of formal authority and more as a result of informal consensus. Indeed the structure of the organization itself would seem to contribute much to the

emergence of this type of informal process. Little difference in training apparently exists between public forecasters and aviations forecasters--who, together with radar observers make up a normal watch. The distinction between the forecasters is largely in terms of the demands made by those the Weather Bureau serves, i. e., the needs of the general public as against those of air transportation. Thus, according to one member of the Minneapolis staff, whenever necessary the aviation forecaster can assume the tasks and authority of the public forecaster. As there are six public forecasters and the same number of aviation forecasters, a total of twelve men have the necessary training and the potential authority to issue such a warning.

The other distinction among the five or six men who are normally on duty at the Weather Bureau is between the forecasters and radar observers, a distinction which would appear more discrete than that between the two types of forecasters. Even here, however, the radar observer, because of the nature of his specialty, is likely to stand in an advisory position, interpreting his radar observations to the forecaster. In addition the physical layout of the bureau office reinforces this relationship between the radar observer and public forecaster. They are located within normal conversation range; there is no need for inter-office telephone or other mechanical communicating devices. The following statement by the public forecaster on duty the night of May 6th, while brief, suggests something of this type of informal decision-making:

> Well, one of the aviation men was standing behind me as I was looking at the radar and the radar observer saw the hook and we all decided practically simultaneously that... [sounding the alarm] was the only thing to do... there was no doubt about it.

Thus at 6:34 p.m. the take-cover alarm was dialed, activating the bell-light system and the air raid sirens. At the same time the following pre-cut tornado tape was sent out over the teletype loop, preceded by the emergency action notification signal of ten ringing bells:

FLASH

THIS OFFICE HAS JUST RECEIVED THE REPORT OF A TORNADO THREATENING TO MOVE INTO THE METROPOLITAN TWIN CITIES AREA. WE ARE ACTIVATING THE CD TAKE COVER WARNING SIREN. DETAILS AS TO THE LOCATION AND EXPECTED MOVEMENT OF THIS TORNADO WILL BE SENT OVER THE CIRCUIT WITHIN FIVE MINUTES.

The promised message was prepared and dispatched a minute later:

HOOK ECHO ON RADAR 10 MILES SOUTHEAST OF EXCELSIOR MINNESOTA MOVING NORTHEASTWARD AT 6:20 PM INDICATES POSSIBLE TORNADO.

CHANHASSEN JUST WEST OF MINNEAPOLIS REPORTS A TWISTER IN VICINITY MOVING TOWARD NORTHWEST SUBURBS OF MINNEAPOLIS. RESIDENTS OF AREA IN NORTHWEST SUBURBS TAKE COVER IMMEDIATELY FOR NEXT 15 MINUTES TO 1/2 HOUR OR UNTIL ALL CLEAR IS GIVEN.

PLEASE USE EMERGENCY ACTION NOTIFICATION SIGNAL. *

TORNADO REPORTED CROSSING HIGHWAY 7 AND HIGHWAY 101 IN THE PAST SEVERAL MINUTES HEADING NORTH NORTHEASTWARD.

Additional warnings based on radar observations, visual sightings, or both were issued by the Weather Bureau for the Twin Cities until 11:55 p.m. when the all clear was issued and for surrounding counties until 2:15 a.m. when the all-clear was released for those areas.

Although no systematic data are available, letters received by the State

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*This injunction is addressed to the radio stations receiving and broadcasting message.

Civil Defense in response to a public request for information on the efficiency of the sirens give the impression that most persons probably heard the sirens. There were, however, several reports of "dead spots", especially in suburban areas, where sirens were either inaudible or too distantly located. These same letters suggest that the sirens were probably effective insofar as they provoked many persons to turn to the mass media--especially radio--to determine the meaning of the sirens. (The importance of the Twin Cities' radio stations in providing confirmation will be discussed in the next section of this paper.)

