Jorma Jormakka

SHOULD WE
CALL IT
RESEARCH?

Preface

When I was approaching 50 years, a long time ago, I bothered my colleagues far too much by asking them to read some of my less serious writings. I was too young, you see. A colleague of mine, Matti – no surname not to associate good people with my dubious blog - came up with the great idea that they could give me as a gift my own writings combined as a book and printed by the department. I liked it, narcissism or not, but it was a good idea, nice and original, especially as I had to do all the work for the gift. A fair revenge, that's how is saw it, and accepted.

 I fast wrote some articles, not that good but good enough, and they indeed printed the book. I have the copy in electronic form but I cannot use it. If I open this newer version of MS Word, it complains about not finding a some file for spelling and hangs.

 Never mind, I will use this draft. The final version of the book was much better edited and corrected by Matti before it was printed. This draft is full of typos and other things, but who cares. Not me anyway. The draft is more or less readable, even though some articles feel kind of old today.

 It was, you know, another time and another place.

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But is it Scientific? – Author's Preface

Today the question whether some research article is scientific or not, is easy to answer: it is not a matter of the content but of the publication forum. If the publication forum is peer-reviewed, then the article is scientific, if not, it is not scientific. In this sense none of these articles are scientific. There are alternative criteria. One is whether the article satisfies the conditions to be published in peer-reviewed, but this means filling certain formal conditions in addition to the content. There is also the criterion whether the article follows the main principles of scientific process, for instance it does not use assumptions of supernatural forces as arguments, does not make political statements, reasons in a sufficiently logical way, shows some knowledge of related scientific literature and does not falsify research results. There are even lighter criteria: does the article have some content that is scientifically interesting to a scientist? The author proposes this last criterion. It is a sufficient and necessary condition for an argument to be of interest to the scientific community. The other criteria are suitable to specialists but not to generalists. There is a too wide difference between different fields in order to agree on more strict conditions of what is scientific. It is very common to notice that pure scientists and mathematicians do not consider for instance futurology as a science. If a generalist makes research on one field and applies some set of criteria to what is scientific, and then works on another field with a different set of criteria, how does he explain to himself that when he wears one hat he calls some particular research rubbish, while if he wears another hat, he calls it perfectly good science.

The author has his education in various fields of pure and applied mathematics, in physics, theoretical physics and electronic engineering. All of these fields apply rather strict criteria to what is scientific, though for pure mathematicians theoretical physics is clearly below the level of real strict science. Later the author worked for a long time in telecommunications in upper layers, where telecommunications meets computer science. It turned out that this joining of two fields does not mean joining the theoretical research methods of the two fields, but instead the combined field had research problems that were not easily studied by theoretical methods of neither field. The author tried for a long time to develop theoretical research approaches of some practical interest to the field of upper layer telecommunications, but finally concluded that this field of techniques is constructive research and analysis is not a suitable way to approach the problems. Yet, the author never considered becoming a generalist, nor tried to formulate any character to what a generalist research might be. Generalist scientists were characters from the past: Aristotle, Leonardo, and presently, as we are taught in the school, science is far too wide for generalists.

The National Defence College (NDC) educates officers who consider themselves generalists: general staff officers, people capable of all trades. If a general staff officer becomes a researcher, he apparently should be a generalist researcher. At the moment this is not the case: a general staff officer makes a doctorate on one field. Let us for fun think what it could be if he would be asked to show research results in all of the fields of the university, though more articles on one particular field of this choice. This would be very interesting and give a unique character to dissertations from the generalist university. The

articles on other fields than the major field of the doctorate candidate would usually be seen through the eye glasses of the major field, but exactly for this reason we might obtain some original ideas, or at least ideas borrowed from so far away fields that they pass as original. Following this idea, we naturally would be forced to drop the formal scientific criteria from articles written on other fields than the field of major competence, because this would require a following a contradictory set of requirements and be harmful to researcher's eye of what is good research. Let us recall that the great generalists of the antiques and Renaissance past did not follow the individual criteria of each field but did all fields in their own ways. The only requirement would be that the articles have sufficient scientific interest. In the field of the major we naturally would require following the scientific criteria of the field also in formal matters.

The questions would be, is it possible and is there any sense in it? The author wrote basically for fun some articles on various topics and there is at least the sense that it is more fun to write on different topics than on narrow areas of technology. It is actually quite possible to write articles, even though they may not pass as research articles on the various fields. The question whether it has any sense to write articles on various topics is related to the question whether there is any sense in becoming a generalist. Not necessarily, not for everybody, but how much sense is there to write research articles on some narrowly defined field of technology or science?

The first article is the inaugurial talk the author gave in the Helsinki University of Technology (HUT) to the chair of information networks, a joint professorship between HUT and NDC. At that time it already was obvious to the author that research on upper layer issues of communication networks cannot be successfully turned into problems with a mathematical character. The second article is a talk in the National Days of Military Technology 2006 and you might consider it as some kind of technical view to the operational art. The article of ethics, or actually of the Gnostic view to Christian teaching, was written as a response to a joking request of two colleagues that an article on officer ethics would be needed. The article on university management may be seen as a response to the efforts that are being made in governmental institutes. The article on pedagogy was given in the meeting of the Scientific Society of Military Technology. Though there were only four listeners, there was some interesting discussion. The article on project management is naturally based on the author's personal experiences and it was written to the publication of the doctorate seminar on project practices. The article on asymmetric warfare is a talk to the National Days of Military Technology 2006, to the session of technology. The article of research strategy tries to be a constructive response to strategy building sessions in various work places. Futurology has an important e.g. in tactics and operational research and the article on prediction of future technology describes the author's thoughts on this issue. The article on evolution is a response to the highly nonscientific reaction of HUT professors towards a professor arranging a lecture series on the theory of Intelligent Design. The last article is homage to Leonardo Da Vinci, the first true scientist and the last true generalist. Only the author is not equally talented in drawing as Leonardo was.

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MITÄ TUTKITAAN PROTOKOLLAOHJELMISTOTUTKIMUKSESSA?

Tietoliikennetekniikassa on osa-alueita, joissa on selvää mitä ja miten tutkitaan, esimerkkeinä ovat perinteiset matemaattisesti suuntautuneet tietoliikennetekniikan osa-alueet: liikenneteoria, informaatioteoria, modulointi-, koodaus- ja kompressiomenetelmät. Näillä alueilla voidaan tutkia ongelmia esimerkiksi soveltaen analyysiä, simulaatioita ja mittauksia. Protokollaohjelmistojen tutkimuksessa nämä menetelmät eivät ole yhtä korostuneita ja usein eivät lainkaan sovellettavissa. On myös tekniikan alueita, joissa tutkimusmenetelminä ovat pääosin kirjallisuustutkimus, haastattelut, kenttätestit ja kehitettyjen menetelmien arviointi. Nämä ovat usein muodoltaan niin sanoittuja pehmeitä menetelmiä. Protokollaohjelmistot ei ole pehmeän tutkimuksen alue vaan puhtaan tekninen alue, mutta se on luonteeltaan konstruktiivinen. Kysymys soveltuvista tutkimusmenetelmistä on tärkeä sekä TKK:n Teletekniikan laboratorion, että MpKK:n Tekniikan laitoksen osalta.

Tietoliikenneprotokollaohjelmistot alueena sijoittuvat tietoliikenneohjelmisto-arkkitehtuurin ylemmille kerroksille. Ne liittyvät tietoliikenneverkon tiedonsiirtopalve-luihin ja käyttäjän muihin ohjelmistoihin, jotka eivät ratkaise tietoliikennekysymyksiä, esimerkiksi käyttöliitäntöihin, tietokantoihin, käyttöjärjestelmiin ja sovellusohjelmiin. Tietoliikenneprotokolla-ohjelmistot tarjoavat joko palveluita, lähinnä lisäarvon palveluita, käyttäjille tai hallitsevat palveluita tai tietoliikenneverkkoa. Esimerkkeinä tietoliikenneprotokollaohjelmistoista voidaan mainita yhteiskanavamerkinantoverkko (SS7), GSM:n kiinteän verkon osa (MAP), älyverkko (IN), verkonhallinta (TMN), oliopohjaiset arkkitehtuurit (TINA, CORBA, DCOM), agenttiteknologia, OSI-sovellusprotokollat ja Internet-arkkitehtuurin sovellusprotokollat.

Tietoliikenneprotokollat ovat automaatteja - automaatilla tarkoitetaan ohjelmaa, joka on jossain tilassa, ottaa vastaan syötteitä, tekee jotain toimintoja, lähettää vasteita ja siirtyy johonkin tilaan. Protokollat muodostavat suurempia kokonaisuuksia, joita kutsutaan arkkitehtuureiksi. Nämä protokollat toteutetaan sangen suurilla ja monimutkaisilla ohjelmistoilla, pääosin käyttäen niitä varten kehitettyjä määrittelymenetelmiä ja kehitystyövälineitä. Määrittelymenetelmät ja työkalut ovat sidoksissa ohjelmistoarkkitehtuuriin, joista kehittyneimmät välineet tarjoaa ITU-T:n OSI-pohjainen arkkitehtuuri, seuraavaksi parhaimmat löytyvät oliopohjaiselta puolelta ja vähiten menetelmiä ja työvälineitä on Internet-arkkitehtuurissa.

Tutkimuksen kannalta ongelmallista on, että tietoliikenneprotokollien ja erityisesti uuden arkkitehtuurin määrittely vaatii suuren määrän työtä. Työmäärä ja pyrkimys saada protokollat yleisesti hyväksytyksi johtaa siihen, että määrittely tapahtuu yleensä standardointiorganisaatioissa ja joka tapauksesa ryhmätyönä. Tästä seuraa, ettei omia uusia ajatuksia voi kovin helposti saada määrittelyihin mukaan, ainakin se vaatii hyvin kiinteää osallistumista standardointiin. Toisaalta määrittelyvaiheen vaatima työmäärä ei tietoliikennealalla ole rajoite.

Alan tutkimusmenetelmiä voidaan yrittää selvittää monella tavalla. Eräs lähestymistapa on lähteä yleisesti hyväksytyistä tieteellisistä tutkimusmenetelmistä. Muita mahdollisuuksia on tarkastella alan keskeisiä kysymyksiä ja johtaa niistä tutkimusongelmia. On myös mahdollista löytää alan saavuttamat päätulokset, ne luonnehtivat alaa ja sen tutkimusmenetelmiä. Hieman eria asia on tarkastella päämenetelmiä, joita käytetään alan julkaisuissa - näissä on tutkimuksellisempi lähtökohta, mutta tulokset eivät aina ole keskeisiä. Edelleen voidaan lähteä asettamaan

vaatimuksia ja toiveita siitä, mitä tutkimusten tulisi ratkaista. Lopuksi voi yrittää esittää näiden tarkasteluiden pohjalta soveltuvia tutkimusmenetelmiä ja tutkimusalueita.

Tiukimmin tieteellisistä menetelmistä analyysiin, simulaatioon ja mittauksiin painottuvien tutkimusmenetelmien ongelmana on, että protokollasuunnittelussa pyritään sopivaan kompromissiin erilaisista ominaisuuksista, joista vain osa on kvantitatiivisesti kuvattavissa - tällaisia ei-kvantitatiivisia ominaisuuksia ovat hallittavuus, kehitystyön tehokkuus ja yleinen hyväksyntä. Kvantitatiivisia ominaisuuksia, kuten suorituskyky ja turvallisuus voidaan tutkia matemaattisin menetelmin, mutta usein voi todeta, ettei ole edes tarkoituksena optimoida protokollia näissä suhteissa. Protokollaan halutaan esimerkiksi sisällyttää suuri valikoima ominaisuuksia, mutta ominaisuuksien määrän maksimointi ei voi tietenkään olla tavoitteena. Samanlainen on tilanne suorituskyvyn osalta, päämäärä on saavuttaa riittävä suorituskyky ja se usein ei ole ongelmallista. Selvien tavoitteiden puute kvantitatiivisten ominaisuuksien osalta johtaa siihen, että matemaattiset tarkastelut - joita tutkijat liiankin paljon pyrkivät tekemään - tällä alueella usein johtavat vain teoreettista mielenkiintoa omaaviin tuloksiin.

Muita tieteellisiä menetelmiä voi soveltaa, esimerkiksi kirjallisuustutkimusta ja haastattelututkimuksia on sovellettu MpKK:n tutkimusmenetelmissä muilla aloilla, mutteivat ne erityisesti sovellu akateemisiksi tutkimusmenetelmiksi tietoliikennetekniikan alueelle. Erilaisten järjestelmien vertaaminen on monessa tapauksessa yrityksien tutkimuslaitosten tutkimuksen todellinen päämäärä, kuitenkin TKK:n kannalta päämäärän tulee olla vielä tutkimuksellisempi.

Koska useimmat muilla aloilla käytettävät tutkimusmenetelmät vaikuttavat soveltuvan huonosti tai vain tiettyihin ongelmatyyppeihin protokollatutkimuksessa, on lähdettävä tarkastemaan mitä kysymyksiä alalla pyritään ratkaisemaan ja mitä tuloksia on saavutettu. Yleensä tietoliikenteessä keskeiset kysymykset on aika hyvin kuvattu OSI-mallin kerrosten yhteydessä: on selitetty millaisia asioita kukin kerros ratkaisee. Sovellustason osalta malli ei selitä tutkittavia kysymyksiä riittävästi

Keskeisiin kysymyksiin kuuluvat ainakin seuraavat asiat. Järjestelmien määrittely, joka on johtanut formaaleihin kuvauskieliin ja kehitysprosesseihin; toteutus, siis ohjelmistokehitystyön tekeminen onnistuneesti, joka on johtanut kehitystyövälineisiin; testaus, johon on myös kehitetty kieliä, metodologioita ja työvälineitä; yhteentoimivuus, jonka osalta tuloksia on vähemmän; järjestelmän ja sen tarjoamien palvelujen onnistuminen, jonka osalta on pääosin satunnainen lista onnistumisia ja epäonnistumisia; sekä kaikki tietoturvan ja palvelun ja verkonhallinnan kysymykset. Erilaisten ratkaisuiden vertailu on usein käytännössä esiintyvä kysymys kun on tarpeen päättää mihin tekniikkaan panostetaan. Nämä laajat kysymykset ovat niin suuria, että ne voivat ohjata ajattelua, mutteivät vielä johda tutkimusongelmiin. Listaa voidaan kuitenkin jatkaa yksittäisiin ongelmiin, joista voidaan saada tutkimukselle asetettavia kysymyksiä: esimerkkeinä voi mainita seuraavat: palvelun löytäminen, nimeäminen, osoitteistus; rajapintojen ja komponenttien valinta, neuvottelu yhteentoimivuuden saavuttamiseksi, liikkuvuuden tukeminen ja automaattinen koodin generointi.

Päätuloksia, joita tietoliikenneprotokollaohjelmistoissa on saavutettu, on löydettävissä. On muodostumassa käsitys millaisia rajapintoja ja komponentteja tarvitaan palveluiden toteuttamiseen - useassa arkkitehtuurissa esiintyvät samanlaiset komponentit. Sovellustason arkkitehtuurin rakenteen osalta vaikutaa siltä, ettei kerrosmainen rakenne ole paras, vaan tarvitaan kontrollielementtejä. Nimeämisongelmaan on löydetty hyviä

ratkaisuja, mutta ongelma on laajemmin sidoksissa löytämisongelmaan - liikkuvuuden tukemiseksi löytäminen ei ehkä perustu nimeen ja osoitteeseen vaan ominaisuuksiin. Määrittelyn osalta formaalit kuvauskielet, datan määrittelykielet ja templaattikielet ovat selvästi päätuloksia, samoin kuin verifioinnin ja testauksen menetelmät. Alempien kerrosten käytön osalta on löydetty pieni joukko tarpeellisia rajapintoja: rajapinta ominaisuuksista neuvottelemiseen, etäisproseduurikutsu, pitkän datan lähetys, kaksi erilaista reaaliaikarajapintaa. Lisäksi alempien kerrosten käyttö voidaan kuvata esimerkiksi sopivilla templaateilla. Oliosuuntautuneen suunnittelun soveltaminen tietoliikenteeseen on joitain lisätuloksia, kuten metodeja sisältävät rajapinnat. Kehitystyövälineet voidaan myös laskea alan päätuloksiin.

Näissä päätuloksissa on luonteenomaisena se, että ne ovat konstruktioita - on määritelty uusi kieli, kehitetty uusi työväline tai identifioitu tarpeelliset rajapinnat joita käytännössä tarvitaan. Kunkin tuloksen osalta on hyvin vaikeaa tai mahdotonta tieteellisessä mielessä sanoa, että se olisi paras ratkaisu tai edes parempi kuin muut vaihtoehdot. Se, mitä pystytään sanomaan on, että on löydetty mielenkiintoinen ja hyvältä vaikuttava ratkaisu, jossa on yleensä keksinnöllisyyttä mukana.

Päämenetelmät, joita käytetään alan julkaisuissa, eroavat alan päätuloksista, koska alan päämäärä on kehittää määritelmiä ja tuotteita, ei julkaisuja. Julkaisuissa on havaittavissa esimerkiksi seuraavia päätyyppejä. Yksi päätyyppi on, että standardointiryhmä selittää lyhennettynä standardin pääsisällön - kansainvälinen projekti voi samassa mielessä selittää lyhennelmän päätuloksistaan. Tämän julkaisutyypin erikoispiirre on, että jos vastaavan tuloksen julkaiseen vähemmän merkittävä organisaatio, niin tuloksen kiinnostavuus on pienempi. Toinen päätyyppi kertoo, että jokin järjestelmä on toteutettu ja todettu toimivaksi - tällaisessa julkaisussa toteutus kuvataan ja kerrotaan kokemuksista. Enemmän uutuusarvoa on julkaisutyypillä, jossa jotain järjestelmää on laajennettu joillakin ominaisuuksilla - kuvataan laajennus ja todetaan, että menetelmä toimii prototyyppiasteella. Eräänä julkaisutyyppinä on kehittää uusi kääntäjä tai muu kehitystyöväline - työväline kuvataan ja väitetään, että sitä käyttäen kehitysprosessi nopeutuu ja virheiden määrä pienenee, mitään tieteellistä perustelua ei voida tietenkään antaa väitteen tueksi. On myös julkaisuja, joissa kuvataan piloottitoteutuksen avulla saatuja kokemuksia ja mahdollisesti vertaillaan eri ratkaisuja. Edelleen on havaittavissa seuraava tieteellisempi julkaisutyyppi: poimitaan pieni, usein epäolennainen, erityisongelma suorituskyvyn, luotettavuuden, virheettömyyden tai turvallisuuden alueelta ja käsitellään sitä matemaattisluonteisin menetelmin.

Voi todeta, että useimmat menetelmät ovat hyvin työläitä tutkimusmenetelmiä perustuen suuren järjestelmän määrittelyyn tai toteutukseen, niistä saatavat tulokset eivät silti ole tarkasti ottaen tieteellisiä. Tästä osittain johtuu, ettei alan julkaisuja esiinny kovinkaan paljon tieteellisissä aikakausilehdissä vaan pääosin konferensseissa ja projektiraportteina. Kokeiluihin painottuvan tutkimuksen eräänä haittapuolena korkeakoulututkimuksen kannalta on se, että vaikka uusimman tekniikan kokeileminen tuo hetkellisesti mielenkiintoisia tuloksia, niin uusimpien järjestelmien hankkiminen on kallista tai ei lainkaan mahdollista korkeakoululle.

Tutkimusmenetelmien ja ongelmien johtaminen vaatimuksista on tietynlainen sovellus ylhäältä alas etenevää suunnittelua. Jos lähdetään TKK:n ja MpKK:n tarpeista, niin TKK:n osalta vaatimuksena on, että tutkimusten tieteellinen taso on korkea ja erityisesti soveltuva tieteellisiin jatkotutkintoihin. MpKK:n kannalta tilanne on osittain toinen,

koska päämääränä on antaa upseereille soveltuva koulutus tekniikan alueella ja päästä tasokkaaseen tutkimukseen, mutta samalla vastata puolustusvoimien tarpeisiin. Näitä tarpeita ovat ostettavan tekniikan eri vaihtoehtojen arvointi, tekniikan seuraaminen sangen laajalla rintamalla, kehitystrendien tunnistaminen. Nämä päämäärät ovat sangen yhteneväisiä tekniikkaa hyödyntävien muiden instituutioiden tarpeiden kanssa, erityisesti TKK:n ulkopuolisella rahoituksella tehtävän tutkimuksen tilaajien päämäärien kanssa. Erotuksena on se, että puolustusvoimien kiinnostus suuntautuu johtamisjärjestelmiin ja telealalla toimivien yritysten kiinnostus TKK:n projekteissa suuntautuu kapeammin TKK:n professuurin alueelle.

Tekniikan seuraamisessa tärkeä päämäärä on ennustaa mitä tekniikkaa käytetään tulevaisuudessa 3-5, 10 tai 15 vuoden aikataulussa. Tietoliikennejärjestelmien tulevaisuuden ennustaminen on erityisen vaikeaa mikäli halutaan ennustaa mikä tekniikka on tiettynä aikana yleisesti kiinnostavaa - tämä kiinnostuksen kohde muuttuu nopeasti ja arvaamattomasti. Jos toisaalta halutaan vain ennustaa millaista tekniikkaa on käytössä, niin alan investointien suuruus tekee sen mahdolliseksi - toteutetut järjestelmät ovat niin kalliita, että ne ovat käytössä sangen pitkään ja niiden kehitys on vienyt kauan. Kymmenen vuoden päästä käytössä oleva tekniikka on jo sangen pitkälle suunniteltu ja sinänsä yleisessä tiedossa, ongelmana on vain seurata kaikkia mahdollisia tekniikoita liian pienellä määrällä henkilöitä. Pidemmän aikavälin trendit ovat myös selvillä: liikkuvuus, laajakaistaisuus ja verkon älykkyys ovat joitakin teknisiä trendejä.

Pyrkimys seurata uutta tekniikkaa johtaa siihen, että tutkimusprojekteissa tutkittava tekniikka muuttuu sangen nopeasti, noin 1-2 vuoden jänteellä. Tämä nopea kiinnostusalueen muutosvauhti on ristiriidassa pitkäjänteisen tutkimustyön kanssa, koska se pakottaa opettelemaan suuren määrän uusia käsitteitä - käsitteitä ja akronyymejä alalla on riittävästi.

Ala siis on teknillinen, muttei erityisen tutkimuksellinen. Yhteenvetona voi todeta, että tutkimuksen tekemistä vaikeuttavat seuraavat seikat: määrittelyvaihe on suurten standardointijärjestöjen tekemää ryhmätyötä, määrittelyissä pyritään kompromisseihin useista tekijöistä eikä erityisesti optimoimaan mitään erityistä kriteeriä, ala muuttuu sangen nopeasti ja pelkkä tekniikan seuraaminen on usein päämäärä, alan julkaisut eivät yleensä sisällä tieteellisiä tutkimusmenetelmiä, joita voi seurata omassa tutkimuksessa, alan keskeiset kysymykset ovat harvoin matemaattisesti formuloitavissa ja alan päätulokset ovat luonteeltaan konstruktioita.

Seuraavaksi yritän esittää tutkimusalueita, joissa edellä esitetyt näkökulmat on pyritty ottamaan huomioon. Tarkempia tutkimusaiheita en esitä tässä yhteydessä joko siitä syystä, että en ole niitä valinnut tai siitä syystä, että ne ovat salaisia - tai kummastakin systä.

Voidaan lähteä alan kahdesta keskeisestä kysymyksestä: tietoliikennejärjestelmien suunnitteluprosessista ja järjestelmien vertailusta. Suunnitteluprosessissa on ensimmäisenä vaiheena vaatimusmäärittely tai business-malli. Business-malli nimeä käytetään nykyään myös laajemmassa mielessä - jos yrityksen liiketoiminta ei toimi, voidaan sanoa, että business-mallit eivät ole vielä hioutuneet. Tarkoitan tällä käsitteellä suppeampaa asiaa - oliopohjaisiin suunnittelumenetelmiin ja ITU-T:n TMN-arkkitehtuuriin kuuluu suunnittelun vaihe, jossa kuvataan perusideoiden käsitteet, toimijoiden roolit ja osin vaatimukset kaavioina, joita kutsutaan business-malliksi. Tällaiseen malliin ei yleensä kuulu analyysiä eikä erityisiä päättelyitä järjestelmän

mielekkyydestä. Siitä huolimatta tällainen malli on pohjana suunnittelun seuraavalle vaiheelle, jossa määritellään järjestelmän tarkempi toiminta. Tätä suunnitteluvaihetta seuraa toteutus, toteutuksen testaus ja lopulta, mikäli business-mallissa on jotain vikaa, toteutetun järjestelmän hyllyttäminen eräänä lukuisista epäonnistuneista järjestelmistä.

Toinen vaihtoehto business-mallin sijaan on vaatimusmäärittely. Se toimii olennaisesti samalla tavalla. Vaatimusmäärittely laaditaan ilman erityisiä perusteluita ja se ohjaa suunnittelun muita vaiheita. Vaatimusmäärittelyn tai business-mallin ajatellaan syntyvän esimerkiksi markkinatutkimusten pohjalta, mutta on vaikea sanoa syntyykö se yleensä minkään pohjalta. Vaatimusten pohjalta voidaan kehittää esimerkiksi uusi palvelu ja käyttää siinä sangen kehittyneitä palvelunkehitysmenetelmiä, kuten älyverkon SIB-pohjaista palvelunkehitys-menetelmää tai oliopohjaisia, hieman keskeneräisiä, mutta kehittyviä menetelmiä. Suunnittelun ensimmäinen vaihe näyttää olevan heikoin lenkki ketjussa.

Järjestelmien vertailussa lähdetään myös vaatimusmäärittelystä. Lisäksi laditaan erilaisia uhkakuvia. Eri vaatimusten täyttyminen todetaan esimerkiksi määrittelyiden tai harvemmin toteutusten testauksen pohjalta. Toteutuksia ei usein voi testata, koska määrittelyjä ei vielä vertailuvaiheessa ole edes toteutuettu. Vaatimusmäärittelyn pohjalta voidaan edetä erilaisilla monikriteerimenetelmillä ja saada jonkinlaisia tuloksia, joita voi eri tavalla tulkita. Erityisen uuden alueen uhkakuville muodostaa kilpailullinen monioperaattoriympäristö.

On mahdollista kehittää tätä suunnittelun vaihetta. Jos verrataan tietoliikenneverkon sunnitteluun, niin todetaan, että jälkimmäisessä tapauksessa ongelma kuvataan optioitavana funktiona - ongelma formuloidaan kysymyksenä verkon elementtien sijoittelusta ja mitoituksesta siten, että kustannus minimoidaan pitäen verkolle tarjottua liikennekuormaa annettuna suureena. Varsinainen parannus ei ole niinkään jonkin funktion optimointi vaan se, että on löydetty kvantitatiivisia suureita: kustannus, kapasiteetti, palvelun laatu. Tietyissä tapauksissa voidaan business-mallin yhteydessä löytää saman kaltaista menettelyä. Kaikissa palveluissa, joissa jaetaan kapasiteettia voidaan tunnistaa kvantitatiiviset suureet kustannus, kapasiteetti ja palvelun laatu. Näiden lisäksi on muita kvalitatiivisia suureita, joista osaa voidaan kuvata uhkakuvilla, esimerkiksi turvallisuusuhkia, hallittavuutta ja saatavuutta. Business-malli voisi sisältää kaaviot siitä kuinka palveluidean tulisi toimia, mitä uhkakuvia siinä on. Näihin kaavioihin liitetään kvantitatiiviset ja kvalitatiiviset tarkastelut.

Itse vaatimuskriteeristöä voidaan ja tulisi kehittää, mitä esimerkiksi tarkoittaa hallittavuus - tätä voidaan luonnehtia kuvaten sangen yksityiskohtaisesti geneerisiä toiminnallisuuksia, joita hallintajärjestelmällä tulisi olla. Yleensä vain vaatimusmäärittelyssä ja vertailutaulukossa esiintyy joukko termejä, joilla ei ole selvää sisältöä ja joiden pisteytys on lähes mielivaltaista. Tilanne on samanlainen käyttäjän näkökulmasta: käyttäjän vaatimukset tarpeellisten piirteiden osalta ovat sangen selkiytymätön alue. Toistaiseksi osataan paremmin kuvata käyttäjän vaatimuksia turvallisuuden ja suorituskyvyn, siis palvelun laadun, suhteen, mutta on vaikeampi sanoa millaisia piirteitä tai ominaisuuksia käyttäjä palvelulta haluaa.

Tietyt asiat business-mallin osalta ovat helposti lähestyttäviä ja niistä voidaan osoittaa jo saavutettuja tieteellisiä tai teknisiä tuloksia: esimerkiksi erilaisten tariffi-käytäntöjen vaikutus ja toteutettavuus ja geneeristen palvelunluontirajapintojen määritteleminen.

Business-mallin kehittäminen johtaa kahteen vaikeasti ratkaistavaan ongelmaan: käyttäjien toiminnan mallintaminen ja tulevaisuuden ennustaminen. Huolimatta näistä ilmeisistä ongelmista minusta vaikuttaa, että tällä alueella voidaan saada tutkimuksellisa tuloksia käyttäen tietoliikennejärjestelmien asiantuntemusta, analyysiä tai loogista päättelyä, sopivaa formalismia ja kenttäkokeita.

Toinen tutkimusalue liittyy verkon ja palveluiden hallintaan. Hallinnassa on viisi osa-aluetta: vikojen konfiguraation, laskutuksen, suorituskyvyn ja turvallisuuden hallinta. Useimpaan näistä alueista, vikoihin, laskutukseen, suorituskykyyn ja turvallisuuteen liittyy mittauksi. Mittausmenetelmät ovat osa-alue, jossa päästään menetelmiin, algoritmeihin, matemaattisiin tarkasteluihin ja menetelmien yhdistämiseen sovellustason protokolliin. Mittausalue on myös kuulunut maassamme kauan harrastettuihin tutkimusalueisiin, erityisesti puhelinalalla. Tästä seuraa, että yhteydet standardointiin ja tutkimukseen muualla ovat olemassa.

Turvallisuuden, suorituskyvyn ja vikojen hallinta liittyy hyvin luontevasti informaatiosodankäyntiin ja siinä mielessä soveltuu MpKK:n kannalta tutkimusalueeksi. Liikkuvuuden tuomat erityispiirteet näissä asioissa ovat myös MpKK:n kannalta erityisen kiinnostavia. Varsinaisiin kryptologisiin algoritmeihin ei ole niinkään tarpeen keskittyä, sillä kryptologia ei ole julkinen tiede ja sitä tutkitaan muissa TKK:n professuureissa. Lisäksi salausmenetelmät, samoin kuin pääsyn valvonta ovat sangen helposti ratkaistavissa nykyisillä menetelmillä. Kryptologiset protokollat toisaalta liittyvät läheisesti protokollatutkimukseen, samoin kuin ne turvallisuuskysymyksiet, jotka seuraavat palvelun estosta verkon ylikuormituksen tai reitityksen sotkemisen avulla, ja myös ne ongelmat, jotka aiheutuvat siirtyvästä toteutettavasta koodista sekä protokollien ja toteutusten virheistä. Kaikki nämä ongelmat ovat toistaiseksi ratkaisemattomia turvallisuuskysymyksiä.

Suorituskyvyn mittaamisen ja hallinnan osalta voidaan soveltaa liikenneteorian menetelmiä, kuitenkin sillä erolla, että sovellustasolla tiedetään mikä tyyppisiä rajapintoja tarvitaan ja voidaan selvittää millaista liikennettä ne tuotavat. Verkkotasollahan täytyy yleensä olettaa, että sovelluskerroksen tarjoama liikenne voi olla mitä vain. Näin ei kuitenkaan ole: perusrajapinnat alkavat olla selvillä: niihin kuuluvat etäisproseduurikutsu, posti-tyyppinen lähetys, tapahtumaksi sidotut toiminnot, reaaliaikarajapinnat ja eräitä muita rajapintoja. Parempien hallintarajapintojen määrittely on tarpeen, MIB-tyyppisiä rajapintoja on määritelty, mutta matalamman tason geneerisiä rajapintoja tarvittaisiin MIB:ien toteuttamiseksi.

Näitä verkon- ja palvelunhallinnan osa-alueita voidaan tutkia analyysillä, simulaatioilla ja laboratorioon rakennetulla kokeilualustalla, koska on kyse sangen rajattujen mekanismien toiminnasta. Voidaan ajatella esimerkiksi lähestymistapaa, jossa identifioidaan jokin ongelma, kehitetään siihen ratkaisu, analysoidaan se ja todetaan se toimivaksi.

Tässä lyhyessä puheessa olen, ehkä apologina, pyrkinyt selittämään käsitykseni siitä, miksi protokollatutkimus ei ole tieteellisempää, kuin se käytännössä on, mutta myös esittämään tutkimusmenetelmiä ja alueita, joilla tutkimusta parhaiten voitaisiin TKK:n ja MpKK:n yhteisprofessuurissa 5:n vuoden aikana kehittää.

VOITTAMISEN KAAVA JA JOHTAMISJÄRJESTELMÄ

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1.   Johdanto

Tasavahvojen osapuolten välisen kamppailun lopputulos ei yleensä ole arvattavissa. Mikäli toisella osapuolella on menetelmä, jolla se useammin voittaa, sanomme että tämä osapuoli on löytänyt voittamisen kaavan.

Ensimmäisen maailmansodan alussa keskusvalloilla oli voittamisen kaava. Tosin kaikki ei mennyt suunnitelmien mukaan ja keskusvallat hävisivät. Voittamisen kaava on helppo perustella. Se seuraa matemaattisesta epäyhtälöstä $\pi > 1$. Näin ollen ympyrän halkaisija on lyhyempi kuin ympyrän kehä, joten keskellä oleva osapuoli voi nopeammin siirtää joukkoja reunan johonkin kohtaan kuin reunalla oleva osapuoli. Siirtämällä joukkoja saavutetaan paikallinen ylivoima jossain ratkaisupisteessä ja reunalla olevan osapuolen joukot voidaan voittaa peräkkäisillä operaatioilla. Tämä on ns. sisälinjojen teoria. Se on sovellus Baron Antoine Henri de Jominin kirjassaan "Precis de l'Art de Guerra" [1] esittämistä strategisista prinsiipeistä. Jomini, toisin kuin yleisesti ajatellaan, ei esitä matemaattista teoriaa sodalle vaan löytää sodankäynnin lakeja lähinnä vain strategian osalta. Yhteenvedossa teoriastaan ([1] s. 328-331) hän esittää olennaisimmat tulokset teoriastaan ja nostaa sisälinjojen teorian tärkeimpien oivallusten joukkoon. Myös esipuheen laatija Charles Messenger korostaa Jominin strategisia tuloksia (ks. [1] s. viii.). Jominin ajattelu juontaa juurensa Napoleonin sotien analysoinnista ja Jominin kirja perustelee hänen havaintojaan seikkaperäisesti, mutta jo vanhentuneena teoksena se ei liene enää kovinkaan luettu. Napoleon epäonnistui lopulta, vaikka sovelsikin voittamisen kaavaa ja joukkojen tuomista eri teitä samaan kohtaan tarkalleen oikeaan aikaan, siis israelilaisen jatkuvan virtauksen kaltaista toimintamallia. Keskusvallat epäonnistuivat von Schlieffenin suunnitelmaan sisältyneen riskin vuoksi. Englanti vastoin odotuksia kunnioittikin turvatakuitaan Belgialle, Helmut von Moltke ei seurannutkaan Schlieffenin suunnitelmaa tarkasti ja liike pysähtyi asemasodaksi. Lisäksi Englannin saartamiseen tarvittu sukellusvenesota johti USA:n liittymiseen sotaan. Jomiin voittamisen kaavan edellytys, muissa suhteissa tasavahvat osapuolet, ei ollut enää voimassa, mutta voittamisen kaavahan ei joka kerta takaa voittoa.

Matemaatikkoa ehkä kiusaa π :n käyttö yllä olevassa perustelussa. Voidaan ajatella, että sisälinjojen teoria seuraa paremmin kolmioepäyhtälöstä tai siitä, että ympyrä on konveksi. Esimerkiksi, jos asetetaan yksikköympyrä origoon ja molempien osapuolten armeijat ovat pisteessä (-1,0), niin ympyrän halkaisijan kautta pisteeseen (1,0) on kaksi yksikköä ja kehän kautta π yksikköä, joten epäyhtälön tulisi olla $\pi > 2$. Tässä on kyse Jominin ajattelun väärinymmärryksestä. Kummankin osapuolen joukot on jollain tavalla sijoitettu suljetun alueen reunalle. Sisäpuolella olevalla osapuolella on todennäköisesti lyhempiä teitä keskittää tarvittava osa joukoistaan tiettyyn ratkaisupisteeseen kuin ulkopuolella olevalla osapuolella, ja yleensä matkasta tulee paljon pidempi kuin kehää

pitkin kuljettaessa. Koko armeija ei yleensä siirry tiettyyn pisteeseen. Piin käytöllä korostan, että kysymys on sotanäyttämön metrisestä ominaisuudesta, metriikkana kuljetusten vaatima aika. On sotanäyttämöitä, joissa keskusta on vaikeakulkuinen ja reunan ulkopuolelta siirrot ovat nopeita. Esimerkiksi jos sotanäyttämö on vuoristoinen saari ja ulkopuolella olevalla osapuolella on laivasto. Tällöin voisimme sanoa, että tälle näyttämölle $\pi < 1$. Jominin geometrinen käsittely ei ole sodan kuvaus euklidiselle tasolle, vaan käsitteillä on niiden todellinen merkityksensä ja niitä vain kutsutaan geometrisilla termeillä. Siis piste ei ole pistemäinen, viivalla on leveyttä ja ympyrä ei ole aina ympyrämuotoinen. Kirjoittajan määrittelemällä suureella π ei ole numeroarvoa 3.14... eikä epäyhtälöiden tarkalla muodolla ole merkitystä. Matemaattisempikin formulointi ajatukselle löytyisi, muttei ehkä soveltuisi tähän alustukseen.

