PROGNOSTIC CRITERION OF EFFECTIVENESS OF CREWMEMBER INTERACTION

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ABSTRACT

The results of experiments that have been conducted by the authors since 2004 together with professional pilots and students of the University of Civil Aviation are analyzed. The aim of the research is to study the possibilities of the socionic model of intertype relationships for assessing the interaction in a two-member aircraft crew using the complex socionic efficiency criterion and data of indirect sociometry. The statistical criterial dependencies are given. The article continues the previously started topic (see *World of Transport and Transportation*, 2014, Iss. 5; 2016, Iss. 1; 2017, Iss. 3).

Keywords: civil aviation, aircraft crew, interaction of pilots, intertype relationships, sociometry, crew resource management.

Background. *The majority of all recent air crashes have, as the main or concomitant cause, a violation of interaction in the crew. Reference example is the crash of An-148-100B aircraft of Saratov Airlines, which was operating flight 6W703 from Moscow to Orsk on February 11, 2018. According to the investigation, soon after takeoff, the attention of the pilots was attracted to the different and at the same time critically low speed readings on the instruments; the commander of the aircraft tried to change the situation by make the aircraft while the co-pilot pointed to the inadmissibility of such actions. There was a clear psycho-emotional tension, a curse was heard on the voice recordings. As a result, attempts to fix something were unsuccessful until the collision with the ground.*

Typical examples of such interaction violations were also the crashes of the planes Tu-134 (Ivanovo, 27.08.1992) [1], Tu-154 (Irkutsk, 04.07.2001) [2], Tu-154 (Sukhaya Balka, 22. 08.2006) [3], Boeing 737 (Perm, 13. 09.2008) [4], Tu-154 (Domodedovo, 04.12.2010) [5], Tu-134 (Petrozavodsk, 20.06.2011) [6], Yak-42 (Yaroslavl, 07.09.2011) [7, pp. 195–196, 221].

Objective. *The objective of the authors is to consider prognostic criterion of effectiveness of interaction in the crew.*

Methods. *The authors use general scientific methods, graph construction, evaluation approach, statistical method.*

Results. *The authors in [8, 9] considered some possible ways to reduce the negative impact of the human factor on flight safety, including increasing the efficiency of interaction in the aircraft crew. This article, like a number of others [10–18], examines the issue of assessing the effectiveness of interaction in the aircraft crew based on the socionic approach, that is, using the theory of intertype relationships (IR). At the same time, since we are talking about socionics, naturally, only the informational aspect of interaction between people is taken into account.*

However, the results of studies published in [12–18] are somewhat controversial. So, for example, when using IR proposed by V. V. Gulenko [19], in works [15–18] only the negative effect of the mismatch of the rational and irrational principles among the subjects, i.e. «rationality–irrationality» (R/I) dichotomy was unambiguously revealed. However, as was subsequently shown [12–14], the situation was much more complicated.

From the modern views on the theory of IR, some ideas by G. A. Shulman [20, p. 35–49] seem to be the most productive, he first expressed the extremely logical, in our opinion, idea that there are not sixteen, but much more IR. Shulman himself numbered 256 IR and, in our opinion, groundlessly attributed the authorship of this idea to A. Augustinavichiute [20, p. 37]. However, considering that, based on the usual common sense a relationship of for example, an ethical-sensory extrovert with an intuitive-logical introvert is absolutely the same thing as relationship of an intuitive-logical introvert with an ethical-sensory extravert, there will be still 136 IR.

In [13], for each of 1946 pairs of participants of numerous experiments conducted by the authors according to the method of [21], a socionic model of intertype relationships (SMIR) was calculated using Gulenko–Shulman IR (in [21, p. 221] it was called SMIR (GSh)). Depending on the sign and magnitude of correlation coefficients obtained in these experiments between the corresponding component of SMIR (GSh) and the total normativity in the pair, calculated according to the method of A. M. Etkind [22], a rank from 1 to 136 was assigned for each case of IR. Sixteen identical IR were counted once, and the ranks of all other IR were doubled.