One of the reasons for the effectiveness of the sirens is that they were sounded at an unusual hour. The long-standing policy of Civil Defense, from which there was apparently no deviation until May 6th, was to test the sirens at 1:00 p. m. on the first Wednesday of the month. Thus when the sirens sounded at 6:34 p. m. on the first Thursday of the month, relatively few persons apparently concluded that they indicated a test. Studies of surprise soundings of the air-raid sirens in Oakland, California, Washington, D. C., and Chicago provide more rigorous evidence for this conclusion than is possible to derive from any of the Minneapolis data. Interviews with random samples of the populations of Oakland and Chicago, and questionnaires sent to a random sample of government employees in Washington all contained inquiries about first interpretations of the sirens. The responses to these inquiries led Mack and Baker to the following hypothesis on consistency of tests and interpretation of surprise alarms:

> The more consistent the practice alerts--same day, same time--the greater the percentage interpreting the [surprise] alert as the real

> thing... Repeated use tends to dilute the meaning of a signal used in randomly timed practice alerts and weakens its symbolic value... In both Oakland and Washington [where practice alerts were random], over half the population defined the sirens as a test, practice drill, or mistake--an interpretation made by only four percent of the Chicago sample [whose practice alerts were consistent]. [9]

One would suspect that the situation in Minneapolis was most nearly comparable to that in Chicago.

None of the DRC data indicate that any major functions were served by the activation of the bell-light system. Interviews with members of the local police departments and other organizations produced frequent mention of the sirens and the radio as warning devices but very infrequent references to the bell-light system in other than explanatory terms. Had the emergency occurred at another time however, particularly at night, the importance of the bell-light system would very likely have increased.

Confirmation

The warning process is not complete when the alarm has been sounded. The necessary third stage in the process--confirmation, the attempt to determine the meaning of an alert signal--must follow the actual warning. The outcome of this third stage will largely determine the countermeasures those in danger will take--or fail to take. Only in those circumstances where the warning signal and the appropriate responses have become automatic can the sounding of the alarm be defined in any way as the terminating step in the process of warning a population of danger. Indeed, under most conditions, confirmation might well be seen, from both the practical and the theoretical points of view, as the most crucial of the three stages. It is probably the single most characteristic feature of the circumstances surrounding the

warning process. Chapman, for example, states that "the prevailing situation in the period of warning is that of human search for certainty in the absence of reliable information".[10] Williams nicely summarizes the pattern this search is likely to follow: "When people get a message saying 'this is it!' they seem to need a second message which says, 'yes, this really is it!'"[12]

Most persons would prefer to believe that they are safe rather than in danger and also that despite the sounding of an alert signal nothing bad will happen. With the exception of those individuals who are psychologically set to believe the worst in any situation and those who have recently suffered a "near miss" disaster, this generalization is probably valid for most persons in most warning situations.[12] Thus the initial interpretation of an alert signal is likely to be the most unalarming of those alternative interpretations available. An air raid siren indicates first another test, a drill, or a mistake--only when these definitions are proven untenable are other less acceptable interpretations considered. Any ambiguity or apparent contradictions in the warning messages and environment will typically be cited as evidence not for the worst but for the best. From this perspective a successful warning becomes, as Withey suggests, "a function of the amount of information to be contradicted...a confirmation of one alternative among several possible ones."[13]

The information which must be contradicted if the warning is to be successful derives from at least two sources: past experience and immediate perceptions. When air raid sirens in the past have always sounded for tests and drills, this experience itself provides reason to believe that a present alarm is also a test or a drill. In Minneapolis this was the case: the air raid

sirens had never been used to warn of an actual emergency. However, the past experience and the present were inconsistent in day and time. One alternative interpretation as a result had to be questioned if not rejected. Air raid sirens on the wrong day and at the wrong time for a test are less easily dismissed as another test.