Carl von Clausewitzin "Von Kriege" ei Charles Messengerin (esipuhe [1]) mielestä juurikaan eroa Jominin ajatuksista, vaikka viittaus sukkelaan päähän tarkottanee Jominia, ja Clausewitz suoraan hylkää sisälinjojen teorian ([3] s. 84-85). Saksalaisessa sodankäynnissä sisälinjojen teoria kuitenkin esiintyy voittamisen kaavana molemmissa maailmansodissa Schlieffenin suunnitelmana eikä saksalaisen sodanjohdon Clausewitzin teoksen opiskelu ollut tätä voittamisen kaavaa muuttanut. Clausewitzin 800-sivuisesta teoksesta on tapana julkaista lyhennelmiä, kuten [2] ja [3]. Tämä johtunee siitä, että olennaiset erot Clausewitzin ja Jominin ja yleensä 1800-luvun sotataidon välillä voidaan kiteyttää lyhyesti esitettäviin periaatteisiin. Clausewitzilta on lähinnä Napoleonin toimintatavan mukainen painotus joukkojen tuhoamiseen ja painopisteisiin vaikuttamiseen. Jominillahan on kahden tyyppisiä päämääriä: maantieteelliset strategiset pisteet ja tilanneriippuvat strategiset pisteet, joista viimeksimainitut liittyvät joukkojen tuhoamiseen ([1] 339). Clausewitzilta on myös sodan näkeminen väkivaltaisena toimintana ja politiikan jatkeena. Yhdistämällä Clausewitzin ajatukset voittamisen kaavaan saadaan Hitlerin toimintamalli, joka Clausewitzilta peri myös kaksi virhettä. Clausewitz piti Napoleonin hyökkäystä Moskovaan oikeana strategiana ([2] s. 301) – sehän on painopiste, kun taas englantilaisen sotaopin mukaan tämä rikkoi sodankäynnin kolmea kieltolausetta: "Älä marssi Moskovaan, älä syö keltaista lunta, äläkä sotkeudu Balkanin asioihin." ([4] s. 331). Jomini puolestaan arveli, etteivät hänen strategiset prinsiippinsä skaalaudu Venäjän suurille etäisyyksille, jossa kuljetusyhteydet venyvät ja ratkaisutaisteluita voi välttää. Clausewitzin toinen virhe oli, että Clausewitz, toisin kuin Jomini, ei tarkastellut maihinnousua vastustajan linnoittamalle rannikolle. Jominin kirja taas oli kauan West Pointin oppimateriaalina ([1] xi). Voittamisen kaava siis epäonnistui myös toisessa maailmansodassa.

Verkkokeskeisen sodankäynnin doktriinissa USA on korvannut Clausewitzilaisen joukkojen tuhoamisen Sun Tzu:lta [5] omitulla joukkojen taistelukyvyn estämisellä. Ilmeisesti tässä on lähinnä kyseessä Jominin maantieteellisten strategisten pisteiden valinta Jominin tilanneriippuvien strategisten pisteiden sijaan ja perusteluna lienee poliittinen sopivuus pikemminkin kuin sotilaallinen sopivuus. Maantieteelliset yhteydet on nyt korvattu tietoliikenneyhteyksillä. Edelleen on kysymys taisteluvoiman nopeasta keskittämisestä strategiseen pisteeseen. John Wardenin ilma-asetta korostavassa strategiassa on eroteltu vaikuttamisen viisi kehää, sisimpänä kehänä on johto. Ilmahyökkäys, tarkkuusaseet, tilannetietoisuus ja verkottuminen voidaan nähdä välineinä,

joilla voimien keskittäminen voidaan tehdä. Itse voittamisen kaava on muuttumaton: paikallinen ylivoima ratkaisupisteissä voidaan saada nopeammalla liikkuvuudella. John Boydin nopea päätöksentekosykli, aloitteellisuus, monipuolisuus, harmonia ja nopeus ovat juuri liikkuvuutta hyödyntävä salamasodan kaltainen toimintatapa.

Näitä neljää voittamisen kaavan teoreetikkoa Napoleon ([6] s.69 laskee Napoleonin teoreetikoksi, toki kaikki nämä suuret sotateoreetikot ovat myös olleet sodan ajan joukkojen komentajia), Jomini, Clausewitz ja Sun Tzu voitanee kutsua neljän koplaksi. Heidän oppiensa tuloksena on suuri määrä loistavia voittoja, mutta lopulta sodat on hävitty. Neljän koplan teorian tärkein vastateoria löytyy, ei lainkaan yllättävästi, Maon sissisotataktiikasta, joka voidaan nähdä myös Vietkongin sissistrategiassa, terrorismissa ja Irakin sodan nykyvaiheessa. Teoria voidaan pelkistää matemaattiseen muotoon Hilbertin aksioomaksi: kahden pisteen välissä on aina muita pisteitä. Näin ollen ratkaisupisteitä voidaan lisätä siihen saakka, että varsinaista ratkaisupistettä ei lainkaan ole eikä peräkkäisesti toisiaan seuraavilla operaatioilla voi koskaan tuhota kaikkia pisteitä. Suuremman liikkuvuuden antama paikallinen ylivoima ei siis voi johtaa ratkaisutaisteluun tai taistelumahdollisuuksien poistamiseen. Sissi- tai vastarintasodankäynnin teoria on sukua myös paljon vanhemmalle sodankäynnin muodolle. John Keegan [7] on päätynyt omissa pohdinnoissaan siihen, että sodankäynnin päämäärä ei yleensä ole ollut voitto. Se on yleisemmin ollut rituaalinen taistelu tai/ja ryöstö-, hävitys- tai kostoretki. Tällaisella sodalla ei ole ratkaisutaisteluita eikä niitä edes pidetä tarpeellisina.

Tämä artikkeli tarkastelee voittamisen kaavaa ja sen vastamenetelmää sekä muita voittamisen kaavoja johtamisjärjestelmien näkökulmasta. Johtamisjärjestelmällä on merkittävä roolinsa verkkokeskeisen sodankäynnin voittamisen kaavassa. Ensiksi joudumme tarkastelemaan johtamisjärjestelmiä lyhyesti.

2.   Mikä on johtamisjärjestelmä?

1800-luvun sodankäynnin teoreetikot von Clausewitz ja Jomini kuvastavat aikaa, jolloin johtamisjärjestelmiä nykyaikaisessa merkityksessä ei vielä ollut. Sähköisen tiedonsiirtoverkon sotilaskäytön aloittaminen ajoitetaan yleensä Amerikan sisällissotaan, jossa lennättimellä oli merkittävä johtamisrooli. Marconi keksi radion 1896 ja langattomien yhteyksien sotilaskäyttö alkoi Krimin sodan aikaan. Johtamis-järjestelmänimitystä johtamisen teknisestä ratkaisusta alettiin käyttää 1980-luvulla.

Johtamisjärjestelmä on tekninen apuväline, jonka avulla johtaja johtaa alajohtoportaita. Johtaminen voi perustua puheelle, jolloin tarvittava järjestelmä on huutoetäisyyttä pidemmille etäisyyksillä jokin tietoliikenneverkko. Yleensä johtamisjärjestelmä on enemmän kuin puhekanava. Johtamisjärjestelmä sisältää johtamissovelluksen tietoliikenneverkon päällä. Tämä johtamissovellus antaa johtajalle päätöksentekoon tarvittavia tietoja, kuten tilannekuvan, paikkatietoja ja muuta informaatiota.

Johtamisjärjestelmään vaikuttaminen estää joukkojen johtamisen ja tästä syystä johtamisjärjestelmä tulee suojata. Vaikuttamismahdollisuudet ovat fyysinen

vaikuttaminen epäsuoran tulen tai erikoisjoukkojen avulla, elektroninen sodankäynti, lähinnä häirintä, sähkömagneettisen pulssin käyttö ja tietoverkkosodankäynti, lähinnä palvelunestohyökkäykset, virukset ja järjestelmiin murtautuminen.

Fyysisen vaikutuksen pienentämiseksi verkon solmut voidaan linnoittaa, tehdä niistä liikkuvia tai lisätä solmujen ja linkkien määrää siten, että verkko kestää tappioita.

Häirinnän vähentämiseksi voidaan käyttää suuntaavia antenneja ja lisätä häirinnän vastatoimia, kuten virheenkorjausta tai häiriöksi tunnistettavan signaalin suodatusta.

Johtamisjärjestelmän tiedustelu antaa arvokasta tietoa vastapuolesta. Menetelminä tiedusteluun ovat elektroniseen sodankäyntiin kuuluva signaalitiedustelu ja tietoverkkosodankäyntiin nykyään laskettava salakuuntelu. Tiedustelun vaikeuttamiseksi on monta menetelmää. Suuntaavia antenneja käyttäen pyritään vähentämään vastustajalle kuuluvaa signaalia. Hajaspektritekniikka erilaisilla tavoilla toteutuettuna antaa menetelmiä piilottaa signaali kohinaan. Salakuuntelun vaikeuttamiseksi käytetään kryptologisia menetelmiä.

Johtamisjärjestelmien avulla voidaan myös antaa vastustajalle harhaanjohtavia tietoja, jolloin puhutaan harhautuksesta.

Johtamisjärjestelmätekniikka sisältää siis seuraavia osa-alueita johtamisjärjestelmien kannalta tarkasteltuna:
    Tekninen alusta:
- Tietoliikenneverkot (siirtoverkot, reititinverkot, taktiset verkot)
- Hajautetut tietojärjestelmät (hajautettu alusta, palvelut sen päällä, arkkitehtuuri)
- Johtamissovelluksiin tietoa tuottavien sensorien tekniset ratkaisut

    Johtamisjärjestelmän käsittelemä informaatio
- Johtamissovellukset (eri puolustushaarojen ja aselajien vaatimukset)
- Paikkatiedon esitysmuodot (topografiset kartat, muu informaatio)
- Sensorien tuottaman tiedon muuntamisen tilannekuvaksi (sensorifuusio)

    Teknisten uhkien analysointi ja torjuminen
- Elektronisen sodankäynnin tekniset ratkaisut (tiedustelu, häirintä, harhautus)
- Sähkömagneettiset pulssiaseet (EMP, HPM)
- Tietoverkkosodankäynnin tekniset ratkaisut (tekninen tietoturva)

Teknisenä kysymyksenä johtamisjärjestelmätekniikka on kokoelma erilaisia tekniikan osa-alueita ja sangen kaukana johtamisesta. Peruskysymys on kehittää entistä parempi tekninen järjestelmä ja hallita siihen kohdistuvat uhat. Johtamisjärjestelmätekniikan kehitystä ohjaavat käyttäjän vaatimukset perustuvat asioihin, jotka eivät ole puhtaasti teknisiä, kuten:
- Johtamisjärjestelmän sijoittuminen johtamiseen
- Sodan kuvan muutos
- Informaatiosodankäynti yleensä
- Tekniikan kehityksen suuntaviivoja

Myös nämä on otettava huomioon. Itse substanssiosuus, johtaminen ja sodankäynnin taito, eivät näissäkään asioissa tule korostetusti esille.

Tietotekninen järjestelmä

Johtamisjärjestelmä sisältää strategisen, operatiivisen ja taktisen tasan johtamissovelluksia. Käyttäjälle näkyvä osa näistä sovelluksista liittyy suoraan sodankäynnin taitoon. Teknisen ratkaisun puolelle sovellukset vaikuttavat vain tarvittavan siirtokapasiteetin, yhteyden laadun, verkon liikkuvuuden ja suojausmene-telmien tason osalta. Tekniseltä kannalta johtamisalustan päällä pyöritettävä sovellus voisi olla mikä hyvänsä viestinvälitys-, puhe- ja tietokantatoimintoja sisältävä graafisen käyttöliitynnän omaava sovellusohjelmisto.

Strategien tasan sovellus antaa strategisen tasan tilannekuvan sisältäen strategisen tiedustelun tietojärjestelmän.

Operatiivisen tasan tietojärjestelmä sisältää operaatioiden suunitteluun ja johtamiseen tarvittavia toimintoja. Näitä ovat sodan ajan joukkojen muodostaminen, ryhmittäminen, joukkojen siirrot ym.

Johtamisjärjestelmän taktinen tasa muodostuu eri puolustushaarojen johtamissovelluksista.

Ilmavoimien johtamissovellus antaa ilmatilannekuvan, joka muodostuu erilaisten sensorien keräämästä tiedoista. Tärkeimpinä sensoreina ovat erilaiset tutkat. Johtamissovelluksella johdetaan lentueita joko puheella tai datalla.

Merivoimien johtamissovellus antaa meritilannekuvan, joka myös muodostuu paljolti tutkasensoreiden keräämästä tiedosta. Johtamissovelluksella johdetaan laivueita, lippueita ja viirikoita. Merivoimien johtamissovelluksen vasteaikavaatimus ei ole aivan yhtä kriittinen kuin ilmavoimissa, mutta yhteydet ovat pitkiä eivätkä aina hyvälaatuisia. Data soveltunee paremmin johtamiseen kuin puhe.

Maavoimien johtamisjärjestelmä sisältää taktisen tasan johtamissovellutuksen aselajeittain jakautuneena. Jalkaväen osalta sovellus on taktisen tasan johtamissovellus. Taktisella tasalla tilannekuva esitetään karttapohjaan sidottuna. Johtamissovellus antaa teknisen ratkaisu jolla havainnot siirretään johtamispaikalle ja komennot anntetaan johtamispaikalta joukoille. Tykistön osalta tarvitaan tulenjohtosovellus. Ilmatorjunta tarvitsee myös tulenjohtosovelluksen. Se on luonteeltaan ehkä lähempänä ilmavoimien johtamissovellusta.

Johtamissovellukset ovat vielä nykyään eri puolustushaarojen ja aselajien kehittämiä sovelluksia ja näiden tietojärjestelmien yhteentoimivuus on puutteellista ja tietoa voidaan siirtää vain korkeimmalla tasalla järjestelmästä toiseen. Yhteisoperaatioden tarpeellisuus on kasvanut ja tärkeä kehityssuunta johtamisjärjestelmissä on mahdollistaa teknisellä

tasolla puolustushaarojen yhteisoperaatiot ja eri kansakuntien johtamisjärjestelmien yhteiskäyttö.

Kehitettävälle johtamissovellutukselle muodostetaan yhteinen arkkitehtuuri, joka lienee palvelusuuntautunut arkkitehtuuri Web-keskitasonohjelmiston päällä. Siis saman-kaltainen ratkaisu, kuin siviilimaailman WWW-pohjaisessa palveluverkkoarkki-tehtuurissa. Kansainvälisen yhteentoimivuuden syistä suunnittelussa noudatetaan Naton tietomallia.

Tietoliikenneverkko

Tietoliikenneverkon rakenne yleensä sisältää strategisen tasan kiinteän verkon ja taktisen tasan langattomat verkot. Kiinteässä verkossa voi myös olla langattomia liitäntäverkkoja suuremman liikkuvuuden saamiseksi esimerkiksi prikaatin esikunnille.

Kiinteän verkon solmut ovat kiinteitä, millä tarkoitetaan, että niiden siirtäminen on suhteellisen hidasta. Siirtotiet kiinteässä verkossa voivat olla langallisia tai langattomia. Toisinaan ajatellaan, että koko verkko voi olla langaton. Kiinteällä verkolla on hyviä ja huonoja puolia. Langalliset yhteydet antavat suuremman kapasiteetin ja niiden tiedustelu on vaikeampaa, joskaan ei mahdotonta. Haittapuolena kiinteässä verkossa on, että kiinteän verkon solmut ja langalliset yheydet voidaan helpommin tuhota fyysisellä vaikuttamisella. Toisaalta sensorit, esimerkiksi valvontatutkat, ovat vaikeasti liikutettavia ja suuri osa strategisesti tärkeistä kohteista on joka tapauksessa paikallaan. Näin ollen verkko on kuitenkin kiinteä. Toisena haittapuolena on, että kiinteä verkko on vain omalla alueella, joten toimittaessa oman alueen ulkopuolella yhteydet kiinteään verkkoon muodostuvat pitkiksi. Nämä haittapuolet eivät tee kiinteää verkkoa tarpeettomaksi.

Taktinen verkko on liikkuva ja hyökkäävien joukkojen osalta pääosin langaton verkko. Taktisessa verkossa voi olla langallisia osiakin, kuten prikaatin esikunnan kulkuneuvoja yhdistävä langallinen verkko, mutta langallisen verkon pienempi liikkuvuus, hitaampi pystytys ja haavoittuvuus fyysiselle vaikuttamiselle ovat usein suurempia haittoja kuin langallisilla yhteyksillä saatavat edut: suoja elektroniselta sodankäynniltä ja varmempi toimivuus eri olosuhteissa. Taktisen verkon alin tasa muodostuu kenttäradioista. Kenttäradiosta suuri osa tulee olemaan digitaalisia radioita. Digitaalisissa kenttäradioissa on usein IP-pohjainen tiedonsiirto ja digitaalisten kenttäradioiden avulla voidaan muodostaa taktinen internet MIL-STD-188 standardin mukaisesti. Käytännössä tällainen verkko on kapasiteetiltaan sangen pieni. Yhteen radioon liitettävien radioiden verkon koon suhteen on myös rajoituksia. Näistä syistä johtuen taktiseen verkkoon kuuluu usein taktinen runkoverkko, jolloin runkoverkon solmut ovat kenttäradioita suurempikapasiteettisia. Runkoverkon solmut ovat liikkuvia ja yhteydet langattomia. Tulevaisuuden tekniikkana runkoverkon osalta nähdään nykyään ohjelmisto-radiotekniikka. Siinä käytetään myös IP-protokollaa.

Koko tietoliikenneverkko muodostaa hajautetun alustan johtamisjärjestelmä-sovellutukselle. Kiinteän verkon suuremmasta tiedonsiirto- ja prosessointikapasiteetista

johtuen palvelinosat johtamisjärjestelmän sovelluksista ovat yleensä kiinteän verkon solmuissa. On täysin mahdollista, että osa solmuista on siirrettäviä tai jopa liikkuvia.

3.   Onko voittamisen kaavaa?

Alustuksen pyydettiin tarkastelevan johtamisjärjestelmiä filosofiselta kannalta seuraavien kysymysten valossa:
- Onko voittamisen kaavaa?
- Onko Carl von Clausewitz enemmän oikeassa, vaiko Antoine Henri de Jomini?

Modernissa sodankäynnissä sodan kuva on olennaisesti muuttunut Clausewitzin ja Jominin ajoista. Hyvän lyhyen yhteenvedon saa esimerkiksi katsauksesta Ison Britannian vuoden 1945 jälkeisiin sotilaallisiin operaatioihin [4]. Niissä ei korostu mikään voittamisen kaavan soveltaminen, vaan usein ajaudutaan poliittisesti vaikeisiin tilanteisiin, joissa sotilaallisen voiman käytön osalta kädet on osittain sidottu.

Voittamisen moderni pohjapiirustus ilmenee parhaiten Yhdysvaltain kahdessa Irakin operaatiossa. Tämä johtamisen kaava etenee seuraavasti. Ilma-asella tuhotaan vastustajan ilmavoimat mieluiten kentälle tai konesuojiin. Yleensä tulisi ensin tuhota puolustajan valvontaverkko, mutta Persianlahden sodassa hyökkäävät koneet lensivät niin matalalla, etteivät tutkat nähneet niitä ja puolustavan osapuolen tutkat tuhottiin samalla aikaan kuin lentokoneet. Kun on saavutettu täydellinen ilmaherruus tuhotaan vastustajan johtamisyhteydet, jolloin joukkojen taistelutahto ja kyky laskee. Ilma-aseella ja paremmilla panssarivaunuilla tuhotaan vastustajan panssarivoimat. Epäsuoran tulen laukaisualustojen suhteen on vielä joitakin ongelmia, mutta ohjusaseiden vaikutukset onnistutaan pääosin eliminoimaan. Mielipiteeseen vaikuttamisella ja omia tappioita minimoimalla kotirintaman ja kansainvälinen mielipide saadaan pidettyä riittävän myötämielisenä.

Voiton jälkeen tosin tilanne ei välttämättä selvene vaan helposti päädytään saman tyyppiseen tilanteeseen, kuin missä Iso-Britannia on ollut Pohjois-Irlannissa, Kosovossa ja muissa vastaavissa kriisipesäkkeissä. Näin on käynyt myös Irakissa. Erityisesti kysymystä, voidaanko Sun Tzun oppien mukaisesti voittaa tuhoamatta vastustajaa, ei vielä voida vastata tällaisten esimerkkien valossa, koska sota ei ole ohi ensimmäisen vaiheen päättyessä.

Puolustava osapuoli voi tätä voittamisen pohjapiirustusta vastaan käyttää etäisyyttä ja pyrkiä epäsuoralla tulella, esimerkiksi risteilyohjuksilla, tuhoamaan hyökkääviä maavoimia. Mikäli maasto tarjoaa suojaa sinkoaseet voivat myös olla tehokkaita panssaroituja joukkoja vastaan, samoin miinoitteet. Jos puolustajan lentoaseesta jää osa tuhoamatta, niin se voi tehdä paikallisia iskuja ja ainakin häiritä hyökkäystä. Sotilaallisesti tämä voittamisen pohjapiirustus saattaa olla toimiva ratkaisu aavikko-olosuhteisiin heikkoa puolustajaa vastaan, mutta ei välttämättä yleisesti.

WWW:stä läytyy yksi voiton kaava [10]. Mig-3 pilotti Aleksandr Ivanovich Porkryshkiniä selostavalla sivulla kerrotaan, kuinka venäläiset löysivät tavan voittaa omia koneitaan nopeammat saksalaiset hävittäjät. Venäläiset keksivät lentää korkeammalle kuin saksalaiset hyökkäävät koneet. Korkealta alemmas syöksyttäessä venäläisten koneiden nopeus kasvoi suuremmaksi kuin saksalaisten ja kaksintaistelussa nopeus ratkaisee. Tämä voiton kaava perustuu siis energian säilymisen lakiin, mutta se on liian rajoitettu tämän artikkelin tarpeisiin.

Vertaillaan nyt eräitä mahdollisia voittamisen kaavoja.

Voittamisen kaava 1 (sisälinjojen teoria)
Tasavahvojen osapuolten välisessä kamppailussa keskustassa oleva osapuoli voittaa reunoilla olevan osapuolen.
Perustelu: Keskustassa oleva osapuoli pystyy saavuttamaan joukkojen siirrolla paikallisen ylivoiman ratkaisupisteissä. Jos sisäpuolella olevan osapuolen liikkuvuus on pieni, kuten jos moottoroitu yksikkö motitetaan tielle, niin se ei pysty keskittämään voimiaan. Samoin käy, jos keskellä olevalla osapuolella ei ole tarvittavaa tulivoimaa.

Paikallisen ylivoiman käyttö voidaan ajoittaa ainakin kreikkalaiseen kenraaliin Epaminondasiin, jonka menetelmään kuului rintaman toisen puolen vahvistaminen (s. 41 [9]). Liikkuvuuden käyttö paikallisen ylivoiman saamiseksi oli jo Aleksanteri Suuren menetelmänä. Napoleonia voitanee kuitenkin pitää sodankäynnin teoreetikoista ajatuksen esilletuojana. On selvää, että kaikilla sankarikuninkailla ja sotapäälliköillä on ollut jokin voiton kaava, mikäli he ovat jatkuvasti voittaneet tasavahvojen osapuolten väliset kamppailut.

Jotain yleistä havaintoa voi yrittää muotoilla. Taktiikan peruselementteinä mainitaan usein tuli, liike ja suoja. Tasavahvoja tai hieman vahvempia vastustajia vastaan sotineiden valloittajien menetelminä on usein ollut liike ja seuraavalla tärkeystasolla tulivoima. Näin voinee sanoa esimerkiksi Aleksanteri Suuresta, Attilasta, Tsingis Khaanista, Timur Lenkistä, Napoleonista ja Hitleristä. Heikompia vastustajia vastaan sotineet imperiumin rakentajat ovat ehkä enimmäkseen perustaneet toimintansa aseiden ja harjoituksen avulla saatuun tulivoimaan, toiseksi linnoittamisen antamaan suojaan ja vasta näiden jälkeen liikkuvuuteen. Tällaisina valloittajina voinee nähdä roomalaiset, eurooppalaiset siirtomaavallat, USA intiaanikansojen kukistajana ja Venäjä Siperian valloituksessa. Valloitusten vaikutus on ollut suurempi jälkimmäisessä ryhmässä ja se varmaankin johtuu siitä, että heikommat vastustajat on sulautettu valloittajan maahan siirtämään omaan väestöön tai tuhottu. Itse sodan brutaalisuudessa eroja näiden kahden ryhmän välillä ei löytyne, mutta ryhmien sisällä on aika suurtakin vaihtelevuutta.

Pohditaan seuraavaksi muodostaako USA:n sodankäynnin menetelmä Irakin sodissa uuden voittamisen kaavan. Mahdollisia voittamisen kaavoja tarkasteltiin Sotatekniikan laitoksen Technica Belli 2006 päivillä, joten tällöin kehitetyt kaavat on nimetty Technica Belli mukaisesti. Tykistökenraali Nenosen kunniaksi järjestetty "Technica Belli"-tilaisuus soveltuukin mainiosti voittamisen kaavan puhdiskeluun, Nenonenhan oli merkittävä tykistöstrategian kehittäjä. Heti alkuun on syytä korostaa, ettei operaatiotaito ja taktiikka

kuulu Sotatekniikan laitoksen ja varsinkaan kirjoittajan leipälajeihin, eikä tämän alustuksen asiasisältöä jokaisessa kohdassa tule pitää Maanpuolustuskorkeakoulun korkeaa osaamistasoa kuvaavana.

Lienee mahdotonta pitää USA:ta ja Irakia tasavahvoina osapuolina. Formuloidaan väite seuraavasti:

Voittamisen kaava 2 (Technica Belli). *Mikäli toinen puoli on ylivoimainen jokaisessa olennaissa suhteessa (aseet, tilannekuva, johtaminen, taktiikka, harjoittelu, resurssit), niin tämä puoli todennäköisesti voittaa ensimmäisen vaiheen sodasta. Voitto voidaan saavuttaa verkkokeskeisen sodankäynnin avulla nopeasti ja hyvin pienillä omilla tappioilla.*
Perustelu: Ensimmäinen väite on ilmeinen. Toinen väite on mielenkiintoinen. Osittain se on seuraus Voittamisen kaavasta 1, koska tässäkin tilanteessa voidaan saavuttaa paikallinen ylivoima ratkaisupisteissä. Nopeus on seuraus nopeista kuljetuksista. Omien tappioiden pienuus voisi olla seuraus Lanchasterin yhtälöstä, joka ennustaa pienempiä tappioita suuremmalle osapuolelle, mutta se lienee seuraus paremmasta tekniikasta ja osaamisesta. Mikäli paikallinen ylivoima voidaan keskittää hyvin nopeasti, niin sodasta tulee lyhyt ja omat tappiot voivat jäädä pieniksi sen vuoksi, että niitä ei ehdi syntyä. On syytä korostaa, että aikatekijän ratkaisee vain liikkuvamman osapuolen tarvitsema aika. Periaatteessa sota voidaan siis voittaa mielivaltaisen lyhyessä ajassa ja mielivaltaisen pienin omin tappioin. Kuten voittamisen kaavat yleensäkin, tämäkin voi epäonnstua.

Seuraava kaava ei ole triviaali, mutta ehkä helpommin perusteltavissa. Perusteluna sodan käymisen innovaatioita lisäävälle vaikutukselle voidaan todeta, että ensimmäisessä maailmansodassa keksittiin kaasuase ja panssarivaunu. Lentokone oli jo keksitty, mutta hävittäjät ja pommikoneet ovat ensimmäisen maailmansodan tuotteita. Toisen maailmansodan osalta voi mainita rakettiaseet, rynnäkkökiväärin ja tietyin varauksin atomiaseen.

Voittamisen kaava 3 (Technical Belli). *Voittamisen kaava on panostaa sotatieteisiin ja käydä koko ajan pieniä sotia.*
Perustelu: Voittaminen perustuu innovaatioihin, jotka usein ovat teknisiä, mutta voivat myös olla taktisia ja joissain tapauksissa pedagogisia. Innovointi perustuu osin ajatteluun. Jos lisätään ajattelua esimerkiksi lisäämällä tutkimuspanosta, niin innovaatioiden määrä nousee. Innovaatiot liittyvät myös ongelmiin. Jos ongelmia ei tiedetä, niin niitä ei voi ratkaista. Näin ollen innovatiivisuus kasvaa, mikäli käydään sotaa. Siis pienen sodan käynti koko ajan lisää innovaatioiden määrää.

Sotataidon edustajat usein korostavat strategian ja taktiikan osuutta todeten Clausewitzin tavoin, että osapuolilla on kuitenkin samanlainen tekniikka. Tämä käsitys on paljolti totta kahden saman tasoisen valtion välisissä sodissa. Tekniikan edistysaskeleet ovat usein olleet pääsyy sodan kuvan muuttumiseen. Itse sodassa tekniset edistysaskeleet eivät ole yleensä tuoneet pitkäaikaista etua, koska sodan molemmat osapuolet hankkivat nopeasti uutta tekniikkaa. Säännöstä on poikkeuksia. Tekniikka voidaan pyrkiä pitämään salassa, kuten oli rauta-aseiden ja edelleen on atomiaseiden osalta tilanne. Tekniikka voi olla liian

kallista tai hidasta rakentaa sodan aikana, kuten on ollut laivastojen osalta toisinaan tilanne. Voittamisen kaavassa 3 tarkoitetaan hieman eri asiaa. Ei yksittäisiä edistysaskeleita, vaan koko joukkoa toisiaan seuraavia innovaatioita. Näiden avulla tekniikan tasojen ero osapuolten välillä voidaan säilyttää pidempiä aikoja.

Neljäs voittamisen kaava esittää kuinka puolustaja tietyillä edellytyksillä voittaa sodan toisen vaiheen.

Voittamisen kaava 4 (Technica Belli). *Hyökkääjä ei voi tukahduttaa sinnikästä ja johdettua vastarintaa käyttäen sivistyneitä menetelmiä, joten se joutuu lopulta hyväksymään kompromissin tai vetäytymään.*

Perustelu: Kun sodan ensimmäinen vaihe on päättynyt ja maa on valloitettu ja asevoimat saatu puolustuskyvyttömiksi seurannee vastarinta. Mikäli johtamisjärjestelmää ei ole onnistuttu tuhoamaan ja johtajia eliminoimaan niin vastarinta on keskitetysti johdettua. Jos johtaminen on saatu sekoitettua niin vastarinta perustuu erillisiin sangen itsenäisesti toimiviin soluihin. Kummassakin tapauksessa vastarinta johtaa sabotaaseihin ja pommihyökkäyksiin sekä miinojen ja tarkka-ampujien käyttöön. Hyökkääjä ei yleensä onnistu rauhoittamaan maata ja mahdollisuus kansalaissotaan tai kansannousuun säilyy.

Hyökkääjä voi rauhoittaa maan useallakin menetelmällä, joita ei kuitenkaan helposti voida käyttää nykyaikaisessa sodassa. Näitä ovat kansan siirto toiselle alueelle, mikäli sellainen on käytettävissä. Esimerkkitapauksia löytyy historiasta paljon, kuten israelin heimojen siirto Assyrian takamaille Babylonian toimesta 570 eKr ja Stalinin tekemät kasakoiden rauhoittamissiirrot 30-luvulla. Rauhattomat kansat voidaan myös internoida, heikentää ja sulattaa väestöön. Esimerkkinä voi mainita Amerikan intiaanikansojen rauhoittamisen. Yleisesti käytetystä menetelmästä siirtää omia kansalaisia alueelle löytyy paljonkin esimerkkejä. Riittävän kova hallinto myös toisinaan onnistuu rauhoittamaan alueen. Roomalaisten hajoita ja hallitse politiikka voi myös estää useimmat rauhattomuudet. Machiavellin suosittelema menetelmä on myös yleisesti käytetty. Siinä onnistuneen hyökkäyksen päätteeksi tuhotaan nopeasti vallassapitäjät ja korvataan heidät hyökkääjän valitsemilla kilpailijoilla, jonka jälkeen armeija vedetään pääosin pois, mutta maahan siirretään omia kansalaisia [8]. Näistä vastatoimista johtuu, että sana "sivistyneitä" on aivan olennainen tässä voiton kaavassa.

Yksinkertainen voittamisen kaava "hyökkää aina" ei ilmeisestikään aina toimi. Mitä voidaan sanoa käänteisestä menetelmästä:

Voittamisen kaava 5 (Technica Belli). *Älä koskaan hyökkää, pitäydy hyökkäävässä puolustuksessa.*
Perustelu: Tappiot hyökkäyksessä ovat usein suuremmat kuin puolustuksessa. Puolustuksen tulee olla hyökkäävää, koska puhdas puolustus lopulta murtuu.

Useat sotateoreetikot pitävät kylläkin hyökkäävää puolustusta hyökkäystä voimakkaampana menetelmänä. Silti voiton kaavana periaatteessa on ongelmia. Tämä voittamisen kaava ei ota huomioon sitä, että tappio johtaa joukkojen vähenemiseen myös

taistelusta luopumisena ja tappiolle joutuneessa osapuolessa tapahtuvan sekaannuksen aiheuttaman taistelukyvyn laskun seurauksena. Hyökkääjän joukot sitä vastoin aiempina vuosisatoina kasvoivat onnistuneiden taisteluiden seurauksena, koska hyökkääjiin liittyi uusia voimia. Tämä voittamisen kaava on yleisessä tilanteessa virheellinen, mutta edullisessa maastossa puolustettaessa se voi toimia.

Tarkastellaan lopuksi kaavoja, joita käytetään taistelun matemaattiseen mallinnukseen. Perusesimerkki niistä ovat Lanchesterin yhtälöt. Niillä on rajoitettu soveltuvuus. Parempana esimerkkinä voiton kaavoiksi voi kutsua lukuisia voimien laskenta-menetelmiä. Näitä ovat erimerkiksi Dupoyn menetelmät. Ne ovat todellakin kaavoja ja taistelun, ehkä koko sodan, kulku voidaan jollain tarkkuudella kuvata lausekkeella, joka ottaa huomioon taisteluun vaikuttavat seikat. Seuraavassa yksi ehdotus, joka ei ole vielä puettu kaavamuotoon.

Voittamisen kaava 6. (Technica Belli)
Voittaminen on kolmesta osapelistä muodostuva peli, Osapelit ovat strategisen operatiivisen ja taktisen tasan pelit. Kussakin pelissä on useampi kuin yksi osapuoli ja kullakin osapuolella on parametrit (Tools, Skill, Will). Kussakin pelissä kukin osapuoli voi tehdä hyökkäysoperaation. Hyökkäysoperaation lopputulos vaikuttaa Will-parametriin. Operaation lopputulos riippuu Tools, Skill ja Will-paramterista. Jos jonkin pelaajan Will-parametri laskee tietyn tason alapuolelle, niin se luopuu pelistä.

Tämän kaltainen kaava, vaikka se olisikin kuvattu matemaattisena kaavana, ei ole tämän artikkelin mielessä sellaisenaan voittamisen kaava. Se on vain tilanteen kuvaus. Kaavaa voi käyttää voittamisen kaavana, mikäli sotapäällikkö pyrkii toimimaan sen mukaisesti saadakseen voiton tasavahvojen osapuolten kamppailuissa. Sotapäällikkö voi hyvin pystyä arvioimaan sotilaallisen voiman kummallakin puolella, mutta silti olla kykenemätön saavuttamaan kaavan mallintamaa ylivoimaa ja voittoa.

Tässä yhteydessä on hyvä tarkastella seurapelejä, kuten shakki ja bridge. Shakissa on lopputilanteita, joissa pelinappuloiden määrä ja sijainti ratkaisevat tilanteen. Niissä voidaan siis laskea voima ja päätellä lopputulos. Pelin alkuvaiheissa useimmat pelaajat eivät, toisin kuin shakinpeluuohjelmat, laske numeerisesti nappuloiden sijainnin avulla tilanteen voimaa. Peli perustuu strategiaan, eikä pelinappuloilla ole voima-arvoa muuten kuin suhteessa suunniteltuun operaatioon. Hyvänä strategisena päämääränä on hallita siirtymälinjoja. Usein keskeinen asema on edullinen, mutta aina on tärkeää, että asemat antavat hyvän liikkuvuuden erilaisten mahdollisesti syntyvien tilanteiden suhteen. Tämä muistuttaa suuresti Jominin linjoja ja strategisia pisteitä ja mahdollisuuksien säilyttämistä edullisilla strategisilla asemilla. Voisi ajatella, että shakissa syy siihen, ettei laskelmia tarvita liittyy sen täyteen informaatioon ja mikäli pelissä olisi epävarmuutta, niin laskelmia tulisi tehdä. Helposti voidaan perustella, että näin ei ole. Bridgessä esimerkiksi on epävarmuutta ja siinä lasketaan kortteja, mutta laskemisen syynä on se, että pakassa on tietyt kortit, joten kaikkien täytyy jossain vaiheessa tulla peliin. Syy siis ei ole se, että kyseinen peli voitettaisiin laskemalla todennäköisyyksiä, vaan se, että pelaajien informaatio kasvaa koko ajan laskemisen seurauksena. Pelissä, jossa epävarmuus pysyy samana pelin kuluessa, ei laskemisesta ole yhtä suurta hyötyä. Sellaisissa peleissä

olennaista on strategia, siis jokin ajatus jonka mukaan peliä kehitetään, ei laskeminen. Sota pelinä tietenkin sisältää suurta epävarmuutta. Koska epävarmuus ei pienene, niin merkittävin onnistumisen menetelmä ei ehkä ole epävarmuuden hallinta, koska sitä ei kuitenkaan voi hallita, vaan tiettyjen strategisten periaatteiden noudattaminen. Voittamisen kaava ei siis ole taisteluvoiman laskemisen kaava, vaan se on strategisten periaatteiden löytäminen ja seuraaminen.

Voitanee sanoa, että voittamisen kaava on olemassa. On jopa monta voittamisen kaavaa. Pääosin voittamisen kaavat perustuvat paikallisen ylivoiman saavuttamiseen ja menetelmä siihen on suurempi liikkuvuus, mikä vaatii johtamisen apuvälineitä, kuten johtamisjärjestelmää. Muitakin mahdollisuuksia on: Fredrik Suuren voittamisen kaava esimerkiksi perustui harjoittelun avulla saatuun suurempaan tulivoimaan [9]. On todettava, että mikään esitetyistä voiton kaavoista ei ole olennaisesti uusi eikä takaa pysyvää voittoa koko sodalle.

Johtamisjärjestelmän osuus verkkokeskeisen sodankäynnin voittamisen kaavassa on olennainen. Tarkastellaan tätä kysymystä seuraavaksi.

4. Voittamisen kaava ja johtamisjärjestelmä

On perusteltua olettaa, että moderni taistelun voiton kaava rakentuu verkkokeskeisen sodankäynnin idealle. Verkkokeskeinen sodankäynti vaatii yhteisoperaatioita ja erittäin liikkuvaa sodankäyntiä. Johtamisjärjestelmille aiheutuu näistä syistä melkoisia muutospaineita. Tarkastellaan seuraavaksi verkkokeskeisen sodankäynnin perusideoiden kantavuutta voittamisen kaavana.

