

Analysis of Networks of Cause-and-Effect Relationships or Etiological Analysis

Tomas G. Petrov
St. Petersburg State University
Institute of Earth Sciences
7/9 Universitetskaya Emb., St. Petersburg
190034 Russia

ABSTRACT

Filing-tabular version of the cause-and-effect relationships analysis in complex multiaspect systems, characterized by using special techniques to activate consciousness and record the results as "maps of centers of attention" and "tables of links" between them is described. Analysis method has been used to reveal significant factors when training highly qualified personnel, during particular organizational and administrative issues in specific conditions, to resolve a conflict in the team, in teaching students methods of scientific work, when analyzing and monitoring the ideas during improvement of production process of jewelry-ornamental malachite.

Keywords: cause-factor-effect, center of attention, activation of consciousness, knowledge generation, organization of expedition, ANCER

1. INTRODUCTION

In 1980, the author, finishing "training" at the University of Marxism-Leninism, defended a thesis titled "Analysis of training of high-skilled research personnel" (lost with the liquidation of the Institute during the "Perestroika"). The paper described developed by the author method of analyzing a system that by diversity (legal, traditional, psychological, economic, etc.) as well as by the number of identified factors operating within it (more than 120) may be recognized as "complex". The analysis contained critical notes (accounting for the role of negative psychological characteristics, the role of acquaintance and the like), so the self-censorship that prevailed then forbidden printing of the method description. A year later, in summer 1981, several accidents took place during the expeditions organized by the Leningrad State University; this fact generated at the Geological Faculty a desire to identify the possible causes of such events. A seminar was organized and within a few months using the method, the process of organizing, carrying out, and completion of scientific expeditions under their administrative control had been analyzed. A DOCUMENT was drafted for submission to the Ministry of Higher and Specialized Secondary Education of the RSFSR. It contained a brief description of the method and its results, which comprised recommendations for improving the organization of expeditions (E) in the direction of simplification of organization and formalities, facilitation of administrative work "in the field" and safety improvement, upgrading quality of work performed. University sent the document to the Ministry, which caused changes to the instructions that led to strengthening of control over work without simplification of organization and work of expeditions. This reinforced the reluctance to publish a description of the method and thus to give an additional tool to enhance the power of bureaucracy over science. However, knowledge of the method was spread, the method enabled to resolve a conflict situation in

laboratory, it began to be used in the planning of student work; the method has been used to analyze the

technological process of jewelry and ornamental malachite production [1]; it was mentioned in [2] along with the other three dozens of universal cognitive technologies and got the name of etiological analysis. Inventive activities have been rapidly developing in the country. It was reported of similar activities in other countries. Silence has lost all sense. Publications usually lack of examples of the proposed methods use. This makes them difficult to understand. Let's try to make it easier.

Published below (translated) DOCUMENT [3] contains a brief description of the Analysis method and its results. The latter reflect the state of organization in the important for several faculties area of work in one of the largest universities in the country before "Perestroika". In this regard, the Document may be of independent historical interest. After it, there are some additions to the method description.

2. DOCUMENT:

МИНИСТЕРСТВО ВЫСШЕГО И СРЕДНЕГО СПЕЦИАЛЬНОГО ОБРАЗОВАНИЯ РСФСР
ЛЕНИНГРАДСКИЙ ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ им. А. А. ЖДАНОВА
ГЕОЛОГИЧЕСКИЙ ФАКУЛЬТЕТ
НИИ ЗЕМНОЙ КОРЫ
СОВЕТ МОЛОДЫХ УЧЕНЫХ

А Н А Л И З
ОБЩЕЙ СИТУАЦИИ ПРИ ОРГАНИЗАЦИИ, ПРОВЕДЕНИИ И ОТЧЕТНОСТИ ЭКСПЕДИЦИОН-
НЫХ РАБОТ В ЛГУ НА ПРИМЕРЕ ГЕОЛОГИЧЕСКОГО ФАКУЛЬТЕТА

Итоги работы
методологического семинара Совета молодых ученых геологического
факультета и НИИ земной коры

Научный руководитель
семинара,
Т. Г. Петров /т. н. с. т. г. Петров/
Секретарь семинара
Т. Г. Руссо /и. н. с. г. в. Руссо/

Ленинград, 1982г.

¹ Analysis of the overall situation when organizing, conducting, and reporting of expeditions in LSU exemplified by the Geological Faculty. Outcomes of the methodological seminar under the Council of Young Scientists of the Geological Faculty and the Research

СПИСОК
лиц, принимавших участие в работе семинара по проблеме

1. Алексеев Е.П.	НИИСК	мл.н.с.
2. Вадило А.П.	НИИСК	зам. дир. по общим вопросам
3. Виноградова Е.А.	ВСЕГЕМ	ст. инженер
4. Воинов А.С.	НИИСК	ст. н.с.
5. Дуленова Н.В.	ВСЕГЕМ	инженер
6. Жоголева В.Ю.	НИИСК	инженер
7. Захаревич К.В.	НИИСК	ст. н.с.
8. Клишевич И.А.	НИИСК	мл. н.с.
9. Книзель А.А.	НИИСК	ст. инженер
10. Коробейникова Л.П.	НИИСК	мл. н.с.
11. Кондратьева В.В.	НИИСК	мл. н.с.
12. Нардов А.В.	НИИСК	мл. н.с.
13. Кузнецов В.П.	НИИСК	инженер
14. Мазалов А.А.	Геол. ф-т	мл. н.с.
15. Останина Г.А.	НИИСК	лаб.
16. Петров Т.Г.	НИИСК	ст. н.с.с.
17. Руссо Г.В.	НИИСК	мл. н.с.
18. Руденко Ю.Л.	НИИСК	мл. н.с.
19. Савицкий Ю.В.	Геол. ф-т	мл. н.с.
20. Татарский Б.В.	НИИСК	мл. н.с.
21. Усанова С.С.	НИИСК	инженер
22. Ягочкина М.А.	Геол. ф-т	студ. IV курса

1. PREAMBLE

Reason that caused the problem statement was a high accident rate in LSU expeditions in the summer of 1981. The basis for consideration of the problem, given below, was the status of organization and realization of expeditions at the Geological Faculty of LSU and the Research Institute of the Earth's Crust. This question, however, is much more common, since the expeditionary form of work is widespread both in LSU and in the country in general.