Immediate perceptions are also likely to exercise influence on responses to a warning. The reactions of other persons in the area, discernible and potentially threatening changes in the physical environment, the statements and actions of "officials", the opinions of members of one's family, and other sources of immediate evidence tend to influence the interpretations individuals make of an unexpected warning. Warning signals provoke such behavior as looking out the window, watching the sky, turning on the radio or television, telephoning one's family, and the like. Confirmation is, then, the process of testing one or a series of possible interpretations against past experience and information directly available. Mack and Baker reach the following conclusion on the importance of the process of confirmation from their review of the Oakland, Washington, and Chicago studies:

> Probably the most conclusive general finding from the research experiences in the three cities is that hearing the warning siren alone is totally inadequate to stimulate people to immediate protective action. What people do, in fact, upon hearing the siren, is to seek additional information either to validate or to refute their own initial interpretation of the meaning of the signal.[14]

The importance of this process of confirmation in leading to the initiation of protective countermeasures is suggested by Blum and Klass in their report of the 1955 California floods:

> In each city where evacuation occurred in response to communicated instructions, residents had had opportunity to confirm or verify the

> danger. It is questionable whether or not efficient response to official orders would occur under conditions where individual verification of danger is not possible.[15]

If confirmation is as crucial as has been suggested, three requirements for the successful completion of the warning process are implied. These requirements would have particular relevance to those organizations charged with the responsibility of warning populations of imminent danger. The warning message--i. e., the information received by a population in the process of confirmation--should be immediate, consistent, and "official": immediate in that this information should be available as soon as the alert has been given; consistent in that it should be as free as possible from ambiguity and contradiction; and "official" in that its source should be identified with organizations and individuals widely defined as "authorities". In addition, the content of the warning message ought to include, as Williams and others have argued, both information concerning the nature of the threat and instructions of appropriate countermeasures.

In the Twin Cities, the organizations most involved in providing confirmation of the alert were the mass media, especially the electronic media, radio and television. Radio is probably more effective than any other media in disaster warning situations because it is somewhat more flexible, allowing for rapid and "on-the-spot" coverage of unanticipated events. The Minneapolis experience confirms this statement. Data from every radio station included in DRC material indicate that both 5:45 p. m. tornado forecast and the 6:34 p. m. warning were broadcast immediately. Information from six stations indicates that all regular programming was "killed" as early as 6:34 p. m. in favor of what became "tornado watch". Residents of the Twin

Cities who were tuned to their radios at the time of the siren alert or who tuned in following the alert were thus likely to hear almost immediate confirmation of the meaning of the sirens. Those who had heard the earlier forecast were perhaps able to make the connection between the sirens and the forecast. One radio station had retained its disaster equipment set up during the floods that had ended only ten days before. For that reason, it was prepared to make the change from normal to emergency broadcasting even more efficiently than would otherwise have been possible. Equipment allowing for the immediate transfer of incoming telephone calls to the air, maps of the Minneapolis area, and other disaster facilities--not the least of which were men who had had some experience in such broadcasting--were available for immediate use.

Roy A. Clifford reports a classic example of inconsistency in disaster warning, the kind of inconsistency which leads almost inevitably to the loss of any warning value in the message.

> In Piedras Negras [a Mexican town threatened by the rising Rio Grande] two loudspeaker cars "drafted" from a local theatre supplemented the four official units. It has been said that one of these cars cruised through the streets for a few minutes repeating, "An all time record flood is going to inundate the city. You must evacuate immediately. (Pause) The_____ theatre is presenting two exciting features tonight. Be sure to see these pictures at the _____ theatre tonight."[16]

Something of the effect that must have been the result of this message--confusion and disbelief--may also be unwittingly generated by any mixing of the normal and the emergency in the same message. Such confusion was probably avoided by those Minneapolis radio stations that broadcast only tornado information, but may not have been avoided by other radio and television stations. Television programming was reportedly not altered in any major way.

This may have been because of the sheer physical and organizational difficulties that would result in any shift from network to ad hoc local broadcasting. The economic losses from cancellation of regular programs may also have been a barrier to changing TV schedules. Bulletins from the Minneapolis Weather Bureau were issued as they were received, but their impact may well have been weakened by the station's quick return to normal programming. The stations that did switch totally to disaster operations may have impressed their listeners with the seriousness of the situation simply because they did make that change. Statements in a number of the letters to the Civil Defense clearly indicate that for some persons this unusual behavior on the part of the radio broadcasters confirmed in itself the unusual nature of the weather. (No general conclusions, however, can be drawn from these letters.) On the other hand, it is more than possible that some residents of the Twin Cities might have listened to other radio stations or viewed television throughout the danger period without ever realizing either the extent or the proximity of the danger.