Johtamisjärjestelmä verkottaa yhteen sensorit, asejärjestelmät, joukot ja päätöksentekijät. Verkkokeskeisessä sodankäynnissä usein perustellaan tämän verkottumisen etuja nopeutuneella päätöksentekosyklillä. Ajatellaan, että nopeampi päätöksentekosykli johtaa siihen, että vastustaja joutuu reagoimaan sen sijaan, että se voisi suunnitella omia operaatioitaan. Vasta-argumentti tälle ajatukselle on, että nopeampi päätöksentekosykli vain tuottaa vääriä päätöksiä nopeammin. Ajatus saa tukea Jominin pohdiskeluista: Jomini selittää strategian päätöksenteko-ongelman seuraavasti: yleensä vaihtoehtoja on hyökätä vasemmalta, oikealta tai keskeltä. Joku näistä vaihtoehdoista on selvästi huonompi kuin muut ja jäljellä olevista tulee valita parempi. Tällaisessa tapauksessa ratkaisevaa on valita oikea suunta, ei valitsemisen nopeus. Manööverissä joukkojen siirron nopeus on usein ratkaisevaa, mutta joukkojen siirron nopeus ei riipu kovinkaan suoraan päätöksenteon nopeudesta vaan joukkojen liikkuvuudesta. Lukuunottamatta suurta päätöksenteko-nopeutta vaativia tilanteita, esimerkiksi kaksintaistelua ilmassa tai mmuita aikakriittisiä operaatioita, on vaikea löytää hyviä perusteluja erityisen nopean päätöksentekosyklin eduille.

Toinen verkkokeskeisyyden merkittävä periaate on tilannetietoisuus. Ajatuksena on paikallistaa vastustaja tarkasti missä vain paikassa maailmassa. Tämän periaatteen osalta on suuresti epäiltävä sen teknistä toteutettavuutta, minkä terroristien paikallistamisen

vaikeus on jo osoittanut. Paikan piilottaminen on periaatteessa helpompi tehtävä kuin globaali paikantaminen. Paikantaminen vaatii tunnistamisen, koska muuten kohteita pienessäkin avaruudessa on liian paljon. Tunnistaminen perustuu tunnusmerkkeihin ja paikantaminen välttämättä perustuu tunnettuihin tunnusmerkkeihin. Näitä tunnusmerkkejä voidaan välttää mikäli ne tiedetään. Vastaavat tunnusmerkit omaavien harhautusmaalien luominen on periaatteessa aina mahdollista. Pyrkimys täydellisen tilannetietoisuuden saavuttamiseen saattaa hyvin olla virheellinen idea.

Yhteisoperaatioden mahdollistaminen on johtamisjärjestelmien kannalta yksi tärkeistä päämääristä. Se on myös saavutettavissa teknisesti. Voittamisen kaavan kannalta yhteisoperaatioiden tarve johtuu paljolti itse aiheutettujen omien tappioiden minimoimisesta. Vastustajan aiheuttamia tappioita ei kuitenkaan voida poistaa rajoittamatta oman yhteiskunnan toimintaa liikaa, koska mikäli vastustaja ei voi aiheuttaa tappioita asevoimille, niin se voi edelleen aiheuttaa tappioita yhteiskunnalle. Tavoitetta omien tappioiden minimoimisesta ei siis oikeastaan voi saavuttaa. Yhteisoperaatiokyky voidaan saavuttaa, mutta se ei välttämättä ole primääritavoite.

Moderniin sodankäyntiin kuuluva teknistyminen johtaa taistelukentän tyhjyyteen ja ammattimaisin sotilaisiin. Trendi ei suoraan kuulu verkkokeskeiseen ideologiaan, mutta sitä ei voi käytännössä erottaa siitä. Tässä trendissa on ongelmana se, että vastaavanlainen tilanne syntyi jo keskiaikana, kun raskas ratsuväki oli jonkin aikaa voittamaton. Jatkossa vastakeinoja löytyi useampia ja lopulta päädyttiin Napoleonin ajan massa-armeijoihin. Tämä kehitys ei siis ole yleinen trendi, kuten tulivoiman ja liikkuvuuden kehittyminen, vaan trendi, joka voi kääntyä tekniikan edistysaskelten myötä, nykyään hyvinkin nopeasti. Ongelmahan on, että muutamat hyvin kalliit järjestelmät voivat olla haavoittuvia useiden halpojen järjestelmien vastaiskulle.

Itse verkkokeskeisyys sisältää haavoittuvuuden tietoturvahyökkäyksiä kohtaan. Operatiivisen verkon suojaaminen tietoturvaratkaisujen avulla lienee mahdollista, sen sijaan yhteiskunnan tietoverkkojen suojaaminen voi olla mahdotonta. Kyseessä on balanssi turvallisen, mutta hyvin jäykän ja vähemmän turvallisen, mutta joustavamman järjestelmän välillä. On mahdollista, että jäykkä turvallinen järjestelmä jää jälkeen tekniikan kehityksestä suljetun luonteensa vuoksi. Näin ollen joustavampi, mutta turvattomampi, järjestelmä korvaa sen tarjoamalla parempaa toiminnallisuutta. Jos näin todella on, niin turvallinen ratkaisu yhteiskunnan ja kustannussyistä osin myös sotilassektorin verkoille saattaa olla saavuttamaton tavoite. Tietoturvahyökkäysten vaarallisin piirre on niiden halpuus suhteessa järjestelmiin, joita verkoilla hallitaan.

Voimme todeta, että verkkokeskeisen sodankäynnin perusideat eivät ole yhtä vakuuttavia kuin sisälinjojen teorian yksinkertainen idea. Sisälinjojen teoria lienee epäonnistunut aina kun sitä on yritetty soveltaa. Missä määrin sama kohtalo tulee verkkokeskeisen sodankäynnin teorialle jää nähtäväksi.

Verkkokeskeisen sodankäynnin perusideoiden heikkoudet eivät vielä riitä murtamaan voittamisen kaavaa. Tarvitaan joitakin uusia innovaatioita, joilla poistetaan verkkokeskeisen sodankäynnin selviä etuja. Hahmotellaan lopuksi joitakin periaatteessa

mahdollisia innovaatioita, ja koska alustus on sotatekniikan puolelta, niin valitaan teknisiä innovaatioita.

Ehdotus 1. Jalkaväkimiinojen poistuminen kansainvälisten sopimusten seurauksena poistaa yhden esteen liikkuvalta sodankäynniltä, koska näillä miinoilla estetään panssarimiinoitteiden raivaaminen. Tarvitaan siis jalkaväkimiinojen korvaaja. Siihen on esitetty erilaisia sensoriverkkoja ja epäsuoraa tulta. Jokin sensori siis havaitsee miinakentällä olevan kohteen, kohde näkyy komentopaikalla esimerkiksi kartalla ja päätös epäsuoran tulen tai muun vastatoimen aloittamiseta tehdään komentopaikalla. Sensoritekniikoiksi on esitetty kaikenlaista: visuaalista, ääntä tai tärinää. Yksinkertaisin lienee kuitenkin kosketussensori. Siis aivan jalkaväkimiinan kaltainen halpa kosketussensori (langallinen tai sarvellinen), joka on verkottunut muiden sensorien kanssa lyhytkantoisella verkolla. Jossain on releontiasema, joka toimittaa tiedon komentopaikalle. Etuna kosketussensorilla on, että se on halvin ja se toimii aivan samoin kuin aiemmatkin jalkaväkimiinat. Tärinäsensorin ongelmana on, että lumi, suo tai kevyt liikkuminen vaimentaa tärinän havaitsemattomaksi. Äänisensorien ongelmana niiden laukeaminen sopivalla äänellä jopa kaukaa. Visuaalisten sensoritn osalta ongelmana taas on niiden toiminnan epävarmuus ja väärien hälytysten suuri määrä.

Ehdotus 2. Häivelentokoneiden havaitseminen aktiivisensorilla, kuten tutka, muodostuu yhä vaikeammaksi. Periaatteessa avaruudesta ja ilmakehästä tulee erilaista suoraviivaista säteilyä (valoa, muuta säteilyä). Häivekonekin antaa varjon suoraviivaisesti etenevälle säteilylle, joten riittävän tarkka passiivinen sensori voi sellaisen maan pinnalta havaita erona varjon ja varjostamattoman alueen säteilyjen välillä. Teknisenä ratkaisuna tämä ehdotus vaatii paljon kehittelyä, mutta periaatteellista ongelmaa ei ole, on vain parannettava passiivisten sensoreiden tarkkuutta ja niiden valvoman kaistan laajuutta.

Ehdotus 3. Ilmasta tulevan elektronisen häirinnän voi periaatteessa poistaa differentiaaliperiaatteella. Jos paraboloidiantennissa on kapea keila ja sopivalla illuminaatiolla saatu riittävästi pallon muotoinen sivukeila-alue, niin sivukeilasta tuleva häiriösignaali saadaan kahteen vastaanottopäähän olennaisesti samanlaisena riippumatta häirintälähteiden lukumäärästä ja suunnasta. Jos toinen vastaanottopää on suunnattu hyötysignaaliin, toinen sen vierestä, niin toinen pää vastaanottaa signaalin ja häiriön, toinen vain häiriön. Erotuksena saadaan signaali. Tekniikalla on etua suuntaavaan ryhmäantenniin verrattuna. Paraboloidin keila on kapeampi ja antennivahvistus suurempi kuin antenniryhmällä. Antenniryhmä pystyy muodostamaan vain n-1 keilaa mikäli siinä on n elementtiä, joten riittävällä määrällä häirintälähteitä se on aina häirittävissä: nollakohtien määrä on n-1 − hyötysignaalikeilojen määrä. On todennäköistä, että paraboloiditekniikan avulla saadaan paljon halvempi ratkaisu.

Ehdotus 4. Signaalin sisältämän kaista-alueen viivästyttäminen ja voimakkaampana lähettäminen on mahdollista ilman signaalin ilmaisua ja muuttamista. Vastaanottaja lukkiintuu signaaliin yleensä vaihelukitulla silmukalla. On mahdollista saada vastaanottaja lukkiutumaan viivästettyyn signaaliin. Vastaanottajalla voi olla monen kanavan vastaanotin monitie-etenemistä varten, mutta kanavia vastaanottimessa ei ole kovin montaa. Useammalla viivästetyllä signaalilla kyllästetään vastaanottimen kanavat,

jolloin kaikki vastaanotetut signaalit ovat viivästettyjä. Menetelmällä voidaan aiheuttaa virhe satelliittipaikannukseen ja rikkoa tahdistus tietoliikenneyhteyksissä.

Vastaavanlaisia teknisiä menetelmiä voisi luetella useampia, mutta nämä riittäkööt sen osoittamiseksi, että sopivilla teknisillä innovaatioilla voidaan merkittävästi haitata verkkokeskeisen sodankäynnin teknisen johtamisjärjestelmäalustan toimintaa. Ei ole mitenkään selvää, että verkkokeskeinen sodankäynti tulee säilymään voittamisen kaavana tulevaisuuden muutoksissa.

5. Yhteenveto

Voittamisen kaava on toki olemassa ja sellaisia on aina ollut. Niiden käytöllä ei aina ole ollut toivottuja tuloksia. Erilaisista syistä voittamisen kaava on epäonnistunut. Syinä ovat voineet olla voimien odotusten vastainen liian suuri epätasapaino, tekniset ongelmat tai yksikin taitamattomuus kaavan käytössä. Erityisesti johtamisjärjestelmiin tukeutuvan verkkokeskeisen sodankäynnin menetelmässä on voittamisen kaavaksi joukko riskitekijöitä. Lisäksi tulee kysyä onko verkkokeskeinen sodankäynti luonteeltaan hyökkäyksellinen strategia ja mikäli se muotoillaan hyökkäävän puolustuksen strategiaksi, niin tuleeko verkkokeskeisyyden olettamasta yhteydellisyydestä ja täydellisestä tilannekuvasta joustaa tehtävätaktiikan suuntaan, jolloin strategia ei ehkä enää sisällä paljon uutta.

Tulee muistaa, että tunnetaan voittamisen kaavoja joilla pitäisi voittaa, mutta joiden käyttäjä lopulta häviää. Uhkapelissä esimerkiksi on martingaalistrategia, siis panosten tuplaaminen joka häviön jälkeen. Jos pelin säännöt pysyvät muuttumattomina ja pelaaja saa ja pystyy tuplaamaan panokset joka häviön jälkeen, niin hän aina lopettaa voittajana. Käytännössä kuitenkin pelin säännöt muuttuvat ja pelaaja häviää. Ehkä suurin riski jokaisessa voittamisen kaavassa, jossa pyritään paikalliseen ylivoimaan ratkaisupisteissä liikkuvuuden avulla, on pelin sääntöjen muuttuminen. Mikäli vastapuoli ei tarjoakaan ratkaisupisteitä, niin voittaminen tämän kaavan avulla käy mahdottomaksi.

6. Viitteet

Alkuperäislähteiden sijaan viitteet on annettu suomennoksiin tai helpommin saatavissa oleviin uudelleenpainoksiin.
[1]   Baron Antoine Henri de Jomini, The Art of War, Greenhill Books, London, 1992.
[2]   Carl von Clausewitz, Sodankäynnistä, Art House, 1998.
[3]   Carl von Clausewitz, Ajatuksia sodasta ja johtamisesta, KR-Kirjat, 1999.
[4]   Julian Thompson, The Imperial War Museum Book on Modern Warfare British and Commonwealth Forces at War 1945-2000, Pan Books, 2003.
[5]   Sun Tzu, The Art of War, Wordsworth ed. 1993.
[6]   Mika Huttunen, Näkökulmia taktiikkaan, MpKK Taktiikan laitos, Sarja 3, Nro 1, 2005.
[7]   John Keegan, Sodankäynnin historia, Gummerus, 2005.
[8]   Niccolo Machiavelli, Ruhtinas, WSOY, 1999.
[9]   Lord Montgomery, A Concise History of Warfare, Wordsworth ed. 2000.
[10]   www.sovietwarplanes.com/mig3/mig3/pokryshkin.html

Etiikan ja luovuuden mahdollisesta yhteydestä

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1. Johdanto

Etiikka kuuluu sotilasopetuksen piiriin, joskaan ei suoranaisesti Sotatekniikan alueeseen. Sodankäynnin eettisenä ongelmana on, ettei tappamisen optimointia voi pitää korkeasti eettisenä ja toisaalta omien kansalaisten puolustamatta jättämistä tulee pitää epämoraalisena. Näin ollen on löydettävä jonkinlainen kompromissi, mutta korkea etiikka ei hyväksy kompromisseja. Ongelma pyritään yleensä ratkaisemaan seuraavasti. Länsimaissa korkea etiikka perustuu kristilliseen etiikkaan. Kristinuskon eettiset periaatteet pohjautuvat juutalaiseen perinteeseen ja kirkon tulkintaan Jeesuksen sanoista. Jeesus ei kuitenkaan antanut eettisiä periaatteita yhteiskunnalle vaan pienelle joukolle valittuja. Näin ollen Jeesuksen periaatteita ei voi suoraan pitää pohjana sotilaan etiikkaan ja käytännössä kristinuskon korkeista eettisistä periaatteista on tingittävä. Tämä argumentti on niin tavanomainen ja uskottava, että sitä ei tässä artikkelissa käsitellä.

2. Elävän sanan menetelmä

Edetäänkin suuntaan, joka on paljon mielenkiintoisempi. Artikkelissa perustellaan väite, että Jeesus esitti luovuusmenetelmän, jolla voidaan nopeasti saada uutta tietoa. Tämä menetelmä lähtee olemassaolevista "totuuksista" tai uskomuksista. Se vario uskomuksia muuttaen ne vastakkaisiksi tai vieden ne loppuun asti. Se myös vertaa uskomuksia analogisiin tilanteisiin, joita ympäröivässä maailmassa on nähtävissä. Saatuaan joukon mahdollisia muunnoksia, menetelmässä valitaan se, joka tuntuu oikealta ja hyvältä. Näin menetelmä perustuu hakualgoritmiin, jossa varitaatioita etsitään dialektisesti (vastakkainen, kärjistetty) ja analogsesti (allegoria, analogia), sekä valintaan, jossa valitaan oikea ja hyvä vaihtoehto.

Tätä menetelmää sanotaan jatkossa elävän sanan menetelmäksi. Voidaan todeta, että menetelmä on yleinen taiteessa. Sävellettäessä musiikkia säveltäjä varioi erilaisia teemoja ja valitsee sen, joka kuulostaa hyvältä. Näin edeten hän lopulta saa aikaan kokonaisen kappaleen. Kirjallisudessa kirjailija miettii erilaisia vaihtoehtoja ja valitsee parhaimman vaihtoehdon. Hän kirjoittaa osan tekstiä ja jatkaa eteenpäin. Ei ole tapana kirjoittaa vaikkapa kymmenen sivua huonoa tekstiä ja sitten löytää tapa, jolla huonosta tekstistä saa hyvällä lopulla hyvän. Ohjaava kriteeri "valitse aina hyvä" on käytössä koko ajan. Myös matematiikassa tulee varioida mielessään erilaisia tapoja ja valita oikea. Ei voi edetä siten, että välillä askeleet eivät ole oikeita ja lopuksi jollain tavalla ratkaisusta tulisikin oikea. Kriteeriä "valitse joka askeleella oikea" tulee soveltaa koko ajan.

Etiikan mielessä elävän sanan menetelmä on siis tehdä joka vaiheessa oikea eli hyvä valinta ja näin päästä lähemmäs totuutta. On helppo perustella, että Jeesuksen menetelmä

on juuri tämä. Jeesus lähtee olemassaolevista "totuuksista": "Olette kuullut sanottavan" ja etenee sitten variaatioon "Mutta minä sanon". Nämä variaatiot ovat usein täysin vastakkaisia "Kukaan joka ei vihaa äitiään ja veljiään ei pääse taivasten valtakuntaan.", "Rakastakaa vihollistanne.", "Tehkää muille, kuten haluatte heidän tekevän teille.". Jälkimmäinen on positiivinen muunnelma juutalaisesta maksiimista "Älkää tehkö muille mitä ette halua heidän tekevän teille". Hyvän valinnasta Jeesus sanoo, tehkää Isän tahto. Isän tahto on juuri hyvä ja oikein.

Tällainen menetelmä johtaa nopeasti uusiin tuloksiin. Taiteessa se on menetelmä, jolla voi nopeasti saada aikaan loistavia tuloksia. Jos katsomme aloja, joilla esiintyy lapsineroja, niin ne ovat juuri aloja, joilla variaation ja valinnan avulla päästään tuloksiin. Näin on esimerkiksi musiikissa ja matematiikassa. On mahdollista soveltaa suoraan kriteerejä "Kuulostaako se hyvältä?", "Onko se oikein?". Aloilla, joissa tällaista testiä ei suoraan voi tehdä, eteneminen on paljon hitaampaa. Verrataan tätä luonnontieteelliseen menetelmään. Siinä laaditaan teoria ja tehdään kokeita. Kokeiden tuloksia verrataan teoriaan ja tulokset esitetään tieteelliselle yhteisölle. Tieteellinen yhteisö joko hyväksyy tai ei hyväksy tuloksia. Yleensä näin eteneminen on paljon hitaampaa.

Matematiikassa päättelyn oikeudellisuus ja musiikissa melodian tarttuvuus tai muu välitön havainto sen hyvyydestä, ovat helposti todettavissa. Eettisten periaatteiden käytössä valintakriteerinä ongelmana on, etteivät kaikki ymmärrä samalla tavalla. Näin ollen Jeesus joutuukin jatkuvasti käyttämään kuulemisformelia "Jolla on korvat, kuulkoon". Useimmille Jeesuksen variaatiot ovatkin vain kryptisiä ja absurdeja viisasteluja, tai suorastaan loukkauksia heitä kohtaan. Variaatiot eivät ole koskaan loukkauksia, vaan ne johdetaan periaateesta, että mikä hyvänsä väite on oikein ymmärrettynä virheellinen. Näin jokainen väite voidaan muuntaa vastakkaiseksi ja se on edelleen tosi tietyssä mielessä. Kun kriteerinä on eettinen hyvyys, niin ne, jotka eivät pyri seuraamaan etiikkaa ehdottomasti vaan käytännöllisten kompromissien kautta, kokevat tällaisen variaation hyökkäyksenä heitä kohtaan, vaikka kyseessä onkin vain tapa löytää lisää totuutta.

Tässä vaiheessa on tarpeen tarkastella kolmea sanaa "Tie, Totuus ja Elämä". Totuudella on aivan tavanomainen merkityksensä tosien väitteiden joukkona, siinä ei ole mitään uskonnollista väritystä mukana. Jeesuksen sanat ovat siis eläviä sanoja. Elävä sana tarkoittaa sitä, että todet väitteet johtavat uusien tosien väitteiden löytämiseen, kun taas kuollut sana on valhetta eikä johda kuin valheeseen. Asia ehkä selviää paremmin Tuomaan evankeliumista.

Tuomaan evankeliumissa on kiinnostava kohta, jossa Jeesus kysyy opetuslapsiltaan, mitä karitsaa kantava mies aikoo tehdä. Opetuslapset vastaavat, että hän syö karitsan, johon Jeesus vastaa, ettei mies suinkaan syö karitsaa, vaan hän teurastaa sen ja syö ruumiin. Tähän opetuslapset vastaavat "Miten muuten hän voisi toimiakaan?"([3] s. 78). Toisessa kohdin tarinaa valaistaan selityksellä "Jos olette syönyt kuollutta ja tehnyt sen eläväksi, mitä saattekaan aikaan jos syötte elävää?" (vrt. [3] sivu 62, viite 19 Hippolytekseen). Jeesus kutsui tosia sanoja elämän vedeksi ja tarkoittaa elävällä tosia sanoja. Jos opiskelija saa totta tietoa, niin hän syö elämää. Virheelliset tiedot ovat kuollutta. Virheellisten

tietojen omaksuja tekee niistä elävää, koska hän niitä toteuttaa, mutta ne eivät kasva mihinkään arvokkaaseen suuntaan. Jos hän toisaalta saa tosia tietoja, niin hän pääsee valtakuntaan. Valtakuntaa päästyään hän saa lisää toisia tuloksia, mikä ilmenee lupauksissa [1] "Se jolla on, saa lisää, kun taas se jolla ei ole, menettää senkin mitä hänellä on.", "Pyytäkää niin teille annetaan." ja lopulta jopa "Älkää miettikö mitä sanotte, henki antaa teille lauseet suuhun.". Jeesus siis sanoo, että oikea oppi on elävää tietoa, joka elää siinä mielessä, että se johtaa uusiin totuuksiin. Jossain vaiheessa totuuden tien seuraaja pääsee siihen, että hän voi johtaa uusia viisauksia miettimättä. Hän ammentaa totuuden lähteestä.

On mahdollista ymmärtää, että karitsan syöminen on tulkittava vähemmän filosofisella tavalla. Jos ruumis syödään, niin se muuttuu syöjän osaksi. Jos emme halua muuttua huonommaksi, niin hengen on päästävä irti ruumiista ennen kuin jokin eläin syö sen. Osa alkukristityistä epäilemättä ajatteli tämän suuntaisesti. He hautasivat ruumiinsa vastoin roomalaista polttohautausperiaatetta, koska uskoivat, että ruumis tarvitaan ylösnousemukseen. On hyvin luultavaa, että gnostilaisia vaikutteita omaavassa Tuomaan evankelimissa tarkoitetaan eräissä logoneissa tämän kaltaista suoraa tulkintaa. Jeesus ei kanoonisten evankeliuminen mukaan koskaan painottanut ruumiin säilymistä ja koska logonit perustuvat Jeesuksen sanoihin, voidaan sangen suurella varmuudella hylätä kirjaimellinen tulkinta. Jeesus monessa kohdin tarkoittaa aivan selvästi elävällä tosia sanoja ja kuolleella virheellistä oppia.

Elävän sanan käsite selkeytyy, jos katsomme luonnehdintoja Taivasten eli Isän valtakunnasta. Luonnehdinnat ovat kahden tyyppisiä. Toisessa on kielikuva todesta sanasta, joka johtaa uusiin totuuksiin (siemen, joka kasvaa puuksi; hapate, joka hapattaa koko leivän; nainen, joka tiputtaa jauhoja pellolle). Siis eläminen tarkoittaa totuuden kasvamista. Toinen kielikuva on aarre, jonka löydettyään jättää muut asiat (mies, jolla oli aarre pellossaan; kalastaja, joka piti vain suuren kalan; mies, joka löysi helmen). Tien löytäminen saa henkilön keskittymään vain tien seuraamiseen. Valtakunta on aarre, koska valtakuntaan päässyt pystyy löytämään jatkuvasti uusia totuuksia ja jakamaan niitä muille. Valtakuntaan päässeestä tulee elävän sanan kylväjä.

Totuus on siis tietoa. Elämä on siis kasvavaa tietoa. Tie on eettinen periaate valita aina oikein ja hyvä. Tie on siis kapea ja sitä eivät pääse kulkemaan ne, jotka yrittävät saavuttaa menestystä tässä maailmassa.

3. Onko tämä oikea tapa ymmärtää elävä sana?

Lähestymistapa tässä artikkelissa on filosofinen, ei historiallinen. Filosofisesti ei ole niinkään kiinnostavaa miten jokin asia on joskus ymmärretty vaan se, voidaanko asia ymmärtää jollain tavalla, joka on edelleen mielenkiintoinen. Tarkastellaan kuitenkin lyhyesti kysymystä missä määrin Jeesuksen sanat tukevat esitettyä tapaa ymmärtää ne.

Varsinaisesti lähteitä Jeesuksen todellisiin sanoihin on hyvin vähän: Uuden testamentin kirjat [1] ja Nag Hammandin varhaiskristilliset kirjat [2], joista suurin osa on gnostisia.

Uuden testamentin kirjoituksista vanhimpia ovat Paavalin kirjeet, jotka ajoitetaan joillekin vuosille 47-60. Markuksen evankeliumi on vanhin evankeliumi. Se lienee kirjoitettu noin 70. Vanhimmat olemassa olevat kopiot ovat paljon nuorempia, täydelliset tekstit ovat noin ajalta 300. Vanhin lieneen Johanneksen evankeliumin osa, joka ajoitetaan noin vuoteen 150-170 [5][7][26], ellei sitten pidä Thieden ajoitusta Matteuksen evankeliumiin kuuluvalle Magdadenin papyrukselle noin vuoteen 60 oikeana [4]. Matteuksen ja Luukkaan evankeliumeissa on käytetty lähteenä Markuksen evankeliumia ja kadonnutta Q-lähdettä. Q-lähteen muotoa pidetään Tuomaan evankeliumin [3] kaltaisena, mutta temaattisemmin järjestettynä kokoelmana sanontoja eli logoneita. Paavalin kirjeissä ja evankeliumeissa esitetty Jeesuksen hahmo on uskonnollinen opettaja. Suomalaisten teologien käsitykset [5][6][7] antavat myös tällaisen kuvan. Erilaisiakin näkemyksiä on, kuten Eisenmanin jokseenkin spekulatiivinen teoria Jeesuksen veljien klaanista [20] ja Vermesin yritys selittää Jeesus hyvinkin juutalaisessa valossa [9]. Ongelmana on, että Jeesuksen sanonnat eivät ole samanlaista loogista tekstiä kuin Paavalin kirjeet ja evankeliumit tai lähes samanaikaiset Flavius Josefuksen historialliset tekstit [16] puhumattakaan Augustinuksen hieman myöhäisemmistä pohdiskelevista argumentoinnista [23]. Evankeliuminen analyysi vertailemalla eri tekstejä, kuten [21] ja [18] eivät voi antaa oikeaa kuvaa, koska näissä vertaillaan eeppisesti rakennettuja myöhäisempiä ja paljon loogisempia tekstejä. Voidaan tietenkin vertailla evankeliumeita kuolleen meren kääröihin [10][11][12] ([13] on sangen erikoinen tapaus) ja hieman vanhempiin apokryyfisiin teksteihin [8], mutta ne antavat vain vähän tietoa Jeesuksen todellisista ajatuksista. Sen aikaisten olojen [14][15][19][22] ja vastaavien hahmojen tarkastelu [17] sekä Raamatun yleisen rakenteen tutkiminen [24][25] valoittavat jossain määrin Jeesuksen mahdollisia ajatuksia, mutta tuskinpa voimme koskaan vakuuttavasti selvittää mitä Jeesus oikeasti tarkoitti. On todennäköistä, että Jeesus tulisi nähdä ennen kaikkea uskonnollisena opettajana, eikä ole perusteltua syytä olettaa, että Paavalin käsitys kristinuskosta olisi erityisen väärä, tosin Paavalihan ei koskaan tavannut Jeesusta. Tämän artikkelin kannalta ei ole niin olennaista missä määrin historiallinen Jeesus vastasi Tuomaan evankeliumin antamaa kuvaa. Tuomaan evankelium oli gnostikkojen käytössä ilmeisesti sangen laajalti, mutta he lukivat myös kanoonisia evankeliumeita.

Jeesuksen sanoman voi ymmärtää usealla tavalla. Kristillisen kirkon tapa ymmärtää Jeesus on Paavalin opetusten pohjalta painottanut armoa ja uskoa. Toinen mahdollisuus ymmärtää Jeesus johti gnostismiin toisella ja kolmannella vuosisadalla. Gnostikko tavoitteli tietoa. Puhdas, eettisesti korkeatasoinen elämä oli tarpeen tien seuraamiseen. Tie johtaa totuuteen ja totuus on salattua tietoa. Kun gnostikko saavuttaa totuuden, niin hän pääsee korkeammalle tasolle ja voi ammentaa lisää tietoa totuudesta. Gnostismi tuomittiin harhaoppina ja onkin todettava, että gnostismi on kirkon oppia myöhäisempi rakennelma. Tästä huolimatta on vaikea ratkaista missä määrin Jeesuksen etiikka oli gnostisesti painotettua, missä määrin Paavalin tulkintojen mukaista. Muista varhaisen kristinuskon suunnista kuin kirkon oppien mukaisista kanonisista evankeliumeista ja gnostisesti väritetyistä Nag Hammadin teksteistä meillä ei ole riittävää tietoa.

Perustellaan seuraavaksi, että kirkon edustama tulkinta uskon ja armon merkityksestä ei voi olla Jeesuksen alkuperäinen sanoma.

Jeesus ei voinut toiminnassaan esittää kristinuskon nykyistä muotoa. Paavalilta peräisin oleva käsitys uskosta ja armosta kristinuskon pohjana ei tietenkään voi olla Jeesuksen alkuperäinen opetus. Kristinuskossahan uskolla tarkoitetaan uskoa siihen, että Jeesus on Jumalan Poika, siis uskoa Jeesukseen ja Jeesuksen kuoleman vapauttavaan voimaan.

Jeesuksen omissa sanoissa on kahdenlaisia uskoon viittaavia kohtia. Uskolla parantaessaan hän kysyy, uskotko siihen, että voin sinut parantaa. Jos potilas parani, Jeesus totesi, että hänen uskonsa on hänet parantanut. Aina suinkaan paranemista ei tapahtunut, eikä se usein ollut pysyvää. Tämä usko-sanan käyttö vastaa täysin sitä mitä tiedämme uskolla parantamisesta. Parantavana tekijänä on potilaan usko siihen, että parantajalla on voima parantaa. Parantajaan ei suinkaan tarvitse uskoa yliluonnollisena olentona. Paranemisen aiheuttaa potilaan usko, ei mikään parantajan voima.

Toinen tyyppi Jeesuksen usko-sanan käytöstä on esimerkeissä Pietarista, joka vajosi veteen, koska hänellä ei ollut uskoa ja toteamuksessa, että jos opetuslapsilla olisi uskoa, niin he voisivat siirtää vuoria. Näissä on kysymys opetuslapsen uskosta omiin voimiinsa. Tämä on myös hyvin tavanomainen käyttö usko-sanalle nykyäänkin, uskokaa itseenne. Jeesushan ei ollut ilmaissut olevansa Jumalan Poika, eikä kukaan hänen oppejaan kuuleva siis voinut sellaiseen uskoa.

Vain Vuorisaarnassa todetaan uskosta Jeesukseen, mutta tämä saarna sijoittuu ylosnousemuksen jälkeiseen aikaan ja sitä yleensä pidetään kokoelmana eri henkilöiden muokkaamia Jeesuksen opetuksia.

Armon osalta kysymys on vaikeampi vastata. Jeesus puhuu allegorioissaan taivaallisesta rakastavasta Isästä, joka kutsuu ihmiset taivasten valtakuntaan. Jeesuksen toimita kohdistui yhteiskunnan moraalinvartijoiden hyljeksimiin ihmisiin, joille hän antoi synnit anteeksi, kastoi, paransi heidät ja kutsui heidät taivasten valtakuntaan. Parannettaville Jeesus oli henkilö, jolla oli voima antaa synnit anteeksi, siis Messias ja Jumalan valittu.

Ei ole ilmeistä, että Jeesus itse ajatteli näin. Jeesus kutsui itseään ihmisen pojaksi, jolloin ihmisen pojan isän tulisi siis olla ihminen. On mahdollista, että hän ei uskonut syntiin käsitteenä ja antoi synnit anteeksi uskolla parantajana. On vain kaksi mahdollisuutta: joko Jeesus piti itseään Jumalan veroisena tai ainakin valtuuttamana, tai hän ei pitänyt syntiä todellisena ja hän toimi lääkärinä. Ihminen, joka pitää itseään Jumalan veroisena, on yleensä mieleltään sairas tai ainakin häiriytynyt. Jeesuksen sanat ovat usein omalaatuisia, mutta niissä on usein syvällinen ajatus punottuna paradoksiksi tai muuten absurdiksi ja päällisin virheelliseksi päätelmäksi. Tuskin hän oli häiriytynyt, pikemminkin kyseessä on uskomusten variointi dialektisesti ja analogisesti. Ihminen, joka tahallaan käyttää muiden uskomuksia omaksi edukseen on huiputtaja tai poliitikko. Tämä mahdollisuus ei sovi yhteen Jeesuksen edustaman korkean etiikan kanssa, eikä hän ilmeisestikään ajanut omaa etuaan. On myös pääteltävä, ettei Jeesus ollut uskonnollinen juutalaisen sen hetkisen uskonnon mielessä eikä pitänyt itseään Jumalan Poikana. Tähän viittaavat lukuisat seikat.

1) Ristiinnaulitsemisen syy oli Jumalan pilkka, joten monet Jeesuksen lauseet viittasivat tähän suuntaan.

2) Jeesus käyttää Raamatun kohtaa "Minä olen Abrahamin, Esaun ja Jaakobin Jumala" muka todisteena siitä, että kuoleman jälkeen on elämää. Toisaalta Jeesus monessa kohdassa toteaa, että Raamattu ei ole kaikissa osin oikein, esimerkiksi Mooseksen lain avioerosäädännäsä. Argumetointi sanalla "olen" ei vastaa käsitystä Jumalan Poikana itseään pitävän henkilön todennäköisestä tavasta osoittaa kuolemanjälkeisen elämän todellisuus. Tämä kohta vihjaa teologisiin diskussioihin, joissa käytetään ajalle tyypillistä argumentointia.

3) Gnostikot hieman myöhemmin eivät nähneet Jeesuksen Jumalaa samana kuin Vanhan Testamentin Jumalaa, eli demiurgia. Gnostikoilla oli myös aitoa perinnettä Jeesuksen sanoista. Usein Tuomaan evankeliumia pidetään gnostilaisena, mutta ehkä noin puolet teologeista uskoo sen perustuvan aitoihin lähteisiin.

4) Jeesus hyökkää voimakkaasti fariseuksien oppeja vastaan. Yleensä saman uskonnon edustaja myös löytää paljon hyvää muista oppineista ja vastustaa vain joitakin kohtia. Jeesus sen sijaan toteaa sokean taluttavan sokeaa. Vain yksi kohta vihjaa siihen, että Jeesus katsoisi fariseusten edustavan samaa uskontoa: "Heillä tosin on avain, mutta he eivät itse mene sisälle eivätkä anna muidenkaan mennä.". Pääosin Jeesuksen käsitys on niin negatiivinen, että häntä voi pitää aivan toisen opin edustajana.

5) Jeesus hylkää juutalaisen teorian, että synnin palkka on kuolema ja sairaudet ja synti kostetaan jälkipolville. Jos Jeesus ei pitänyt syntiä sairauden syynä, niin parantajana syntien armahtaminen oli vain potilasta auttava toimenpide. On kuitenkin toinen tärkeämpi syy syntien anteeksiantamiseen: henkilön sisäinen muutos. Tähän liittyy myös kaste.

Toistaiseksi olemme havainneet, että Jeesus ei opettanut samaa kristinuskoa kuin kristillinen kirkko Paavalin ajoista lähtien, eikä todennäköisesti ollut uskovainen samalla tavalla kuin sen ajan juutalaiset. Jeesus ei ollut moralisti siinä mielessä, että uskonnollisten tapojen noudattaminen on vaadittua.

Tarkastellaan seuraavaksi edustiko Jeesus gnostista käsitystä.

Jeesus korosti eettisesti korkeaa elämää. Hänen sanoissaan on voimakas painotus sisäiseen tilaan: "Tehkää sisäpuoli samanlaiseksi kuin ulkopuoli, alapää samanlaiseksi kuin yläpää." (vrt. [3] s. 67) ja "Miksi te pesette astian ulkopuolelta, peskää se sisäpuolelta, niin myös ulkopuolesta tulee puhdas." (vrt. [3] s. 88 viite 135 Simon Mesopotamialaiseen). Jeesuksen etiikan päämäärä on siis sisäinen totuuden seuraaminen. Sen seurauksena myös ulkoiset piirteet täyttävät korkean etiikan vaatimukset. Toisaalta Jeeses sekä söi että joi, toisin kuin Johannes Kastaja, eikä siis pyrkinyt asketismiin. Gnostikot painottivat sukupuoliyhteydestä pidättäytymistä. Jeesus ilmeisesti oli moralisti siinä, että hän suhtautui negatiivisesti sukupuolielämään. Tällainen painotus on

nähtävissä kaikissa kristinuskon varhaisissa suunnissa. Toisaalta gnostikkojen painotus vaikuttaisi perustuvan Jeesuksen sanojen liian kirjaimelliseen ymmärtämiseen.

Logoneissa 21 ja 37 [3] annetaan vertauskuva valtakunnan lapsista jotka riisuvat vaatteensa. Tätä on tulkittu kasteen symbolina ja gnostismin piirissä ruumiillisen olemuksen jättämisenä. Todennäköisin selitys on, että siinä tarkoitetaan maallisten tavoitteiden hylkäämistä ja kaste on todellakin saman asian symboli. Mitään syytä olettaa ruumiillisesta olemuksesta luopumista ei ole.