22 persons who worked in expeditions, of which 10 persons have repeatedly led field teams, participated in analyzing the problem.

Problem of organizing and conducting field studies, due to its multiaspect nature, is complex, including legal and moral norms of society, financial, administrative, economic and personnel sides of organizations; research and production objectives of work, biological and psychological characteristics of the individual, social, moral, and economic consequences of certain actions, etc. Lack of an integrated approach to the problem leads to a huge number of difficulties during organization and realization of expeditions, and, ultimately, to reduced field work effectiveness, reduced safety, increased morbidity, etc. The need for appropriate organizational rearrangements, at least at LSU, is clearly overdue. In order that separate unrelated and unfounded changes in instructions and practices of organizational work did not lead to deterioration of the situation, but to its improvement, first of all, a multiaspect problem analysis is necessary.

Standard analysis methods and presentation of their results are inapplicable to complex problems; linear text is poorly adapted for description of complex systems; directed graphs (digraphs), when the number of graph nodes exceeds 30-50, are difficult to read.

To analyze and display complex systems, Senior Researcher, Head of Crystallogenesis Laboratory of the LSU Research Institute of the Earth's Crust T.G. Petrov developed the graph-filing method presented below and

Institute of the Earth's Crust. Supervisor Senior Researcher T.G. Petrov. Secretary G.V. Russo. Leningrad, 1982.

² List of persons participating in the seminar on the issue.

used for the analysis of organization, realization, and completion of expeditions.

2. METHOD DESCRIPTION

It is known that any macroscopic change is the result of some specific conditions, as well as driving forces, which can be regarded as the cause of change. In case of directed graphs, it is displayed with the pattern of Fig. 1 type.

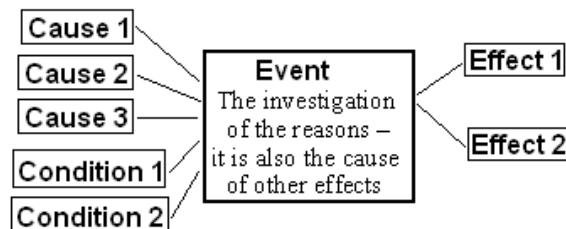


Fig. 1 Cause-and-effect relationships of the considered event

What is called a consequence, at the next stage of consideration may appear and always appears the very cause of subsequent events (states). Interlinking of events indicating the direction of link enables, in principle, to obtain networks of cause-and-effect relationships. They can stretch almost arbitrarily far, capturing more and more aspects of the problem and its details. However, the limited human memory leads to the need to reduce the simultaneously used information, which usually leads both to loss of important links and inability to cover the entire network.

Proposed method relates to ways for digraphs description, but it overcomes the difficulties of different types associated with construction of graphs of complex systems. This is achieved by mapping each graph node with its causes and consequences on a separate card (Fig. 2).

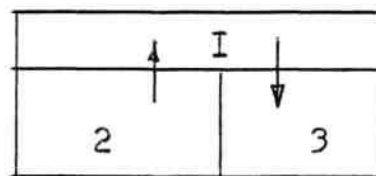


Fig.2. View of the card for describing a graph node

In field I in the card, the name of the state or process simple enough for this level of consideration is inscribed, i.e. the name of the considered digraph node. Field 2 lists all the causes and conditions that affect the state (process). The effect described in field I is shown by an arrow. Field 3 is used to specify all the consequences of the state (process) identified in field I.

At the beginning of the system analysis, a few simple states are randomly selected and put in fields I of cards. Further, when identifying the causes and consequences of these states, new digraph nodes are generated, which are put in new cards. At directed work, linking of all identified elementary states in a single system takes place. Analysis depth is determined by the level of problem knowledge, set goals and intuitively assessed sufficiency.

Representation of the resulting information in the form of card packs is not very convenient, so the following display

method is used. Digraph nodes, i.e. names of the considered states (with both numbers) are printed in the sheet center, numbers of all the causes generating this state are written down to the left of the text, numbers of all the consequences are to the right, i.e. conversion is performed, as shown in Fig.3.

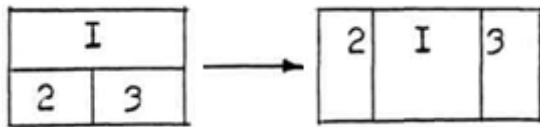


Fig. 3. Transition from card to textual representation

Next, we used just such a way of presenting information (see Annex 1).

2.1. Labour costs

Analysis to the issue of presented materials, including intense creative and great technical work required approximately 350 man-hours of work, including the stage of generation, formulation discussing and search for links of work of a team consisting of 10-20 persons.

Reducing the problem coverage leads to misconceptions on the importance and power of substantiation of individual provisions, and accordingly, to a sharp increase in the probability of making wrong decisions. Under reached fullness of the analysis, it is far from exhaustive, and therefore the recommendations made with it should be treated as provisions required for focusing attention during subsequent much deeper understanding of the situation and making final decisions.