Once the initial warning bulletin had been released by the Weather Bureau and broadcast, those radio stations operating full-time on the disaster relied rather heavily on unofficial information, especially on telephone messages from residents of the Twin Cities who had spotted tornado funnels. Additional information was issued by the Weather Bureau throughout the evening, but the original relationship between the bureau and the radio stations had been in effect reversed. As one member of a radio station staff put it:

> It was pretty much us, followed by some kind of an official back-up from the Weather Bureau. And what was really happening is that

they were listening to us. They'd hear a report from the public... and they'd look at the radar screen after hearing it on the air and say, "Yes, this is correct."

During this period the Weather Bureau itself was also receiving telephone messages and its staff were making calls to a number of their ground observers for reports on weather conditions. The bulk of the warning information, however, was being received and disseminated by the various radio stations. And the sources of this information were largely unofficial. Unavoidably, this raised several serious issues. The "tornado watch" was completely unrehearsed. DRC data includes no evidence that any of the radio stations had anything like a disaster plan. Limited previous experience was all that was available. On what basis, then, was the validity of the reports from local citizens to be judged? Were all reports equally important? Should they all be broadcast? Since there existed no policy on the matter, answers had to be adlibbed--just as the entire disaster presentations had to be "unpolished, fly-by-the-seat-of-your-pants, catch-as-catch-can." One radio station practiced an informal censorship of incoming calls and information, focusing on sightings and warnings of tornadoes. The following excerpt from their broadcast in which two telephone messages are employed to pinpoint the location and direction of one tornado, illustrates what were apparently typical sources of this warning information and the use to which this information could be put:

Radio: This gentlemen on the other [telephone] line, you say that you have sighted the tornado?

Man: Yes, about one and a half miles north of Wayzata on 101. We were down in our basement when the twister went over. Three windows were broken.

Radio: About a minute and a half ago?

Man: Yes.

Radio: We can add Hamel to our take cover area right now?

Man: Yes, you should.

* * * *

Radio: We have a report from a sheriff. Where are you, sir? You want to give us your [location] ?

Sheriff: 101. It just went through going north about two minutes ago.

Radio: Give us that location again.

Sheriff: County Road 6 and State Highway 101, about a mile north of Wayzata.

Radio: OK, and do you see any damage at all?

Sheriff: No sir, we do not. There was quite a bit of fire from power lines in the sky, however, we did not see it touch down. This was a funnel at approximately four to five hundred feet in the air, moving in a northerly direction. Very high wind.

Radio: That more or less puts it in a line towards Maple Grove and Anoka, is that right?... That's the same one that went past... the north end of Minnetonka there and also the gentleman who called in north of Wayzata. I'm looking at a map that puts it in the vicinity of--perhaps dead even with Hamel, but not as far west as Hamel.

Staff at this same radio station attempted to keep reports of individual property damage out of their broadcasts: "I kept them from the air because at this point, with the possibility of people being torn apart, I didn't care about porches that had been torn apart." What was important, then, was locating funnel clouds, plotting their likely directions, and, on the basis of this information, despite its unofficial sources, issuing immediate warnings to those communities which appeared to be threatened. Some criticism of the

"amateur standing" of the radio tornado spotters was reportedly voiced by local newspapers the following day. One response to this criticism was suggested by a radio staff member: the risk, he argued, lay not in reporting a non-existent tornado, but in missing a real one. To the extent that this is a valid argument, unofficial information is probably as good as any other kind.

Radio confirmation of the danger--as special bulletins or as complete emergency programming--continued until midnight when the all-clear was issued for the Twin Cities.