The assumption was studied about the fact that it is necessary to take into account not only the coincidence or discrepancy for one or another (psychological dichotomy), but also which psychological functions or attitudes coincided. In this case, we have not $16 = 2 \times 2 \times 2 \times 2$ IR, but $3 \times 3 \times 3 \times 3 = 81$ IR, and the number, so to speak, of the original Shulman intertype relationships in each of 81 type IR is not the same. Therefore, in [13, p. 39], it was not the sum of ranks that was calculated, but the average rank in the group of the same type of IR, taking into account their number.

It was expected, from the point of view of the theoretical assumptions expressed in the monograph [21, p. 229], and the results obtained in the articles [15, pp. 222–223; 17, p. 112; 18, p. 31], that the discrepancy in terms of PD R/I is definitely worse than a coincidence in rationality or irrationality within any combinations of coincidence or discrepancy in all other PD. But coincidence in rationality was better than coincidence in irrationality in cases of coincidence in introversion, ethics and intuition. But the most theoretically unexpected result came from the dichotomy of extraversion–introversion (E/I). For any combination of coincidence or non-coincidence in all other PD, coincidence in extroversion was better than a mismatch in E/I PD, and it, in turn, is better in coincidence in introversion.

Table 1

Average rank of IR, depending on the coincidence or discrepancy in individual PD for 780 pairs, taking into account their total norm

		PD E/I			PD L/E			PD S/I			PD R/I		
		Coincidence in extraversion	Discrepancy in PD E/I	Coincidence in introversion	Coincidence in logic	Discrepancy in PD L/E	Coincidence in ethics	Coincidence in sensoric	Discrepancy in PD S/I	Coincidence in intuition	Coincidence in rationality	Discrepancy in PD R/I	Coincidence in irrationality
PD E/I	Coincidence in extraversion				54,25	63,06	62,94	48,69	60,19	74,25	108,56	66,44	9,88
	Discrepancy in PD E/I				67,69	73,44	71,81	59,63	71,09	84,56	110,38	79,94	16,13
	Coincidence in introversion				73,38	73,25	67,56	57,13	71,69	86,94	99,25	78,94	30,31
PD L/E	Coincidence in logic	54,25	67,69	73,38				51,13	64,63	86,63	87,19	77,44	20,94
	Discrepancy in PD L/E	63,06	73,44	73,25				57,63	70,47	84,63	109,88	77,59	18,13
	Coincidence in ethics	62,94	71,81	67,56				58,69	68,50	78,44	121,63	68,63	15,25
PD S/I	Coincidence in sensoric	48,69	59,63	57,13	51,13	57,63	58,69				97,75	56,69	13,94
	Discrepancy in PD S/I	60,19	71,09	71,69	64,63	70,47	68,50				108,06	75,00	16,00
	Coincidence in intuition	74,25	84,56	86,94	82,63	84,63	78,44				114,69	94,56	26,50
PD R/I	Coincidence in rationality	108,56	110,38	99,25	87,19	109,88	121,63	97,75	108,06	114,69			
	Discrepancy in PD R/I	66,44	79,94	78,94	77,44	77,59	68,63	56,69	75,00	94,56			
	Coincidence in irrationality	9,88	16,13	30,31	20,94	18,13	15,25	13,94	16,00	26,50			

To verify the findings obtained in [13], two groups were studied in [12]. One group consisted of 823 pairs composed of 81 people, and the other of 895 couples composed of 72 people. At the same time, the results obtained did not coincide with the previous results in everything.

Perhaps the most interesting option is for PD E/I. Thus, in the first group, in 100 % of cases, coincidence in extraversion is better than discrepancy in PD E/I, but the latter is in turn better than coincidence in introversion. In the second group, the result is almost the same, except for two cases: coincidence in introversion with a coincidence in ethics is better than a discrepancy in PD E/I, but worse than coincidence in extraversion, and also in coincidence in rationality, coincidence in extraversion and introversion is equally better than mismatch on PD E/I. In the first group, also in 100 % of cases, the coincidence in logic is better than the discrepancy in terms of PD logic – ethics (L/E), but it is already better than the coincidence in ethics. In the second group, such a picture is observed only in four cases out of nine. In three cases, there is an opposite picture and in two more cases coincidence in logic is better than coincidences in ethics, and this, in turn, is better than the discrepancy in terms of PD L/E. In both the «old» and «new» experiments in 100 % of cases, the coincidence in sensory turned out to be better than the mismatch in PD sensoric – intuition (S/I), but that turned out to be better than the coincidence in intuition.