3. PRELIMINARY ANALYSIS RESULTS

A. As shown in Annex I, to increase the operational efficiency of expedition personnel, the following is NECESSARY:

- 1) centralized supply of expeditions with equipment and products (4)
- 2) centralized transport supply (5)
- 3) separation of scientific and economic leadership (6)
- 4) supply of the expedition leader with a set of forms (9)
- 5) introduction in the work book of information about working in expeditions (for temporary workers) (17)
- 6) informing personnel of legislation (with multiplication of instructions) (22)
- 7) compiling a handbook on expeditions organizing (including instructions: financial, duty, safety) (23)
- 8) instruction for expedition leaders (24)
- 9) supply of expeditions with radio sets and pistols (signaling means) (28)
- 10) issuance of arms (29)
- 11) compliance with the rule: "changing of instruction is not retroactive" (31)
- 12) organization of field materials acceptance (57)
- 13) transparency of the funds allocation (70)
- 14) priority of scientific and educational purposes over organizational and economic forms (71)
- 15) understanding the supporting functions of administrative apparatus in relation to scientific and educational goals of the university (72)
- 16) periodic review of regulations (74)
- 17) introduction in the Labour Code of a chapter on expeditionary studies (75)
- 18) ability of the expedition leader to navigate in difficult situations (76)
- 19) studying of the foundations of social psychology by all

expedition members, especially by the expedition leader (85)

20) greater confidence in the expedition leader on organizational and financial issues (87)

21) intensification of substantive control over the expedition missions and simultaneous minimizing of formal control (88)

22) improved supply of expedition with equipment appropriate for work area (94)

23) full use of the salary fund for its intended purpose (108)

24) possibility of hiring temporary workers for funds that became available due to illness of employees and for other reasons (109)

25) establishment of a fund of planned seasonal units for work during the expedition (110)

26) permission of maneuverability within the budget (111)

13) presence of a seal in the expedition leader's possession (112)

DESIRABLE:

1) ordering of LSU employees secondment to other expeditions (maybe under "cooperation agreements") (30)

2) creation of a single expedition fund (economic agreement and state budget)

B. When drawing up new regulations on the organization of field works, it is necessary to consider the following temporary (i.e. acting now as a result of the prevailing traditions and instructions) and permanent (i.e. depending only on the working conditions in expeditions) restrictions and prohibitions:

PERMANENT FACTORS

- 1) work in unpopulated areas (26).
- 2) inability to foresee the exact amounts under budget items (35).
- 3) inability to predetermine the exact timing of field work (37).
- 4) dependence of the field work on weather conditions (39).
- 5) dependence of the field work on other institutions (40).
- 6) difficulties of re-work during the expedition (62).
- 7) inability to re-examine some geological sites (63).
- 8) impossibility to draw instructions providing all possible situations (86).
- 9) expedition work in extreme conditions (104)
- 10) instructions are behind the rate of economic and social development of the country (118).

TEMPORARY FACTORS

- 1) difficulties of combining the functions of scientific and economic leadership (7).
- 2) existence of low rates in the system of the RSFSR Ministry of Higher Education (including: worker - 60 roubles, collector - 69 roubles) (13).
- 3) lack of clear rights and duties of the expedition leader (20).
- 4) lack of E. consistency in legislation and guidance materials (25).
- 5) increased risk and lack of communication (27).
- 6) rigid budget items regulation (34).
- 7) organizational difficulties during field works (36).
- 8) lack of skills to prevent and eliminate conflicts among expedition leaders (81).
- 9) lack of skills to prevent and eliminate conflicts among administrative staff (82).
- 10) lack of psychological education among members of expeditions (83).

- 11) lack of a single expedition supply with equipment (95).
 12) lack of management training with the expedition leader (116).
 13) weakness of public control over the administrative and economic apparatus (117)

ANNEX 1

Description of digraph of cause-and-effect relationships occurring during organization, realization, and completion of field works

2. Causes	1. Events Factors	3. Effects
119	1. Organization in the Leningrad State University of expeditions at 8-10 faculties	-
19,20,34, 38,43,52, 95,100, 103	2 Difficulties in E. ³ organization	10,45,59, 62
59,88,103	3 Need to facilitate documents processing	9,50
7,36,59	4 Need for a centralized logistics and supply with equipment and products	69
36,41,59	5 Need for a centralized transportation	-
7,59	6 Need for shared responsibility (scientific and economic leadership)	50
34,52,95	7 Difficulties of combining functions of scientific and economic leadership	4,6,8,10, 76
7.11,12, 15,42,43, 49,52,58, 68,78,79, 80,84,98. 99,100, 105,107, 121,123	8 Quality deterioration of both research and economic supply	-
3,59	9 Necessary supply of the E. leader with a set of forms	-
2,7,16,36, 49,52,55, 68	10 Refusal of potential scientific leaders to lead the E.	11,12,50, 58,59,114
10, 19	11 Leadership duality	8
10	12 Leader positions are held by persons uninterested in the scientific results	8,50,51, 115
14	13 Existence of low rates in the system of the RSFSR Ministry of Higher Education without taking into account regional factor (worker - 60 roubles, collector - 69 roubles)	15,38
-	14 Instructions	13,20,34, 42,43,68, 103,107, 113
13,17,18	15 Impossibility to hire manpower legally	8,16,21, 38,114
15,34,35,	16 Forced financial violations	10,49,52,