Concluding remarks

In the most general sense, William's statement that "the burden of proof seems to be on the warning system" is probably an appropriate a summation of the implications of this paper for organizations likely to be involved in the warning process.[17] Given the psychological and sociological environment of most warning situations, the major task of any warning system is to convince the population that there is imminent danger. This generalization applies to forecast activities as well as to the alert and to the confirmation process. The following summary statements all bear witness to the importance of William's conclusion.

1. As in any disaster warning, the timing of the Minneapolis tornadoes was an important, if uncontrollable, factor. The SELS forecast was received by the Minneapolis Weather Bureau at 5:45 p. m., in time to be included in the 6:00 p. m. news programs of the radio and television stations in the area. In this way the forecast was apparently widely disseminated. As a result, at least some residents of the Twin Cities were aware of the possibility of sever weather. The major problem at this stage of the warning process lies

in the language of Weather Bureau bulletins of this kind. While the language is immediately clear to the professional, there is reason to believe that for the greater part of the public such bulletins remain ambiguous at best, incomprehensible at worst. If the purpose of such forecasts is to sensitize the public to possible changes in weather conditions, the conclusion must necessarily be that they are not generally successful. However, the SELS forecast does serve a highly important function in providing the basis for the local Weather Bureau's interpretation of changing conditions. Sensitization does very clearly occur at this level. If laymen are to be convinced, changes in procedures and language at this stage are required.

2. A warning signal or an alert by itself is incomplete under most conditions. Simply activating the air raid siren system does not convey a total warning message nor constitute the final step in the warning process. (Thus alert, even with its popular connotations, seems a useful term to apply at this stage in the process.) Past experience--the timing of test alerts, for example--and immediate perceptions--the behavior and opinions of other persons, etc.--are two sources of information which will affect the initial interpretations persons make of alerts. And these effects are most likely to focus at the hopeful end of the continuum. Mack and Baker are most emphatic on the inadequacy of warning signals by themselves:

> A signal is not enough. It must have meaning in its cultural context. People must be taught its meaning so that they interpret the signal correctly and act upon it automatically. Society must be organized into groups and organizations which will help individuals interpret the signal and guide them to correct behavioral responses.[18]

Tests of warning signal thus ought to be as consistent as possible. Also implied in this statement is the necessity of employing different signals for

different dangers. When such a battery of signals is either unavailable or impractical and when automatic response is absent, sources which issue confirming information take on increased importance.

3. Ideally, confirmation should be available immediately following the sounding of the alert. It should, in addition, be both consistent and official. Because persons may turn to a wide range of sources for confirmation, it is unwise to rely on only one medium in issuing warning messages. As many channels of communication as possible ought to be employed. It would also be helpful, as Williams has suggested, to consider all messages issued through these channels during the warning period as constituting only one message.[19] Any combination of normal and emergency information will contribute to the discounting of the danger message. Thus the radio stations in Minneapolis that suspended their regularly scheduled programming in order to cover the tornadoes full-time provided immediately understandable confirmation of the danger. The most "official" warning organization in disasters like tornadoes is the Weather Bureau. In the context of "tornado watch" its bulletins probably added considerable evidence for the seriousness of the situation; simply interrupting normal radio or television programs, they may have had a somewhat lesser impact.

4. The Minneapolis experience suggests that it is possible to place perhaps too much confidence in the mechanical elements of a warning system. The Weather Bureau's radar scope (which was inoperative for a brief period during the tornado activity) and teletype loop, and the Civil Defense air raid siren and bell-light system, admittedly vital to the success of the Minneapolis

warnings, did not in themselves constitute the heart of the system. Rather more important was the human system--the staff of the Weather Bureau and the personnel of the Twin Cities radio stations. Existing plans for warning the population of danger had placed more emphasis, it would appear, on the physical than on the human system. That such a vital element in the warning process as confirmations should have to be almost completely ad hoc demonstrates the one-sidedness of this emphasis. A result of this experience is that one radio station has considered setting up on a permanent basis an emergency broadcast system, staffed by men with some experience in this kind of operation. And clearly the Weather Bureau's ground observer system requires reactivation if not reorganization if it is to serve its original purpose. That such a system could be most helpful was suggested by one member of a radio staff. Reflecting on the events of May 6th, he stated:

> The public with the capability of any old telephone now-a-days is the best source of information be it snow, hail, or whatever.