The largest discrepancies between two experiments were recorded in terms of PD R/I. In the «new» test, mismatch on PD R/I, in 100 % of cases turned out to be better than the coincidence in rationality. But in the «old» one with coincidence in introversion and intuition, coincidence in rationality is better than coincidence in irrationality and in 100 % of cases discrepancy in terms of PD R/I is worse than coincidence.

It seems to be premature to make any unambiguous conclusions, but given the relatively large and roughly intersecting samples of the same size and composition, we can say with some certainty that the hypothesis in the monograph [21] about the superiority of identical IR was not confirmed. The picture is clearly more complicated.

To clarify the emerging picture, another sample of 780 pairs composed of 40 graduate pilots was investigated [23, pp. 21–28]. This sample is interesting because, in addition to the data on the total norm (N) for each pair, the total valence (V) was calculated using the method of A. M. Etkind [22, p. 110–114]. The results of the calculation of the average rank for the group of IR of the same type, taking into account their number, as it was done in [12, 13], are given in Tables 1 and 2. (The authors [23] did not make these calculations). The calculation of ranks was performed by us, based on the correlation coefficients between the corresponding component of SMIR (GSh), and also on:

- *total norm N in the pair (Table 1);*
- *total valence V in the pair (for Table 2).*

In 100 % of cases, as well as for the sample from [12], the coincidence in irrationality turned out to be better than the discrepancy in terms of PD R/I, but that in turn turned out to be better than the coincidence in rationality. Moreover, this result is valid for norm and valence.

For PD S/I and in [12], and in [21], and in the experiment under consideration from [23] (for both

Table 2

Average rank of IR, depending on coincidence or discrepancy in individual PD for 780 pairs, taking into account their total valence

		PD E/I			PD L/E			PD S/I			PD R/I		
		Coincidence in extraversion	Discrepancy in PD E/I	Coincidence in introversion	Coincidence in logic	Discrepancy in PD L/E	Coincidence in ethics	Coincidence in sensoric	Discrepancy in PD S/I	Coincidence in intuition	Coincidence in rationality	Discrepancy in PD R/I	Coincidence in irrationality
PD E/I	Coincidence in extraversion				68,50	75,13	77,13	57,56	74,25	89,81	125,13	80,06	10,63
	Discrepancy in PD E/I				66,94	72,97	73,06	55,81	71,66	86,81	120,31	73,00	19,63
	Coincidence in introversion				53,94	59,56	59,38	47,81	57,06	70,50	102,44	52,88	24,25
PD L/E	Coincidence in logic	68,50	66,94	53,94				48,56	63,88	80,00	107,19	70,19	8,75
	Discrepancy in PD L/E	75,13	72,97	59,56				55,75	69,81	85,25	119,13	71,25	19,00
	Coincidence in ethics	77,13	73,06	59,38				56,94	71,13	83,44	122,75	66,25	27,38
PD S/I	Coincidence in sensoric	57,56	55,81	47,81	48,56	55,75	56,94				106,69	48,69	12,94
	Discrepancy in PD S/I	74,25	71,66	57,06	63,88	69,81	71,13				118,25	69,63	17,13
	Coincidence in intuition	89,81	86,81	70,50	80,00	85,25	83,44				125,00	91,00	26,94
PD R/I	Coincidence in rationality	125,13	120,31	102,44	107,19	119,13	122,75	106,69	118,25	125,00			
	Discrepancy in PD R/I	80,06	73,00	52,88	70,19	71,25	66,25	48,69	69,63	91,00			
	Coincidence in irrationality	10,63	19,63	24,25	8,75	19,00	27,38	12,94	17,13	26,94			

Table 3

The proposed table of modified intertype relationships based on SMIR (GSh) [21]

