RADAR AND COLLISION

Handbook for Mariners

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Quote: ***Sources of a collision disaster***

A vessel is following, in fog, one of the main shipping routes, on which 99 percent of the encounters between ships,and 99 per cent of the accidents, occur.

From time to time and echo is seen on the radar screen, on a bearing close to the heading. It's apparent that this represents a vessel on a reciprocal course: it will be an end-on meeting, and our vessel, without bothering to see whether there is any change in bearing, alters course away from the initial bearing. One vessel alters to port "in order to keep clear" while in the majority of cases is on the reciprocal and the other vessel argues the same, and turns to port, and an accident is avoided. Variations prevail, so if one ship misreads the Direct of Relative Motion (DRM) and turns starboard, it not only increase the collision risk but provides a wider target.

IMO automatic radar plotting ARPA accuracy specs are all based on at least being equal to the best SINGLE target WW II manual plotting techniques. Thus allowable computational errors are totally inadequate for the most needed "determining a side of passing." ALMOST ALL end-on and near end-on encounters NEEDs DRM = 1deg.

DigiPLOT's, 3 year/$3M at sea development, based on its embedded UNIVAC derived (MAC 16 minicomputer that completes math operations in two microsec cycles) creating the only Real Time Collision Avoidance System that analyzes every echo, selects the closest/closing 200 targets then solves the complete true/relative vector triangle maneuvering board solution every 2 second radar scan for up to 40 targets--- Situational Awareness!

DigiPLOT, the ONLY precision Automatic Radar Analyzer, with its DRM < 1 degree that is 10 times more accurate in one minute, after own ship and/or a target ship turns, compared to USCG Final ARPA scenario calculation specs. This data was Third Party IMO Type Approved and is the ONLY UNATTENDED ARPA to always confirm "Side of Passing on any of the 40 closest echoes, by also indicating their true course < 2 degrees for "ASPECT on 40 target Situation Awareness" comparable to close range visible contacts while time is still available!

Ship Collisions can ONLY be prevented by knowing WHAT the HELL IS GOING ON around you!

Capt Ouedet compares visual versus radar encounter in time consumed stating "...in clear weather 5 min are needed to recognize a risk of collision and the necessary evasive action to be carried out, whereas using radar at least 20 min are

A major reason for the Andrea Doria/Stockholm 40 knot closing speed from 5 nm detection was the Captain's decision to make up time by going against the normal traffic (in then unmarked lanes) that increased the odds (4 to 1), because 80% vs. 20% statistics, of essentially like getting off of a major highway by going down the on ramp.

Not only traffic, ships speed and lack of maneuverability have increased exponentionaly since WW-II, and real time computing radar plotters that provided ALL echo situational awareness at a glance stopped production.

A 1984 USCG IMO Final ARPA Reg was created UNATTENDED as a "FAKE Collision Avoidance System" with "sounds alike performance" since its stated purpose is that ARPAs SHOULD "improve the "STANDARD of collision avoidance at sea by (watering down US government mandate for an unattended 1978 Law mandate and UNATTENDED "HANDS OFF" at a slight slight ly reduced cost):

2. **Reducing work load of observers by enabling them to automatically obtain information so that they can perform AS WELL with multiple targets as they can by MANUALLY plotting a SINGLE target (as in WW II when traffic lanes were less busy that now in S. China sea; and**

3. **Provide continuous, accurate and rapid situation evaluation.**

   Appendix B US Marad, WAS in effect from 1971 to 82 (until the US

   government and shipowners lobbiest

convinced the Coast Guard and they in turn the NAVY and NTDS/CIC radar lobby to reduce cost of any anti-collision system and the government accepted collision risk for oil damage to US coast and any associated casualties so that essentially they allowed WWII manual grease pencil ARPAs)

The DigiPLOT system provides unattended monitoring of ALL echoes for AT A GLANCE Situation Awareness with automatic audio and visual alarm signals to alert the watch officer of ANY echo as a possible threat, DigiPLOT on a "One man bridge" was allowed on coastal operation of a few dozen tug barges in US waters by the 1972 to 82 active state Laws of AL, CA and WA for oil. One man vessel (not Navy talk of automated ships) proved the "Zumwalt increased anti-collision safety @ reduced manning."

DigiPLOT IMO/ARPA Min Std-Insignificant deviations-Rel ORM) & True Course, Very Accurate, Near Real time

Table Tarqet and OWN Shios turninq TRACKING ERRORS·Processisnq intentiallv slowed to seoarate O to <2 kts soeed verv slow movinq or fixed echoes

1 Minute After Taraet Turn Comoletion

Data Scenario	Relative DiaiPLOT	Course deg IMO	Relative DiaiPLOT	Speed kts IMO	CPA DiaiPLOT	nm IMO	
1	0.1	11	0.9	2.8	0.4	1.6	
2	0.2	7	0.2	0.6			
3	0.9	14	3.0	2.2	0.1	1.6	
4	1.6	15	0.9	1.5	0.1	2.0	
Av Scenario	0.7	12	1.2	1.8	0.2	1.7	
Av Ratio	16.8		1.4		8.7		16.8