Nonetheless, because telephone connections can be broken during an emergency--or simply overcrowded--other means of communication ought also to be available.

Warnings convince those in danger, and thus are successful, because communication takes place among organizations, groups, and individuals. No mechanical system--no matter how sophisticated--appears at the present time capable of replacing the human in this process.

## FOOTNOTES

1. Barton, Allen H., Social Organization Under Stress: A Sociological Review of Disaster Studies (Disaster Research Group, Study No. 17; Washington D. C.: National Academy of Sciences-National Research Council, Publication No. 1032, 1963), pp. 3-8.

2. See Richard H. Blum and Bertrand Klass, A Study of Public Response to Disaster Warnings (Menlo Park, California: Stanford Research Institute, 1956); Dwight W. Chapman, "A Brief Introduction to Contemporary Disaster Research" in George W. Baker and Dwight W. Chapman (eds.), Man And Society in Disaster (New York: Basic Books, Inc., 1962); James G. Miller, "A Theoretical Approach to Reactions to Stress" in George H. Grosser, et. al. (eds.), The Threat of Impending Disaster: Contributions to the Psychology of Stress (Cambridge Massachusetts: The M. I. T. Press, c. 1964); Raymond W. Mack and George W. Baker, The Occasion Instant: The Structure of Social Responses to Unanticipated Air Raid Warnings (Disaster Research Group, Study No. 15; Washington, D. C.: National Academy of Sciences-National Research Council, Publication No, 945, 1961); Harry B. Williams, "Human Factors in Warning-Response Systems" in Grosser, op. cit.

3. Williams, loc. cit.

4. Minneapolis Weather Bureau, "A Report on the Minesota Tornadoes. May 6, 1965" (Typewritten report, June 18, 1965), pp. 1-2.

5. Weather Bureau Survey Team, Report of Palm Sunday Tornadoes of 1965: April 11, 1965 (Washington, D. C.: U. S. Department of Commerce, Weather Bureau, 1965), p. 1, Annex 1.

6. Wolfenstein, Martha., Disaster: A Psychological Essay (Glencoe, Illinois: The Free Press and the Falcon's Wing Press, c. 1957), pp. 28-29.

7. Weather Bureau Survey Team, op. cit., p. 6

8. Cf. ibid. One of the survey team's recommendations following their study of the northern Indiana tornadoes was in fact to strengthen the spotter system in that area by hiring an additional staff member whose principal assignment would be to insure periodically that all members of the system were willing to continue their work. This ought to be accomplished by a personal visit to these individuals at least once a year, according to the team's recommendations. (p. 7)

9. Mack and Baker, op cit., pp. 36-38. The three original studies include: William A. Scott, Public Reaction to a Surprise Civil Defense Alert (Ann Arbor: Survey Research Center, 1955); George W. Baker

Operation 4:30: A Survey of the Responses to the Washington, D. C., False Air Raid Warning (Washington: Office of Civil and Defense Mobilization, 1959, Working Paper); and E. Katz, Joy in Mudville: Public Reaction to the Surprise Sounding of Chicago's Air Raid Sirens (Chicago: National Opinion Research Center, 1960, Working Paper).

10. Chapman, op. cit., p. 10.

11. Williams, op. cit., p. 100.

12. Cf. the evidence cited and the hypotheses presented in Irving L. Janis, "The Psychological Effects of Warnings" in Chapman and Baker, op. cit.; Stephen B. Withey, "Reaction to Uncertain Threat", ibid.; and Wolfenstein, op. cit.

13. Withey, op. cit., p. 115.

14. Mack and Baker, op. cit., p. 39.

15. Blum and Klass, op. cit., p. 5.

16. Clifford, Roy A., Informal Group Actions in the Rio Grande Disaster (Washington, D. C.: National Research Council, February, 1955), p. 27.

17. Williams, op. cit., p. 94.

18. Mack and Baker, op. cit., p. 1.

19. Williams, op. cit., p. 92.