TIR		1111	1110	1101	1100	1011	1010	1001	1000	0111	0110	0101	0100	0011	0010	0001	0000
		LLLL	LLLP	LLPL	LLPP	LPLL	LPLP	LPPL	LPPP	PLLL	PLLP	PLPL	PLPP	PPLL	PPLP	PPPL	PPPP
1111	LLLL	LLLL	LLL0	LL0L	LL00	L0LL	L0L0	L00L	L000	0LLL	0LL0	0L0L	0L00	00LL	00L0	000L	0000
1110	LLLP	LLL0	LLLP	LL00	LL0P	L0L0	L0LP	L000	L00P	0LL0	0LLP	0L00	0L0P	00L0	00LP	0000	000P
1101	LLPL	LL0L	LL00	LLPL	LLP0	L00L	L000	L0PL	L0P0	0L0L	0L00	0LPL	0LP0	000L	0000	00PL	00P0
1100	LLPP	LL00	LL0P	LLP0	LLPP	L000	L00P	L0P0	L0PP	0L00	0L0P	0LP0	0LPP	0000	000P	00P0	00PP
1011	LPLL	L0LL	L0L0	L00L	L000	LPLL	LPL0	LP0L	LP00	00LL	00L0	000L	0000	0PLL	0PL0	0P0L	0P00
1010	LPLP	L0L0	L0LP	L000	L00P	LPL0	LPLP	LP00	LP0P	00L0	00LP	0000	000P	0PL0	0PLP	0P00	0P0P
1001	LPPL	L00L	L000	L0PL	L0P0	LP0L	LP00	LPPL	LPP0	000L	0000	00PL	00P0	0P0L	0P00	0PPL	0PP0
1000	LPPP	L000	L00P	L0P0	L0PP	LP00	LP0P	LPP0	LPPP	0000	000P	00P0	00PP	0P00	0P0P	0PP0	0PPP
0111	PLLL	0LLL	0LL0	0L0L	0L00	00LL	00L0	000L	0000	PLLL	PLL0	PL0L	PL00	P0LL	P0L0	P00L	P000
0110	PLLP	0LL0	0LLP	0L00	0L0P	00L0	00LP	0000	000P	PLL0	PLLP	PL00	PL0P	P0L0	P0LP	P000	P00P
0101	PLPL	0L0L	0L00	0LPL	0LP0	000L	0000	00PL	00P0	PL0L	PL00	PLPL	PLP0	P00L	P000	P0PL	P0P0
0100	PLPP	0L00	0L0P	0LP0	0LPP	0000	000P	00P0	00PP	PL00	PL0P	PLP0	PLPP	P000	P00P	P0P0	P0PP
0011	PPLL	00LL	00L0	000L	0000	0PLL	0PL0	0P0L	0P00	P0LL	P0L0	P00L	P000	PPLL	PPL0	PP0L	PP00
0010	PPLP	00L0	00LP	0000	000P	0PL0	0PLP	0P00	0P0P	P0L0	P0LP	P000	P00P	PPL0	PPLP	PP00	PP0P
0001	PPPL	000L	0000	00PL	00P0	0P0L	0P00	0PPL	0PP0	P00L	P000	P0PL	P0P0	PP0L	PP00	PPPL	PPP0
0000	PPPP	0000	000P	00P0	00PP	0P00	0P0P	0PP0	0PPP	P000	P00P	P0P0	P0PP	PP00	PP0P	PPP0	PPPP

Table 4

Coefficients (η_i) for calculating the prognostic socionic interaction efficiency criterion (Υ_{GSh01})