Login 98 [3] on toisinto kanoonisten evankeliumien vertauksesta. Mies lyö miekkansa oman talonsa läpi, jotta hän varmistuu siitä, että on riitävän vahva tappamaan vahvan miehen ja ryöstämään hänen talonsa. Kirkon tulkinta tälle on ollut, että se tarkoittaa Jeesuksen kuolemaa ja kuoleman jälkeistä Kuoleman lyömistä ja uskovien pelastamista. Gnostikkojen tulkinta oli, että siinä tarkoitetaan jonkinlaista itsensä kuolettamista, lähinnä sukupuolisuuden kieltämistä. Kirjoittajan käsitys on, että tässä tarkoitetaan yksinkertaisesti harjoittelua. Logon on samaa tyyppiä kuin rahojen laskeminen talon rakentamisessa ja tarkoittaa, että tehtäviin tulee valmistautua harjoittelulla ja suunnittelulla.

Gnostilaisimmat logonit 83 ja 84 [3] puhuvat kuvista. Muissakin Tuomaan evankeliumin logoneissa puhutaan kahden tekemisestä yhdeksi ja kuvista. Ilmeisesti tässä on kyseessä Platonin ideaopin yhdistäminen Jeesuksen sanoihin. Näkyvä maailma on varjomaailma ja on myös todellinen maailma, jossa ihmisella on todellinen vastineensa. Gnostikon päämäärä on yhtyä todelliseen valossa elävään kuvaansa. Kirjoittajan tulkita on, että gnostikot yhdistivät Platonin teoriapohjaisen lähestymistavan Jeesuksen elävän sanan menetelmään ja saivat tulokseksi mielikuvituksellisia rakennelmia. Elävän sanan menetelmä ei käytä teoriaa eikä sitä tule yhdistää teoriaa. Jo logonissa 2 [3] on kuvattu elävän sanan lähestymistapa:

Joka etsii se löytää. Varioimalla "totuuksia" etsitään uusia totuuksia. *Joka löytää se hämmästyy.* Löydetty uusi totuus on suuresti erilainen tai jopa vastakkainen edelliselle. *Joka on hämmästynyt, se hallitsee.* Hallitsee tien, löytää uusia totuuksia. *Joka on hallinnut se luopuu (tai lepää).* Totuuksista ei luoda pysyvää teoriaa, vaan niistä myös tulee luopua.

Gnostikot pyrkivät luomaan teoriaa ja ymmärtämään mikä oli elävän sanan menetelmän kuvaama totuus. He päätyivät siihen, että totuus on tietoa siitä mitä olemme, mistä tulemme ja minne olemme menossa. Näihin tarkoituksiin luotiin teoriat maailman luomisesta, demiurgista ja Sofian lankeemuksesta. On ilmeista, ettei teorian rakentaminen johtanut todelliseen tietoon.

3. Enemmän elämän sanan menetelmästä

Pääsisältö Jeesuksen opissa on väite taivasten valtakunnasta, jossa voi juoda elämän vettä. Siis, on totta oppia, joka on elävää siinä mielessä, että se kasvaa. Tulee muistaa

vertaukset kylväjästä ja siitä, että sadon korjaa toinen. Siis, oikean tiedon opettaja ei voi etsiä omaa etuaan. Siemen joko tukahtuu tai se kasvaa. Kaikki tapahtuu toisessa maailmassa. Pyhä henki johdattelee totuuteen ja tien seuraaja saa sen mitä hän pyytää. Tien seuraaja tietenkin pyytää vain uutta tietoa. Tarvitaan oppilaan sisäinen muutos ja uudelleensyntyminen, jotta hän voi seurata tietä. Kasteella ja syntien anteeksiantamisella symbolisoidaan uutta alkua ja maallisista päämääristä luopumista tien seuraamisen tähden. Tämä on siis Jeesuksen pääteoria, eikä mikään maksiimi lähimmäisen rakastamisesta tai vihollisen rakastamisesta. Ne ovat seurauksia ja osa tietä, mutta eivät sen ydin. Ydin on pääsy valtakuntaan, ja se on jo täällä ja löytyy ihmisen sisältä. Valtakunnan ydin taas on siellä virtaava elämän virta josta voi juoda tosia sanoja. Tavoite on päästä totuuden lähteelle ja totuus on elävä, se kasvaa uudeksi tiedoksi.

Tarkastellaan Jeesuksen elämän sanan menetelmällä saamia tuloksia. Usein Jeesus nähdään etiikan opettajana. Jeesukset tulokset etiikan alueella eivät välttämättä ole erityisen suuria. Monet juutalaiset oppineet, kuten Vernes [9], ovat todenneet, että pääosa Jeesuksen oppeina pidetyistä maksimeista olivat jo juutalaisten oppineiden kehittämiä, kuten "tehkää muille niinkuin haluaisitte heidän tekevän teille" on vain positiivimuoto vanhemmasta juutalaisesta maksiimista "älä tee muille sitä, mitä et haluaisi heidän tekevän sinulle". Maksiimin positiivimuodossa tulee tietenkin ongelmia, koska esimerkiksi naisilla ja miehillä ei ole samanlaista käsitystä siitä, mitä he toivoisivat itselleen tehtävän ainakaan kaikissa suhteissa. Ehkä tästä syystä Jeesus toteaakin, että jokainen nainen, joka tekee itsensä mieheksi pääsee valtakuntaan. ([3] s. 96). Gnostinen tulkinta tälle logonille on androgyyninen ihanne, mutta yksinkertaisempikin selitys siis löytyy. Maksiimi ei siis ole Jeesuksen suurin tulos, vaan vain Jeesukselle tyypillinen tapa kärjistää juutalaisen eettisiä prinsiippejä sen osoittamiseksi, että kukaan ei ole täydellinen. Jeesus opetti olennaisesti taivasten valtakunnasta, ei nykyisen maailman eettisistä periaatteista.

Jeesus ei siis välttämättä ollut suuri etiikan opettaja, mutta häntä voi myös pitää tieteen edustajana. Jeesuksen edustamia tieteenaloja tulee tarkastella juutalaisten silloisen kulttuurin tasoon verraten. Selvästi Jeesus oli filosofi, koska hän etsi ja opetti totuutta. Hän esitti menetelmää totuuden löytämiseksi ja useita esimerkkejä tosista sanoista, joita on kerätty ja järjestelty teoksiksi, jopa kaikkein laajimmin julkaistuun ja referoituun työhön. Jeesus oli myös kriittinen teologi, joka pyrki vastaamaan juutalaisten teologian pulmakysymyksiin, erityisesti synnin ja messiaan problematiikkaan. Jeesus oli etiikan tutkija, joka kehitti oman teoriansa, jossa vastustajaa ei vastusteta. Empiirinen varmennus näiltä tuloksilta puuttuu tosin edelleen. Epäilemättä Jeesus oli uskolla parantaja, siis lääketieteen ja psykologian edustaja. Tuloksista dokumentoituja tietoja on mahdotonta varmentaa, mutta niillä on ollut ilmeinen vaikuttavuus aikoinaan. Voitanee todeta, että Jeesus oli myös profeetta, eli nykyisessä terminologiassa tulevaisuudentutkija. Tässä hän esitti tunnusmerkkiteoriaa: maailma kehittyy samoin kuin luonto ja tulevat muutokset voidaan ennustaa tunnusmerkeistä, mutta vasta kun asiat ovat jo tapahtumassa. Muutosaikaa taas ei voi ennustaa. Näin ollen, elävän sanan menetelmällä voidaan todeta saadun tuloksia monella tieteen alalla. Menetelmä siis toimii ja luonnontieteelliseen menetelmään verrattuna elävän sanan menetelmä vaatii paljon vähemmän pohjatutkimusta. Menetelmä on olennaisesti luovuusmenetelmä.

Luovuus tarkoittaa eri asiaa taiteissa ja tieteissä. Monet luovina pidetyt taiteilijat ovat hyvin tuotteliaita, eikä heidän työssään ole pyrkimystä totuuteen. Tieteessä luovuus on mahdollista vain, jos pitäydytään totuuteen. Mitään erityistä luovuutta ei ole virheellisten tulosten tuotteliaassa generoinnissa. Luovuus tieteessä ei myöskään ole suoraan mitattavissa tulosten lukumäärästä. On luovempaa esimerkiksi todistaa uusi lause matematiikassa kuin laajentaa tunnettua lausetta. Vielä luovempaa on saada tulos kokonaan uudella menetelmällä ja luovinta lienee luoda kokonaan uusi omaperäinen teoria.

Elävän sanan menetelmällä voisi siis esitetyn teorian mukaan saavuttaa korkean luovuustason. Niiden mielestä, jotka itsekin seuraavat tietä, saadut totuudet ovat luovia ja syvällisiä ja ne antaa Pyhä Henki. Muiden mielestä tällä tavalla kehitetään kyky laukoa kryptisiä viisauksia suoraan ja miettimättä, suututtaa vallassaolijat ja ajautua vaikeuksiin.

On montakin mahdollista perustelua teorian toimivuudelle. Yksi luonnollisimmista perustuu harjoitteluun. Tiede yleensä perustuu harjoitteluun. Matematiikassa esimerkiksi pyritään antaman opiskelijoille tarkka silmä nähdä virheellinen päättely. Ei ole mahdollista opettaa siten, että välivaiheissa hyväksytään mitä hyvänsä virheellistä päättelyä ja todetaan, että kun opiskelijasta sitten joskus todistaa jonkin merkittävän tuloksen, niin silloin se pitää tehdä oikein. Harjoittelussa riittää pienempi tarkkuus. Näin ei voi menetellä, koska opiskelija ei opi näkemään virheitä. Näin voisimme ajatella, että totuutta on seurattava koko ajan ja tästä syystä korkea etiikka on välttämätön ehto sille, että joskus voi päästä luovuuteen totuuden etsinnässä. Tällöin mitään pyhää henkeä ei siis ole, se on harjoittelulla saatu nopeus. Jos ajattelemme asiantuntijaa, niin eihän ole niin, että jos kysymme asiantuntijalta vastausta ongelmaan, niin hän miettii sitä pitkään ja lopulta laskelmien kautta saa tuloksen, joka voi olla oikein tai väärin. Asiantuntija vastaa heti ja oikein, koska hän tuntee asian niin hyvin. Ajattelua ei tarvita, kaikki on luonnollista. Vastaukset tulevat kuin itsestään. Jos tämän onnistuu tekemään uusille asioille ja tulokset ovat oikein, niin henkilö on tieteellisesti luova. Tässä selityksessä Jeesus tekee sokeista näkeviä, kuuroista kuulevia ja kuolleista eläviä. Ihminen, joka ei ole ymmärtänyt totuuden sana on kuuro, sokea ja kuollut, mutta jos totuden siemen itää, hänestä tulee näkevä, kuuleva ja elävä.. Jeesuksen oma kuolema on hyväksytty tosiasiana ja Jeesuksen ylösnousemus on myös välttämättä totta, koska muuten kirkkoa ei olisi syntynyt. Tässä selityksessä voidaan ajatella, että opetuslapset varmasti huomasivat, että elävä sana oli edelleen elävä ja uusia Jeesuksen sanontoja syntyi opetuslasten joukossa ristiinnaulitsemisen jälkeenkin. Selitys voi tuntua symboliselta eikä todelliselta, mutta totuuden tien seuraajille totuus on todellinen ja fyysinen maailma on valhe. Näin Paavali olisi väärinymmärtänyt Jeesuksen opin ja Pietari olisi kolmasti kieltänyt Jeesuksen liittyessään Paavaliin.

Toinen kirjoittajan mielestä varteenotettava vaihtoehto on, että todellisuus on erilainen kuin yleensä ajatellaan. Tietoa usein ajatellaan vastavuusteorian pohjalta, että tieto on tosi jos se vastaa todellisuutta. Vastaavuusteoria on puutteellinen, koska tieto ei ole tosiasioiden toistamista, vaan niiden selittämistä. Näinpä esimerkiksi planeettojen liikeen kuvaaminen ei anna paljonkaan tietoa, mutta liikkeen selittäminen gravitaatioteorialla on

tietoa. Jos tieto on selityksiä, voi tietenkin kysyä, onko todellisuudella tällainen rakenne, vai luoko selitys sille sellaisen rakenteen. Fysiikassa voisi ajatella, että rakenne tosiasiassa on olemassa. Kaikissa muissa tieteissä näin ei välttämättä ole, eikä se ole selvä fysiikassakaan. Jos silloin kaksi toisistaan erillistä ryhmää kehittää tietoa, niin ne eivät välttämättä ole samoja, eikä ryhminen todellisuuskaan ole sama. Jos tuomme ryhmät yhteen, tapahtuu kulttuurien törmäys ja vain toinen jatkaa. Toinen totuus osoittuu virheelliseksi. Annetaan tästä esimerkki. Nykyään ajatellaan kvanttikryptologiaa ehdottoman varmana menetelmänä todeta, että tietoa ei salakuunnella. Menetelmää on jo demonstroitu ja teoria toimii. Jos hiukkanen esimerkiksi lähetetään kahta tietä, voimme diffraktiokuvasta päätellä onko toisesta hiukkasesta tehty havainto. Jos havainnoija on suljettu laatikkoon, josta ei tule tietoa ulospäin, niin kyseessä pitäisi olla Schrödingerin kissa laatikossa. Silloin havainnoijan havainto ei välity, eikä havainnointia nähdä. Kun laatikko avataan, niin havainnoijien havainto on sama kuin ulkopuolisen maailman havainto. Siis, jos havainnoija teki havainnon, mutta ulkopuolella sitä ei nähty, niin tämä havainto katoaa kun maailmat yhdistetään. Jos Schrödingerin kissalla on ydinsotanappi, ja havaintonsa pohjalta se painaa sitä, niin ulkopuolinen maailma häviää. Kun laatikko avataan, niin havainnoijan maailma jatkaa ainoana. Tämä esimerkki osoittaa, että fysikaalinen usean maailman teoria antaa todellisuudessa erilaisia tuloksia kuin yhden maailman teoria. Esimerkki oli fysikaalinen, voidaan myös tehdä vastaavia esimerkkejä kulttuurin tai muun vastaavan alueelta, vaikkapa etiikasta.

Tämä jälkimmäinen teoria on mielenkiintoinen Jeesuksen tapauksessa, koska Jeesus eristäytyi erämaahan ja useissa yhteyksissä korosti, että hänen seuraajansa eivät kuulu tähän maailmaan. On mahdollista, että Jeesuksen taivasten valtakunta, jossa juodaan elämän vettä keskellä virtaavasta joesta on toteutettavissa vain yhteisölle, joka seuraa korkeaa etiikkaa. Kirjoittaja kutsuu tällaista usean maailman teoriaa "ihmeiden teko"–teoriaksi, koska toisessa maailmassa voivat olla voimassa lait, jotka toisessa maailmassa ovat mahdottomia. On luonnollista harkita "ihmeiden teko"–teoriaa Jeesuksen yhteydessä. Tässä selityksessä ihme voi siis olla muutakin kuin symbolinen. Jeesuksen teoriaan kuuluu myös olennaisena osana katastrofiloppu ympäröivälle maailmalle. Tämä olisikin loogisin ratkaisu kahden maailman kohtalolle. Muuten ne on pakko lopulta tuoda yhteen ja pienempi osoittautuu humpuukiksi. Tällainen tulkinta perustelee, miksi tulisi aina olla varuillaan uskonnollisesti faanaattisten ryhmien suhteen. Katastrofi-ajattelutapa on sangen tavallinen, eikä välttämättä edes virheellinen.

4. Yhteenveto

Etiikasta puhuttaessa Länsimaissa etiikka pohjautuu kristillis-juutalaiseen perintöön. Mikäli eettiset ohjenuorat halutaan perustaa Jeesuksen oppihin, tulee ensin miettiä olivatko Jeesuksen opit tarkoitettu eettiseksi perustaksi yhteiskunnalle. Jos ajatellaan tämän artikkelin mukaisesti, että Jeesus tarkoittikin aivan muuta, eikä edes yrittänyt antaa tälle maailmalle eettisiä periaatteita, niin sotilasetiikkaa ei tulisi yrittää sovittaa Jeesuksen etiikkaan. Oikea tapa on varmaankin käytännön eettisten periaatteiden käyttö.

Jos taas tutkijana ajattelee seurata tie, totuus ja elämä –menetelmää, niin se todellakin saattaa johtaa tietynlaiseen luovuuteen. On myös hyviä perusteluja käsitykseen, jonka mukaan kyseisen tien seuraajille on yleensä käynyt tässä maailmassa huonosti.

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How to prove that a business management paradigm does not apply to a university?

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Abstract: This article presents seven arguments against the use of business management methods connected with change leadership which presently are being introduced to universities in Finland.

1.   Introduction

By the business management paradigm we refer to the various management methods that are recently being introduced to universities in Finland. They include results-oriented management, process management, quality management and naturally the already familiar project management. Together, there seems to be going on an effort for organizational change, which is run by transitional management. The book [3] in the title calls the approach leading change, so we will use the name change leadership of this management approach.

Most university staff agrees that business management methods do not suit a university. Despite of this, the state has been introducing business management methods to every state institute, including universities and the defense forces. Business management methods have been advocated by consultants with business management education and they claim that the management methods suit well everywhere and that there are examples of successful applications of the methods in universities. Business management is taught in universities and leadership and management is a research area using soft methods now proposing its results to be used in fields of hard sciences. Symmetrically, it seems necessary to use logical reasoning of the type which is demanded in hard sciences to analyze whether these management methods have a sound basis when applied to universities. More specifically, let us try to prove that the methods are not applicable.

The first reaction to a suggestion to prove something of this type is that why should anything so obvious need to be proved. However, on the first course of algebra mathematics students traditionally prove that zero is zero, and while the claim turns out to be true it is neither useless nor especially hard to prove it. The second argument is that it is not possible to prove such claims. This may be so, but there are also so called plausibility arguments. They are a bit short of an exact prove, but can be used to communicate an idea if the basic idea is sound and the claim correct.

Let us start by a mathematical method as the author is in a way a mathematician, more precisely, a renegade mathematician. Let us take the combination of management paradigms which Finnish universities currently have to cope with. Projects have provided external funds for a long time, so there is project management. Recently the linear organization has adopted results-oriented management. Quality management and process management are being introduced. There could be more management methods, such as

deep management and risk management. Additionally there is the management implied by the definition of jobs: a teacher's task is to give good education to students and the character of this job has been formed by centuries of experience. A manager, who tries to introduce changes to this job, has to convince teachers that his new methods are better than the existing methods, or the existing methods will be reintroduced as soon as it is possible.

The selected set of management methods can be thought as a set of rules defining a transformation from the present state to a better target state.

2. Necessity and sufficiency

Claim 1: *The set of selected management methods is neither a sufficient nor a necessary condition for a successful transformation to a better state.*

Proof: Let us show this transformation is not a sufficient condition for moving to the target state. Indeed, if the transformation is a sufficient condition, following the given methods necessarily leads to the target state. That is, the organizational change cannot fail. We know from business management studies that leading change is very difficult and change processes very often fail [3]. This is enough for showing that the transformation is not a sufficient condition. As homework the reader may supply details of some organizational change process that has failed or is likely to fail. There are many but it is better not to mention such cases in writing.

We can show that the transform is not a necessary condition. This only requires showing that there are organizations which have moved from an original state resembling the one where we now find ourselves into a better state by other means than following the proposed transformation. This is easy: American universities made quite a jump after the Second World War though these new management methods were not even known. The book [1] on John Nash, while probably incorrect in many places, describes the atmosphere in Princeton in the fifties which confirms to eyewitness stories: the raise in the level was created by allowing the researchers free hands to do research instead of spending all their time in teaching. It is very different from the methods presently suggested to universities. In order to show that the condition is not necessary we still need to show that the environment has not changed so much that counterexamples would lose their value. This is also easily done: simply walk back to the department of theoretical physics or mathematics where you studied twenty years ago. Nothing much has changed. Organizational cultures last for very long times and the impression that the world is now totally different than it was ten years ago is not true everywhere, especially not in universities in several fields of pure science. Telecommunication, the field or the author, and business life give a bit biased view on the actual speed of change. This completes the proof that the transformation is not a necessary condition.

If a method is shown to be neither sufficient nor necessary condition for a successful transformation to a better future, the rational approach is to keep looking for other methods. There is no scientific justification to imposing this particular method.

3.   Contradictory requirements

Claim 2: *The set of management paradigms is self-contradictory.*

Proof: We do this by selecting some pairs which have contradictory goals. Then the combination has contradictions in goals and all rules cannot be followed. Mathematically only one contradiction is sufficient, but let us do overkill and find three contradictions.

Project management does not work with quality management. Quality management was developed in Japan for making better cars. Car industry is process industry, the work is usually not organized in projects. The goal of quality management is to raise the quality in a process. In process-based work quality can indeed be raised by following best practices and by improving the practices gradually. A project is a tradeoff between time, resources and quality. A project has a starting time and an ending time. After the project finishes, it does not exist. In the lifetime of a project quality is not gradually improved. It is a parameter in the tradeoff and the quality should be as low as is acceptable. Over the lifetime of many projects quality is not improved since projects start basically from a zero level using the results of previous projects if possible. Projects are asked to collect learned lessons but the author does not think they are much used. A project manager basically learns only from the projects he has managed or participated in. Project manager's experience reaches some level and here are typically new people in the project. Thus, it is not a process of gradual learning. Projects do not record their work methods and strictly following the idea of a project, it is not even acceptable in a project as it is not a part of the original tradeoff. Keeping a quality book of the project work is an additional burden to the project and in clear contradiction with the project idea: get it done and finish. Projects produce results, what happens in a project is not essential. It is also true that processes see quality as a parameter that is satisfied, not maximized. Thus, sausage should have as little meat and paper as much water as is acceptable by customers. There are some firms which compete with quality, but usually quality management does not go well with project or process management. Even in universities, quality is something to be filled, not maximized, and the amount is to be maximized, such as produce the maximum number of papers which with minimum effort fill the quality criteria of being published in a given forum. It is a long time since the maximum "little but good" was applied.

Results-oriented management is in contradiction with project and process management. This is the most commonly commented contradiction. The manager of the linear organization does not give resources to process or project managers and always tries to reserve project's resources to other tasks. Especially often this happens if the linear organization uses results-oriented management. There are goals to the linear organization imposed by results-oriented management and reaching these goals is measured. Processes

and projects are an additional management level going across the units or firms. Their results are usually not fully counted in results-oriented management.

Results-oriented management is in contradiction with job definitions and process management. This issue was touched already before. There is silent management created by the common understanding of the tasks belonging to the job. This common understanding can be formulated into process descriptions. For instance, in a university there are two basic processes: research and teaching. They are rather well, but not quite faithfully described by the concept of a process as a process must have an owner, while traditionally teaching and research have not needed an owner. Thus, we get to the owner of the university research process and other strange animals. Teaching and research have a particular rule that in order to lead, this means supervise, require, teach, you must be on an academic level two to three higher than the one you lead. Thus, master's theses are supervised by a professor, not by another master, who can be only an instructor. Doctor theses are supervised by a professor or a docent with five years after becoming a docent. Thus, not by a new docent, who is only one degree above a doctor. The rule has been adopted because supervision can only be based on expertise, not on authority. We must remember that in research and in teaching the goals are much higher than in business life. There is no single measurable quantity, such as profit, that should be maximized. This means that to lead a professor or a docent you must be on a very high level. By this rule a laboratory head should be on so high scientific level that such people cannot usually be found. The solution has traditionally been that the laboratory head is not a leader or a manager who sets goals. Instead, he is an administrative manager and personnel leader who takes case of administrative issues of personnel and resources and represents the laboratory to upper levels of hierarchy. Efforts to change this, i.e., setting goals to professors and professors setting goals to docents and so on, have met with resistance in universities. It seems that the only adherents to this new system are people with insufficient experience on supervision. They do not know what level of expertise is needed in order to advise (not to mention require results from) experts on their fields. They believe that leadership in a university is similar to leadership in other areas and a leader does need to be an expert, but in the next proof we will demonstrate that this view is completely erroneous. This completes the proof.

The set of methods was shown to be self-contradictory, so it could not be followed (exactly) even if tried. The arguments given so far against a proposed method would normally be enough in mathematics to discard the method without further consideration. Let us continue to another proof.

4.   No evidence that business management methods work in universities

There is a bulk of experience collected from business life and public sector as case studies. Business management methods proposed to universities are derived from observations of this experience mingled with some theoretical thinking. Clearly, this bulk of knowledge is larger than personal experiences of the author. Limiting to a particular

environment, like to universities on some technical or scientific areas, it is likely that a wider knowledge of a narrower field can be reached by personal experience. In military parlance, the larger strength of the opponent is spread in a way that is strong nowhere and weak everywhere, which always allows a surprise by local superiority. We still have to show that the bulk of experience cannot be transported to the particular area we are interested in, i.e., universities. We will do so by devising a logical argument showing that there is a different species of management method used in universities and as it is a different species and has survived quite long, it is more believable that it suits the environment better. Therefore we cannot use the experiences derived from different species of management methods and apply the results directly. This proof requires some work. We first need to create a model.

Model of managerial types

Let us proceed to make a logical argument. We will make a model of leader/manager characteristics. This model must be simple enough, but it must contain all essential factors. There are different management styles and they can be differentiated by a finite set of characteristics. Let us try to select a small number of essential characteristics and create what we will call pure manager types. A manager has relations to superiors and subordinates. A manager can be a decision maker or arranger of resources. A manager can succeed in making the group work or fail in it. A manager can have own thoughts and supervise other, or he may not. This last dimension we take especially considering a university but the dimension can be shown to exist in all fields where success is achieved by individual achievement and followers are lead by a master.

This gives us six dimensions: support from up (SU), support from down (SD), decision maker (DM), resource enabler (RE), get the group to work (GW), has own creative contribution (GU, for guru). As we look for abstractions of pure manager types, we can just as well let all dimensions take binary values (1, -1). Furthermore, we are here interested not on the absolute managerial competence, but on different characteristics. Therefore we will assume that the sum of the variables is always zero. This means that we model pure managerial types as vectors in a six-dimensional space and each vector takes values 1 or -1. There are always three ones and three minus ones in each vector. Thus gives us six over three combinations, i.e., 20 types. We will remove the worse managers which are not especially good in getting the group to work (GW=-1). This leaves 10 types. We notice that in order to arrange resources (RE=1), the manager needs support from up (SU=1). We remove three types which do not fill this condition as impossible combinations. We notice that a decision maker (DM=1) getting the group to work (GW=1) must have support either from up (SU=1) or from down (SD=1), or he cannot succeed. We remove one of the remaining types as impossible by this condition. This leaves us six pure managerial types:

SU	SD	DM	RE	GW	GU	name
1	-1	1	-1	1	-1	Change leader, military leader (crisis leader)
-1	1	1	-1	1	-1	Military leader, leader of men (crisis leader)
1	1	-1	-1	1	-1	Administrative, personnel manager (boss)

1	-1	-1	1	1	-1	Manager, project manager	(boss)
-1	1	-1	-1	1	1	Guru, professor, supervisor	(thinker)
1	-1	-1	-1	1	1	Consultant, advisor of management	(thinker)

The column with GW=1 seems redundant, but this model can also describe less perfect managers who have GW=-1. This does not mean that they do not get any work from the group. It is simply not an especially strong point in their management method. Many of these types are also common in university professors. For brevity reasons we only look at GW=1 types in this article.

We have inserted some suggestive names to the pure managerial types. Let us investigate this table.

There is a traditional division between managers and leaders. We have the essential element of management in the dimension RE. We have not taken leadership as a dimension since there are several types which are called leaders: there are spiritual and political leaders who propagate some theory, and there are military leaders, who make hard decisions. We have a special dimension to the first category of leaders, Guru, and use decision maker as a maker of hard decisions in a short time. Thus, military leaders have this dimension at one. There is a classical division of military leaders who mainly have support of their superiors or support of their men. The latter type is here taken as the pure managerial type of a military leader, because most discussion of military leaders put much emphasis on being admired by their men. This naturally is only a naming convention, not a suggestion that this is the most common type for military leaders. This type is one of the crisis leader types.

There is a civilian crisis leader corresponding to the military commander that men do not like, the transformation or change leader. He must have the support of superior management and for reasons which become perfectly clear from the book [3] he will not have the support of the subordinates. This is the other type of a crisis leader.

Crisis leadership is problem solving. For that reason management methods and information technology applications supporting them have only a minor role in crisis leadership. It is possible to add command and control type tools and automatic data filtering to aid decisions. A crisis leader needs a vision where to go and strategy/tactics plan how to get there. Group work is favored for higher speed.

In business life there is an old division to management styles: hierarchical, democratic and so on. This division is of finer granularity that the one we discuss and does not appear in the pure types. The managers may use any way of persuasion as long as they get the group to work. We have made a more fundamental division to administrative managers and to managers focusing on planning and budgets. As it turns out today in many organizations, there is the linear (i.e., hierarchical) organization and there are process and project managers. The tasks of the linear organization manager are largely personnel management and administrative issues. The core work is often done in projects

or by processes. Both of these types are called Boss types and neither of the types is comfortable with fast decision or theoretical thinking and supervising others.

Boss type plans work, budget, and schedules, employs people, solves personal conflicts and handles a large number of meetings and paper work. There are computerized aids to this work and this work is occasionally characterized by statements like the following one the author once heard: a good developer was lost by making him a manager.

There are the thinker types Guru and Consultant. At first look the type Consultant seemed unnecessary as this type leans on superior support. The type of leadership in this pure managerial type requires essentially the support of the group and Consultant type as a manager is always worse than Guru type. Later it seemed useful to include the Consultant type as this type is the reason why an article like this needs to be written. Guru type is a type we find in traditional professors. In modern professors we mostly find manager types. We find Guru type in many other fields also: art, individual sport, spiritual matters, literature and in fact everywhere where the achievement is an individual achievement. If there are followers (students, apprentices, disciples, juniors) they must be lead and supervised by Guru. There is a theory of leadership connected with Guru type. It is often considered ridiculous by business managers or military leaders but one can easily check from university staff that it is not any new leadership method but it indeed is the way which traditionally has been used, and with good results. It is leading by being first. That is, just like a leader in a running competition is the one running first. He does not try to motivate, force, set goals, measure results or persuade the other runners to follow him. They follow because they must follow if they cannot pass and their task is to pass the leader and become leader themselves. This very simple leading way is in a way leading by example, but it is not the same as a military leader running first to a battlefield. The difference is that leading by being in the lead is not a way of encouragement, while a military leader tries to overcome the natural fear of death among the men. In the leading by being the first, all runners are fully motivated. They simply do not know how to do better and how good is good. The difficulty is to invent how to run faster and this is why the other runners must study the leader's way, or invent a better one. The other aspect is that it sets a base line: to get to lead you must pass this level and the level is constantly increasing. Finally of course the leader is passed and if it is by one from his group he has succeed as an excellent supervisor.

There is another dimension to Guru-type. He is not only a leader by leading but also a supervisor. This means advising the group what to do and how to do it. This task is problem solving and requires understanding the work of the person to be advised. The goal of supervision is that the student learns to do himself. Supervision does not mean delegation of own research tasks to a student. It does not basically mean division of a large research effort to small research tasks and have the job done this way. In reality, in most cases a thesis work would not need to be done at all. If it were an important research task, the supervisor would himself do it better and in half the time. The goal is mainly educational. The tasks the students are supposed to solve in the future are much more challenging and difficult than the thesis research and that is why they are trained with more simple tasks. Indeed, a supervisor cannot supervise a student, who is capable of

solving problems the supervisor should be solving. In such a case the two can only co-operate. There is today some basic misunderstanding of this fact that the level of student's research cannot be the level to which the supervisor must target. If it is, he is supervising well over his level of competence as a supervisor. The usual reason for this situation to be true is that most supervisors do not set to themselves high enough goals.

We have a natural tendency to discard theories proposing six managerial types or the ten best rules for a manager as a type of esoteric knowledge, like personality types in popular literature. The normal tendency is to think that people are not black or white but different shades of grey. It might be natural to think that the pure managerial types are only illusions and real life managers are mixed types. There are quite good counterarguments to such a thought. In reality, competition might well have lead to a finite number of excellent solutions. We do not see such discrete set of types if there is no effort to be the best. For instance, most people do not try to be good in the sense of the Bible and we should see shades of gray. However, such spiritual leaders as Jesus were claimed to state that who ever is dishonest in small is dishonest in large. This sounds absurd, and simply wrong, to most of us but in the black and white world of those who try to be best in this dimension it makes a perfect sense. Let us look at the mechanism of competition as Darwin explained it. We have two arguments, another theoretical and the second empirical, albeit from a small sample.

Firstly, let us think of the highly competitive life of a manager of any type. This kind of competition pushes each pure type to improve and specialize. Most scientists today take Darwin's theory of natural competition as a well-supported fact. Darwin explicitly explains a mechanism [2] which produces distinct species, not mixed types. The mixed types fail to excel in anything and will not survive. This is the reason we have not included the type with all parameters put to zero into our model. This kind of good for all purposes type is not especially good for any task. There will be a small number of discrete types. Rather than assuming that most leaders are of mixed types, we should assume that in a particular situation a leader will follow some pure type. Maybe, a versatile person can handle many roles and adapt to another type in some other situation. The types need not be the ones we proposed, maybe a change of basis is needed, but it is irrelevant to pinpoint the precise managerial types to our purposes. Additionally, a manager is not poor in any dimension. We have simply normalized the sum of the dimensions to zero. In the book [3] a change leader is said to be 70% leader and 30% manager. If our change leader has RE=-1 and DM=1, then adding the basic level of a manager, say 2, gives RE=1, DM=3. This is roughly 30% and 70%. Naturally, the model is very rough and cannot give any precise figures.

Secondly, we have some experience that mixing types is difficult. Traditionally professors have been of Guru-type. Today they are of Manager-type. It is very rare to find people who successfully manage to mix the roles at the same time. This is why the sabbatical year has been seen necessary in universities. Then one can be at different roles in different times.

Let us look at interactions of these pure managerial types from a university point of view. Traditionally we had something like:

Ministry, rector, dean	Laboratory head	Professor
Administrative boss	Administrative boss	Guru

Here we have the laboratory head, typically a senior professor already pass his productive years, working as a buffer to the active researchers. Yesterday in universities of technology and economy we had increasingly something like:

Ministry, rector, dean	Laboratory head	Professor
Manager	Administrative boss or Manager	Manager

Here we have lost some brain power from the university as there are fewer thinkers, but measurable results look good. At the moment there is an effort to push an organizational change to all, not only to technical and economy) universities. There are still some hiding places to Guru-type professors and Administrative bosses there are everywhere. The figure looks like this:

Ministry, rector, dean	Laboratory head	Professor
Change leader Consultant	Administrative boss	Guru, Manager or Administrative boss

We should get some conflicts. The Administrative boss is obliged to pass the new methods of the Change leader to the Guru, who's management methods are incompatible with the proposed ones. We now have a model. Let us go to the argument.

Claim 3: *The evidence supporting the new management method is not relevant to universities.*

Proof: The Consultant has gathered data from business life and some public sector institutes. The last comes mostly from more business like institutes because the new methods have not yet been tried on many public sectors. The managers in this sample are mostly of the two Boss types. There are some Change leaders, but the experience from these cases is interpreted with a bias: if they have succeeded they are taken as examples supporting the theory of change leadership, if they have failed, it is because the organization did not follow Consultant's advises. We do not see any Guru-type managers in these sectors. However, theory based on experimental data which is missing the particular manager type which is common in universities, will be useless if applied there.

We conclude that the theories of business management are based on data which does not describe the situation in universities. There is a fundamental omission of a main and the best suited management type. Therefore this experimental data and derived theories cannot be used and local superiority in understanding the actual situation cannot be overcome by moving results from other areas. This concludes the proof.

5.   Evidence that business management methods do not apply

The next argument also relies on the model of managerial types.

Claim 4: *Business management methods lead to conflicts when applied in a university.*

Introduction of quality management has lead to conflicts in the real life. An incidence (17. February 2006) in the University of Helsinki was titled a professor rebel in daily newspapers. In this incidence 46 laboratory heads opposed to the introduction of a quality program after having unwillingly just accepted result-oriented management and new salary calculation method.

This incidence may have complicated roots. In this article let us look at the proposed conflict as a result of the Guru managerial type when new management methods are introduced. The Guru method of leadership is not motivating the group and we may not expect that the whole group is working hard. Let us take an invented example, but with reasonable numerical values.

Let us assume that a traditional professor using the Guru leadership method writes himself two journal papers a year, which is reasonable as he has less administrative work and is not looking for external sources of money. He has six doctorate students, out of which three are outside the university and three are assistants. Assistants have the traditional one day a week work duty, giving exercises and such things. The traditional suggestion to students is that they have 7 days a week for research and a day has 16 hours, but this is not mean that they are required to do 16 hour days. It is left to the students to decide how hard they work. Some work really hard, some not much. The salaries are low as the goal is not that the students stay in this job but try to get forward in their academic careers. With the Guru leadership method about one third of the group work hard, one third work normally and one third work less. The best third, two students, produce about one journal paper a year. The second best two students work half as hard. Thus, we get about five journal papers from the whole group including the professor. The two best students get the required five single authored journal papers in five years and earn their Ph.D. The second best two students earn their Ph.D. in ten years. The traditional professor is not a coauthor of papers he supervises, but he has two single authored papers in a year.

Let us assume the same professor adopts the leadership style of Manager. He has ten students and spends most of his time filling project proposals and attending meetings and he does not write own papers. He appears as a coauthor in each student paper as he is supervising them. Manager does not get the group working any better because he does not inspire the students enough. Three of the best students again write a journal paper a year, though they have somewhat more duties in teaching as managers delegate work. The three second best students get a journal paper every second year, while the worst four students produce together equivalent of half a paper. The group produces 5 journal papers

in a year. It also produces more dissertations and four journal papers with two authors are now considered enough for a Ph.D., as the professor has only supervised them and they are counted fully as results of the student in the Ph.D. The professor has 5 journal papers a year, and since he is an author these are counted as his papers in professorship evaluation.

We see that the second group has produced twice as many measured results and this explains why Manager-type is replacing Guru-type in a rapid phase. Naively one might say that they have simply calculated the papers twice. We get more doctors, but have lost the creative work of the professor. In most fields students cannot produce as good results as professionals, but let us not discuss the actual quality of the results here. There is a bigger difference in favor of Manager if the traditional professor has passed from the role of Guru to the role of Administrative boss, as often finally happens.