41,52	in E.	96
-	17 Need to make records in the work book about working in expeditions (for temporary workers)	21,38
19,20	18 Lack of a seal at the E. leader disposal	15,112, 114
-	19 Traditions of the Leningrad State University	2,10,18,20 41,42,43, 48,68,96, 99,100, 103,116, 117
14,19,25, 48	20 Lack of defined rights and duties of the E. leader	2,22,23,24 51,52,75, 92,96,97, 100,102
15,17,114	21 Need to regulate the records in work-book	-
20,48	22 Need to familiarize the employees with the legislation (multiplication of instructions)	23
20,22,48, 59,74	23 Need for a handbook on organizing E. (financial, safety, duty)	-
20,48,59, 74	24 Need for instructing the E. leader	-
-	25 Lack of consistency in legislation and guidance materials	20,44,74, 75 98
-	26 Work in uninhabited areas	27,36,38, 39, 62,76, 84,94,104, 106
26,94	27 High risk and lack of communication	28,29,37, 62,76,104
27	28 Need to supply E. with radio sets and pistols (signaling means)	-
27	29 Need of arms issuance	-
59,60	30 Desirability of ordering of LSU employees secondment to other E. (maybe under "cooperation agreements")	-
59	31 Need to observe the rule: "changing of general instruction is not retroactive"	-
44,59	32 Need to develop clear terms in E. organization (advance!)	-
-	33 Overall limited budget	41,108
14,52,113	34 Strict regulation of the budget items	2,7,16,36, 80, 111
36,37,39, 40,41,104	35 Impossibility of foreseeing the exact amounts per items	16,36,86, 111
26,34,36, 37,38,40, 41, 78.79, 80,104 122,123	36 Organizational difficulties of field work during E.	4,5,10, 35,50,59
26,27,38, 39,41,104	37 Impossibility of foreseeing the exact timing of work during E.	35,36,56 80, 111
13,15,17, 26,56	38 Difficulties of recruitment	2,36,37, 50.62,78, 79,84,110, 114
26	39 Dependence of the field	35,37,86,

³ "E." stands for "expedition"

	<i>work on weather conditions</i>	94,104,111		2,26,27,38,66	62 Difficulties of re-works in E.	61
-	40 Dependence of the field work on other institutions	35,36,37,80,84,86		64,65,66,67	63 Inability to re-examine geological sites	53,61
19, 39	41 Lack of own transport in E.	5,16,35,36,37,80,84,86,94,111		-	64 Development of deposits	61,63
14,19,107,113	42 Lack of interest at administrative services of LSU in scientific results of E.	8,43,44,49,52,73,99		-	65 Study of unique objects	61,63
14,19,42,49,96	43 Presence of interest at administrative services of LSU in observance of formalities	2,8,49,100		-	66 Study of expensive not preserving geological materials (core, tunnels, diggings)	61,62,63
25,42,46,107	44 Possibility of actions of officials not in the interest of the affair	45,49,70,73,97		-	67 Loss of natural objects in economic activities	53,61,63
2,44	45 Generation of the issue among the E. members - "who is for whom?"	49		14,19	68 Inelaborated facilities for correlating the financial gap (faculty-economic/contract) and unity of geological topics	8,10,58,69
-	46 Desire of individual to self-affirmation	44,47,89,90,97		4, 5, 9, 68, 94	69 Desirability to create a single expedition fund of IEC (contract+budget)	-
46	47 Desire to preserve the possibility of arbitrariness	44,47,89,90,97		44,49,69,73,107	70 Need for transparency on the funds allocation	-
19,47,107	48 Lack of available instructions	45,48,49,52,79,97		-	71 Need for priority of scientific-educational goals over economic - organizational forms (substance over form)	72,88
16,42,43,45,47,51,73, 81,82,96,107	49 Generation of mutual distrust and conflicts (between administrative-governmental entities and the E. organizers)	8,10,43,44,52,100		71	72 Need for awareness by service personnel! Of functions of the administrative apparatus in relation to scientific and educational goals of the university	-
3,6,10,12,36,38,59	50 Importance of separating in the instructions of administrative, financial, and scientific responsibility	-		42,44,107,117	73 Possibility of financial violations and abuses in organizational-administrative apparatus	45,49,70
12,20,96,97,99,100,115	51 Possibility of a mismatch of declared and actual goals of the E.	49,52,57,88,92		25,118	74 Need of periodic review of instructions	23,24
16,20,42,47,49,51,115	52 Administration's desire to strengthen formal control over E.	2,7,8,10,34,100,103		20,25,119	75 Need to introduce in the Labour Code of chapters on E. studies	-
60,61,63,67	53 Possibility and desirability of creating comprehensive E. and reports on them	54		7,26,27,61,77,86,104,106,122,123	76 Necessity of the E. leader to be able navigate in difficult situations	85
53	54 Need to reconcile the interests of different E. participants	85,91		-	77 Difference of characters (habits, behaviours, interests) of the E. members	76,78,79,123
116	55 Lack of organizational skills, knowledge, and abilities in the leader	10		38,77,81,83,89, 93,104,106,114, 120	78 Conflicts between the E. members	8,36,105,122
61	56 Need of compliance of experts' skills with the work performed	38		38,77,81,83,89,90,92,104,106,114,120	79 Conflicts between the leader and members of the E.	8,36,105,122
51,61,88,115	57. Need to organize, accept field materials	-		34,37,40,41,81, 83,93,104	80 Conflicts between the E. leader and local authorities	8,36,105
10,68	58 Reduced possibilities for system solutions of scientific tasks	8		83	81 Lack of skills to prevent and eliminate conflicts among expedition leaders	49,78,79,80 123
2,10,36	59 Need to facilitate the E. organization	3,4,5,6,9,23,24,30, 31,32,50, 69		83	82 Lack of skills to prevent and eliminate conflicts among administrative staff	49
-	60 Necessity of reducing expenses of forces and means per 1 E. member	30,53		-	83 lack of psychological education among members of	78,79,80,81,82,85,
62,63	61 Need of high-quality works in E.	53,56,57,76,108,110,111				