3 Minutes After Taraet Turn Camoletion

Data Scenario	Relative DiaiPLOT	Course deg IMO	Relative DiaiPLOT	Speed kts IMO	CPA DiaiPLOT	nm IMO	TCPA DiaiPLOT	MIN IMO	TRUE DiaiPLOT	COURSE deg IMO	TRUE DiaiPLOT	SPEED kts IMO	
1	1.4	3.0	0.8	0.8	0.1	0.5	0.2	1.0	1.6	7.4	1.2	1.2	
2	0.1	2.3	0.0	0.3					0.4	2.8	0.5	0.8	
3	0.6	4.4	0.9	0.9	0.1	0.7	0.0	1.0	1.4	3.3	1.3	1.0	
4	1.4	4.6	1.3	0.8	0.1	0.7	0.0	1.0	4.5	2.6	0.1	1.2	
Av Scenario	0.9	3.6	0.8	0.7	0.1	0.6	0.1	1.0	2.0	4.0	0.8	1.1	
Av Ratio	4.1		0.9		6.3		15.0		2.0		1.4		5.4

Table 3 TRACKING ERRORS AFTER OWN SHIP MANEUVERS (90 DEG AT 5 DEG/SEC AT 6 MINUTES)

1 Minute After OWN SHIP Turn Camnletion

Data Scenario	Relative DiqiPLOT	Course deg IMO	Relative DiaiPLOT	Speed kts IMO	CPA DiaiPLOT	nm IMO	
1	1.1	11	0.2	2.8	0.1	1.6	
2	2.0	7	1.1	0.6			
3	0.5	14	0.6	2.2	0.1	1.8	
4	1.1	15	0.7	1.5	0.1	2.0	
Av Scenario	1.2	12	0.7	1.8	0.1	1.8	
Av Ratio	10.0		2.7		18.0		10.0

3 Minutes After OWN SHIP Turn Camnletion

Data Scenario	Relative DiqiPLOT	Course deg IMO	Relative DiqiPLOT	Speed kts IMO	CPA DiqiPLOT	nm IMO	TCPA DiqiPLOT	MIN IMO	TRUE DiaiPLOT	COURSE deg IMO	TRUE DiaiPLOT	SPEED kts IMO	
1	0.5	3.0	9.0	0.8	0.1	0.5	0.1	1.0	3.5	7.4	1.2	1.2	
2	1.8	2.3	0.0	0.3					0.4	2.8	0.2	0.8	
3	1.1	4.4	0.7	0.9	0.1	0.7	0.1	1.0	1.0	2.6	0.2	1.0	
4	0.2	4.6	0.3	0.8	0.1	0.7	0.1	1.0	2.1	2.6	0.5	1.2	
Av Scenario	0.9	3.6	2.5	0.7	0.1	0.6	0.1	1.0	1.8	3.9	0.5	1.1	
Av Ratio	4.0		0.3		6.3		10.0		2.2		2.0		6.0

Average Maneuvering Accuracy Advantage-IMO ARPA Spec/DigiPLOT RATIO at 1 vs. spec of 3 minutes-IS FULL 2 Minutes 9.5

PREFACE

[illegible]

Such a conclusion would be quite mistaken. An encounter between two vessels contains certain elements that are patient of geometrical solution, but there are others-experience of watch-keeping officers, handling qualities of ships, thickness of fog-which have little relation to the exact sciences.

Nor has the intention been to arrive at an abstract code for the use of radar. It is a pleasure, in stating the principles on which I have worked, to acknowledge my debt to the writings of Captain F. Wylie, R.N., in particular, *The Use of Radar at Sea*, where, in spite of the modest cloak of anonymity, the forceful reasoning proclaims his hand as evidently as if the book bore his signature. It would be impossible to recall in detail all my debt to Captain Wylie, but attention must be drawn to two main principles of guidance:

[illegible]

1. If radar is to be used profitably, it must be used intelligently.
2. The possession of radar entails its own proper responsibilities.

[illegible]

The Initial Dissappointment

Radar has been used for navigation for more than ten years. during that time the majority of ships have been equipped with it: 1111d yet it has foiled to fulfil the hopes it inspired. Radar can be of gre:tt service in determining position in fog, but so far has it fallen short of providing the mariner with a certain method of avoiding collisions that it has even been accused of causing them. The consequent uneasiness, common to most seamen, is aggravated by the fact that collision is now the gravest and most frequent of navigational hazards. This is entirely a matter of speed, and has no intrinsic connection with radar. In the days of sail, collisions at sea were as rare as collisions on land between horse-drawn vehicles; they are now, with power-driven vessels, as common as automobile collisions.

The lesson of the tremendous efforts that have been necessary to check at last the increase of accidents on the road is that we cannot expect to find some magical formula which will immediately eliminate all collisions at sea, whether in fog or in clear weather; and yet when radar first appeared there were high hopes that collisions in fog would soon be a thing of the past.