Now, let us look at the introduction of results-oriented management, quality management and other methods of the business management paradigm. The traditional professor and the two best students are already working as hard as they can, so they cannot improve their work with the new encouraging salary system. Their superior, a Manager laboratory head, has not done creative research work for so long that he believes that management is the main work. He will most probably set goals which are not proposing doing research on some high risk breakthroughs, but instead minor tasks of no global importance.

Guru type traditional professor and his two best students on their turn find it ludicrous that the manager thinks that the amount of work could be increased because of a better salary and take the suggestions of this type as a proof that the manager is not himself trying his best, because how else could he think so. Guru type probably has no appreciation to the type of work managers do, such as attending ineffective meetings. The use of Consultant he will find ridiculous seeing it as equivalent to a situation where a university research team when facing a problem calls on a commercial consultant to solve it. Clearly, there is little hope of avoiding a conflict. We also get a conflict with Administrative boss, as he opposes any changes. In universities where the majority of professors are Managers, leading change proceeds better.

Let us discuss the salary incentives a bit more. The best third cannot improve their performance as they already try hard. The last third has some mental barriers and cannot improve their performance, but what about the middle third? We should expect that for a while there may be some improvement, but it does not last. Salary incentives fail also there to create a lasting improvement because the middle third does not want to increase the efforts. Talent is distributed roughly normally, but because people like to belong to some group motivation tends to have a discrete distribution. Using an analogy with sport, the middle third is playing for fun and these people have other goals in their life, while the best are playing seriously. Fun players do not want to enter the competition with the serious players since they would lose and nobody likes to lose. Losing is fine only if both the losers and the winners consider it just a game.

This has some relevance to group cohesion. Manager type bosses often try to increase group cohesion thinking that they will create a team. Whether they can succeed or not depends on the distribution of motivations. Competition level depends on the culture and in Finland the division (1/3, 1/3, 1/3) to the best, middle and worst groups may be typical and made immortal by the old joke: "How many are working in this firm? About every third." As has been described by hundreds of novels and films, a team can be created if the starting level distribution is roughly equal (0,1,0). Another possibility is to take a butch of heroes with the distribution (1,0,0), i.e., the dream team. When Kotter [3] describes creating a team out of top managers we talk about a bunch of heroes, as is also the case in the legendary multidisciplinary operational analysis teams of the fifties. Multidisciplinary groups do not easily make a team unless they are bunches of heroes since there are serious communication problems. Meetings organized to elevate group cohesion in groups with many motivation levels (like (1/3, 1/3, 1/3), but the exact distribution is irrelevant) create mostly confusion and if group pressure is increased high enough, the best decide to leave or suppress the open expression of their goals. If a university tries to give all sufficiently competent students a chance to continued studies, we usually have researchers on different levels. There are professors who try to select only the best to their groups, but this only pushes to problem to other supervisors. It is better not to try salary incentives but to create the attitude that a researcher salary is actually a scholarship enabling studies, not a salary for work done. There hardly is any chance of competing with salaries anyway: if a master level researcher in a university earns about, say 1000 euro, a month before tax and he knows that if he moves to industry the salary is more than twice that, there is no way to match the salaries offered by the industry with any salary distribution. We cannot divide the small university money so that those master level students who perform well get 2000 euros and those who perform worse get 200 euros. More likely, emphasis on salary will have the result that the best are ashamed to stay on so low salaries and only the worst stay. Manager type professors would naturally like salary incentives and receive substantial raises in salary, but this is not a good reason for a new salary system.

A sufficient number of conflicts have been demonstrated to support the claim.

6.   Conflicts with existing theories are not explained

We will now analyze change leadership as it is described in the book [3] where the back cover announces that the author, John P. Kotter, is the outmost guru in change leadership. The book reads as Machiavelli, indeed it is worse since despite the efforts to human approach here and there, the general style of the book is very cynical and unfortunately very familiar to the present efforts of organizational change. We will use Kotter's method as an example of an organizational change process. The new management methods introduced to universities have so much in common with the process Kotter describes that we can use the description in [3] as a sufficiently accurate description of the currently ongoing process.

Claim 5: *There are unexplained and unexpected differences between the change leading theory and military leadership. That is, the new theory has not explained the differences to older theories.*

Proof: Professor Kotter describes an eight-stage process to create a change. It starts with removal of complacency and increasing the sense of urgency. If there is no real need for the sense of urgency, it is increased in artificial ways e.g., by setting goals that cannot be reached. The whole method relies on keeping the organization at the tip of their toes in a never ending sense of urgency.

Vision and strategy are created and all personnel in the organization must be aware and adopt vision and strategy. We may compare this to the other crisis leader type: a military commander. It is usually not necessary to create the sense that we are near a catastrophe if we are not and it is usually not necessary for every soldier to know the vision and strategy. A good military leader must indeed talk to the troops, but what is his message, is he repeating the vision and strategy? In practice business vision and strategy do not create any response from the workers. They are experienced as empty words. In order to talk to anybody, especially to groups of people, you must have something different to say. In a university, the manager might consider saying something that makes sense on an intellectual level, such as motivations why this is a reasonable thing to do.

Personnel, especially managers, who are not convinced by the vision or strategy and try to slow the change down are to be either converted or eliminated. As a way of converting people some sort of soft brain washing is used by taking the group together to mounting climbing or to similar artificial events, which are carefully planned to create one mind and one vision.

If introduction of Consultant's change process fails, it is the fault of the organization and caused by inertia of people to adopt new ideas. It is not caused by poor leadership as it would normally be considered if a military leader tries to introduce a change and is unable to do it. The trick in management and what distinguishes good managers from poor ones is to find such a change and such a way that you will succeed in making the change.

People working in an organization going through a change often wonder why there is such hurry. Reading Kotter's book makes it plain clear. Creating urgency and reducing complacency, i.e., making the work place less pleasant is indeed the goal. Should people have time to think again, they would stop the change process.

Thus, the leading change methods of Kotter resemble a manual for making a coup de force. Let us look at a strategy and vision in university sector. There is a need for vision and strategy, and there have been visions and strategies. When the telecommunication sector started booming, the government in Finland increased education programs and professor positions in telecommunications. This is what strategy means to a university: shift focus of teaching, start new research areas. The strategy was correct, albeit it was started too late and with too few resources. The few professors had far too many master

students and the industrial drive was too high, so very few doctors were educated and related theoretical fields took much of the funding which was intended to the growing field. The final outcome was not so optimal: the strategy failed to create top level expertise on the targeted area and presently the telecommunication sector in Finland is in a recession and companies are wondering whether the universities have developed any superior competence. The partial failure of the strategy was caused by it not being though carefully through in realistic steps. Let us recall that Napoleon planned the route of every troop [4]. The vision and strategy as planned today are simply not any war plans of von Moltke's type in Franco-German war [4]. They are vague roadmaps which for their vagueness very easily can fail. A detailed strategy will fail at some point, as it did with von Moltke, but it is never useless to make detailed plans. Currently what is called a business strategy is a sentence or a few italic lines. Strategy thus should be more detailed, but there is a need for a strategy. Strategy has a limited scope of putting resources where they are needed in a given time. It is in fact quite similar to a military strategy and grand tactics. There the problem is putting correct troops to correct places at correct times.

We looked at the character of change leadership and noticed that it has very suspicious differences with another field of crisis management, military leadership. As change leadership is very young compared to military leadership, we should expect that the differences are explained by the proponents of change leadership, like every new theory must explain conflicts with existing theories or else the differences are accounted as errors in the new theory. Let us continue to the next proof. Let us construct an argument showing that change leadership is not needed in the university.

7.   There is no need to the new management methods in a university

Claim 6: *The need for new management methods has not been demonstrated.*

Proof: The only argument for the need of change is that in modern life change is needed. Modern business life has become more competitive and managerial or administrative management is not enough to meet the competition. Let us think how fast a university in reality changes. It takes about five years to educate masters and about three to five years to educate doctors. Much of the material taught in universities is fairly constant since it is the accumulated experience of centuries in a very compressed form. There are fast changing fields, such as telecommunications, but also there traditional methods of updating the course material are quite sufficient. Developing research to some level on a new field also takes years. Simply, universities do not naturally live in as fast changing environment as business life.

There is another crucial difference: to whom is the result intended. In a commercial firm it is clear, the result is profit. Although for a while it might have seemed that the firm is partially working to satisfy the needs of the workers, in the present time of globalization it is plain that the firm works in order to bring profits to its owners and senior managers. In case the profits are not good, the firm faces bankruptcy. There is a need for a constant change.

As for a university, are the research results something the owners want? Obviously, the owners are not reading the papers, but why should they be counting the papers? Owners of a commercial firm want the money, but who wants scientific papers. Or do the owners of a university enjoy the high number of publications? The fact is that the research results are usually of any use only to the researcher himself. Sometimes, but rather rarely, the results of research turn out to have applications. In such cases they benefit the society and humanity and this is the reason the society supports research. It has very little to do with the quantitative amount of research done. The same is with education. The numbers of graduated masters of doctors or the student feedback are really not of similar immediate benefit to the owners as the profit of a company. Education benefits the people who receive education. The teaching process, especially teaching to be more innovative for the high-tech future, is a difficult process and business consultant's advises what parameters should be maximized do not help this process. The conclusion of this argument is that university environment does not change so fast and there is no clear parameter that should be maximized in order to succeed in the competition. As there is no clear parameter that reflects the success, there is no reason why the owners, if they understand what a university is about, should conclude that the institute is facing bankruptcy.

8.   A learning organization is not a good goal to a university

Lastly, let us look at the concept of a learning organization. This concept is explained in Kotter's book in a very lucid way. In fact, though Kotter's book is 12 years old, it contains all current features of change leadership except for the reward methods, quality management and process management.

Claim 7. *A learning organization does not lead to excellent research or teaching*

Proof: An organization has intelligence and it does not have much to do with the personal intelligence of its superior managers. The superior managers can be quite intelligent, but an organization has an intelligence well described by Kotter with the example of a traditional organization being an elephant and a learning organization being a customer-friendly tyrannosaurus rex. While both of these animals are intelligent, they do not invent gun powder. Intelligence of organizations is of different type than intelligence of individuals. The organization's results are something no individual can accomplish. The university has its curriculum as the result and a firm can have a product line. These are examples of organizational intelligence. Change leadership tries to increase urgency and put the organization and its workers into a state where it is pushed to the corner and must fight. It will fight as well as it can and produce the largest profits. The negative aspect of this is that the workers are put to the lower end of their need hierarchy. Any living creature has a hierarchy of needs: first you have to remove the immediate threat of death, then of food, sex, and so on. Research and teaching can only be developed in a true way if the more basic needs are filled. This does not mean that a researcher, who will be fired if he is not producing papers or getting a high student feedback from his courses, would not try to achieve these results. Unless he feels very

strong he probably will do exactly what is required. What he will probably not do in this state of mind is truly original thinking and inspiring teaching. Pressure is good, but it is a different pressure. The good pressure is the pressure how to achieve best results, not the pressure how to keep the job. A learning organization is a misnomer. The more correct name is a frightened organization.

8. Conclusions

We conclude this article by summarizing the arguments. It is indeed possible to create logical arguments against using business management methods in a university. First we showed that a particular combination of management methods does not make sense as it is neither necessary nor sufficient to bring an improvement and additionally it is self-contradictory. Then we showed that the collected experience used as the basis of the business management methods have been collected from sectors which use different management practices. We described cases where business management methods cause conflicts or do not work, so they should not be seen as applicable. Next we analyzed briefly change leadership and showed that it has several unexplainable differences compared to a better known theory of military leadership. A sound theory must explain such differences. We noted that the basic assumptions of a need to change are not filled in a university. Lastly we commented that the goal of a learning organization is counterproductive to a university.

We cannot prove that in single cases change leadership cannot produce good results. We could only devise seven scientific arguments against the approach. Probably seven is not enough but neither have the proponents of change leadership in universities any better arguments for their cause.

The goal of this article is not so much to support the professor rebel in the University of Helsinki, but to offer an explanation and an alternative. The first claim points to successful raises of level done with other ways in the past. The second claim reminds us of the fact that many business management methods do not lead to the highest quality, though that should be the goal in science. The third recalls that there is a different management approach, which applies better to the university. The last claims make it plausible that the direction of the change is wrong. The article may seem to have a tendency and it may seem to argue in favor of one management method. This is true but the reason is that if professors use the managerial approach, the direction to business management methods logically must be continued and it will not lead to a good result. The students form their approach of the university from the experiences they get while being supervised. If their experience is that professors are Managers or Administrative bosses, they will introduce an organizational change when they are decision makers. The likely result of such an organizational change is not an institute of innovative research and inspiring education. The alternative suggested in this article is to analyze the situation carefully. This article has tried to formulate arguments in a clear way. The analysis in this article points out that a traditional understanding of a university is not in reality less efficient than a modern one, and in order to go forward, one should now go backward.

A note on the literature: there has not been any effort to refer to scientific literature on change leadership: the book of Kotter already says it all. The other references are to books that have influenced the author while writing this article.

9. References

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On pedagogical aspects of teaching technical subjects

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1.   Introduction

Education is the first task of the National Defence College and pedagogic aspects of teaching have recently received lots of attention in preparation of the new curriculum for officer education. Especially there has been a request to describe a student's learning experience in military technology. Supervision of research is also increasingly important on master's theses and doctor's dissertations. These reasons motivate pedagogical considerations in education of technical subjects. This article gives a brief discussion on the topic based on author's experiences and concludes with a possible characterization of a student's learning experience.

2. Some dubious ideas on teaching of technical subjects

Pedagogy is a much studied field of science and the author does not claim any competence on the theory of teaching. On the theoretical side author's experience is in reading some books on pedagogy. A short look at pedagogic literature gives the impression that the field focuses on education of pupils [2], [7] on developmental psychology [3], [5] and on general studies on how people learn [1], [6], [4]. These kinds of topics of pedagogic research do not try to address the questions of university level education in sciences and technology, probably because the researchers of pedagogy do not have direct experience on these fields. Clearly, teaching sciences and technology has traditionally not been a haven of pedagogy but populated by straightforward technically-minded people. Application of results obtained from teaching pupils in schools into highest level university education in technology is of doubtful validity. Let us ignore these theories as the teaching experience does not confirm their validity on technical subjects and the author has not studied them in detail.

There also exist a body of common knowledge in teaching. This is easier to address as common knowledge does not hide under the disguise of science. It is a collection of common believes and may well turn out to be wrong. Let us go though some of the most common arguments.

2.1.   It is necessary to build a solid basis on which new knowledge can be laid

The idea is that knowledge is like a pyramid and you cannot found a pyramid on a weak basement. This may have some validity in pure sciences, but let us focus on technology. In reality the basement is not very long lasting. If a student studies very well some topic and then is not using it for 10-15 years, it is all but forgotten. It can be relearned but it is difficult to say whether it is relearned essentially faster than some totally new topic. If the knowledge is used all the time, it is naturally learned better, but in that case it probably would not have harmed if the basement was not so strong to start with. We also see that

students who have quite different basic studies do equally well on new topics. A student who has a university education on a typical field of modern high technology is not essentially better trained to work in this field of technology than if he has his university education for instance on mathematics or physics. At least this seems to be the case in telecommunications. The reason probably is that the master level university studies on any major are so narrow and short that they never give such a basis that cannot be later acquired. Doctorate studies on the other hand are too focused on the dissertation and this knowledge is typically not directly needed in work life.

What seems to be the case is that if a student continues studying actively, his abilities to learn new topics improve. If he does not study, his abilities deteriorate. The gain has been the ability to learn. It is quite possible for somebody who has learned to learn on one field to learn another field. We must conclude that the knowledge that the basis contains is not the essential advantage from studies. Therefore the solid basis theory is wrong: we can start from any basis, from scrambled basis, no basis at all. As long as the student has acquired the skill to learn, all these problems can be overcome. Naturally, it is much easier to the student if he has the basis. The time required to produce results with or without the basis is more or less the same based on experiences from work life, but certainly the stress level of the student who is without the basis is much higher. Yet, let us recognize that a high stress level is not only negative.

For a teacher it is easier if a solid foundation is laid. Then the teacher may decide to assume that the previously taught material is learned. If the teacher is more honest he will realize that not all students actually learned it. Thus, it is more of a question that he is justified in assuming so it if he so desires.

2.2 You cannot climb to the tree backwards but from the bottom

Climbing a physical tree backwards is not impossible but it looks foolish since there is a better way. This argument claims that it is foolish to study material in such an order that unknown concepts do not first get explained and then used. Material that is commonly available from a topic, such as technical documents and scientific papers, does not have this kind of perfect order unless it is worked out into study material.

The argument implies that new subjects can only be learned from reading text books, but in reality new subjects can also be learned by reading material which is not prepared to be used as study material. The difference is that the latter type material requires that the student either can for some time tolerate the uncertainty of not knowing some concept that keeps on appearing in the text, or has enough energy to look up the concept from some external source like e.g. WWW. It is not only possible to learn in this way most subjects but actually it is necessary that students learn to learn this way. Otherwise they are lost when they have to learn topics that are not yet in text books, and that is the typical case in technical research.

2.3 Do not give new material to students faster than they can learn it

This argument seems very plausible. A student can absorb some amount of new information. If more information is given, the student does not learn it, therefore teaching it is a waste of time. While the argument seems correct, it is essentially wrong – while the student does not learn the content of all material if it is given too fast, it is still not a waste of time to teach it because the student improves in his ability to learn more. The speed how fast a student can learn is increasing when he learns more. The ability to tolerate new concepts before learning them also increases, so the student learns to learn from unprepared material faster if he gets more new concepts to learn. We see this in such teaching methods as the language immersion for learning foreign languages, i.e., the student is immersed by an environment where he only hears the foreign language and consequently for the most time does not understand a large part of it. It is not a constant speed by which new concepts can be learned but we may compare the situation to a river dug on sandy ground. The faster the water flows, the wider the river becomes. The correct image is not that of a constant size leaky bucket, but that of a lake with a river from which water goes out and another from which it comes in. If we get the speed of water coming in faster, the lake fills up, but it is so large that it is unlikely to flow over. The more we feed into the incoming river, the wider it becomes. Clearly, the optimal speed should be the maximum.

There is an opposite factor in increasing the speed of new concepts making the optimal speed smaller than the maximum. Learning gets all the time more difficult when you pass the currently natural speed. Learning with a speed that a student can absorb all material is easy to the student. Increasing the speed makes the learning experience less pleasant. When it is too unpleasant the limit has been reached. If the goal is teaching knowledge, the speed can be the nice easy speed. If the goal is increasing the learning ability of the student, and this must be the real goal in all modern education, the speed must be faster than the nice speed. Therefore, to be effective, learning cannot be very pleasant.

2.4 Lecture form of teaching is inefficient, students should be learning independently

Independent learning is possible on some subjects and on any subject as soon as the student has acquired the skill to learn independently. In scientific and technical subjects students have a high threshold before they can learn independently or discuss the issues in groups. Several efforts to use this type of education have been made but there are only few courses where the method is suitable. One example where the method has been successfully used is new product development, which can be sort of brainstorming. Other examples are programming and hacking courses, which can be made as independent or group exercises in a computer class.

2.5 The way to learn to swim is to jump into cold water

When talking about swimming, this is the way to drown almost surely. When talking about studying techniques, this is a suboptimal way that must sometimes be used, but a much better way is to acquire education beforehand. It is not so important that the education is on the area of technology, but if it is not, a supervisor is helpful. There are

large differences between the fields and it may take very long before the student realizes the character of technological studies: that is, in what sense the material should be studied, what aspects are important and where is the meat in it.

2.6 There are the ladders of knowledge a student must climb

The ladder theory is another variant of the solid foundation theory. Technology does not build much on earlier knowledge. There is a ladder, but the ladder refers to the student's ability to learn more. That ability is increasing, but the knowledge does not accumulate.

3. Towards a theory of student's learning experience

Technology is taught in the traditional way combining lectures, exercises, special assignments and group works. The methods work in practice, but there is no theory of a student's learning experience. We need this kind of theory and it should not only be applicable to military technology, but also appealing to students. We may say that proposing the traditional way of teaching as a student's learning experience is applicable to technology, but not modern enough to be appealing to students.

Technology focuses on creation of new technical innovations, so theories on creativity and research might seem appropriate. Most of the literature on these issues focuses on general questions how to make research reports, like [8], or on general discussion on creativity, like [9]. The author has not read anything in the literature that actually seems helpful in describing the student's learning experience.

Let us consider what could be a student's learning experience. There is a characteristic feature in command and control (C2) system technology: there are lots of acronyms and words spelled in capital letters. This is a feature of all of the subfields of C2: computers, communications and military technology. None of these fields are necessarily especially appealing to the majority of officer students.

The most common feedback from students on the author's courses has been that there are too many acronyms that confuse students who have learned that they can understand everything on the lectures – they are totally unaccustomed to meeting terms that are not carefully explained. For a beginning student studies in telecommunications may be a quite esoteric experience before he starts to understand the majority of the used acronyms. At that point it is naturally revealed that there is no esoteric content: the acronyms are simply names of bulks of code or standard documents. The reason why he has not been explained the detailed content of these acronyms is that standards are very long, very technical and new acronyms are introduced all the time. If the teacher does not consider it worth to explain them in detail, why should the student want to understand them any better than by the name or one line explanation?

Let us look at the goal of education in modern information technology, the situation is similar in military technology as the military sector will rely more and more on information technology and needs the advantages of modern technology. There is a task

to be done and we can collect some people to do it. There will be specialists and generalists. The specialists have their own small area that they know well, while the generalists know nothing and cannot combine the knowledge of the specialists. About 80 % of the work will not be done since there are too huge gaps between the areas of knowledge, see Figure 1. The specialists claim that the generalists simply do not explain the problems in a way they can understand and that it is the generalists who should cover the 80 %. Naturally, they would then have the 20 % of the task and be happy, but the generalists do not have the special knowledge of the 80 % of the task
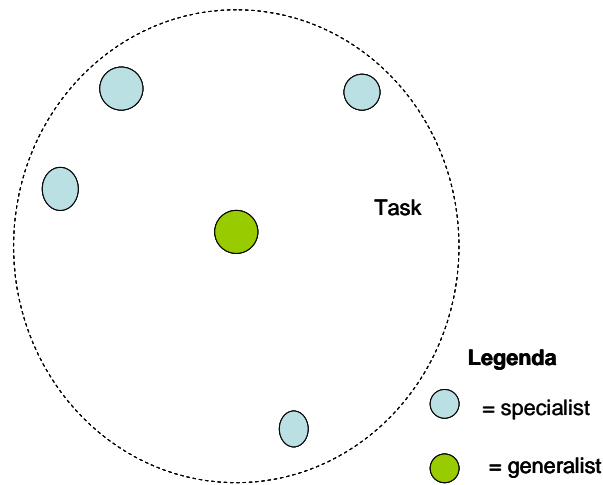
Figure 1. The present situation

A possible approach is to hire so many specialists that there are no gaps, see Figure 2. In that case there are lots of interfaces and it will take very long time before the specialists understand the interfaces and the general goal of the task. Usually economic and time constraints are such that this solution cannot be used. Even if it is used, it is not an agile organization. Today agility is a main concept in information technology and also in Network Centric Warfare [10].
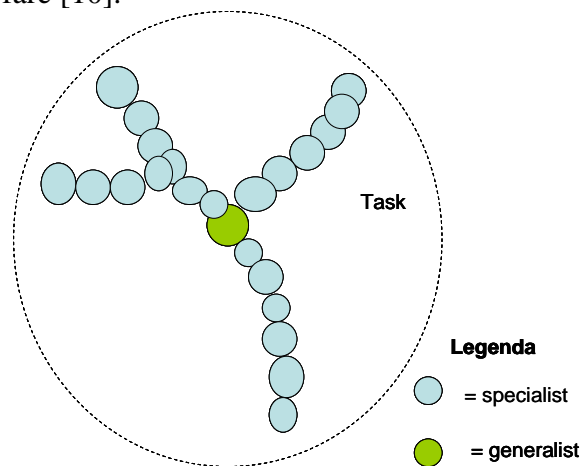

Figure 2. The multidisciplinary solution.

There is a tendency in Finland to urge researchers to specialize. As a small country cannot have specialists on every field, some fields should be selected. This solution is possible but it has the important negative aspect that agility is lost. Therefore the connection to real tasks to be done in business or military will be lost. There is little reason to expect that specialization on some narrow area can be on the centre of interest in the future. If we look only at the results on the particular task, chains of specialists are eventually the best solution to the task, but only if the task needs to be made for a long time as stable business. Today we need more agility. An agile organization is able to move to new areas fast and cannot work in this principle. Therefore the targeted competence is that the experts can learn new areas fast and learn to cover all the area from beginnings to a leading edge level, see Figure 3. This is indeed possible. What is not possible is to master the style and large area of the new fields, but it is possible to reach the level where the subject matter is on the high level.
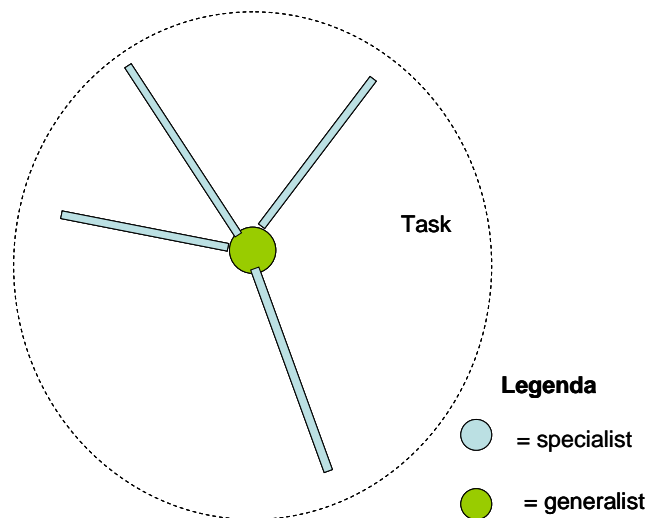

Figure 3. The targeted competence.

4. Student's learning experience

There is no single student's learning experience. Students are motivated differently and we should not imply that it is any worse to be motivated by a deep interest in the subject than by considerations of the subject's usefulness in the future work life. Likewise, some students are competitive and like taking challenges, while other study because it is the duty of a good student. Let us have several ways for reaching the targeted competence.

Also, the student's motivation may change during the studies as the student matures. Let us impose a model with several stages. On each stage the student's main motivation is different.

Let us propose a staged model as in Figure 4. It contains the integers from 1 to 10 and the explanations are given in the following list:

1. Targeted competence
2. Operational use
3. Technical know-how
4. Deep interest
5. Duty
6. Understanding
7. Challenge
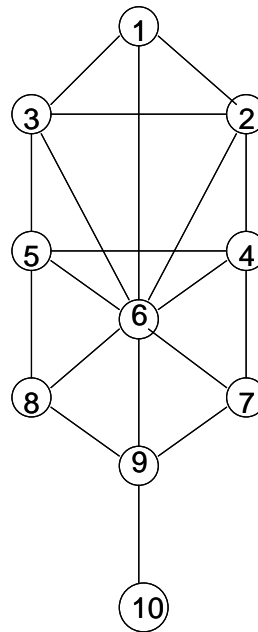8. Future need
9. For fun
10. Initial state

Figure 4. Stages of motivation.

The goal of the highest level education is that the students reach the top level, Targeted competence.

At the start the student is in the state 10, Initial state, with only the seed of interest to technical studies.

First we must get the student to the next state, the state 9 or "For fun". This is the state where the creative energy students possess is used to awaken interest in technical studies. This stage is reached by placing into the beginning of technical studies one or some courses that are actually interesting and interactive with group works and other play-like things.

The next states 8 and 7 are Future need and Challenge. They are two of the three possible motivations for a student to move to a higher level. Future need is the motivation that the studies will turn out useful later in life. The challenge is the motivation that many students are competitive by nature and like solving problems and puzzles. In mathematics the first interest is usually that for many pupils it is interesting to solve mathematical problems. This is internal competition against the problem. Competition can also be among the students for better achievement.

Let us discuss another dimension of Challenge as it is relevant to motivation of people in general. An ancient heroic way to motivate people with a challenge is that a warrior is boasting and insulting the competitors trying to get them to take the challenge. The boasting states that he is the best and the most beautiful (like Cassius Clay) which the others can either accept or take the challenge and try to show him wrong. The insulting is

that the others are not as good. In our Western society boasting and insulting are considered rude manners, but in societies using the warrior challenge, that is the majority of pre-industrialized societies, the challenge is not experienced as rude. There is a code of honor in a warrior challenge: you should challenge only equal freemen so that the fight is fair. Challenging weaker or slaves is not proper. Instead of challenging a slave, you should challenge the slave owner, typically a chieftain. For a warrior to challenge a chieftain always bears a risk. The chieftain often will not dare to take the challenge in fear of losing, but he will revenge in some other way.

This ancient method of motivation is still interesting because in the author's opinion it is currently still one of the best ways of motivating people. If is very typical to hear that a project manager or a teacher tries to motivate using Future need and Duty but the people are not motivated. It is because Future need and Duty are perfectly rational motivations. The person will calculate what actually is the future gain from this and is this actually his main duty. In many cases it is not. For instance, for a student, is military technology the most important topic? In Challenge the motivation is not rational. The author estimates that about 50 % of men can be motivated by a fair and suitable size challenge. The author does not recommend motivating women with a challenge: most women misunderstand this type of motivation as threatening. At most 30 % can be motivated by Future need and Duty, but often only 10 % can be motivated by these means.

There is still the third motivation: Understanding. Some students are motivated to study because they want to understand technology. Such people are a minority: maximum 10 % in the author's estimate. It uses a rather rare philosophic desire to understand things.

At the next level the student can be motivated by the combination of Future need and Duty, when he starts to realize that studies in technology are not a bag of tricks that are directly useful in work life, but instead it gives some basic abilities that can be used in the future. Then the motivation may be mostly by Duty and by trusting that the education is well-planned while it does not seem to be directly usable. Motivation by Future need and Duty is work oriented motivation and does not require special interest in technology.

Hobby oriented motivation is shown ton the right: Deep interest and Challenge. The studies give interesting challenges and the students gets more and more interested in the topic. Let us mention that Deep interest is not an especially common motivation in studying technology. We can deduce it for instance from the fact that there are no talk shows in the television of technology and talking of technical things of technology on a dinner party is socially discouraged as a too dull topic. You may see talk shows on politics, sport, humanistic sciences, philosophy, religion and sometimes even natural sciences, but you hardly ever can spot a talk show where experts discuss mathematics or techniques on a technical level. This should point out that these topics are not equally easy to grasp as some other topics. This is why motivating beginning students with Deep interest may not be especially successful. The students need to pass some stages before this can work.

On the top level there are the motivations that a student may want to become a technical expert, or may want to understand how to use technology wisely into operational needs. These are both good targets for a student of military technology. The stage 3 is more technical while the stage 2 is more tactical. Finally the target level is reached.

There is the current complaint that teaching is too much forcing the student to sit on lectures and checking by exams that knowledge has been acquired. This complaint is about putting too much emphasis on Duty as the motivation. This criticism makes sense: students have different motivations and teaching should allow differently motivated students to reach the target. With a more harmonious teaching approach, not focusing so much to Duty, we give the student a better chance to reach the target of the education.

We should still be more careful of motivating students with the "Deep interest". This is because of the targeted competence in Figure 3. The author has met with hostile attitudes from all parties: students, professors and pedagogically oriented amateurs when stating that techniques is dull and one should teach the students in a dull enough way so that they learn to tolerate the dull and can find enough motivation without being very interested. This opinion of the author can be easily explained. Anything becomes interesting if you continue and study it for a prolonged time. The interest derives from two sources: knowing much of the field gives positive experiences and appreciation of your colleagues on the same field also gives positive experiences. Therefore your natural tendency is to become to a specialist and we are in the situation in Figure 1. In tasks to be done we constantly see the problem in Figure 1. For instance, we may have a teletraffic expert who denies knowing anything of teleoperator needs and is not even interested since it is not his area. Or we may have a cryptologist who claims that he does not have the competence to make the security architecture. In both cases the specialists have twenty years of experience on the field and the proposed work is as close as is possible to get in the task to be done. Yet, there is apparently missing a whole chain of specialists who cannot be introduced to the task. If a task only has some months of work to each subtask, there is no sensible way of splitting this work into subtasks for three experts and to expect that the results are meaningful. No specialist can adapt to the task and understand the goals in so short a time. Therefore, if we are not satisfied with the outcome of an organization as in Figure 1 and cannot use the solution as in Figure 2, we must use the solution in Figure 3. It is rather impossible to imagine that becoming an expert from zero level in some months can be rewarding. It is much more difficult than being a specialist. You may take any scientific or technical literature on a field you do not know and imagine how pleasant and interesting it is to write an original treatise on it in a matter of months. Further more, you cannot count on any positive feedback from the specialists. They feel threatened once you enter their field as they consider it as their play ground. They will point out all stylistic drawbacks on your treatise and ignore the merits of the content. As Figure 3 is the targeted goal of an agile organization, almost any other motivations than "Deep interest" in Figure 4 are more likely to motivate the student. Yet, "Deep interest" when correctly understood cannot be ignored. Writing articles on various topics, such as on pedagogy, is naturally interesting, but we are here talking of a generalist's skill of writing expert level scientific contributions on different fields of technology. That is more difficult and most probably less interesting. However, there are

interesting things once you admit that you need a philosophical attitude to the word "interesting".

As for the scientific motivation to the model in Figure 4, it for the time being is not verified. However, one can create this kind of a model for the present situation by a scientific experiment. We may ask the students to rate the individual courses and the whole curriculum in technology, as well as in other disciplines, on the proposed model. Then we may verify if there are stages and what exactly should be the structure of the model. Figure 4 is simply a proposed model, but a careful investigation may reveal the true situation. Then the curriculum can be compared to the targeted competence and decisions how to improve the course contents can be made.

Let us finish by looking at some learning concepts. Laboratory rats and dogs can be taught tricks with carrot and whip. The corresponding concepts in Figure 1 are Future need and Duty. Naturally, teaching people as if they were rats, is a mistaken concept, but this great idea of behaviorists is nevertheless much used.

Motivating with "For fun" and "Deep interest" is today proposed as the new constructive learning paradigm.

Motivating with Duty only is the traditional choice in a school system. Learn because you are punished if you do not learn. Fortunately these days are long gone. Despite of that, Duty remains as a main motivation in technical studies because interest is not equally easy to create in all topics.

Ph.D. students often want to study under some well-known expert. Then their motivation is Technical know-how. The author thinks this motivation cannot be used to beginning students but requires that some stages are passed.

Children and dogs are basically educated using severity and love. This is the relation of God to humans in Jewish and Christian teaching. In the previous centuries this was the relation between the king and the subjects. Still today dictators may have this kind of relation to the people. Severity corresponds to Duty in Figure 1. Love has no correspondence in the figure. In a university today it is impossible to think that a severity-love relationship can be established between a teacher and a student. At most one could hope for severity only, but even that is difficult today.

5. Conclusions

After discarding a number of common ideas of teaching in the special field of military technology we proposed a staged model for a student's learning experience. The model has a more general application in illustrating the options for motivating people not only in studies but also in technical research.

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On outsourcing military research projects to civilian universities

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Abstract: The article discusses reasons why technical research projects which the military orders from civilian universities often do not satisfy the needs of the customer. The reasons to the situation are identified as consequences of incorrect use of project work, poor selection process for selecting projects to be funded and incorrect goals of civilian universities imposed on them. The suggested improvements are focusing outsourced research to product development, which can be made as project work but with other partners than civilian universities, and focusing research on more innovative work funding in a more stable way than by projects.

1. Introduction

External projects are the main source of research funding in information technology in most universities of technology in many countries, including Finland. The reason why project funding has such a large role in research in Finland is the government's strategy of directing public money through science and technology funding organizations instead of directly increasing budgets of universities. The goal has been to create innovations in high technology. Whether the goal has been reached, or whether this is the best way to reach this goal, is too much a question of research politics to be discussed in this article.

The defense forces have ordered much research from civilian universities in the area of military communication technology. While many projects have been successful, it is justified to say that it is not uncommon for such a project to fail the original expectations. The reasons for this situation and possible improvements are the topic in this article.

The basic reason for the failures is that the results seem to miss the needs of the defense forces. Technology has an increasingly important role in warfare and following and utilizing new technology is of the highest priority for the defense forces. Studies of technological development identify some key areas where technological developments may have military importance. A research project is launched in a civilian university of technology. The outcome is that many students make their theses and a set of research papers is produced. In the final evaluation it is noticed that all that has been done is adding some more research papers to the bulk of existing papers, while there is little progress in understanding how the technology might be used for operational or tactical gain. Why is this so?

Many, or probably most, changes in military tactics are a response to new technology. In some cases it is a matter of taste whether a new innovation is considered as new technology or new tactics. For instance, when Scipio defeated Hannibal by causing panic in Hannibal's elephants with trumpet sound [1], was it a use of a new noise weapon combined out of Commercial-of-the-Shelf (COTS) equipment, i.e. trumpets, or was it

tactical use of the well known tendency of elephants to panic on anything scary. In other cases it is clearer that technology is an enabling factor, as with stirrup, firearm, tank and airplane. The most important goal of military technology research is to find and develop such possibilities for new tactics. This may mean new innovations or elaboration of existing technology, like with handguns, which sometimes develop to longer range and better accuracy, sometimes to higher firepower and smaller cost at the expense of smaller range and worse accuracy. There are some typical trends: increased mobility, increased firepower, higher accuracy, resiliency to countermeasures and increased availability in large numbers.

A research project on military technology should ideally find new operational and tactical possibilities, but often it does not. The starting point is that there is current research on some new area of technology. Much of the research is publicly available, but the user, the defense forces, has a particular environment and other conditions and looks for potential usage of the technology under these particular conditions. The civilian university has the goal of satisfying the customer, but even more that of filling the tasks assigned to it by the ministry of education. These tasks are education of doctors and masters and publishing papers on scientific forums. To the civilian university it is sufficient to make some new research on the topic. The research does not need to create new innovations or consider any particular conditions in order to be published on scientific forums. It is sufficient that it is formally suitable to scientific forums and has enough originality. For the defense forces there are the following alternatives for a result of military gain. 1) The result may be a solution to the particular conditions and it does not need to have scientific value. 2) The result may have scientific value and be as good as other existing results, but then it can bring military gain basically only if it is kept secret. 3) Or the result may have scientific value and be clearly superior to existing methods and then it has value even if made public. Let us take an example. There could be a research project developing an implementation of an existing crypto-algorithm. The results give an implementation which is then known not to have back doors or vulnerabilities. It is of type 1), not of scientific originality, but clearly it is research. The results could be made public without losing their value. There could be a research project developing a new crypto algorithm from well understood parts. It is a scientific result but if it is not essentially better than existing algorithms, it has value only by the added delay in its analysis which is achieved by keeping the algorithm secret. It is of type 2). If the crypto algorithm is not kept secret, it is better to use the well known algorithms since they have been more intensively studied. Finally, the crypto algorithm could be much better than existing ones. It would be nice to keep such a result secret, but most probably it would be made public and it still would be of value. This would be of type 3). For the civilian university 1) is product development and not suitable, 2) is confidential and not publishable, while 3) is too difficult to try in a project. The civilian university will focus on results of the type 2) but it will publish the results in thesis works and on scientific forums.