	<i>E.</i>	<i>91,93,123</i>
<i>54,76,83,104</i>	<i>85 Need to familiarize the E. members and especially E. leader with the bases of sociopsychology</i>	-
<i>35,37,39,40,41,104</i>	<i>86 Impossibility of drawing up instructions providing all possible situations</i>	<i>76,87</i>
<i>86</i>	<i>87 Need of more trust to the E. leader on organizational and financial issues</i>	<i>88</i>
<i>51,71,87,99,115</i>	<i>88 Need to strengthen meaningful control over the activities of E. by decrease of formal</i>	<i>3,57</i>
<i>46</i>	<i>89 Increased self-esteem of (subordinate) E. member.</i>	<i>78,79,93</i>
<i>46</i>	<i>90 Understatement by the E. leader of evaluation of a subordinate expedition member</i>	<i>79,92,93,97</i>
<i>20,51,90,97,121</i>	<i>92 Work of subordinates in the personal interests of the E. leader</i>	<i>79</i>
<i>83,89,90</i>	<i>93 Absence of self-criticism of the leader and members of the E.</i>	<i>78,79,80,123</i>
<i>26,27,39,41,95</i>	<i>94 Need to improve the E. supply with equipment appropriate to the area</i>	<i>4,69</i>
<i>19</i>	<i>95 Lack of a unified E. supply with equipment</i>	<i>2,7,94</i>
<i>16,20,121</i>	<i>96 Possibility of financial violations by the E. leader</i>	<i>43,49,51,115</i>
<i>20,44,46,47,90</i>	<i>97 Possibility of manipulating minds of the E. members by the leader and vice versa</i>	<i>51,92</i>
<i>25,104</i>	<i>98 Possibility of abuse in the literal adherence to safety regulations and duty descriptions</i>	<i>8</i>
<i>19,20,42</i>	<i>99 Weakness of control over the content of E. activities</i>	<i>8,51,115,121</i>
<i>19,20,43,49,52,113</i>	<i>100 High level of formal control over the E. activities</i>	<i>2,8,51,88</i>
<i>124</i>	<i>101 Attempts to escape from responsibility for one affair</i>	<i>102</i>
<i>20,101</i>	<i>102 Increase of responsibility for one affair</i>	<i>103</i>
<i>14,19,52,102</i>	<i>103 Signing the Expedition order by 16 persons</i>	<i>2,3</i>
<i>26,27,37,39</i>	<i>104 Work of E. in extreme conditions</i>	<i>35,36,37,76,78,79,80,84,85,98,105,122</i>
<i>78,79,80,104</i>	<i>105 Increased morbidity</i>	<i>8</i>
<i>27</i>	<i>106 Working in conditions of a closed team</i>	<i>76,78,79</i>
<i>14</i>	<i>107 Dependence of accountants' bonus on cost cutting during field works</i>	<i>8,42,44,48,49,70,73</i>
<i>33,61</i>	<i>108 Need for full use of the salary fund for its intended purpose</i>	<i>109</i>
<i>108,114</i>	<i>109 Need of hiring temporary workers for funds that became available due to illness of</i>	-

	<i>employees and for other reasons</i>	
<i>38,61,114</i>	<i>110 Need to create a fund of planned seasonal units for working in E.</i>	-
<i>34,35,37,39,40,41,61</i>	<i>111 Need to permit maneuverability</i>	-
<i>18</i>	<i>112 Need for a seal at the E. leader disposal</i>	-
<i>14</i>	<i>113 Necessity to comply with formalities according to the instructions</i>	<i>34,42,100</i>
<i>10,15,18,38</i>	<i>114. Discrepancy between expedition personnel and its tasks</i>	<i>21,78,79,109,110</i>
<i>12,96,99,121</i>	<i>115. Possibility to choose places (of resort type) for the expedition</i>	<i>51,52,57,88</i>
<i>19</i>	<i>116 Lack of managerial training with the E. leader</i>	<i>55</i>
<i>19,48</i>	<i>117 Weakness of public control over the activities of the administrative apparatus</i>	<i>73</i>
-	<i>118 Lag of instructions behind the pace of economic and social development of the country</i>	<i>74</i>
-	<i>119 Multiplicity of types of economic activities that require field works (geology, geography, archaeology, biology, linguistics, history etc.).Accordingly, a large number of people is involved in this form of activity</i>	<i>1,75</i>
-	<i>120 Presence of relatives in the expedition</i>	<i>78,79,121,123</i>
<i>99,120</i>	<i>121 Possibility to conceal the facts of violation of labour and financial discipline</i>	<i>8,78,79,92,96,113</i>
<i>78,79,104</i>	<i>122 Deterioration of works security</i>	<i>36,76,84</i>
<i>77,81,83,93</i>	<i>123 Possibility of formation of warring factions inside the expedition</i>	<i>8,36,76</i>
-	<i>124 Self-preservation instinct of people</i>	<i>101</i>

ANNEX 2⁴

ANNEX 3

LIST OF KEY CONCEPTS TO ANNEX 1

Contacts with other organizations: 30,40,80

Control activities: 52,57,72,73,87,88,99,100,113,117,121

Expedition leadership (liability): 6,7,10,11,12,20,50,55,101,102,103,112,114,116

Expedition targets: 51,71,72

Quality of work: 8,36,56,58,61,88,99,108,114

Expeditions: 1,53,119

⁴ DIGRAPH (124 nodes 776 links) is lost.

Funding and financial matters: 33,34,35,60,68,69,70,72,96,108,111
Guidance and legislative materials: 9,13,14,22,23,24,25,31,37,48,50,72,74,75,86,87,99,100,107,113,118
Operating safety: 26,27,28,29,39,78,79,94,98,104,105,122
Organization of expeditions: (financial and disciplinary): 2,32,59
Psychological climate in the team: 45,46,49,73,77,78,79,81,82,83,89,90,93,106,123
People interest: 42,43,44,46,47,51,54,72,78,79,80,87,89,90,97,107,115,117,120
Personnel - organizational issues: 15,17,18,21,38,109,110
Personnel psychology: 72,76,77,78,79,80,81,82,83,85,87,89,90,93,97,101,124
Personnel - qualification: 56,114
Possibility of abuse: 51,92,96,107,115,121
Specificity of geological field work: 62,63,64,65,66,67,68
Supply: 4,28,29,69,94,95
Traditions: 19
Transport: 5,41
Violations and abuses: 16,51,43,96,107
Working conditions in expeditions: 26,27,28,29,35,37,39,62,63,64,65,66,67,76,84,104

END OF THE DOCUMENT

3. ADDITIONS

Since the text describing the Analysis method in the Document was very sketchy, let us pay attention to the central moments in the description method and results, slightly expanding their description