It was an illusion, fostered at first by the small number of vessels which were so equipped. The fortunate few were able to detect ships which were without radar and concluded that they were emancipated from all the customary rules. They pressed on through fog without even announcing their presence by any sound signal: a precaution, they maintained, against causing unnecessary alarm to the other ship. At this stage, they hacl no difficulty in avoiding a collision; but it was not long before the number of sets in use had AO increased that encounters between radar-fitted ships became frequent.

Norwegi:-in underwriter, came to the conclwiion thnt collisiooR occurred most frequently between vcHsels initially on reciprocal courses. Doth before and after that date there was no lack of evidence, from collisions between ordinary merchant ships, to support his view; but in 1956 the collision between the ***Andrea Dor£a*** and the ***Stockholm*** shocked the world by proving that the best-equipped ships were not immune from the common danger.

Everyone asked how it was that such simple encounters could have such disastrous results, and there was unlimited speculation about some hidden fault, inherent in radar, or some grave negli-

A vessel is following, in fog, one of the main shipping routes, on of the accidents, occur. From time to time an echo is seen on the radar screen, on a bearing close to the heading. It is apparent that this represents a vessel on a reciprocal course; it will he an end-on meeting, and our vessel, without bothering to see whether there is any change of bearing, alters course away from the initial bearing.

Fig. 1 illustrates what happens: vessel A, on the course *A* I, believes **B** to be on the course ***Bz*** ; **A** alters to port, until she is on · the course ***A3,*** 'in order to keep clear'. In the majority of cases, **B** is in fact on course ***Bz,*** the reciprocal of A's; **B** argues exactly as A argued, turns to port on to ***B4,*** and an accident is avoided.

Quite inconsiderable variations, however, from the circumstances that generally prevail may set the scene for a catastrophic ending. It can happen that B is on the course ***B1*** ; he argues as A does, concludes that A is on *Az,* and alters to starboard, 'in order to keep clear'. Not only is there now a risk of collision but, since ***A3*** and ***B3*** are at a broader angle to one another than ***A1*** and ***B1,*** each vessel now presents the other with a larger target.

Even when A and B are not simply acting on preconceived ideas, a similar result can follow. They detect one another at a range of some ten miles, sometimes more, on a bearing close to their own headings. They keep each other under observation for some min utes and determine that the bearing remlainss steady, or shows little variation. There is still no anxiety though not until there is no time

rnnge of some 1lix or eight rnile!'l :md think that. tlu:y h:ive the Ril1la-tion well i1l hand. Uncom1cioul-1ly, both arc tr<\llting- the prohll•rn 1l, though it were an ordinary vi1mal cncmmccr, 1111d concludo lhnt 11 few Jegrces alteration of counic will remove uny po1-1sihilily of danger. Even so, they disregard the rule11 for clear weather, under which both vessels should take concerted action; each niters to port

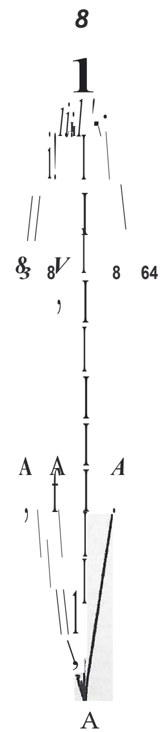

Fig. 1

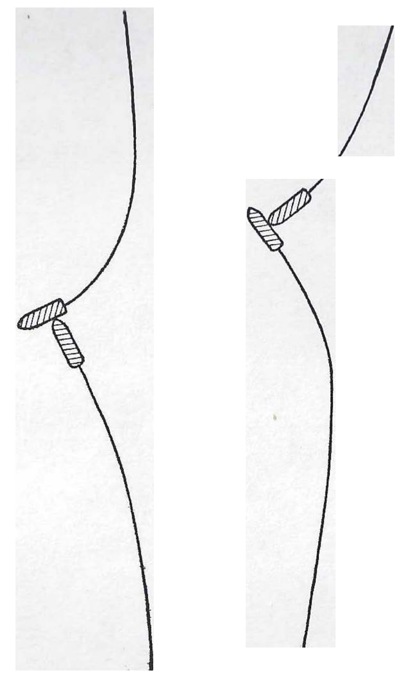

Fig. 2

or starboard, whichever happens to seem best at the moment, in the belief that the other vessel will understand what he is doing, and yet at the same time they both fail to help the other to understand by carrying out a positive and decided maneuvre. The final result is that there is an even chance that each ship's turn increases the chance of collision. and the IMO ARPA specificarion of DRM ot 12 degrees accuracy in 3 minutes is too late and not adequate accuracy to determine the size of passing compare with DigiPLOT's less than 1 degree DRM in only 1 minute not 3 minutes allowing 2 more minutes for optimizing the turn and for large ships with mild rudder's turn circles and advance and transfer to be accounted for in the plan which can easily be viewed with the Trial Maneuverto prove before executing.