The particular conditions are usually not known to the civilian university. Because of this civilian researchers often ask for the exact problem to be given before they can solve it. While this looks logical, it is a profound misunderstanding of the question. There is no exact problem to give. The goal of the research is to find the problem and its solution.

This situation looks like a Gordion's knot but let us try to find a solution. The main difficulty is not the different needs and lack of common understanding of what the exact research problems should be. If there were enough will from the civilian university side to understand the needs of the customer a solution satisfying both sides could be found. The main difficulty is using project type research as a way to fund university basic activities of teaching and research.

The article argues that if research projects are considered in the same way as projects usually are considered, they should in many cases be seen as failures. If an organization aims at outsourcing a large part of its research to universities, it will find that the results do not satisfy the goals because the organization and the university have too separate goals. In this case an institute focusing on research and development is a more natural partner. Secondly, the article argues that if the goal is creating innovations then the present project funding is a poor means of achieving the goal. Innovations require deeper research than the results oriented style of project work allows. In this case, a university is a suitable partner but research should not be organized as project work. It should be long term co-operation focusing on higher level results than to thesis works.

2. Positive and negative aspects of project funding in universities

Project funding of university research in Finland has had several positive effects. The main achievements are listed below, but distilled with some critical observations.

1. Research funding has been increased.

Mostly this is not a consequence of using project funding but a simple result of increased public funding on research which could be organized in other ways as well. Project funding has caused a minor increase in research funding because industry and other organizations have ordered research from universities. These external organizations have other means of funding university research, such as donation of professorships and giving scholarships. For this reason it is difficult to say how much project funding actually has increased university research budgets compared to alternative funding ways.

2. Project type organization requires results and consequently the number of publications and thesis has increased. Statistics shows a large increase in the number of Ph.D. theses and publications mostly connected with thesis research. In Finland the number of Ph.D. diplomas has increased from 300 in 1985 to over 1400 in 2005.

Theses are typically given as project results, but if considered only from the project's point of view, theses often contain material which is only required by the university and not by the project. The increase of theses is more of a side effect caused by results demanded from a university than a direct result of project funding.

3. Quality of research measured by citation indices and the number of publications has increased.

It is very difficult to attribute this to use of projects as a means of funding. Publishing papers in journals has typically so long delays that projects are not very interested in this way if dissemination of results. Projects often arrange their own workshops for dissemination of results and require reports. Such forums are not peer evaluated in a strict sense and as a conclusion, project funding most likely does not increase measured quality any better than other alternative funding forms.

4. Funding organizations have more control on what kind of research is being done. Partial funding by industry and participation of industrial representatives in management groups of projects is expected to bring research closer to the needs of the society. Whether this goal is reached or not remains an open question. Questionnaires filled after all funded projects contain also opinions of industrial partners, but these probably reflect success of the project considering expectations from similar university research projects and do not give a correct comparison to whether the project results would have been considered good if the project were an internal project.

Negative aspects of project funding are also well known, while they are mostly raised on informal discussions. The main criticism to project funding of research is summarized below.

1. It is often mentioned that too much time is spent on making project proposals. Many of the proposals are rejected and work put on them is partially lost. Usually some number of project proposals is accepted and the general experience may be as that roughly the same amount of project funding is obtained every year anyway, giving it through competition only complicates the process. Some universities have direct funding for theses and a comparison to project funding can be made. In the National Defence College (NDC) students do not need funding by projects as they anyway get a salary. It has been difficult to the author to notice any difference in the quality of research in master theses and general staff officer theses in NDC compared to that in civilian universities of technology not attributable to the less technical nature of the studies or to students' individual talents and competence, which of course varies highly in all universities. Organizational structure whether the work is done in a project or as a part of study schedule seems irrelevant. NDC thesis works are supervised in seminars and there is equally much work group character in the research as can be achieved by project style organization. In the society project funding is used as a more flexible way of directing research funding on some areas as there seems to be some fear of too autonomous selection of research topics by universities. In NDC the topics of the theses are mostly connected with research areas of the defense forces and this problem does not appear.

2. Funding organizations select topics of current interest and universities are forced to make proposals on these topics even though they do not have experience or special interest to the topics. We should expect that by the time a topic becomes hot and promising several research laboratories have already worked on the area for a long time. A new-comer to the topic does not have greater chances of making great discoveries. It is a system of picking up some easy fruits of work done by others.

We may understand the approach of studying hot topics by looking at high tech industry. It is clear that most innovations are not created in a small country. For a firm wanting to earn on technology, it is necessary to follow up what has recently been invented elsewhere and as fast as possible to create products utilizing the new discoveries. This is a working strategy: spending on basic research and product development is dispensed with and the products come to a market which is already expecting them. Using this same approach in research is not equally smart. It is true that small results, or some times even medium results, can be made by taking a few papers of current interest and making something similar. Scientific success however is not made by such small results. Instead, it requires research work, many fruitless paths to be followed, and finally maybe something original is found. It is difficult to see why directing research funds to areas which have not been previously studied by groups which the state should help by funding, should bring forth excellent research. These groups are forced to compete with groups which have actually have brought the topic on the level where it is of current interest. Contacts to such groups are often seen as a sufficient remedy, but in reality nothing replaces the original research on the topic.

3. Much of project funding is short term and does not allow specialization to any field. Inability to offer longer work agreements to researchers increases staff turnover, especially in areas where there are many work places outside the university. There is also a clear effort to concentrate funding on groups, which have showed good results. This favors mature theoretical fields and makes it more difficult to start new research areas.

As a summary, there are both positive and negative consequences of project funding. It is doubtful whether all positive consequences are a result of using projects as a way of funding or if they are simply consequences of other mechanisms. Despite these conclusions, there are no clear alternatives to project funding. Direct funding seems to be the only alternative, but increasing direct funding is not so simple. Students do not any more make theses without a salary and if the university does not have the means for employing them, most will make their theses in the industry. Direct funding to universities has already been increased. Many new professorships have been founded, especially on information technology. Ph.D. research schools have been started and increased. Traditional mechanisms such as scholarships also provide funds. Important alternative funding ways, like donations to universities and student fees do not belong to the culture. There seems to be no alternative to project funding, but let us still look at the concept of project funding from a theoretical point of view. Something is wrong in project funding and maybe we can see the problem if we look at the project funding as a mechanism with two central elements: the concept of a project and competition as a way to select project proposals and evaluate results.

3. The project concept

Project is characterized by the work being organized in a matrix organization, i.e., there are both the hierarchical organization and the project organization. A project has a limited

time span, a limited budget, a project plan, a project manager and project workers. Usually a project has a management group and quality control. A project is a tradeoff between time, budget, results and quality. The person responsible for achieving this tradeoff is the project manager.

Projects have traditionally been used in two areas: construction and software. In construction it is a very natural way to organize work. There are work tasks which have to be finished before some other tasks start, therefore planning the time schedule is essential and the success of the project largely depends on keeping the time schedules. Construction work involves reserving some resources, which are expensive and available only for a short time. Planning a construction project means balancing with costs and time. It is straightforward to evaluate the work done and its quality. Construction projects usually succeed. The other typical use of project work is software. Software development experiences unexpected delays and a typical character of software done without project organization is that it never gets ready. Developers tend to add new features and debug software faults for ever. The role of the project is mainly to offer a result to the customer instead of offering constantly improving but never ready versions. In large software projects the role of clearly defined interfaces on planned time schedules is often presented as a compelling reason for project style work. In a close inspection this argument fails: deadlines are quite commonly exceeded and the interfaces are not really so constant, still the development work can cope with the situation. Software projects are said to fail very commonly. They fail in two ways: either the time schedule is kept but work is done over time and the result is not well tested, or less commonly, the project exceeds the time schedule. The failure is essentially in profitability of the work. While failure of software projects has been studied extensively and better software development and testing methods are usually proposed as the answer, the situation has not changed. The main reason why project style work organization is a good solution in this area despite of projects failing very commonly is that alternative methods do not give results that can be sold to customers. We see that project work has a different character in construction and in software.

In research the situation is again very different. Time schedules are often not kept in thesis works and in reality the tradeoff concerning the final result in research and thesis work should always be on the quality, not on the time spent. When there is a planned schedule where some tasks do depend on other tasks or external deliveries, research projects usually experience and must tolerate delays. As a typical example, let us consider a research project where a new measurement equipment or piece of hardware is expected from some vendor. Such equipment is often not from the shelf but instead has been promised. The author remembers very few research projects where new equipment actually was delivered on the promised time. This means that the risk of the delay is very high and the project schedule cannot be assumed to be strictly followed. Concerning results research projects are much easier than software projects. It is because the results are very vaguely described in the project plan and practically any contribution of sufficient quality seems to be acceptable as a result of an university research project, whether it has anything to do with the original project plan or not. Usually university projects give a number of theses and a set of research papers as the result. Clearly, some

research has been made, but in what sense it fills the goals of the project is often rather unclear.

It may be easier to answer to the question whether the project has been a success by looking at reasons why projects fail. A project is considered failed in case the budget is exceeded, time schedule is exceeded or the customer is not satisfied by the results and their quality. Projects typically fail because of the following reasons: lack of support from superiors, unclear project goals, incompetent project team, key people leaving the project, lack of understanding of customer's needs and insufficient quality of results. Let us consider these aspects in turn.

Support of superiors

This condition usually refers to a superior's decision to stop the project or not give it sufficient resources. In general, research funding by projects has the character that sometimes there is more funding, sometimes less, and the funding organizations shift the focus from one topic to another. As a consequence, it is difficult to create expertise on any field and this situation encourages an opportunistic approach to research. In case we consider it lack of support of superiors that funding is not continued on the same area of specialization and little real expertise has been created by the project, then this failure condition is quite often filled in university research projects.

Clearness of project goals

Usually the research questions make sense as the project has been started, but the answers given do not make sense. They do not correspond to the particular needs of the customer, who usually has not stated the needs and the task of the project is to clarify the questions and find the answers. The university team has neither the competence nor the interest to find the correct questions and produce the correct answers. There is also a conflict in the goals of having a successful project and on educating students. Thesis plan is a part of the thesis and should be made by the thesis maker. Instead, the project plan should be made by the project manager. If a thesis is made in a project the goals of the thesis should be left relatively open for educational purposes. Today, theses are often very straightforward literature studies, simulation, implementation or measurement and we may expect that the student does not learn how to approach a large task on his own.

Competence of the project team

Universities in a certain sense have much competence, but the real question is whether it is of the correct type. In general there is the dilemma that if an organization has been working on a problem area for a long time and has ended into problems which they cannot solve, how can we expect that in some research institute there are people who can solve the problem better. In practice project researchers will be students. Often this is sufficient: a talented student can contribute on a field which he has previously no acquaintance of in less than a year. However, let us notice that this also means that the competence the university research team offers does not exceed that of one year studies by a talented student.

Key people commitment to the project

It is very common that key people leave research projects whether it is a question of university projects or international research projects where companies participate. In general, research projects seem always to be of less importance than customer projects.

Understanding the needs of the customer

Universities make an agreement of the results to be achieved with the ministry of education. The results have emphasis on the number of master's and doctor's theses. Publications have some importance of their own, but mostly publications affect the number of Ph.D. thesis. Let us consider the defense forces as a customer for a while. The defense forces as a customer develops better technology for the armed forces. In Finland much of the research outsourced to universities is on the area of information technology while weapon technology is largely developed in co-operation with the defense industry, so let us focus on information technology and especially technology for command, control and communication (C3) systems. The goal of the C3 system is to bring military gain. The gain can be achieved by having a better system or by having some parts of the system secret. The goal of the university is production of thesis works. As thesis works are not usually superior to thesis works done in other countries, and as they are public, these results do not lead to military gain. Universities tend to give a set of publications and thesis works as results of a research project. The defense forces do not have an organization which can take these results as an input for producing a C3 system giving military gain. In practice we see this kind of a situation for instance in projects where customer's representatives to the management group members do not come to management board meetings presumably since they cannot see the relevance of the results to their own development work.

Quality of the results

Research quality in universities is presently measured in terms of publication forum and citation index. In projects quality refers to quality demands of the customer. If the goal is customer satisfaction, then the focus should be mostly in product development and sometimes on difficult research problems. This is because product development gives directly usable results with low risk and medium gain while difficult research problems involve high risk but may give high gain. There is very little to be gained by academic research on easy problems. Ph.D. thesis results usually put much emphasis on form and neither on applications, nor on breakthroughs. We see that the problem is that academic measures of quality do not correspond to customer's actual needs. Academic measures of quality focus research on easy problems which are more likely to give results.

As a summary, let us conclude that university research projects should fail quite often as the reasons for project failure are often filled. However, in practice research projects fail very seldom. The explanation seems to be that the goals and expectations are so low to start with that the customer accepts the results as typical for a research project.

4. Project funding as a case of selection process

Let us investigate project funding as a means to advance innovations in technology as a case of selection process. There are many selection processes which can be used for

comparison. Scientific research according to Kuhn [2] proceeds with major steps followed by several minor steps. This theory, though intuitive appealing and being based on a study of actual cases, assumes some intelligent process for making the major steps. Selection of projects for funding seems to be more believing on small steps and evaluation after each small step rather than on any intelligence capable of large and surprising leaps, so it is more similar to three blind or guided selection processes: liberalism, breeding of plants and animals and the natural selection. Plain liberalism has been tried and it failed, so the theory is wrong and should be discarded here. Natural selection has not been sufficiently verified by tests and must also be discarded as an example of a well understood selection mechanism. Therefore let us use breeding as the comparison. It is something where the mechanism is quite well known and it has been tested for a very long time with good results. The goal of the innovation strategy is indeed to breed successful technological projects.

There are clear similarities between a funding mechanism trying to increase innovation and breeding. Both try to improve the stock by selecting the most promising individuals. There are some differences also. With living organism selection works on natural variations and inherited changes cannot come by learning acquired characteristics. University laboratories clearly have an ability to learn and pass the learned characteristics to later generations of research. This learning process is much faster than in living organisms, but its speed is still relatively slow. There are three ways of passing new knowledge: employing new people with desired knowledge, replacing people with other people who have more desired knowledge and the same people learning new skills. All of these ways are rather slow. Creating new positions to specialists, not to students, usually requires new professorships and it takes about 4 to 7 years before the newly started group is on an internationally competitive level measured from the time when the need for a new group is identified. Replacing specialists requires waiting until professorships are open, redefining their area, filling the positions and waiting until the new group is on a high level. This takes as long. Learning new skills may be faster, but only assuming there is the possibility and the wish to change the orientation. If the required change is great, it will decrease resources from other research. Project funding is typically for 1 to 4 years and does not give sufficient resources for employing new specialists. Thus new researchers will be students and the knowledge gained by the project is on the level which a student can reach within 1-3 years since student researchers very often change their workplaces. Project funding is therefore much less likely to start new groups than e.g. donating professorships or redefining the area of an existing professorship in a university laboratory. Because of this situation project funding should make only very small changes of focus in order to create new knowledge, not change topics from one end to another in a time frame of some years.

What is seen in practice is that project funding organizations tend to select popular topics without much consideration to how realistic it is for any given university laboratory to create high level competence on the field. In this way project funding does not gradually create new knowledge but creates an uncertain environment favoring few survival strategies. One of these strategies is not to specialize. This is one of the strategies that innovation policy officially tries to remove, but it is one of the best working methods. It

creates general experts willing to take any projects. Another strategy is to specialize and look for more reliable funding ways. This encourages focusing on theoretical work and looking for funding from science funding organizations. In this strategy the university does not try to satisfy to needs of the customer but those of the science funding organization. In practice the results will be publications and theses of theoretical character. This strategy means using public funds intended for creating innovations in technical areas into theoretical research. Often the research is at the same time too elementary to be real science and too theoretical to be of practical use. The science funding body believes that the results have practical importance and the technology funding body and the customer believe the results have scientific importance, while in reality neither is true. There is still a third survival strategy: ignoring external funding and focusing on own research funded by university basic budget. This strategy is strongly discouraged and naturally for a good reason: it signals a disappointment to the way quite substantial public funding is currently used. It tries to say that research can be made better if the whole effort of the funding organizations is simply ignored.

We see that a basic rule of breeding is ignored in the selection process for projects to be funded: the controlling process must act on small changes to better and it must only process in small steps.

Accepting that there is a structural, and not accidental, analogy between breeding domesticated species and creating innovations by project funding we may derive some further results of certain interest. A general rule in breeding is that crossings between species are usually sterile. Crossings between remote varieties are hardly ever fully fertile and they are strongly discouraged as the offspring do not make a stable variant. Crossings between very closely related varieties instead are useful and bring vigor to the species. This empirical observation described in Darwin's The Origin of Species is easily explained if we think of DNA as a bulk of information. Merging two remotely related bulks of information is likely to lead to mongrels where only few combinations make any sense. This explanation applies to any information, including bodies of knowledge on different fields. If we take two far away fields there are usually only few meaningful applications of results from one field to the other. In the cases when such a bridge can be found it is often between rather close fields, like two major branches of mathematics, and such bridges are celebrated, and thus rare, discoveries. Despite of this difficulty of finding applications between two remote fields, a permanent great idea fancied by research funding organizations is to look for new promising areas between fields. So, instead of trying to look for results between closely related areas such as communications, networking and information technology, there is a tendency to look for results between e.g. construction and telecommunications. By all we know from crossing varieties, the former example of merging close by fields is much more promising than an effort to merge far away fields.

Another well-known observation is that breeding can only act on visible characteristics, such as the beak and tail feathers of pigeons [3]. Breeding hardy ever makes the variety more competitive in the real struggle for life since most minute modifications in invisible characteristics cannot be acted on and finally they make the competitiveness. Even for

improving visible characteristics demands a very keen eye of an expert breeder. In project funding there is a major violation to this principle of good breeding. Project proposals and results are not evaluated by expert breeders but by a peer evaluation process. Even if we ignore the possibility that friendship could influence the evaluation – an aspect which cannot be ignored in practice – the task of the evaluator is to estimate the present level. There is a difference in estimating the present level and the potential for future. In the latter case the starting level, external conditions and variability must be much more carefully judged that what peer evaluation may be expected to do.

Indeed, selection is usually made based on the project plan. It is much more difficult to evaluate success of a research project from the plan than success of a construction or software project. The expected results are discoveries of something new and they are not given in the plan. The evaluator can estimate whether the group is competent, the area is researched elsewhere and thus is considered a promising field and how strong is industrial support to the proposed research in the country. The latter is indicated by industrial partners in the project plan and by industrial potential in the field in the country. These criteria are very weakly connected to the actual chances of success of the project.

In the case of university research the results are measurable quantities, such as the number of publications and theses. Several distortions may result from evaluation by measurable quantities. As one example, let us assume that product development in a country on some field is rather practical, but the field is important and the country tries to develop it by funding. There are only few publications or Ph.D. theses from this field. There are some theoretical related fields but they are of minor importance. What may happen is that when measuring the number of publications and Ph.D. theses, these theoretical related fields receive substantial economic support. As the field is not very theoretical, it may turn out that the students to these theoretical related fields are not from the actual supported field but actually come from mathematics or physics. After finishing their thesis, most of these students cannot continue in the theoretical related field since it was not the promising area of technology. Some probably manage to switch to the targeted technical field, but they did not gain much from their theoretical studies. Many will probably switch to some other theoretical fields. The mechanism has worked in the following way: instead of developing research on the targeted field of practical importance, the funds were spent on the related theoretical fields. The students received education, which does not actually help them in their future tasks and other, probably more promising, theoretical fields were denied similar economic support.

The basic problem of breeding reappears in the selection of projects for funding: you get what you measure, or in other words, it is possible to improve visible characteristics, but such improvements do not create real competitiveness. Additionally, the selection process for funded projects is made much worse than in breeding. The selection uses project plans, not the outcome. The evaluation is done by peer evaluation or past results, not by an enlightened expert looking at the future promise and having a clear goal what he tries to achieve. Basis of selection change too rapidly, mainly because the topics to be funded

are picked from popular topics. Multi-scientific research is often attempted, while the expected outcome of such crossbreeding is meager.

5. Two styles of work

Project type organization is a suitable form to professional product development. Original research is of different character: more individual and unpredictable. Discussing the character of real research today one risks of being called obsolete. Fortunately there is a very similar difference in the approach to work on a field which is not loaded with centuries of romantic lore of what research once has been. We may compare two styles of software development: the professional style and the hobbyist style. The claim is that projects suit well to the professional style of software development, while the hobbyist midnight hacking is similar to more original research.

Professional development differs quite much from hobbyist approach, not in the terms of competence but in following such practices that have been found necessary when technology is developed not by people who have it as a hobby. This difference is clear in software and communication protocols, where professional development style is quite heavy, loaded with languages, tools, architectures and so on. These professional solutions work and the development is done in time and budget frames, but there is little originality. Hobbyist solutions also work even though they are not developed correctly according to textbooks since there is a high personal involvement and the developers are willing to spend much free time on the tasks. Many of the most successful systems of Finnish origin are work of hobbyists, such as Linux, SSH, IRC. Project style work inherits the problems of professional development work. People change often and when a project is finished and no new funding is provided, solutions are no longer maintained. The results of university projects on communication software tend to be put on the shelf or to the web, but interest to them withers basically because nobody actually feels that they are their own creations. It is difficult to create the hobbyist relation to the results as the project plan has been given, researchers have been assigned to the task and key people keep on leaving university projects for better paid and more stable careers.

Let us compare. Projects are the style of work used by commercial firms and they get their products to the market. Firms do not allow hobbyist work for the simple reason of economy. In a university results of project style of software development end to the shelf and are not maintained or turned into products, while hobbyist work often lead to spill-off companies. Hobbyist work is work of interested individuals or groups, without time schedules or clear plans. These are the reasons they can sometimes succeed.

Research should be more original than hobbyist software writing. Still it has the same character. It is not possible to say in advance what problems can be solved if the goal is something really new and original. Working according to a well-defined plan is good in thesis work on any level, but not in more original research.

6. Conclusions and recommendations

Let us try to answer a natural question: if the defense forces are ordering a research project from a university, what measures should be taken so that the result is satisfactory.

There are at least three cases when the result may be good.

Firstly, if the university team leader knows what the customer demands actually are results can be fine. This kind of a situation can be created by long term co-operation. Then the project manager can select the correct problems and see if the answers make sense. In this case the results can contain both publishable papers and useful results to the defense forces. In such a research project the following suggestions should be considered:

- There should be a research and development institute involved in the project, not only a university. This is because civilian universities are too hard pressed to get theses and publications and someone has to do also other parts of the work.
- The project manager should put the results into a usable form. This means that the project manager must understand the needs of the customer and be an expert on the field. We cannot expect that the project workers ask the correct questions and can evaluate if the answers fill the special conditions. We also cannot expect to get this kind of input from the project management group.
- The project manager should work in the project, not be a managerial person. Otherwise it is very difficult to get the customer's needs satisfied. This is often an argument against ordering projects from civilian universities of technology, but there are exceptions to the common practice of a purely managerial project leader.

Secondly, the defense forces could focus on product development. Then the natural partner is a commercial firm or a research center, not a university focusing on theses and publications. Project organization suits well and if the partner has earlier experience on similar projects, the outcome should be good.

Thirdly, the defense forces could support research trying to find new and original results. This does not mean basic research. It is applied research but the organization and funding allows the traditional academic freedom in selecting the topics of study. In practice, this means researcher positions. Natural places where to put such researcher positions are research organizations closely connected with military research.

7. References

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Use of networks in asymmetric warfare
– why we do not see more of cyber warfare

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Abstract: Cyber warfare has for some time been seen as a future threat. Scenarios where terrorists attack a modern society, or maybe even modern military forces, using cyber attacks have been created. Yet, so far we see terrorists still using bombs and snipers. This article analyses the use of networks by terrorists and modern military forces with research methods that are often applied in information network services. It is seen that cyber-war is not the best way a terrorist can use the network. In the future when the modern militaries are more networked, cyber-war may become a reality, but only when the terrorists have military power. Attacks against the society continue to be violent in the way they are now, but if this is not enough, weapons of mass destruction are a more logical option than cyber-warfare.

2.   Introduction

Asymmetric warfare is most often guerrilla warfare but it also can be terrorist warfare. Asymmetric warfare is characterize by the thought of Mao Zedong (see [1]) "They fight their way, we fight our way." It is also typical that the weaker side in an asymmetric warfare follows Mao's principle "If we have a chance to win, we fight, else we move." Guerilla warfare does not usually need networks, but the possibility of cyber warfare has been widely discussed. What is characteristic to cyber-warfare is that it does not exist as a serious threat, but it is possible to create scenarios which look alarming [2], [3], [4]. The main interest to cyber-warfare seems to have passed and the attack possibilities which have been proposed in books such as [5], [6], and [7], have so far not been adapted by any separatist, guerrilla or terrorist organization. The dimension of information warfare that can be felt is propaganda [8], [9]. A natural counterargument to the topic is that cyber war exits, but we do not see it. In this article we use the definition in [3] to cyber warfare: it is the use of networks as weapons, not aiding other weapons by networks. In this meaning we do not see much of cyber warfare.

The best studied example of asymmetric warfare where networks have some role is the USA's War on Terror against the Al-Qaeda terrorist organization. The Al-Qaeda organization and its relations to the USA have been treated in a large number of books, which seem mostly reliable even though disagreeing in some cases [10], [11], [12], [13]. Bush's War of Iraq and War on Terror have been treated by authors close to the White House as well as by critics [14], [15], [16] and [17]. Studies on the motives, backgrounds and psychology of terrorist organizations, such as Hezbollah [18] and suicide bombers [19] are available for reading. Clashes of civilisations [20], American foreign policy (for instance [21], [22], [23], [24]) and the effects of globalization (e.g. [25], [26], [27], [28], [29]) have also been widely studied. Therefore, the background and the present state of the asymmetric warfare between the USA and the Al-Qaeda must be considered to be

well understood. We do not need to speculate of what potential cyber-warriors might do, but can use this example as a carefully analysed case showing how terrorist organizations and the USA have used the network.

In this article we look at the ways how networks are used in a modern asymmetric warfare between guerrilla/terrorist forces and a modern military force and what can be predicted of its nature in the future. Especially, we will investigate why cyber-warfare is not the main way network is used in a modern asymmetric warfare. While there are many conflicts in the world today, as shown e.g. [30], there seems to be more reason to expect the terrorists to use weapons of mass destruction, such as radiological, chemical and biological weapons [31] than cyber-weapons.

3.   Research method

The focus in this article is technical and the research methods must be chosen in an appropriate way. We could create possible threat scenarios as most articles on cyber-warfare have done, but there is little that can be added to what is already said. Potential attacks against networks exist and they may have damaging effects. Estimation of the risk and damage is a very imprecise science and not suitable as a method of research. Adding more sample cases from more recent data does not essentially add to our knowledge.

Instead, let us try to find more technical research approaches. Usage of networks is a question of services. Distribution of command and control systems is a system level question. Consequently, we will use similar research methods as are used in system level studies in upper layers of communication technology, like in software systems and information/communication services. On the system level technical research is constructive research, it is not trying to create and validate a model for reality. This means that experiments, mathematical models and simulations play only a minor role in system level research, while various kinds of analyses, design and implementation are typical research methods. In this article we will apply several design and analysis methods in the study of the research problem. Let us first describe how system level issues are researched by the methods using in this article.

First we analyse the use of networks on the business model level for the both sides in the War on Terror. A business model is a design concept showing the players, their roles and relations. We will analyse the business models in order to find the points of gravity in the sense of von Clausewitz in order to see where the opponent tries to attack. An analysis of a business model means trying changes to the business model and seeing if it can be broken. For instance, introducing a new role, breaking some relation or removing a restriction may render the business model impossible. The opponent studying the business model tries to attack in such a way that the business model changes in a desired manner.

Then we will analyze, using more or less a taxonomic approach, different usages of the network and will map these usages to military needs. Possible usages of communication

networks are one of the key questions in services. In general, services are composed of basic or generic services and one key question is selecting the generic services. The military setting of the research problem makes the question of services more interesting since to the opposing sides, denying or compromising a service of the opponent is itself considered a valuable service of the network.

Next we look at different paradigms for network usage and for fulfilment of missions. Paradigms are models or patterns how the problem in question should be understood by the designer. Paradigms can be on any level but we are interested on system level paradigms for a network. Such paradigms are for instance the following: service network = warehouse of products; information network = random collections of items or a library without lights; distributed computing platform = network used as one computer. There are also paradigms for a usage or policy: for instance "Hunt-down-and-catch", "Kill-them-before-they-grow" of "Effect-based operations". Paradigms are often similar to something in some other part of the life experience. As an example, "What-You-See-is-What-You-Get (WYSWYG)" is a user interface paradigm, where things on the screen resemble things in an office room, so deleting a file means dropping it to a waste paper basket. Because of this character of paradigms, they are often created by considering analogical situations, allegories and such similarities. Also because of this character of a paradigm, weaknesses of one usage of a paradigm can often be seen in other analogous usages of the paradigm. We get to the key idea in the *pattern* way of understanding a paradigm: a good pattern should have appeared and been tested in many designs. In other words: if there are no analogies the paradigm may be totally new, or it may be faulty and therefore not used. It is suspicious until studied more carefully.

Lastly we study transitions of the business model considering the paradigms. Different paradigms have different vulnerabilities, for instance the distributed computing platform is highly vulnerable to malicious software and hacking. Paradigms give the basic structure of the solutions implementing the business model, so weaknesses in paradigms result into weak points in the business model. By studying the weaknesses of the business model we may make educated guesses where the future is going, that is, usually there is an effort to either remove the weakness or to use it.

3. Business model

Figure 1 shows a possible business model for a modern military power in an asymmetric war. The political, military and business decision makers are all considered the same player. In a true democracy we should consider the people and the political decision makers as one player, but Figure 1 is probably more correct. The network is used in several ways:

- Public, typically broadcast, networks are used for perception management. Perception management is needed to guarantee the support of own citizens and the world to the asymmetric war.

- C3 (Command, control and communication) network is used for command and control (C2) of lower-level commanders, troops, weapon systems and sensor systems. This C3 network is expected to be more survivable and secure than civilian communication networks.

- There is an interoperability C2 interface (IO C2) to allies, such as a coalition. The use of networks emphasises capability to Joint operations.

- There is the strategic intelligence surveillance network. It collects information on the opponent and on the world opinion.

There are two or three weak points: it is possible to convince the voters that this war is not worth it, it is possible to make so big losses that the business decision makers call the game out, and there may be a way to influence the C3 network.
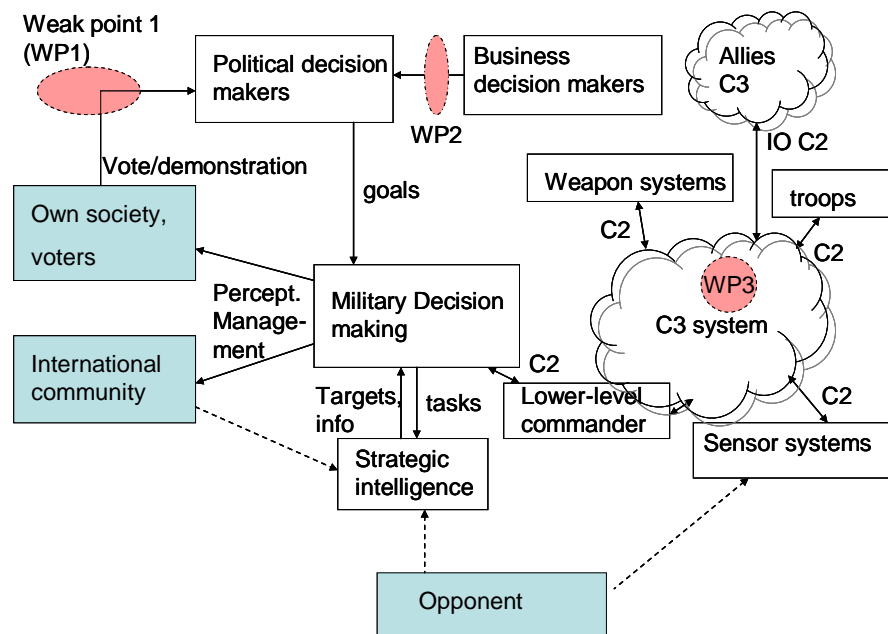

Figure 1. Business model for a modern military power in asymmetric warfare.

In Figure 2 there is a business model for the terrorist organization in an asymmetric warfare. The terrorist organization has a support of its own society. Therefore it is capable of attracting new members and funds from own supporters. The terrorist cells are independent and all have a similar operational model. The network is used in several ways:
- Open networks, typically radio and internet are used for perception management and own supporters. Perception management is directed to the rest of the world to get some support in the asymmetric war, but it is a weak way to influence. Own supporters get information that strengthen believe in the struggle.

- Public networks are used for command and control (C2) of coordinated actions of the cell and possible cooperation with other cells. Good encryption is used to keep communication secret. An effort to keep the both sides of communication anonymous to an eavesdropper are made, such can be access from an Internet café and throwaway mobile phones.

- Intelligence of individuals in the opposing side is collected from public sources. This includes addresses, position and personal data.

- Probably many terrorist organizations use criminal methods for getting funds. These may include hacking and cheating.

There are two or three weak points. According to Warden's circles, the best is to influence the leadership. In this case it would mean elimination of the terrorist core group. Trying to freeze the funds from supporters has also been tried. As the main character of this kind of a growing organization is that it can replace its leaders quite fast and obtain more supporters for funds, the most effective weak point may be trying to influence to the community that supports it.
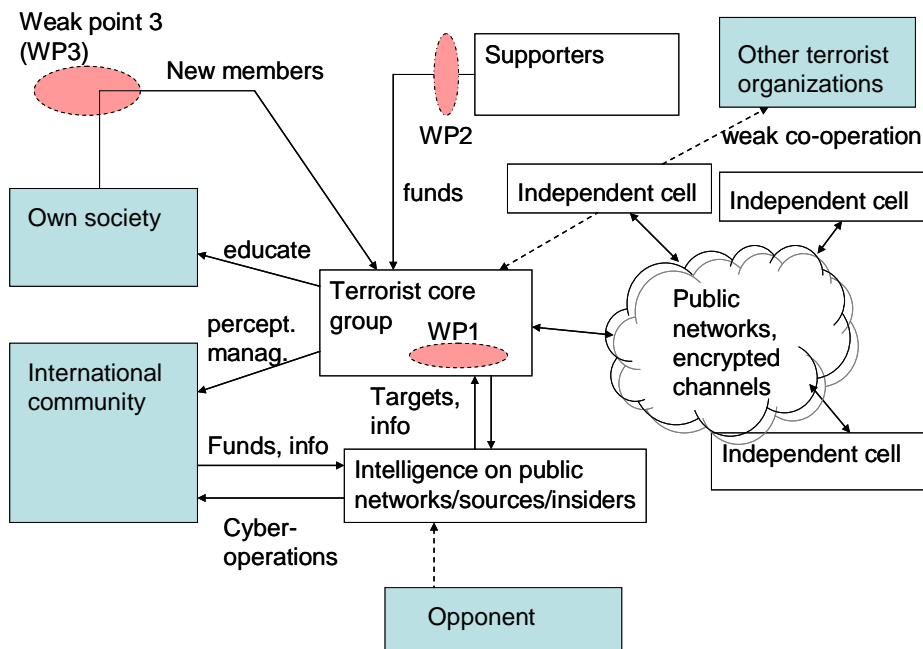

Figure 2. Business model for a terrorist organization in asymmetric warfare.

Business model analysis is in a way similar to relation charts made by intelligence agencies. The difference is that in business models the roles are not unknown, nor are their relations. The focus is on understanding how the organization works and under what conditions the business model breaks down. We need to investigate the paradigms before continuing to analysis, but first, let us look as the use of the network.

4. Usages of a communication network

Information and communication network services can be divided in several ways. Let us use the following division. It is not complete as complete classifications are quite long.

Telecom service group	Conversational	Speech, Instant chat
	Mail	Email
	Group communication	Calendar, Group meeting
Information service group	Information searching	WWW search machines
	Information uploading	WWW FTP sites
	Information downloading	WWW FTP sites
Broadcast service group	Entertainment	Video, Music
	News	WWW newspaper
	Announcements	Official
	Perception management	Propaganda
Computing service group	Distributed processing	Networked computer
	Control	Stay-alive etc.
	Interconnect	Gateways between systems
Usage service group	User data	Directory
	Usage profiles	Preferences, History
	Location	Find location
	Filtering users	Direct marketing
Security service group	Privacy	Encryption, Access rights
	Authentication	User/service authentication
	Create trust	Between unknown parties
	Anonymous	Hide parties identity
	Authorize	Integrity, Digital signature

Table 1. Some information network services.

The services in Table 1 are basic services. End-user services are made by combining several basic services into services offered to users. Table 2 gives two end-user services.

netShop	Information searching
	Conversational and Mail services
	Security services
	(Usage services)
netEducation	Information uploading and downloading
	Group communication and Mail services
	(Security services)

Table 2. Two possible end-user services.

Creation of useful end-user services and identification of a necessary set of basic services is the main task of service creation and provisioning in the telecommunication sector. The main ideas are that there are some building blocks and new services should be created very fast as a response to current market situations. So far services have not turned out to

be as profitable business as was predicted. We will not enter this area in this article, but continue to the mapping of services to military needs in an asymmetric warfare.

5. Military needs for an information and communication network

Military usages of a network are more interesting than the civilian usages in the sense that there are two opposing parties who not only want to use services of a network but also try to deteriorate the usage of the networks by the opposing party. Table 3 gives some possible military needs for a network, together with counter actions.

Military need	Primary usage	Counteraction	Counter-counteraction
Command	C2: connect leaders to lower-level leaders, weapon and sensor systems, troops	Jamming, Cyber-war, Directed energy weapons	Antijamming, Security services, Protection
Administrative	Manage the organization, salary, email, information etc.	Cyber-war, Directed energy weapons	Security services Protection
Intelligence	Surveillance, intelligence	Anonymous services, Encryption	Monitor
Logistic	Provide supplies to troops	Cyber-war, these are often on less secure channels	Security services
Training	Educate troops, netEdu	Sensor www-sites	Change www-site
Perception management	Directed propaganda	Counterpropaganda	
Finance*	Get funds from supporters or by netcrime	Security services, Monitor network	Cheat

Table 3. Possible military needs for an information network. * only for terrorists.