3.1 "Paris is well worth a mass" - must be Paris

Bearing in mind great fatigue when working on the analysis, the task should be worthy of the efforts to resolve them. The fact that the distinctive feature of the method is activation of mental process when concentrating attention on a single term, concept, image, phenomenon requiring the brain to list all the possible causes, conditions, laws, requirements, inducements - all intentions, promotions and slowdowns as well as all possible consequences, conclusions, results, requirements. Such concentration requires a large expenditure of mental energy. Development of animals led to the fact that "energy consumption of nervous system was very high, therefore all mammals are trying to use their brain as little as possible". [4]. Instincts are enough for the present life. They can be very complex, branched. Staying instincts, they provide a response to usual situations of life, to speech - without too much thinking, to professional work according to standard procedures on standard equipment. The main criterion for deciding on method application is high relevance. The challenge is BEFORE the mid work, hard to realize, questions branching is unpredictable. Results are surprising with the number of significant, especially when the researcher worked alone - he discovers how many facts he never knew and did not think about come to light.

3.2. Dissatisfaction with the funds available

Initially, it was clear that linear text was unusable to describe a voluminous system of links between a large number of points – centers of attention. Then known to the author PERT system for some reasons was considered inconvenient. The very first use of the method with obtaining more than 100 parameters of the investigated

system required to solve the problem of fixation and convenience of the obtained material viewing. Digraph in excess of 20-30 nodes is perceived with difficulty. The same applies to the adjacency matrices. It is possible to imagine a 100x100 matrix, but it is impossible to work with it without special means. To store information about the detected system parameters and links between them, the Table of links was proposed, which is given in the Document text as "Annex 1".

3.3 System boundaries

Ideally, the analysis can go to infinity requiring answers to the questions "Why?" and "Where will this lead?" In reality, this spreading to infinity is being restricted. Bad infinities of continuous questions are interrupted at the system boundaries. That is everything not responding to the question "Why" and "For what purpose" at this level of system examination is excluded from consideration. Left cells in the Table of links with the sign "-" correspond to blank fields 2 on of Attention Centers and correspond to the system boundaries on the part of identifying the causes, "left boundaries".

Here is a list:

- Instructions
- Traditions
- State laws
- Existing design and its features
- External impact
- Conditions inside the apparatus
- Process name
- Method of enhancing, weakening of subsequent link
- Requirements to what is happening and/or has happened
- Hereditary programs
- Laws of nature (specific sciences)
- Mentality
- Requirements of "customary law"
- Dogmas

In column 3 of the Table of links "-" sign indicates the end of consequences search, since the purpose is considered achieved at this chain of links. In the card, it will correspond to blank field 3, and field 1 of the card of Attention Centers in this situation will contain:

- Results
- Proposals for action, or continuation of the Analysis
- Conclusions
- Wishes
- Motives of further actions, hesitations
- Desired output
- Idea
- Reason of manufacturing defect
- Direction to the Annex
- Recommendation
- Restrictions imposed by nature, society, state on further questions and requirements.

Rigid boundary imposed on the system study may be represented by restrictions on its interpretation by virtue of mentality, religious framework, political conditions. In historical research, the present-day cause may be the purpose of research - its outcome - "right boundary".

3.4. Card of attention center and work with it

Main analysis element and distinguishing feature of the Analysis is "Center of Attention" card. To begin, A7 size is sufficient (Fig. 2 of the Document). Since the formulation of the problem, first coming to mind future "Centers of Attention" relating to the proposed system without any attempt to understand the significance of parameters and their links are inscribed on the cards in

position 1. These may be "relevant" words and short as possible phrases, at the level of naming state, process. Such cards at the first step of attention centers generation are usually about 10-15.

Work on the described method of analysis is the discovery of inner world. Many emerging things come to mind for the first time - IT was (maybe) in the subconscious, but has never surfaced previously in the discourse of carefully considered now. Incompatibility of volumes that can be recalled by a simple conversation and/or concentration of mind on one center of attention for a few minutes is manifested. Thinking with desire is a key to success. Thinking first about the reasons - 2-3 minutes... and when their number ceases to increase, transition to thinking and fixing consequences, looking at the reasons for another 3-4 minutes - since more reasons may emerge. Often, the reasons seem to flow into the consequences. Do not encourage yourself to the memories, since the required is usually stored not there (and whether is stored, anyway?), but in the subconscious in some "creative vault" where it is impossible to look. Or, in general, is born from a cosmic particle flying through the brain? Or from some radio wave frequency, one of those that are constantly penetrating the body. Imagine, trying to understand: what ELSE can affect, influence, encourage, strengthen, weaken, facilitate, hinder, cause.

Parameters and communication, which were not accounted for, are raising to the surface, and sometimes among them those that are not recommended to discuss. Identifying the lack of discussing the reasons for any action or inaction is the way to *reveal the root causes* for existence (those who act on the minds of people by advertising, propaganda, by any other means), an *interest in concealing information* about the properties of drug or law, on the inner mechanisms of the system functioning. One should refer to the literature if the relationship is intuitively planned, but there is a big gap between two considered centers of attention. In this case, failures in one's own education or in the science that studies this system (which is normally rarely) may be identified. However, referring to the literature is desirable beyond this stage of work - it ruins the mood for an individual search for answers to questions. And in the literature, only things which have already been guessed by others will be found. Really new, original, is not in others, but in your own heads.

3.5 Operation procedure

Prior to work, a Table of links is prepared, which is convenient to divide into 4 columns (instead of three as in the Document), where the course of analysis will be recorded (sample in Tab. 1). In column CA, numbers of the Centers of Attention will be put, in NN Causes - numbers of, generally speaking, causes, and in column NN Events - numbers of consequences, results.