TIR		1111	1110	1101	1100	1011	1010	1001	1000	0111	0110	0101	0100	0011	0010	0001	0000
		LLLL	LLLP	LLPL	LLPP	LPLL	LPLP	LPPL	LPPP	PLLL	PLLP	PLPL	PLPP	PPLL	PPLP	PPPL	PPPP
1111	LLLL	0	+2	-1	+1	0	+2	-1	+1	-1	+1	-2	0	-1	+1	-2	0
1110	LLLP	+2	+4	+1	+3	+2	+4	+1	+3	+1	+3	0	+2	+1	+3	0	+2
1101	LLPL	-1	+1	-2	0	-1	+1	-2	0	-2	0	-3	-1	-2	0	-3	-1
1100	LLPP	+1	+3	0	+2	+1	+3	0	+2	0	+2	-1	+1	0	+2	-1	+1
1011	LPLL	0	+2	-1	+1	0	+2	-1	+1	-1	+1	-2	0	-1	+1	-2	0
1010	LPLP	+2	+4	+1	+3	+2	+4	+1	+3	+1	+3	0	+2	+1	+3	0	+2
1001	LPPL	-1	+1	-2	0	-1	+1	-2	0	-2	0	-3	-1	-2	0	-3	-1
1000	LPPP	+1	+3	0	+2	+1	+3	0	+2	0	+2	-1	+1	0	+2	-1	+1
0111	PLLL	-1	+1	-2	0	-1	+1	-2	0	-2	0	-3	-1	-2	0	-3	-1
0110	PLLP	+1	+3	0	+2	+1	+3	0	+2	0	+2	-1	+1	0	+2	-1	+1
0101	PLPL	-2	0	-3	-1	-2	0	-3	-1	-3	-1	-4	-2	-3	-1	-4	-2
0100	PLPP	0	+2	-1	+1	0	+2	-1	+1	-1	+1	-2	0	-1	+1	-2	0
0011	PPLL	-1	+1	-2	0	-1	+1	-2	0	-2	0	-3	-1	-2	0	-3	-1
0010	PPLP	+1	+3	0	+2	+1	+3	0	+2	0	+2	-1	+1	0	+2	-1	+1
0001	PPPL	-2	0	-3	-1	-2	0	-3	-1	-3	-1	-4	-2	-3	-1	-4	-2
0000	PPPP	0	+2	-1	+1	0	+2	-1	+1	-1	+1	-2	0	-1	+1	-2	0

valence and norm) in 100 % of cases it is true that the coincidence in sensoric turned out to be better than the discrepancy in PD S/I, and then better than coincidence in intuition.

With PD E/I everything is not so clear. If in work [21] in 100 % of cases it is true that a coincidence in extraversion is better than a mismatch in PD E/I, but the latter, in turn, is better than a coincidence in introversion, then for [12] this will be true only in 78 % cases, although coincidence in extraversion is the best in 100 % of cases. For the experiment from [23], if we take the norm (see Table 1), the revealed regularity as a whole remains. In 89 % of cases, the coincidence in extraversion is the best, and only in one case, if it coincides in rationality, the coincidence in introversion will be the best. At the same time, in 44 % of cases, the regularity existing here completely repeats its analogue from [21, p. 229]. But if we take the valence (see Table 2), here the pattern is actually the exact opposite: in 89 % of cases, coincidence in introversion turned out to be better than discrepancy in PD E/I, and that, in turn, is better than coincidence in extraversion, and only in one case, if it coincides in irrationality, everything was exactly the opposite.

For PD L/E the situation is the most difficult. If in the experiment from [21] for 100 % of cases, the coincidence in logic is better than discrepancy in PD L/E, and then again it is better than coincidence in ethics, then for all other experiments there are practically no patterns (especially for the results from Table 1).

In table 3 in 256 four-digit designations of IR, in order of succession, the symbols are located corresponding to PD E/I, L/E, S/I and R/ I, while the symbol «L» means a coincidence in this IR for such properties as extraversion, logic, sensoric and rationality, the symbol «P» is a coincidence in such properties as introversion, ethics, intuition and irrationality, and the symbol «0» is a discrepancy in properties according to the corresponding PD.

Based on the considerations outlined earlier, Table 4 presents the possible coefficients for each of IR for calculating the prognostic socionic criterion for effectiveness of interaction Υ_{GSh01}.

The prognostic socionic criterion Υ_{GSh01} is similar to the previously proposed prognostic criteria χ based on IR A. Augustinavichute [21, 24] or $\chi_{02}, \chi_{03}, \chi_{04}$ – based on IR V. V. Gulenko [16–18] and is determined by the formula:

$$\Upsilon_{GSh01} = \sum_{i=1}^{256} (\eta_i \mu_i),$$

where μ_i – component of SMIR (GSh); η_i – coefficient from table 4.

Conclusions. *The development of a sufficiently adequate prognostic socionic criterion for effectiveness of interaction remains an urgent task, but requires further research, since the results obtained are still ambiguous. With regard to the flight crew, this is all the more important, because the nature of the relationship between people responsible for lives of aircraft passengers is subject to particularly rigorous professional evaluation.*

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