From Table 3 we see that cyber-war might have a large role than it actually has, but mostly against the modern military power. According to the business model in Figure 2 terrorist use the network for secure and anonymous communication, gathering intelligence, education of new cells into terrorist actions, financing their activities, keeping loose control and perception management mostly directed to supporters. None of these usages are effectively hindered by cyber-war. Cyber-war might be effective against the modern military power if it can slow down C2 or logistics. There are rather effective methods to protect against such threats, for instance the C2 and logistics networks do not need to use public communication networks making physical access more difficult. The

real reason why terrorists probably are not very interested in cyber-war at least so far is related to the paradigms. Let us continue to this issue.

6. Paradigms of network usage

When we have the tables of network services and military needs, we can investigate how the network will be used by both parties. Different usage types are often described as network usage paradigms. The paradigms are vulnerable to cyber attacks in different degrees. Let us mention the main paradigms of current interest.

Communication network
This kind of network connects users or user groups. It is like the plain old telephone service paradigm put into a new form. The idea is that anybody is always reachable. The GSM and TETRA networks are examples of communication networks.

Information network
The idea is that of a huge database into which one can do searches. No guarantees are given neither of the operation of the network, nor of the content of the information. The promise is that anybody can get lots of information and some of it is useful. The idea of an information network probably implies that users can also put new information to the network. If not, the paradigm would be something like a broadcast service. The WWW service makes the Internet into a global information network, but FTP and Gopher already provided this functionality in a less user friendly way. Semantic web is a future vision of the information network.

Service network
Service is a functionality that can be offered to customers. This means that it works in a sufficiently reliable way and the customer is satisfied. It is common to charge service usage, but services can be for free. The main idea is to have a platform that provides sufficiently reliable and secure way to connect customers, service providers and the other parties in the concept. The number and types of parties differ from one service network concept to another. Typically there are brokers, traders, 3Pty service providers, VASPS (Value Added Service Providers), connectivity providers and so on. From a technical point of view, a service network offers a simple way to use a service: the customer can search for services, he subscribes to some services, gets authenticated and authorized, and the service runs using interfaces that the user can get without much trouble. A service concept has a fast way for creating and provisioning new services.

Distributed computing platform
The idea is that networked computers could be used as a huge computer. The emphasis is on processing power in addition to the huge storage capacity. The risks of malicious users have been too large to creating very large computing platforms. The underlying platform seems too powerful for it to be secured with the usual methods. Currently there is an opinion that a distributed computing platform can be securely and reliably realized by service oriented architecture, that is, by mixing the ideas of a service network and a

distributed computing platform. This opinion may turn out incorrect. The main ideas behind a service network are that it gives a limited number of tested services over a fairly powerful platform. It is very possible that such a platform cannot be powerful enough for computing usage and that the services for computing usage are not testable.

Looking at the business model in Figure 2 and the mapping of communication services into military needs in Table 3, it is obvious that terrorists use the network as a communication network and an information network. Of these paradigms, a communication network can be made quite strong by cryptographic means, while the present solution to the information network, the Internet, has a known vulnerability level.

We must go to a higher level of paradigms in order to understand why cyber attacks are not more common. The paradigm to realize the business model in Figure 1 for a modern military is Effect-Based Operations (EBO). This means that the military is capable of directing concentrated power in a very short time into a selected spot using the best possible forces, including the capability to joint actions of the services. Paradigms are patterns and a good way to analyse them is to take an analogous solution. We may compare a military with EBO tactics into a scorpion. It is necessary for a military to select a network paradigm supporting distributed computer services. This is a weak paradigm and therefore cyber attacks against the C3 are possible.

The paradigm to realize the business model of terrorists in Figure 2 is a loose collection of independent cells. It has an essential property: it is a growing organization capable of attracting new members and funds. We may compare it into a society of ants.

7. Analysis of the business models and possible transitions

We are now in the position to analyse the business models with the intention of finding the best ways to affect the opponent and speculate on possible transitions. Transitions are reactions to attacks against the business models or natural developments of the business modes. Studying probable transitions in business models is way of making educated guesses of the future in this method.

First, let us look at the business model in Figure 1.

There may be a weak point in the C3 network. For the time being military C3 networks are not easily attacked by terrorists using cyber weapons. The business model in Figure 1 illustrates that modern military powers like to see the network as a service network and a computing platform. When the network-centric warfare paradigm is more widely adopted by militaries, we may see some cyber attacks against the C3 networks. It is quite possible, that such attacks will be successful and that the terrorists can develop a cyber-war capability. However, the terrorists cannot use this advantage because even with poor communication connections a modern military still has local superiority over the terrorists. The time to use attacks against C3 will come only when there is a conventional military power on the side of the terrorists. The reason to disturb communication can only

be to obtain local superiority and military victories. They have a psychological effect, but they can be made only with a sufficient military power.

There is a weak point in affecting the support of business decision makers. Cyber-warfare can cause considerable economic losses. There is only one problem, the Gulf area has lots of oil and it may be peaking in the near future. Most geologists agree that the world reserves of conventional oil are about 700-1000 billion barrels. The world consumption is about 24 billion barrels and it is increasing by 2-4 % yearly. This means that about half of all conventional oil is used already. There is oil for at least 35 years, but the problem is that when about half of the oil is pumped, the production of oil wells starts to decline. This point is called the Hubbert peak point and while not all experts agree on the existence of the global peak point, it is rather widely accepted. It is possible for some time to pump more by artificially draining the wells – for instance, by pumping sea water into wells as Saudi Arabia currently does, but rather soon production turns down. In a situation of growing demand and decreasing production prices increase and there is not enough oil for everybody. The possibility that e.g. Canadian heavy oil would be available in large quantities is speculative since this oil requires lots of natural gas before it can be turned into fuel, and Canada does not have such reserves of gas. We may be headed into a serious oil shortage and the Western powers want to guarantee access to oil.

If the terrorist try to create economic damage to the society by cyber-war or other acts of terror, they have to produce larger damage than what can be the consequence not getting cheap oil. It is improbable that so large damages can be caused and even more improbable that the society would give up instead of following the police paradigm: hunt down the criminals and punish them. The police have never succeeded in removing all crime, but the paradigm is sufficient for keeping the damages on a tolerable level. This is why terrorists cannot focus on economic losses.

The society has much lower tolerance to violence against innocent citizens, and this motivates the acts of physical terror, i.e., the weak point where voters select the political leaders. We may expect that something is done to this weak point in Western countries. There will be efforts to demonize the terrorists so that the voters will refuse to understand their purposes. Alternatively, the real power of the voters may be reduced. In fact, removing this weak point can easily lead into a police state and possibly into a dictatorship. Should so happen, the terrorists may try to create damages which still have effect. This means huge economic and human losses by the use of weapons of mass destruction.

Next, let us look at the business model in Figure 2.

The weak point in destroying the leaders probably will not work. A scorpion has little chance of exterminating the ants by killing them one by one. Even destroying an ant hive has only a temporary effect as they will build a new one. Therefore "hunt-them-down-and-punish" is not a working paradigm against this type of terrorists.

Let us consider the weak point in getting new supporters. The question is why the message of the terrorists is taken by their society. In the case of radical Islam, the society is *umma*, the borderless society of Muslims. The holy war *Jihad* has been announced by Osama bin Laden. This *Jihad* is defensive *Jihad*, as offensive *Jihad* is impossible without a proper authority, while defensive *Jihad* is the duty of every Muslim. The motivation for the defensive *Jihad* is the presence of the USA on Muslim territory. Thus, if the USA withdraws from Muslim areas and stops supporting the Saudi Arabian king family, the war is over. Unfortunately, this is not quite as simple. Israel is also on Muslim territory and then there is the Gulf oil and the possibility of a future oil crisis.

There are a number of paradigms that can be used against growing movements. "Kill-them-before-they-grow" has been a working paradigm sometimes but it is not quite according to the ways Western democracies are assumed to operate. Anyway, it is too late to use it now. Nevertheless, an effort to monitor and stop dangerous ideas will be made and this also can turn Western democracies into police states.

Some other ways to stop movements also exist. There is the counter-reform approach, which limited the protestant reform movement from spreading further into catholic areas. It is clear that the Western democracies have not always acted the way they preach. Supporting separatist movements by funds and weapons for short term political reasons is a part of the conflict. It is equally clear that globalization is a goal that may not be especially positive for the whole world population. Still, expecting a counter-reform in the present situation is not realistic. The Protestants and Catholics went to long wars in the middle ages and finally agreed to peaceful coexistence. This solution does not have much appeal because it was preceded by a war.

There seems to be a small chance in the idea that petrified thoughts also have a peak point. In the Middle East region there is not only petrified forests turned into flammable crude oil. They also have lots of ancient writings that can still feed a movement. We may hope that these ideas start to wane after about half is brought into discussion. In the reality, ideas do die out, but it usually takes decades or centuries.

Should the terrorist win in some area, they will most probably also create a theocratic dictatorship. In general, a study of the business models in Figures 1 and 2 seem to lead to dictatorships on both sides and very possibly into a major armed conflict in the future.

8. Conclusions

Terrorist are not currently using cyber warfare. The reason is that they must focus into acts of violence since economic losses do not give a strong enough motivation for the opposing side to reconsider its position. Cyber warfare may become an effective weapon against the C3 system of a modern military in case network-centric warfare is implemented in a way that relies too much on the inherently insecure distributed computing platform, but this will happen only when the terrorists also have conventional military power. There is little hope that fast concentration of force along the ideas of

Effect-Based Operations would prove useful against terrorists. Any effort to concentrate force is only useful if there is some reason to believe that action will happen on the place where force is concentrated. In the case of terrorist actions, this is not the case. Action will happen on the places from which power is moved away. The best weak point in the business model of terrorists may be to decrease the support of their society. No effective way to do it was found in this study and the predictions for the future were pessimistic.

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Guidelines for defining a research strategy

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Abstract: Modern management paradigms require for any organization to have a strategy. Universities and research centers have developed research strategies, but typically they appear to the personnel as empty papers that actually do not say how the vision can be reached. This kind of a strategy is not a real strategy, but a way to commit the personnel to vague common goals. This article tries to put some content into a research strategy and to discuss what strategy can mean in research.

9. Introduction

Today every organization is expected to have a vision and strategy. Usually these are created in a strategy process involving key personnel, or even the whole personnel. Outcome of group work in strategy building sessions typically falls short of anything that could be called a strategy. Strategy planning means analyzing and creating the highest level of a plan. In the military, the other levels are called the operational and tactical levels. In research, the word tactics is used for small maneuvers, such as meeting tactics, project proposal tactics and arranging professorships. We will not go into research tactics. Thus, a research strategy is a plan and it describes a way to reach the vision. The vision is the targeted future state and it must fill the mission. The mission is the purpose of the organization. Rather than seeing any plan in a research strategy paper, we usually see a loosely coupled set of elements which might be parts of a strategy.

A strategy is usually not a public paper and it does need to be known to all personnel and they do not need to commit to it. Today, there is much talk of committing to the vision, while the actual strategy is left to the managers. Therefore, the outcome of a strategy process with the personnel is basically a bluff, since it is not a strategy that is written in the process. The strategy process is simply a way of getting the personnel committed into an effort to do something. Usually the vision cannot be realized by the personnel as it has no way to take the actions for reaching it and as a vision is typically unrealistic. Usually there are competitors and enemies and the strategy cannot be public, but in research we do not have a clear opponent and writing down a research strategy is less risky. (Some people see other departments and research organizations as competitors, but this is not the author's view. In the author's view a research strategy is not directed into winning the competitors, it is directed to winning oneself.) Let us try to outline one. First we need the mission and then continue to the strategy plan.

2. Mission

Fulfilling the mission is the purpose of the organization. The mission of defense forces can be for instance defending the country against external threats and the mission of the police can be defending the society against criminals. University mission is stated in the

law, but the law can be understood in several ways. In a university there are at least four possible missions:

Produce highest quality research

This is often stated as the traditional mission of a university, though most universities have not been created for fulfilling this mission. In this mission the goal is to create research papers to the scientific community. Teaching is a secondary goal and traditionally students have not been very impressed with the qualities of professors in teaching. Research tasks originate in scientific discussion in the literature of the particular area.

Produce educated people to the society

This is probably in most cases the reason why a university has been created. University staff also makes research which is not connected with education, but the main task is education. Research connected with doctoral education is also primarily educational. In universities where the dissertations are mostly monographs, like in the National Defence College, the topics are more often selected by the dissertation maker than by the supervisor. This means that topics for research are wider and probably correspond better to the needs of the researcher and there is often a customer to the research.

Provide scientific services to the society

The mission of many research organizations, like the Technical Research Centre of Finland (VTT), is to help companies which do not have their own research capabilities by taking research tasks. Most large organizations, including the defense forces, have a research centre for this purpose to fill the research needs of different units. In this case topics for research come from outside and they usually are not of the type which can lead to high quality scientific results. Their goal is often a product.

Create spin-off companies

Some technical universities have taken creation of spin-off companies as a major goal. It is one way to help the economy by public funding. In this mission the mechanism is often that the management has a basic idea for a technical solution and uses public funding and the group of researchers for realization of the idea to a prototype level. At the end a spin-off company makes the prototype into a product and starts selling it. The problem with this mission is that the idea is from the manager, while development is made by the researchers. They often do not want to start a spin-off company as they see themselves as researchers, and they usually are not very convinced by the idea of the manager, but have to do it.

It is common today to try to mix these missions. A university then has the mission of producing highest quality research, educate people, take external projects and create spin-offs. This is one of the most common mistakes in a research strategy. Mixing different missions can be presented in a favorable light, but the reality is often different. The pressure to fill the educational mission may lower the level of research although the number of publications increases. The educational mission may also lower the level of external projects and they may not fill the requirements of the customer. Mixing the

missions of highest quality research and external projects is difficult because of the different time frames. Usually external funding changes focus so fast that there is no time to specialize. Creating spin-off companies as a mission has the negative aspect that competent researchers leave the research institute. Especially, if the institute is selling research services, what happens is that funds are spent into developing solutions. The better ones disappear as spin-offs, while the failed ones stay. Finally there is a heavy weight of failed products and no courage to dump them. We will argue that it is best to have a single clear mission and add other positive goals as subordinate goals to this mission. For this argument we need to look at the results.

Research results are mainly of four types: Publications, Doctoral degrees, Project deliverables and Arrangement of scientific seminars and conferences. There are some other results, such as patents, spin-offs and so on, but let us ignore them as less important.

Publications
Publications are divided into internal and external publications. A publication strategy contains a plan for submitting papers and a plan for editing and publishing own publications, which can range from internal laboratory series to international journals.

There are several types of publication strategies:

Publish or perish
The idea of publish or perish is that all researchers are expected to try to get their articles to peer-reviewed international journals, preferably into those published in the USA. Peer-review is seen as a guarantee of quality, but it forces the papers to take a particular shape. It is necessary to include not essential references to other papers to show that the subject has been studied, just like is demanded in a student's Ph.D. thesis. It is quite risky to have too much originality and to write in a different style. Therefore this approach will produce papers, which are indistinguishable from papers in a Ph.D. thesis. Naturally, anybody who has made a Ph.D. can repeat his effort and write more papers of similar quality, so the test whether the paper is on publication level seems unnecessary to anybody else than a student. The main negative aspect of this strategy is that it focuses research on a very narrow field. This publication strategy is often associated with the mission "Produce highest quality research", but it probably is closer to "Produce educated people to the society".

Keep it confidential
In this approach everything is confidential as default, while some articles may be published for public relations purposes. This is a typical approach of a research institute which offers research services. The results may be patented but in most cases the result is a deliverable. Today there usually is quality control by review of deliverables. The work is usually organized into projects and results cannot be charged before they are accepted. This means that the review cannot be too hard to pass or the whole research process becomes impossible in the economic sense to the research institute. This publication strategy is closest to the mission "Provide scientific services to the society".

Market the results
In this approach results are published for the purpose of gaining visibility. Articles in daily newspapers and other media visibility are appreciated. Conference publications are for the visibility and not for the purpose of actually contributing anything important. It is very typical to see articles that simply explain what is being done in some large project. This publication strategy is best motivated if the mission is "Create spin-off companies", because new spin-offs need marketing. Many universities today see marketing their results as a laudable goal, even though when a scientist turns into marketing, he runs a small risk of being called a show-man by his peers.

Little but good or the reader friendly approach
Reading scientific papers is usually not much fun, especially if they are students' papers to a dissertation as today a large majority of conference and journal papers are. This means that publishing papers usually does not benefit the readers but adds to their burden. In this strategy, papers should be published only for two reasons: either they are breakthrough results and so important that they should be read by a large audience, or there is a requirement to publish. The latter case can be that one is participating in a project where the project plan states that results should be disseminated though scientific conferences and in order to charge the work you have to publish a paper, one is making a Ph.D. or preparing to a professorship evaluation. In other cases, if the paper is not actually needed for anything and it is not extremely important, a much more reader friendly way is to keep it in a drawer or publish it internally to people you think are interested or according to you, should read it, such as students for instance for education purposes. In this approach the quality control is made by the researcher and it is harder than the one made by a journal. We may remember that this approach is very historical: many of the great scientists were not publishing their results as fast as possible. The publishing forum in many cases was preferably a non-reviewed book rather than a peer-reviewed journal. This publication strategy results to low publication rate and is usually associated with the mission "Produce educated people to the society". In reality it is closer to "Produce highest quality research".

Doctoral degrees
There are several alternatives to doctoral studies:

Doctor factory
This is a pipeline production method. New researchers are taken into a group and produce joint papers with the professor and senior scientists. Dissertations are completed in a smooth manner as the student does not need to learn how to do independent research. The student is working in a project together with a team.

Traditional method
In the traditional method there is supervision but no joint research. The student tries to write something either as a monograph or as a collection of papers. The supervisor gives advice, but does not interfere too much. Usually the student is working as an assistant and may feel being a bit lone with his research problems.

"Anything goes"- method
In this method there is very little actual supervision. The student is accepted into a doctoral program but is not physically working in the university. The student tries to write something either as a monograph or as a collection of papers and comes to show up the results. This method is more difficult to the student, but in case there are no possibilities for employing him to the university, this method still gives a fair chance of completing a doctorate.

Project deliverables
There can be several project strategies.

Funding mechanism
Many universities see external research projects as a funding mechanism, especially for doctor students and also as a way to get more personnel to teaching.

Know-how mechanism
Joining projects with knowledgeable partners gives the organization new know-how.

Results mechanism
It may be surprising that projects are not usually made because of the results, but naturally this is the case. The results may be important to the organization funding the project, although this is not necessarily true either if the project is funded by the state. A research institute making the project does not care so much about the results. There can however be a project strategy where the results are important. If the mission is to create spin-offs, the results are important. Also, if the project plan is more interesting than it usually is to the researchers, we might have this case.

Arranged scientific seminars and conferences
There are basically the alternatives of partners. There is the question whether to focus on local events or on international events and with what organizations. The choice should be made depending on the mission: if it is local, such as educational or research services, we should put more emphasis on local events. If it is internationally oriented to publishing or marketing, international visibility is important.

We see that the results are characteristic to the missions. Many of the choices are contradictory. For instance, in order to fill both of the strategies of publishing everything and publishing nothing, the researcher should not create any articles at all. It is much clearer if the mission is not mixed and the results are supporting the mission.

Another common error in the mission is to think that the results should be maximized. It is caused by measuring the results and thinking that usually larger numbers are better. In the general case this is not true. For instance, in the National Defence College (NDC), the average number of master students in technology is decided by the defense forces and it corresponds to the estimated need. This number should be met, not exceeded. With the number of doctors with technology as the specialization, we should expect a similar case. There is no reason why a larger number is better. Probably there is a rather small needed

number of doctors, and somewhat higher number of students who wish to make a Ph.D. It is possible to meet the latter number, but no need to increase the number artificially by encouraging more students to make a Ph.D. from technology. It is as useful if they make the Ph.D. on some other specialization. The number of external publications is not to be maximized either. The logical goal is to have local impact by creating a large number of internal publications, and for the largest scientific impact, we should have some breakthrough results. There is no motivation for a large number of externally published minor results. Ph.D. students of different universities are already filling this task well enough. The number of projects or the amount of money obtained by projects is not a figure to be maximized either. The natural goal here is the content of the projects. There are goals that can be maximized, but they depend on the mission.

3. Basic concepts of a strategy

Let us describe basic concepts of a research strategy in the methodology used in this article.

Mission
Mission is the purpose of the organization.

Vision
Vision is a particular way to fill the mission. Vision is the targeted state on some more or less clearly defined time. Vision in this article is something that can be realized, it is not an unreachable dream.

Operations
Concrete development plans are called here operations. Operations:
- are based on estimation of the situation,
- need a basis made by key competence,
- operations act on one of the research fronts,
- usually need alliances in order to be credible,
- need logistics support for resources,
- have a goal supporting the mission and being a part of the vision,
- may have intermediate goals before the final goal can be reached,
- usually have some critical factors,
- threat analysis to the operation should be made,
- there should be reserve plans,
- operations should leave options open for a changing situation.

Situation estimation
Often SWOT analysis is used for estimating the present situation. It is probably necessary to have a better analysis of the situation.

Basis

Basis is an area where operations start. Key competence forms the basis of operations in research. In a university professorships have a central role as a basis because starting doctoral programs on areas which do not have professorships are often not allowed and in general strongly discouraged. The lack of a doctoral program deprives the research field of new researchers and the research effort stays low.

Fronts
Fronts are where operations take place. Fronts are central areas of research, often called centers of weight for research. They should be supported by the basis, i.e., key competence.

Alliances
Alliances with partners are needed for adding strength. In research we need to create co-operation with partners. Co-operation can be of different type, but the most essential forms are research projects and arrangement of scientific conferences and seminars. The latter one we must postpone until the own department has more research activity. Let us divide alliance into two groups:

Strong alliances
These are alliances which contain concrete co-operation. A subset of strong alliances is the set of trusted alliances. These are alliances where we can trust that the both sides are committed to the operation, for instance a research project. By trusting we will mean that these partners can be expected to behave in an expected and positive manner.

Weak alliances
These are potential alliances, which do not yet have a clear content.

Logistics
Logistics in this case is a method to get the resources to the central areas of research. The resources are researchers, research funds, locations and equipment. The operation must be possible to be realized and typically this means that the resources must be available.

Goals
Operations support reaching the vision. Each operation must have a clear goal. Operations may have intermediate goals that have to be reached before the operation can proceed. Some of the intermediate goals or necessary conditions are critical factors.

Research strategies are creative, not destructive. Therefore the goal of an operation is to strengthen research results, not weaken any opponent or competitor. Each operation should strengthen the research results: publications, doctoral degrees, project deliverables or arrangement of seminars and conferences.

Threat, reserve plan
Threat analysis is made to an operation. If a threat is realized, there should be a reserve plan.

Analysis of operations

This kind of model can be used in strategy planning in the following way. Firstly, the basic concepts are identified. Then a set of operations is planned. For each operation we must see if it supports the mission and helps reaching the vision. We must also see if the operation is feasible:

- Does it have the support of a basis? If not, how the basis will be made. This requires an intermediate goal. If there is no basis, we say that this operation does not belong to this organization.
- Does it act on a front or maybe starts a new front? Starting new fronts must be carefully considered. If the operation does not act on a front, we say that it is not effective.
- Are logistics good? That is, are there researchers, money, rooms, equipment and supervision? If there is a logistics problem, we say that the operation is poorly managed.
- Are there any threats? If there are serious threats, we call the operation risky.
- Usually a good operation plan is simple and understandable. If not, we call the operation fuzzy.
- The staff must understand and commit to the operation. If not, the operation is poorly managed.
- If all of these aspects are fine, the operation can be realized.

As the main results are publications, doctor degrees, deliverables and seminars or conferences, we always expect to see operations for these items.

A typical error in planning operations is the failure to see that each operation requires an effort. A high number of operations is considered a sign of an active institute. In reality, there should be only as many operations as can be completed successfully. This means that it is necessary to drop less effective operations from the plan. Especially starting new fronts should be carefully considered. Much of the work of a planner of a research strategy is to shoot down all wonderful new operations proposed by too active people.

4. Conclusions

Today it is common that superior management requires starting strategy processes for making missions, visions and development plans. Every competent professor or laboratory head however should already have clear plans how to proceed. Usually it is not necessary to write them into a paper or powerpoint slides. It is not necessary to waste time of busy people in strategy building sessions. It should be enough to trust that the responsible people know what they are doing. The worst is if management is initiating too many operations but has not calculated the work effort to carry them out. A particularly destructive way is to initiate new issues and to delegate them to others. In this way a manager easily messes up the existing plans by consuming the available time in poorly thought new actions. In general and especially with management, experience and logical thinking is the key. A golden rule here is that if you do not understand what you are doing, do not start a joint process and involve the staff for doing it. Very possibly, there is no need to change the process provided that the staff has experience. Let us keep in mind that there are two central processes in a university: education and research. Management is a supporting and thus subordinate process.

Prediction of future technologies

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Abstract: Prediction of future technologies is of great importance in procurement of military technical equipment, but is it science and in what way does it differ from divination and other forms of future telling? In the last part of the article, the author describes two ways of predicting technology.

1.   Introduction

Prediction of future, or futurology, is a field of major importance especially in tactics ad operational research. In military technology futurology is often not accepted as a field of real research. In this article we look at philosophical rationales of foretelling the future from the technical point of view and describe the method that the author has found useful in his work.

Futurology is not a science in the strictest sense of the word: making models and verifying them by experiments. There are no clear results that can be called the theory of future or the scientific method of prediction of future. Future does not follow the predictions well enough for this truly scientific interpretation. We must be more relaxed of what is scientific. A common everyday life division is whether the research method is superstitious or scientific, but this division is difficult to use in the case of futurology. Is superstitious or scientific to ask expert opinions, draft visions and try to frighten people with threat scenarios? We could decide that if the subject is studied as science in some universities then it is science, but this is not necessarily so. At least we cannot count on the majority of the scientific community to agree that futurology is science. We could also decide that if the explanation uses gods, spirits or some other similar assumptions, then it is not science. Futurology does not, but the author is not satisfied with such divisions because arguments for removing assumptions should be scientifically motivated. We may say that in physics we do not need certain assumptions. We cannot a priori know this from a order field of science, such as futurology. The author uses the following division: there are literal explanations and there are symbolic explanations. Literal explanations are of the form that the words are to be understood directly with their everyday meanings, while symbolic explanations require giving the actual words to some other meanings. In the author's opinion literal explanations are the widest understanding of scientific explanations, while symbolic explanations are art or myth. Both can contain some truth and both can be false. In this division, Babylonian description of the origin of life, rephrased in the Genesis, is a scientific explanation as it most probably was understood in a literal way. This theory is likely to be a false scientific theory. The myth of the origin of evil was most probably always understood as a symbolic explanation. Another myth is the archetype western: the good guy finally has to stand up against the

bad guy and the good will win. As long as futurology proposes explanations that are to be understood literally, it is a science in this wider sense. Naturally, many of the traditional ways to predict future are also scientific in this wider sense. Because of their scientific character, we will not remove them from the discussion in this article.

Let us look at the main classes of theories in prediction of future:
A. The future is determined and can be deduced from some information
B. The future is decided by some powers and information can be obtained from the powers
C. The future is partially determined by past events and we may predict future events based on past events.
D. The future is first invented and then realized

A. The future is determined

This set of theories contains the following theories:

Theory of cycles: *There are cyclic events. Finding the cycle we can predict the events.*

For instance, we can foretell that after winter comes summer. This cycle has an explanation and it is not counted as a nontrivial prediction. Sun eclipses have cycles and predicting sun eclipses used to impress people. Looking for more complicated cycles is an important tool for future forecasts. In technology there are fewer cycles, in general technology proceeds forward.

Theory of eras: *The history proceeds through eras. Eras are separated by sharp transition periods, often of catastrophic form.*

The most famous case of the theory of eras is the statue in Daniel's book: the gold, silver, bronze and iron describe the major kingdoms. The theory of eras is basically in a very solid foundation. For instance in paleology we see that there have been major eras. Eras are separated by various natural catastrophes that have killed a large portion of life forms. The main problem with the theory of eras is that the end of an era cannot be predicted, nor the character of a new era. In technology we also see eras. Great innovations, such as the invention of writing, printing machines and latest the Internet, are said to define eras. Futurology does often announce that we have moved to another era, so the theory of eras is used.

Theory of microcosmos-macrocosmos similarity: *The reality is like a hologram for 4-dimensional space and by looking at the physical space dimensions in some other part of reality we may see the time dimension in some other part of reality.*

Star positions at the birth, or at the present time, have been used for predicting the future from stars. Reading the lines in the palm has been another traditional way. Clearly, this theory is scientific, but it is not known to give satisfactory predictions. So far there is no

compelling reason to assume the reality has a character of a hologram. Futurologists do not use the micrcosmos-mactorcosmos theory.

Theory of models: *It is possible to create a mathematical or simulation model to the system and predict based on it.*

Modelling is certainly possible and much used. Depending on the system, the model may predict correctly or it may not. Modelling is one of the cornerstones of science. In futurology the models do not predict well enough.

B. The future is decided by some powers

This set of theories contains the following theories:

Theory of decision makers: *Some people decide the future. We may know the future by asking them.*

The people may for instance start funding some large technological programme. These people do not necessarily want to tell what they have decided. They may not understand what will be the probable outcome of their decisions, neither what some other decision makers have decided. A future teller can by posing suitable questions get information of the future. Typical ways are looking at how much funding is put to some areas, what is stated in policies and so on.

The theory of experts: *Some people, the experts, have knowledge that the future teller can obtain by interviews and other ways.*

The experts do not need themselves to know the future: by combining opinions from several experts the future teller can form a good prediction. The experts may also know what the decision makers have decided.

In prediction of future technologies different expert opinion methods, such as the Delphi method and seminar work, are often used in futurology. This is natural since futurologists seldom are experts on the area of technology they try to predict. For an expert on the area, opinions of other experts give little new information. Most of the opinions are known to people working on the field, there are very different opinions around and none of them can be well justified.

Expert opinions are not unknown among prophets. Isaiah mostly gives expert opinions, but in so moralistic style that a modern reader is bored. They are of the pattern: "I prophesize against you Moab, you will cry, your children will cry and even your dogs will cry." These are basically predictions based on observations of daily international politics. The problem with expert opinion as a research method is that while a futurologist using expert opinions is thought to do research, an expert expressing his opinion is not doing research, only making a statement.

Theory of dreams: *Some dreams, especially those of decision makers, can tell the future.*

Freud's explanation of the dreams is that the unconsciousness announces its reflections on the situation. If we accept this theory, dreams of rulers, such as the dream of Nebucadnessar in Daniel's book, might reflect correct fears that the conscious mind refuses to accept. It might be an interesting experiment if a futurologist went to discuss the dreams of Nokia bosses, who unconsciously know the market situation but cannot consciously admit it, and create prediction on the future of mobile communications. To the author's knowledge, futurology does not use dreams, though they might be given some scientific motivation.

Theory of supernatural influence to random events: *If a sufficiently random event is created, supernatural powers can influence the outcome.*

The Roman theory is that if we sacrifice an animal and cut out its entrails, their shape and position gives information on state matters. We may also throw dice or deal cards, two activities that are though to be sufficiently random. As supernatural powers are spirits, we may assume that they intersect weakly with material and it is very logical that they only can influence these kinds of threshold decisions. By posing suitable questions we can get information from the spirits. Clearly, this is a scientific theory, but again it does not seem to be working well enough. Futurology does not use these methods.

Theory of visions from supernatural sources: *A person can attain a mental state in which he can receive information of future from supernatural beings.*

Part of the theory is verified: by several means a person can reach a state where he obtains visions of the future: by fasting; by absorbing poisonous plants, mushrooms or fumes; by isolation, by being strangled and so on. The predictive power of these visions is usually poor. Futurologists do not use the method.

C. The future is partially determined by past events

This set of theories is based on the intuitive, but sometimes wrong, concept that the past influences the future. While usually this is the case, people tend to make mistakes in assuming that the system keeps more memory than it does. For instance, a long run of heads in flips of a coin influences the subjective estimate to the probability of heads or tails on the next flip. Though simple cases can be easily avoided, more complicated cases are likely to mislead most people. This set contains the following theories:

Theory of laws: *There are mathematical laws that with some accuracy can be used to predict the future by interpolating the laws.*

The theory of laws is much used in prediction of technologies. Probably the most famous technological prediction is the Moore's law that the capacity of integrated circuits doubles every 12 months. The law is 40 years old and still valid.

Telephone traffic used to grow linearly with a constant positive slope. Today, telephone traffic in the fixed network decreases also fairly smoothly, but competition and new services have decreased the practical value of this law to an operator.

The Internet usage and the number of routers followed for some time an exponential curve, but it has smoothened now. In general, the S-curve seems to fit rather well to successful communication services while unsuccessful services follow the bell curve or the flat curve. Prediction for a short time in the future is quite possible in the large, provided that there are no technology changes.

Hubbert's peak point theory is another well known correct prediction: Hubbert noticed that the production of oil wells has the shape of a bell curve. Summing up the predicted production curves for American oil wells he correctly predicted that the oil production of the USA would peak at 1970. This we later verified: the actual peak was 1971. Several predictions have been made concerning the world oil production and various researchers have ended up with peak points from 2005 to 2030, while other researchers have disclaimed the validity of the peak point theory.

Theory of trends: *There are long term trends that continue.*

Trends are rather reliable way to predict in techniques. The main problem is that while trends continue, they do not give sufficiently clear predictions. In general, trends are known to most people on the field and predictions based on trends only seem too obvious. Furthermore, trends do not give any time scales for the development.

The trends in telecommunications include decreasing size of terminals, increasing power of accumulators, increasing mobility, increasing bandwidth and increasing multimedia. There are less clear trends: increasing customization and network intelligence. Many people propose certain technologies as trends: ATM everywhere, IP everywhere, Java everywhere.

Theory of signs: *There are signs that show the emergency of some new era.*

Futurologists have the concept of weak signs. According to it, there are some signs that should be followed. It is easy to propose a set of weak signs, but in practise the correct weak signs are usually not noticed. An example of the theory, the signs Jesus gives for his next coming are fairly vague: wars, disrespect, diseases and so on are. Maybe the philosophic content is that there are signs, but there is no way to notice the signs except for afterwards. This would keep the future from being foretold.

Theory of occurring events: *Common events occur often, rare events occur seldom. If you wait for long enough, they will occur.*

It is quite possible to estimate the number of many future events, such as car accidents, yearly sales and so on. Predicting rare events is in principle also possible, but the time cannot be told. Several prophesies by Nostradamus have the character that probably they

will have to happen sometimes. For instance, a knight probably will finally be killed by a lance piercing the eye. There are very clear prophesies such as Jesus' promise to return and Merlin's prophesy that England will be ruined. There is nothing ambiguous in these prophesies, only they have not yet occurred. Some clear prophesies were almost filled, like that Quatzelcoatl would return and start a new era. Spanish come to Mexico and started a new era. There are accurate prophesies that have been fulfilled, such as many of prophesies in Daniel's book. The typical way of dating Daniel's book is by looking for the time when prophesies stop being so remarkably accurate. The assumed writing time is 168 B.C., and the accurate predictions are mostly, but interestingly not only, dated to times before this year.

Of course, one way is to formulate predictions so that they occur either way, like the answer of the Delphi oracle: if you attack, you will destroy a mighty kingdom.

Theory of similar development: *If similar chain of events has occurred in some other place, we may predict that the same happens here.*

This can be used by futurologists e.g. in predicting markets by development of markets in countries that are further in provisioning of some technology. We may also use analogical chains of events from totally separated area. The problem is that many chains of events depend on particular situations and do not necessarily repeat the same way.

D. The future is invented

The main idea is that future is not determined. We can influence the future by inventing a goal towards which many people will work.

Theory of vision: *Visions realize themselves.*

Vision is here used in the meaning of the targeted state, not as a hallucination. As people work towards the vision, it becomes reality. The most famous self-realizing prophesy may be the rebirth of the state of Israel, foretold in Isaiah. Organizations nowadays all have visions. It is unknown how many of them are realized.

Theory of science fiction: *Artists can foresee the future.*

Science fiction and literature contain lost of "predictions" that become real later. Pan Thaddeus was in the moon before the Americans. Jules Verne foresaw lots of technical innovations. Robots first appeared in a novel. The mechanism seems to be that if some idea is well known as a literary concept, somebody will finally realize it. Some biblical prophesies, notably Ezekiel and the Apocalypse, belong to literature that can be likened to science fiction. They differ in being less understandable. Many works of poetry, like the blessings of Jacob and the psalms have been understood as prophesies.

Theory of multiple future scenarios: *It is good to create scenarios where different chains of events may lead. Then decision makers have a clearer view on what they should do.*

Futurology has creation of alternative future scenarios as one of the main research method. Scenarios illustrate well what can happen and actions can be taken to directing the future to a desirable scenario. As the future can only be one or none of the alternative futures, this is not a real prediction but a way to evaluate alternatives for actions.

3. Author's suggestions for predicting technological changes

Section 2 contained a list of possible ways for predicting the future. The list may not be complete, but it shows that there are very many ways that can be used and in the wide understanding of what is scientific we may call most of them scientific. In this section the author describes two concrete methods for prediction of future technological changes.

If there are no changes, predictions based on trends and linear development from the present state give good enough estimates for the future to some years. We cannot predict longer than some years without considering technology changes. Therefore the main problem is guessing fast changes in technology. Two ways are proposed for the area of telecommunications, but they maybe apply more generally.

The first one is for short term prediction of changes and it is a form of "Theory of decision makers": industry and operators employ lots of master's thesis makers. Their topics show the direction where work is being done. The second one is an experimental method, which uses business models for prediction of changes.

The idea is that any major technology has a business model describing why it makes business. Usually when the technology was developed, it made sense to develop the technology, therefore there was some business model idea how it will be used. There are weaknesses in business models and some changes in the environment may render the business model impossible. In such a situation the technology must be changed. Thus, it is not the question that some technology is better or worse. They are all reasonable good or poor, but some fit better to some situation. The normal development process does not consider sudden changes in the environment and produces a good solution to the assumed situation which is a logical continuation of the past. If there is a rapid change of technology, it probably is a result of changed conditions. We do not know what conditions change, but maybe can see from the business model what conditions were fatal to the business model.

3.1 Research work index

Activity in an area of technology reflects in the number of theses and research work done on the field. The author's experience is that the number of research papers and projects is the more volatile index and gives rather poor predictions on the direction of technology.