Tab. 1

NN Causes	N CA	Center of Attention (CA)	NN Events

Work is cyclic. Periods of creative activity - periods of ideas generation, searching, thinking are interspersed with the periods of rest, when positions numbering is produced - technical handling of the results of maximum effort stages. The first Active period. The first generation of the centers of attention - listing obvious, "lying on the surface" system parameters, occurs during it. After it the stage of analysis begins, at which the causes and consequences of each

selected CA are identified. Then, with the onset of fatigue or exhaustion of imagination and completion of the formulation next period of the cycle begins.

The first passive period: 1) enumeration of all the factors identified in the cards. 2) Reproduction of cards, that is transfer to the new cards of formulations found in the active period of causes and consequences with their numbers into CA positions, 3) recording of all the new factors with their numbers in the table of links.

Further a break is needed, lasting at least a day, after which the Second active period begins, that is search for the causes and consequences for all new cards. It is possible to generate new CA not yet connected to others, with their analysis.

Next new break, as shown above, and alternating cycles of handling and generation of ideas.

Nests-clots of meanings are formed around the first CA - later these nests will be combined through the same, or very similar CA. Difficulties in **linking different blocks** arise from the fact that the formulation of effect belonging to one unit may not coincide with the formulation of a similar in meaning cause of another one. In this case, formulation the most satisfying its place as a link between the blocks is chosen; one of the numbers - falls from the table-registry of the digraph that, in general, does not require cumbersome renumbering of all subsequent cards.

3.6 Completion of the analysis begins with joining of blocks that emerged around the distinguished in the early stages of generation, through identical or identifiable by the sense causes and effects that belonged to different blocks.

To facilitate searching for the same parameters during linking, an alphabetical list of the centers of attention - factors is compiled. Work according to the method did not have software that attracted large amount of time on technical work, but did not reduce the importance of enthusiasm in pursuing it. The opportunity to overview lying on a table, or mounted on a vertical surface (cardboard - pins) hundreds of cards is not replaced by sharply bounded surface of a monitor. Capabilities of computer as an auxiliary tool are undeniable, however, they were not used and therefore cannot be appreciated.⁵

It is necessary to stop work at any stage, if minimal disgust feeling arises. After these moments, one continues to work only after the desire to complete it, plus one day.

3.7 Auxiliary facilities

Annex 3 lists as keywords the distinguished factors, permanent and temporary. They are listed in alphabetical order (indicating their numbers in Annex 1) and were a list of "necessities" to improve working conditions and expedition productivity.

In addition to the simple lists of Results, Permanent and Temporary Factors given in the Document, clusters of meanings - the factors most loaded by links can be identified. After ranking of factors by quantities of causes and consequences, we obtain two original "rank formulas" [5], describing, say, "Centers of significance" in the CASE of expeditions in a university (obviously not in one) during the "pre-Perestroika" period of the country development,

⁵ Sick with the idea are "prescribed" night work in complete silence and the absence of other irritants. Very successful work not getting out of bed is possible as well. A box with A7 sheets and pencils is placed on the wall, below the box - a piece of cardboard or plastic, which is a base for sheets when recording the emerging ideas. With good handwriting even local lighting is not desirable.)

which to some extent reflected the general properties of the affairs organization, not only in the higher education.

Two sequences decreasing by amounts of causes and effects are obtained. At the beginning of rows, number of the factor in Annex 1 is put, at the end of rows, number of links.

Factors having the maximum number of *causes*.

8. Deterioration of both scientific work and economic provision (n=21)

36. Organizational difficulties of field works (13)

49. Generation of mutual distrust and conflicts (between administration and organizers of the E. (n=11

79. Conflicts between the leader and members of the E. (n=11)

78 Conflicts between the members of the E. (n=11

76. Necessity for the E. leaders to be able to navigate in complex situations. (n=10)

2. Difficulties of E. organization (n=9)

10. Refusal of potential scientific leaders to lead (n=8)

80. Conflicts between the E leader and local authorities (n=8)

Factors having the maximum number of *effects*

19. LSU traditions (n=15)

20. Lack of clear rights and duties of the E. leader (n=13)

104. E. operation in extreme conditions (n=12)

59. Need to facilitate E. organization (n=12)

41. Lack of own transport in E. (n=10)

26. Work in unpopulated areas (n=10)

83. Lack of psychological education among the E. members (n=9)

107. Dependence of accountants' bonus on cost cutting during field works. (n=8)

52. Desire of the administration to strengthen formal control over E. n=(8)

Nodes with plenty of links identified to the end of the analysis are either the result of insufficiently detailed consideration of the network section in this place, and the node should be split into two or more nodes (e.g., economic and scientific part of the expedition, and, perhaps, separate the technical part) or to ascertain the existence of an indivisible troublesome node in the studied system. In the mentioned lists they are in the first places.

Selection of groups of structural factors, raw material factors, factors of launch, operation, process completion, maintenance, and ecology with identification of critical physical-chemical, economic factors and all the relationships affecting the output of finished products, economy of the entire production took place in malachite synthesis technology. Such grouping makes it easier to get other people in the obtained results. The analysis resulted in revealing the reasons for product defects and recommendations to change the crystallizer design.

3.8 Multiaspect nature of analysis.

Analysis reveals a multiaspect nature of the system. Expedition goal is knowledge. Realization of this goal in the Soviet time required knowledge in many areas (much has left later). Among the essentials: psychology, geography, logistics, history, law, biology, mentality of the population, record management, geology itself (it could occupy the last places), financial affairs.

3.9 Analysis can be continued.

Retrospective analysis consideration reveals its incompleteness. It depended both on understanding and limited capacity to understand. In this context it is interesting to look at one center of attention, symptomatic for the attitude of the group of young people that carried out analysis. This is N10 - Refusal of potential scientific leaders to lead. It has 8 reasons having NN:

2,7,16,36,49,52,55,68 in Annex 1 to the Document. These popping up items are not taken into account, but still deserve being causes, and can get the following numbers:

125. Parenting modesty in family under the rule of patriarchal tradition in the Russian Empire and further in the Soviet Union;

126. Traditional tendency to subordination, preserved with the rejection of orthodoxy (in which all are "servants of God") and transition to a new religion - building of communism, in which the role of God was played by the Secretary General of the only ruling party;

127. Addiction to scientific activity in the absence of tendency to leadership and financial success.

128. Fear of stiff responsibility for preserving the secrecy of geological and large-scale maps, which were used in field works.

129. Fear of responsibility for the lives of the E. members.

130. Fear for *their own* life is not very developed among geologists working in extreme conditions.

In the analysis of the technological process of making malachite, individual coupling chains are revealed; this simplifies perception of both the method and its results.

Based on an analogy between the coupling chains in synthesis technology and processes known in nature, a hypothesis on connection of pattern formation in natural malachite with seasonal and climatic conditions in the deposit area was made.

3.10. More about the attention card and logic

Thing regarded as the cause can be (and perhaps always) not equal to the thing considered as a consequence. This is the reason for the fact that formulation of a consequence of one communication unit does not coincide with the formulation of cause for the other, despite their intuitively equal content. "The analogy is always suffering".

Rising stocks, let us say that the mathematical logic works definitely only on paper and in heads, but not in nature. The fact that, on the one hand, all living and inert matter clumps do not last forever, everything is constantly changing, only the speed of change is different. If this is neglected, on the other hand, any measurement of something is made with an error [6], therefore the law of identity $A=A$ collapses in the measurement moment, since $A \pm \delta \neq A \mp \delta$. By consistent application of the law of identity to the expression containing the sign of error δ one can pass from any point to any other. This implies admissibility - or rather, inevitability of compromises and identifying of different.

4 CONCLUSION

Last use of the Analysis method to identify the causes of malachite defects has showed the usefulness of retaining ranked by the appearance all maps of Attention centers as a document, the development of which will be probably until the liquidation of the production itself. Preservation is desirable because, as far as production goes, there are new problems, questions, ideas, solutions, and the Document history (if, YET, the factor birth is marked by a date) will be an active reflection and assistant for the Production itself. Such document - a form of comprehension monitoring and development monitoring - old ideas are not forgotten (they could be simply not timely) and do not interfere with the appearance of new ones. In the shared folder old sheets are at the bottom - fresh ones are put from above.

Existing computer technologies (FAST, Directed evolution, etc.) support thinking, BUT do not replace it. The decisive

role in all types of analysis of a system, situation, process remains with the human brain and its complex but at the same time elementary cognitive act - a guess, insight.

Russian site IntelTech [7] describes 13 most well-known methods for enhancing consciousness:

Brainstorming

Reverse brainstorming

Round-Robin brainstorming

"Shipboard council" (guided brainstorming)

Method of focal objects

Analogies. Synectics

"Analogies description" method

Dimension *Time Cost (DTC) operator*

Ideas workshop

Modeling with smart little people

Method of garlands, associations, and metaphors

"Six Thinking Hats" method

"Coaching" method

Described in the paper method is different from the above by focusing on the individual nodes in the system of different-quality Centers of attention, as well as by the appearance of table description of link networks. Different people tend to different ways of thinking, and it is hoped that there are brains for it, which will deem it convenient, and it will become the 14th method ("Analysis of Networks of Cause-and-Effect Relationships" - ANCER) in the above list.

Brain development has distinguished human from the animal world. Human after centuries of pride for its exclusivity became interested in the mind of animals and was surprised to learn that animals, using their brain, can also do much to save their life. And often, in this regard they are not inferior to human. It is enough to think about drug addicts, suicides, parents beating and abandoning their children, fanatics of religious self-destructing ideas. The success of those and others in improving human life and in deprivation of others lives to maintain one's own is great. Defense and attack are ubiquitous, and for the success of both one must understand the reasons (to have a reasonable basis) of the decision made and anticipate consequences. What is followed by What is History; What is generated by What, is Genesis. It is useful to know the reasons for previous disasters to reduce the risk of future ones. Unfortunately, the History teaches only scientists, the History does not teach the crowd. Crowds live with emotions, because Emotions are stronger than the reason, and it is so because they are primary, and - consequently - often interfere with acting "correctly" in new conditions that have changed under the influence of Mind.

Acknowledgements: The author is grateful to all the seminar participants, who for several months were enthusiastically engaged in resolving issues related to educational-production expeditions - a major part of the geological education in the country, in which large areas are far from roads and settlements. Special thanks to Prof. S.V. Chebanov for understanding and appreciation of the work done long ago and for the first mention of the Analysis in press.

BIBLIOGRAPHY

[1] T. G. Petrov, E. N. Protopopov, and A. V. Shuyskiy. Decorative grown malachite. Nature and technology. **Russian journal of earth sciences**, Vol. 13, ES2001. doi:10.2205/2013ES000529, 2013.

[2] S.V. Chebanov. Universal cognitive technologies and the problem of their development in education. **Actual problems of modern cognitive science**. Ivanovo. 2013. pp. 289-293. (in Russian).

[3] T.G. Petrov. Analysis of the overall situation during organization, implementation, and reporting of expeditions in LSU on the example of the Geological Faculty. **Results of workshop...** L. 1982 T.G. Petrov's archive. (in Russian)

[4] S. Saveliev. Energy approach to brain evolution. **Nauka i Zhizn**. 2006. 11. Pp.42-49. . (in Russian)

[5] Tomas G.Petrov, Sergey V. Moshkin. RHA(T)-System for Coding of Discrete Distributions and Their Alteration Processes. **Proc. The 3rd International Multi-Conference on Complexity, Informatics and Cybernetics IMCIC 2012**. 2012, pp. 12-16.

[6] L. Brillouin. **Scientific uncertainty and information**. New York and London: Academic press, 1964.

[7] <http://www.inventech.ru/pub/methods/>