Scientific papers can be produced more easily from topics where analysis, simulation and measurement can be used. In technology the main research method is design and implementation, and papers on these topics are much underrepresented in scientific literature. Scientific papers also show the world trends where the USA has a dominating role. Therefore, the number of scientific papers does not correctly describe technical developments e.g. in the Europe or in Finland. Master's theses describe in a more faithful way the work that actually is done in the industry and they show more directly the national directions in technology. These indices predict rather well what happens in the next three to five years, but they do not shed any light on what happens on a longer time spell.

Figure 1 shows the topics of the M.Sc. theses in the Networking laboratory during 1995-2003 classified by the main technology. Most of the theses are made to the industry and operators, so they reflect quite well what the active areas in the commercial sector are. Theses are made in several phases of the technology, but mostly when the technology is developed. There are literature studies, designs, implementations, tests and similar studies. The time spell from the activity in the theses index to the market penetration is typically a few years. We can see that ATM actually never reached the point that much work was put on it in Finland. We can notice the large increase in work on IP. While it is not directly shown in the figure, the GSM curve contains the development work to UMTS also. It was easy to predict, against some expert opinions from the academic side, that UMTS will be developed and probably succeed rather well.
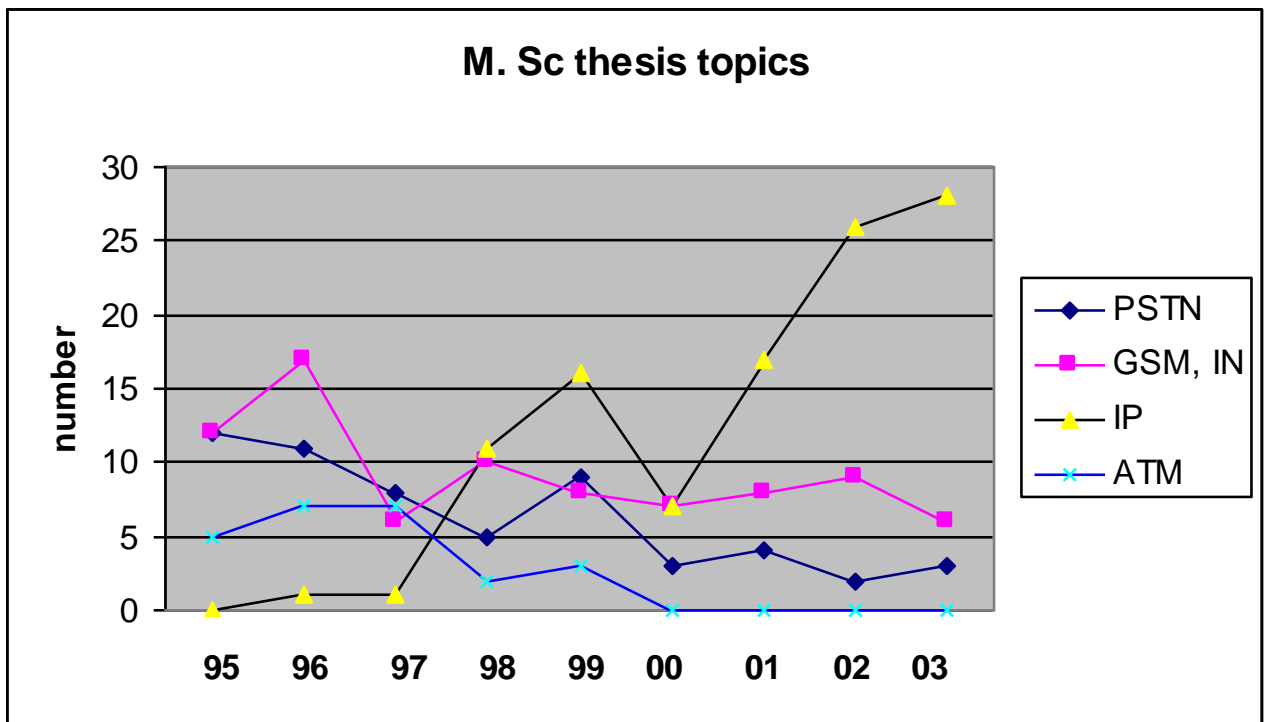
3.2 Predictions based on probable transitions in business models

The author has developed a method for understanding the changes in communication technology. Presently the field is in deep depression in the area of research, even though the sales of mobile phones are still going fine. Consequently, the speed of new paradigms has decreased and prediction based on past events seems possible. For a long time, at least since the author moved to the field 1987 up to 2002 this was not the case: new technologies replaced older technologies before you could say hop, or write a decent text book for that matter. The author's prediction method must be seen against this background. In the late 80ies, the OSI (Open Systems Interconnection) was the assumed future trend. Internet protocols were known, but considered as hobbyist code of questionable quality. TCP/IP protocols were not even considered for commercial usage because the implementations carried a header: not to be used for commercial purposes, and as for standards, what standards? There were ancient looking plain text documents called RFCs, with elementary graphics made out of ASCII symbols. None of the so called standards had any international status, nor were they verified or tested in the way international standards were assumed to be. The real choices for an operator were the commercial standards made by large companies. It was well known that data communication would create great markets in the next decades. The Big Blue, IBM, had a protocol family, SNA, and DEC had another family DNA. These solutions worked fine, but the problem was that they locked the operator into a situation where it would have to buy from the same vendor all the equipment and its upgrades. This was the time of the vendor-centric business model in data communications (see Figure 2).
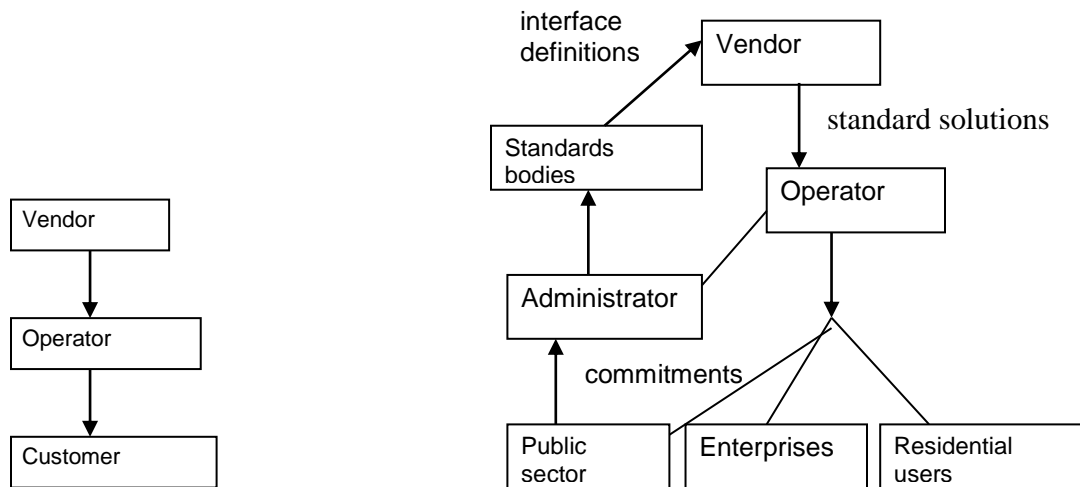

Figure 2. Vendor-centric business model.   Figure 3. Operator-centric business model.

The OSI protocols for data communications were an attempt of the operators to break the vendor-centric business model. Naturally, no vendor supported the effort wholeheartedly, but many played some lip-service. The idea was that as teleoperators were mostly state-owned and in practise tele-administrators were the same as teleoperators, the administraters can define an open standard, the states can mandate that the public sector will use these standards and then the operators can demand standard solutions from the vendors. Thus, the vendors are forced to a competition in a market where every vendor

must follow the same open standards. The free enterprise sector and the residential users will also gain from the competition as the vendors cannot try to trap users to their proprietary solutions. The operator-centric business model was therefore not directed against users, but against vendors (see Figure 3).

The business model in Figure 3 was broken by two changes: liberalization of operator business and release of the TCP/IP protocols to commercial use. The liberalization meant that the operator was no longer state-owned and did not have to follow the standards agreed by tele-administration. Especially, they could adopt standards that are cheaper to provision than the OSI protocols if such appeared. TCP/IP protocols had been created by the funding of the USA government, most notably by the DARPA. The protocols were already old by the time of liberalization and quite unsuitable form commercial usage. TCP/IP got lucky because input from telecom research directed CERN's application for hypermedia exchange of information between researchers of physics towards a general purpose information network, the World Wide Web. The idea of this type of data services were known in telecom since the videotext, but as it happened, the first application came from CERN. The result was removal of the restrictions in the usage of TCP/IP protocols and software, as it now seemed to be promising business.
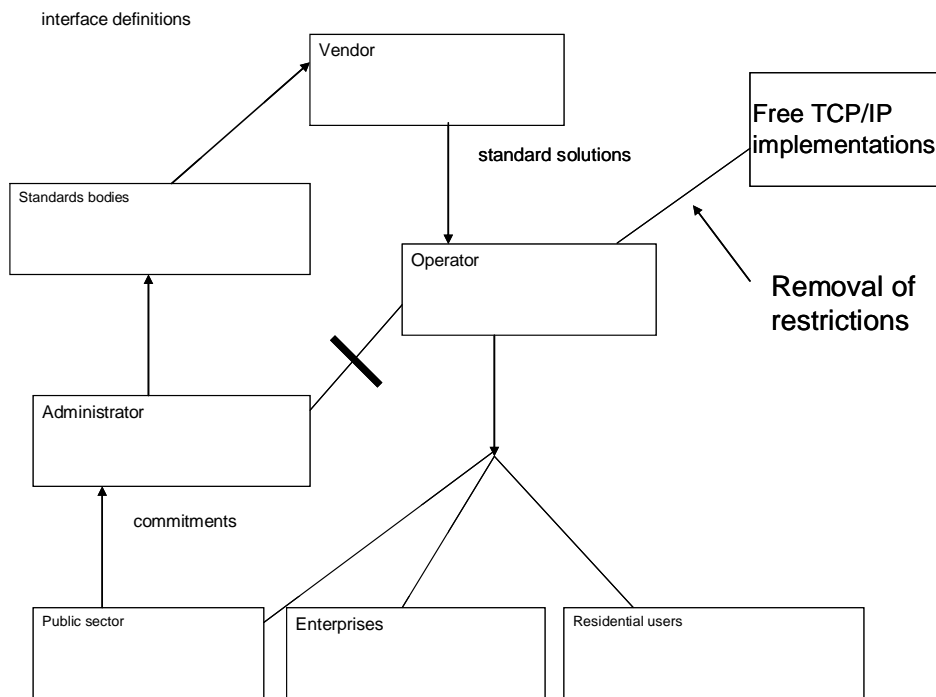

Figure 4. Breaking of the operator-centric business model.

Thus, removal of the connection between the administrator and the operator and allowing the operator to use the USA sponsored implementations of TCP/IP protocols made it almost impossible for the OSI-protocols to gain popularity. The common explanation is that they did not work, but that is most probably false. Computer power increased rapidly and performance of OSI was not the critical issue, neither was the complexity of the protocols. In the author's opinion the real reasons were on the business model level.

The case of ATM was a bit different. ATM was created to the business model idea of B-ISDN, which is similar to ISDN. The users have in their computers an ATM card and use the network as in ISDN: making connections between two points or multipoints. ATM is especially not suitable for interconnecting LANs to a WAN because LAN is connectionless and ATM is connection oriented. ATM failed when the environment turned out to be different than the business model for B-ISDN assumed. The need was to make the network of networks: connecting LANs of organizations into a large network instead of connecting users. The typical reason that is usually given is that ATM does not scale or that it is not possible to surf the Web with connection oriented service, but these technical reasons fail if one studies the problem from the technical side. These technical issues are not at all impossible to solve with ATM. Again, the reasons are in the business model. This time it was a change in the environment.

Let us finally look at the IP and try to make predictions of the future of IP. The old internet business model in Figure 5 is not for making business. It is for connecting researchers and hobbyists. There is no need for the operator role as this communication is sponsored by universities. There is no need for security as all are well-behaving. There is no need for network management as the community is composed of software hackers with expert skills in fixing problems. The community makes its own standards in IETF.
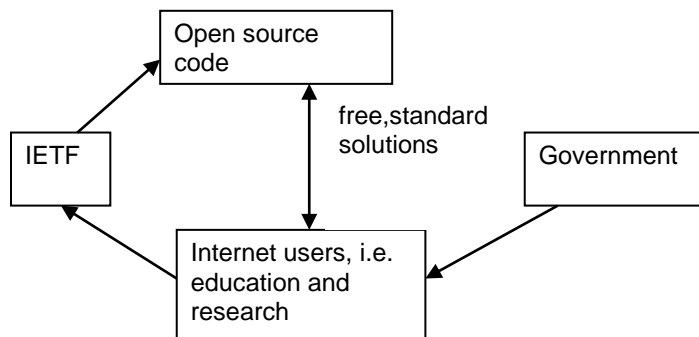

Figure 5. The no-business is good business model.

Several changes could break this business model. If we add the role of a hacker, the set of protocols created for friendly users may be too weak and finally the network may become useless for normal users. Another weak point is the inclusion of the operator role. An operator wants to sell service, so it needs charging, network management, quality of service, security and mobility. So far all of these aspects are either missing or have open issues. The third weak point is the standardization organization. IETF may not be the correct organization for commercial international telecommunications. The official organization for those purposes is ITU-T. Changing IETF to ITU-T would break the connection from Internet fans to standardization.

We see that there are several possible changes that might turn fatal to the Internet business model. At the moment the business model is in a transitional state since operators have already been included to the model. We do not know the final state, but it

is not impossible to think that the future Internet has quite different technology under the WWW user interface than now. We cannot predict any times to the changes, the method only allows locating weaknesses and their potential consequences.

4. Conclusions

The article looked at different approaches to prediction of future. If can be seen that futurology uses several methods, many of them being similar to the ones used by prophets and future tellers. There is a difference in character: gods or spirits are not asked for help, but one should not exaggerate the differences. There are no strictly scientific ways for telling the future, but there are several reasonable ways of guessing of future. The author explained two methods. One of them is very simple and the main reason for bringing is up here is that it may give a better view on local and European technological development than the more typical research index methods used in our country. The second method may have some potential. It is intended as a way for evaluating business models by designers of large communication systems. Too many large systems were developed and later not used. Clearly, there is a need for some method to analyse the viability of the business model before creating the system.

On the role of sexual selection in the evolution of humans

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Abstract: The article discusses the mathematical problem that evolution of the man seems to have occurred with too few trials. An alternative theory, putting more emphasis on sexual selection, is proposed.

1.   Introduction

In 2004 there was a very strange witch hunt in the Helsinki University of Technology (HUT). Some professor had dared to arrange a seminar where a supporter of the Intelligent Design theory was presenting a lecture. The professor was even more daring and put the material on HUT web pages. The orthodox professors in HUT responded rightfully by a most kind request to have the web pages immediately removed because if not, the American scientific circles surely would condemn HUT as a stronghold of creationist teaching. The author following this discussion wondered how many of these HUT professors actually ever had carefully thought of the problems in the presently accepted evolution theory. The objections against the Intelligent Design theory by the American scientific community seemed to have more in common with politics than with science: George W. Bush is supported by Christian fundamentalists while the academic circles may mostly be democrats, and certainly not Christian fundamentalists. We should not mix American party politics into a scientific discussion on the evolution theory. It is very sad that HUT professors have participated in this political effort under the name of science. That there are real problems in the evolution theory should be clear to anybody who has read the Origin of Species [1] and looked at the modern versions of the evolution theory.

Darwin, following his grandfather's footsteps, tried to present an alternative to the creation myth in the Bible and, quite naturally, ended up with a scientific explanation that has much resemblance with the liberal or early capitalistic thinking of the role of competition as a creative force, a popular idea in Darwin's times. Darwin does not present the evolution theory as the truth, but as a theory, and as a theory it is perfectly good science of the time it was created. Scientific theories need to be revisited by scientific discussion as new knowledge is found or problems arise. In the case of evolution theories there are two main flavors of scientific explanations: the older synthetic evolution theory and the punctuated equilibrium theory [2] of Stephen Jay Gold and Niles Eldredge. These theories are quite different in their understanding of the process of evolution. When there already are two theories, adding more theories does not really change anything: we may conclude that evolution is not a well understood subject even though school text books often present the synthetic view of evolution to children as the scientific truth.

We first discuss two serious arguments against the evolution theory as it is currently presented: a mathematical one and a philosophical one. Then we will propose a modified evolution theory, in accordance with evolutionary ideas but clearly different from

Darwin's thoughts of the survival of the fittest, which can explain the human evolution better and does not have the mentioned problems. To what extent the proposed theory can be applied to evolution in general will not be discussed here.

2. Problems in the evolution theory

Let us use the book of Juha Valste [2] as a lucid explanation of evolutionary ideas and the evolution of man. Valste has actually listed the arguments in the evolution theory as if he was trying to refute creationistic attacks. Let us summarize the arguments.

It is very plausible that there is a chain of fossil remains showing how man has developed from apelike ancestors. There is biological evidence that chimpanzee is a very close relative of man. Thus, we can show that the history of man is liked to the history of apes.

It is shown that there are random mutations and that DNA accumulates changes by mutations. Competition for survival can be assumed to have worked on the population. There are several mechanisms that can create a species, such as isolation, reduction of the gene pool in a population by some catastrophe, destruction of intermediate populations from a large population where far away individuals have drifted away from the original species. Thus, we can demonstrate mechanisms, which in the evolutionary theory are creating new species.

There are two current evolutionary theories: synthetic evolutionary theory and punctuated equilibrium theory. Both claim to explain the process how a man came into being. Both theories are logical and punctuated equilibrium seems like a better fit to fossil data of human evolution. It would be neater to have one theory instead of two, but let us say that both follow the main evolutionistic ideas and thus these ideas have much scientific support.

Everything seems good but there is a serious mathematical gap. Let us explain where it is by looking at some analogical problems. Guessing cryptographic keys of a good crypto-algorithm is usually hopeless. If we see a sequence of numbers which converge into a key, we usually do not conclude that the individual steps are be made by random modifications, however small. We could interpret this sequence in two ways. Either somebody knows the key and has left the steps to the key to be visible to us, or there is an efficient crypto-analysis to the algorithm behind the key. Let us take another analog. Let us assume there is a group of people in place A. The people in the group wander to some distance in a random way but stay in the group. The centre of the group moves from A to B. Let us assume we see the tracks of this movement. We cannot conclude that the movement from A to B is caused by random movements, even though there are tracks of random movement in the group. If B is some target place which is difficult to reach, we may be a bit puzzled how they found the way if they did not have a map. There is no difficulty in case B is as good a place as any, or if the cryptographic key does not solve any encrypted text. In that case everything is clear: any sequence of moves leads somewhere. There is also no difficulty if there are very many special places B or very many keys that open the encrypted text. In that case it is easy to see how random

movement can be sufficient. However, if B is very special and the key is hard to get, then there is a difficulty.

This is exactly the problem in human evolution. Human evolution from more ape-like ancestors looks like a very lucky strike. Though animals have culture [4], humans were able to create a culture far greater than that of other animals. It looks like a random walk was stumbling to a very special point B. Usually evolutionists try to explain this problem away by saying that the point is not special: there is no direction in evolution. Humans simply happened to possess capabilities to creation of higher cultures. Human evolution is not the only case of this special type. In general, evolution seems too full of special points – in fact the question should be Heidegger's "Why there is something instead of nothing?" It would be easier if evolution had stayed in modifications of molecules or at least single cell organisms without development of complicated forms of life forms. Everything would be understandable if very primitive life forms had stayed on that level and evolution had merely created a large multitude of such life forms.

Alternatively, if we could show that by cultivating fruit flies under competitive conditions creates radically different species, or that evolutionary algorithms (see e.g. [5]) in a computer create extraordinary solutions, there would not be any difficulty in the theory. We would have shown that the places B are not rare. But as it is, evolutionary algorithms do not evolve very far even though the computable number of operations is currently about 10^{22}. Let us remark that the evolution on the earth cannot have taken a very large number of trials. 1 billion years of evolution with 1 billion as the population size and 10000 generations a year gives only 10^{22} trials. Far from being a huge number giving lots of time to random choices to work on, this is actually a small number and any crypto-algorithm that can be broken in this complexity is weak and can be broken today by brute force. Recent factorizations of modulus in the RSA algorithm are on this range of complexity. It does not help to say that the mutations control larger changes as some genes are control genes, because then the problem is wherefrom is the intelligence or the structure enabling these control changes to have a positive effect.

The present estimation of the time chimpanzee and man separated is 7 million years. We may assume that the breeding population has been below 10 million. The lower estimate to the time to become fertile can be set to about 10 years. Rounding up the figures, we get 10^{13} as the number of individuals, that is, 1 million generations of a 10 million population. There are other much larger sets of combinations that might be of aid. In addition to the direct ancestors of a man there are bacteria, plants and animals, which come in large numbers. However, it is difficult to see how this environment could have imposed intelligent control to the evolution of the man. Usually the environment gives rather random control. There are also large numbers of cells in each individual and there are large numbers of sperm cells also, but these do not help because evolution can only have worked on a fertilized egg cell that is born and matures to an individual. It seems that we are stuck with the 10^{13} trials. This number of trials should have been enough for creation of a modern man.

Let us notice that 10^{13} is about 40 bits. Assuming that the search algorithm is not by brute force but that the natural selection is as effective as a good crypto-analytic method, we might expect that a bit combination of 60 bits could be found by a search of 10^{13} trials. Obviously, the early ape-man has had a great unrealized potential for creating culture since putting 60 control bits correctly changed him into a being capable of creating human cultures. This potential could not be developed by natural selection as it was dormant. If on the other hand, natural selection is much more powerful than our crypto-analytic approaches such an algorithm has huge potentials. Nobody has come up with so powerful algorithms, so apparently their details are not known. Here we see the problem with the scientific explanation of evolution.

The main philosophical argument against the evolution theory is not that it removes God from the loop, but that Darwin's choice of competition as the main creative force removes all of the virtues from their role and allows the use of virtues and good models only at the stage of cultural evolution. Philosophically, God's existence was derived from the existence of the virtues because without the virtues anything was allowed. Darwin replaced the virtues by competition, the survival of the fittest. While this is a solution, it has the problem that the virtues result into behavior that is in clear contradiction to the one that it logically derived from following the survival of the fittest.

Philosophically it is also strange that if Darwin did not see any alternative mechanisms that do not assume God, we should conclude that such mechanisms are not possible. In the cultural evolution and in technical evolution we often see evolution that is guided by some target that one tries to achieve. For instance, the number 10^{13} of trials can be quite sufficient for increasing the processing capacity or memory storage of computer chips provided that the selection criteria is not the survival of the fittest but the survival of individuals that have these desired properties. In the cultural evolution we see movements, such as monk orders or Gnostics that survive for a quite long time even though they do not allow for any practice of sex and are of maximum negative survival value. If we can find a way to allow the population to select rather freely the target of the selection process we may easier understand how the relatively small number of trials might be sufficient for human evolution.

Let us assume that the population observes in some other population some trait that it considers as desirable and admirable, for instance, strength or high speed. Let us assume that the population makes sexual selection in its own population towards this trait. We do not need to assume that this selection increases the chances of survival to this population. For instance, selecting for a higher speed may at the beginning have no practical purposes for survival and selecting for this trait may result into discarding individuals with other traits of a more practical value. After the selection has continued for a prolonged time, there may be some positive survival value. It actually would be likely that the trait later has some survival value since it was seen to be admirable and desirable in the other population.

This is of course the model of protected technical development. Instead of opening your markets into competition, you observe what is developed elsewhere, develop your

technology towards the desirable goals, and later you may achieve real competitiveness. If competition is applied at the beginning, your own solutions fail to reach the target level because of the competition.

In evolution theories often one is assuming that evolution of such traits that cannot have been of survival value in medium stages must have developed in an isolated population. There is a problem with this assumption. Isolation also means that no flow of information is present and as a rule, isolated populations develop slower. In technology we cannot assume that actual isolation can work. Even with a protected market we must have the information from the outside. It is difficult to see how evolution in biology could be in a radically different situation compared to technical development.

3. The role of models

Darwin's evolutionary ideas recognize the role of sexual selection, but the theory of evolution is very unclear in the discussion of what are the traits that sexual selection favors and why. Examples of sexual selection include the long tail of a peacock, which seems to be of negative survival value. Instead, the fancy tail is of great beauty. We may call beauty, strength, intelligence, love and such properties virtues. Let us propose a theory where sexual selection is pushing towards virtues.

The idea of a model is that if some life form has reached a solution which contains desirable features - virtues, then this solution can be taken as a model in the sexual selection of some other species. Then the other species would evolve towards a similar solution as the first species. Of course, because of the genetic differences in the starting point, the solution would not be the same. The evolution would be guided evolution, not blind drift driven by competition and the survival of the fittest.

Let us compare how this theory would explain the long neck of a giraffe. Lamarcism explained this observation by inheritance of acquired characteristics: giraffes stretch their neck and the offspring have longer necks. Darwinism explains the observation by survival of the longest necked giraffes at times of famine. We propose the explanation that some species, giraffes or some other animals, had longer necks and for giraffes they seemed to possess desirable characteristics with survival potential. Because of this, the giraffes with longest necks were more often selected for breeding. This way the very long neck of giraffes might have originally been an exaggerated copy of a slightly longer neck of a totally unrelated species. The length of a neck became the admirable characteristics – virtue - in the giraffe population.

An old objection to this theory would have been that animals do not understand such high virtues as beauty, strength, intelligence and so on. Naturally, not all virtues need be understood by all animals, but as for beauty – why e.g. birds and cat animals have such high beauty if they do not understand it? Even brief observations of dogs show that the differences between man and dog are quite marginal, much smaller than e.g. between man and ant or man and his computer. We may safely assume that long before man

separated from apes there was a good understanding of most of the virtues which we today consider as virtues.

Let us consider how virtues would suit as the criteria for sexual selection. We know that beauty is one of the selection criteria, as with the peacock male and the human female. Clearly strength and power are a criterion for sexual selection, for instance with ruminants. Severity, that is, the punitive power to rule and punish, has been one criterion ever since there were animals living in groups governed by one individual – the ruling male always gets the females. Love can be seen in mammals, such as dogs, and the example of birds shown that love has been a virtue long before mammals. As a sexual selection criterion, a female's love to the offspring and the male's love to the female could be very old. Whether love is a selection criterion in some birds is not known to the author, but it is possible. In humans it is thought to be. Bravery is a selection criterion for at least as long as there are fights for females: that means, very long. Intelligence must be a relatively new virtue, but some kind of cunning is seen e.g. in foxes and might have been taken from some cunning animal as a desirable trait to human evolution.

We could understand many characteristics being obtained as secondary characteristics in the pursuit of virtues. It is possible that the upright position of humans is not a modification developed for carrying weapons, seeing further or running faster, but it is a result of sexual selection trying to achieve the upright threatening position of a cave bear, the mightiest of the animals. The strength would be the actual virtue, but the upright position is imitating the bears threatening pose. We know that most natural people have totem animals and they imagine having been derived from the totem animal. Literally this cannot be true, but symbolically it could. A bear has been the totem animal to a great number of peoples.

The punctuated equilibrium theory seems to fit the fossil data of human evolution, but in the case of humans the punctuated equilibrium theory does not explain punctuated evolution. In major catastrophes punctuated evolution occurs after a great number of species have disappeared. In human evolution there is no such event. The explanation of an ice age seems weak as the evolution occurred in Africa in warm regions. Adopting the proposed new theory, we might understand the punctuated equilibrium resembling development of humans. Several anthropoids developed approximately at the same time, though only the modern humans survived. There was no gene exchange and the parallel development of the upright position could be understood if there was an external model, such as a bear, towards which sexual selection in all groups was pushing. In the same way, development of intelligence in one of the species could have become a model to the other species. This kind of an explanation would remove one of the difficult mathematical problems in evolution – usually the solutions improve to some degree and then stop. We must manually help the solutions to improve further and often need to start again from a rather far away branch with the same desirable selection process. If some solution having reached certain desirable properties can act as a model to other completely separate branches, then we may much easier reach long term improvement.

The proposed explanation agrees with some every day life experiences of sexual selection in humans. We can easily understand that the pursuit for beauty could have been the reason for losing body hair. Women still shave their legs, so body hair is not considered as great beauty. The majestic character of being taller may explain why the upright position and tall men would be preferred in sexual selection. Sexual selection has enough explaining power as a drive of evolution since before the fittest can survive, the fittest must be born, so the sexual selection comes first.

It is interesting to speculate if some strange cases of parallel evolution might be given an explanation by the proposed theory. There was - before its extinction - a marsupial carnivore in Tasmania which resembled a wolf surprisingly much. As marsupials are an older family than mammals, we might speculate that a wolf was modeled after the desirable traits of this marsupial carnivore. Though similar animals, wolf is superior. Consequently, the marsupial later lost the struggle for life and disappeared from other places that the remote Tasmania. This theory would only assume that dog animals have the ability to do sexual selection and notice a desirable trait. This is not especially much to ask considering the intelligence of dog animals. Alternative theories need assumptions that the cases of parallel evolution are either results of pure chance or that there are only a limited number of archetypes for evolution. Considering the large variety of different dog races that humans have bred - many of which are quite capable as hunters, neither assumption seems especially convincing,

4. Conclusions

In the scientific study of human evolution, sexual selection has rather recently been shown to have a role. We did not enter this current discussion in this article. The line of though is on more general argumentation. Mathematically the theory of evolution seems impossible because the small number of possible trials for a search and the poor selection property of the survival of the fittest do not seem to combine into an efficient algorithm for reaching human intelligence. We cannot demonstrate any such algorithm with a computer even though the complexity starts to be within the reach of present computing capacity. Thus, we must conclude that the evolution theory gives no reasonable explanation to human evolution. We also noted that Darwin's choice of the survival of the fittest is not the only possible choice to be used as a selection criterion in a theory dispensing with the assumption of superhuman influence. We proposed an alternative theory: the selection process uses models taken from successful cases of development, not necessarily from the same genetic pool sequence. This allows us to get much more trials to the search and gives us different selection criteria that can achieve the target in the allowed number of trials. The resulting selection criteria are similar to what we are used to calling virtues. This puts evolution in biology to a similar context as evolution of culture or technology, and breeding of plants and animals. It is not evolution by brute force liberalism, but guided evolution by imitation of desirable solutions and improvement of selected characteristics without a constantly applied check of survival value.

As scientific theories are only theories, the proposed theory does not claim to contain the truth. The author, not from evolutionary biology, cannot afford the research time needed for verification of the proposed theory. However, are any evolution theories verified or can we actually ever say that an evolution theory is a scientific theory? Evolution cannot be repeated and even dogs, the animal that has been domesticated for almost as long a time modern humans have existed, is still a wolf. Dogs have developed from wolfs and can still interbreed with wolfs. It is unclear if we may call dogs their own species or preferably a race of wolfs. If this time is not enough for creation of a new species, there hardly is any great chance of verifying that species develop from other species by some mechanisms, be it the survival of the fittest or pursuing desirable features by sexual selection. In this sense all evolution theories are simply myths. They are all based on the best understanding of the current mainstream of logical thought. The Babylonian creation myth, the model for the creation myth in Genesis, was the most natural and scientific explanation at that time. There is constantly a dispute between the new scientific paradigm and the new scientific paradigm. It is often possible to show that the old paradigm has problems, but it is never possible to show that the new paradigm does not have some yet-to-be-found problems. In this way, the rejection a new theory simply because it assumes God's finger, like the Intelligent Design Theory, is quite unscientific.

The theory proposed here is not Intelligent Design, but has only small differences to the mainstream theory of evolution. In the proposed theory species develop from other species and the survival of the fittest has a large role. We may ask if there is anything new in the theory? There is something new. It is not necessary to explain that in some roundabout way some change, that clearly cannot be beneficial for an individual, is actually for better survival. We also should not try to make such explanations because they may and have lead to totalitarism, social darwinism and so on. If we stick to the goal of the survival of the fittest, then the fittest society is very possibly the one where the individuals only live to the society. In the theory proposed here, the goal of the selection in human evolution is virtue: all good traits. They can act as selection criteria even though they do not add the survival value because they are the traits that sexual selection uses. Thus, the proposed theory has a different ethical content. We also get different predictions on the origin of species. For a new species to develop using the proposed selection method, the population must first start to prefer some traits. This means that peacocks were already peacocks when they started to prefer fancy tails, not only after they lost the capability of interbreeding with their biological ancestors. In the usual evolutionary theory we would have to assume that a population of peacock's ancestors was isolated somewhere so that a new species could emerge.

5. References

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Use of drawing as a technical research method
- a complete classification

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4. Introduction

Research methods in techniques usually do not mention drawing. Drawing is only considered as a way of illustrating and explaining technical designs. In this short article we look at some ways of doing research with drawing.

Leonardo Da Vinci is probably the best known scientist who has used drawing as the main research method and as he was a great generalist, and the National Defence College educates generalists, it is hardly possible to ignore Leonardo's ideas how to research though drawing in this article. As the sources, we use [1] and to some extent [2].

Leonardo's most important discoveries in science may be his anatomical drawings. As he stated, one may think that dissecting a body is a better way of obtaining the information than looking at a drawing, but in reality it is not. It is not possible to see the information in drawing without several dissections and a careful study. Actually Leonardo filled in several details from dissections of animals and occasionally he drew wrong conclusions. This does not mean that surgeons should study only from drawings and not participate in actual surgical operations or dissections. It only means that unless a surgeon already knows from drawings what veins and muscles there are, he will not gain much from a dissection of one body. Nevertheless, drawing can be the ideal way of presenting the results and in the case of anatomy the reason why anatomy books still today have excellent drawing is very probably a result the work of Leonardo. In military techniques this way of doing research does not seem promising. The insides of technical equipment are known and drawings can only serve as illustrations. Let us see how Leonardo approached techniques by drawing.

Leonardo presented his technical innovations as drawings. His note books contain sketches e.g. of a submarine, automobile, tank, cliff glider and helicopter. Leonardo did not invent the engine to these devices, so they could not have been implemented and verified by an experiment. In what sense was he the inventor of these things and is this a form of research at all or is it science fiction? The author thinks it is a kind of research: even though the enabling elements were not furnished, there clearly is some innovation in the drawings. Several of Leonardo's inventions were implemented, such as the perspectograph, the ellipsograph (see [1]), compasses and other mechanical devices. Drawing seems to suit best to mechanics.

Geometric proofs are presented in drawings and we might think that geometry is a natural application of drawing as a research method. However, mathematicians are often quite poor in drawing and we cannot usually call geometric illustrations research by drawing.

Leonardo's drawings do not contain geometric studies, but he did much work on a famous problem: squaring a circle: i.e., constructing a square with the same area as a circle using only the compass and a ruler, but no measure. Squaring a circle is now known to be impossible.

There seems to be no evidence that Leonardo used drawings in order to hide information, though Dan Brown's novel has made famous the unprobable theory that Leonardo, Poussin and other artists have hidden secret messages on paintings. As there exists people who indeed hide messages to drawings and paintings, and everything connected with hiding information and cryptography in some way is of military interest, we will also look at this application of drawing.

2. Illustration

A typical usage of drawings in science and techniques is for illustration and different diagrams of dubious artistic value are common in classification. Drawing was earlier much more used in illustrations for teaching purposes. In modern times, illustrations by drawing give the look and feel of the time of the American civil war.
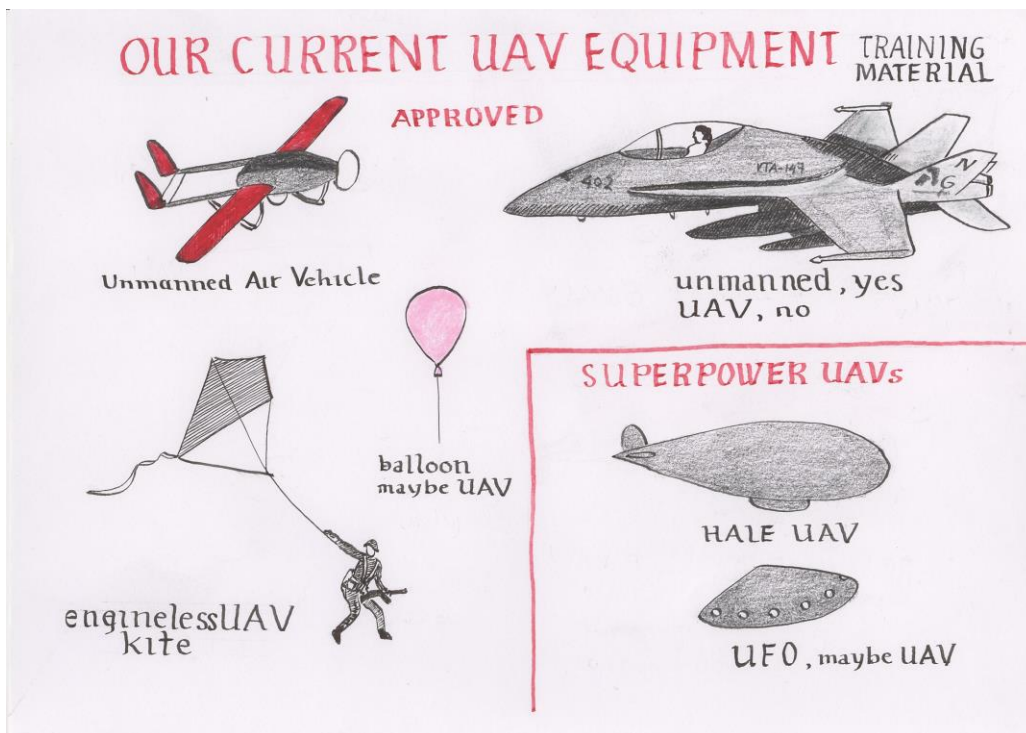

Figure 1. Use of drawings as illustrations and teaching material is disappearing. Photos are naturally much more accurate for these purposes.

Presently students add artwork and photos to their theses quite freely. Even though there is the reference, one may wonder why it is more acceptable to use somebody else's

drawings than to cut and paste somebody else's text. Drawings often take much more time to think and make, so they have more originality than the text. The society seems to be very tolerant on the inability to draw, much more than on the inability to do simple mathematics. Especially if the future target is a more innovative society, one maybe should reconsider which skills should be required. In the school there are drawing lessons, but they approach the subject from an artistic, not from the scientific point of view.

3. Technical description

Technical drawing is an essential part of techniques. Typical ways are to describe the parts and the whole equipment. Unfortunately technical drawings use technical perspectives that look awful as drawings. A real perspective drawing may be added as an illustration of the usage of the equipment. Still some years ago students in technical universities had to pass a course on technical drawing, so this skill has been considered essential.
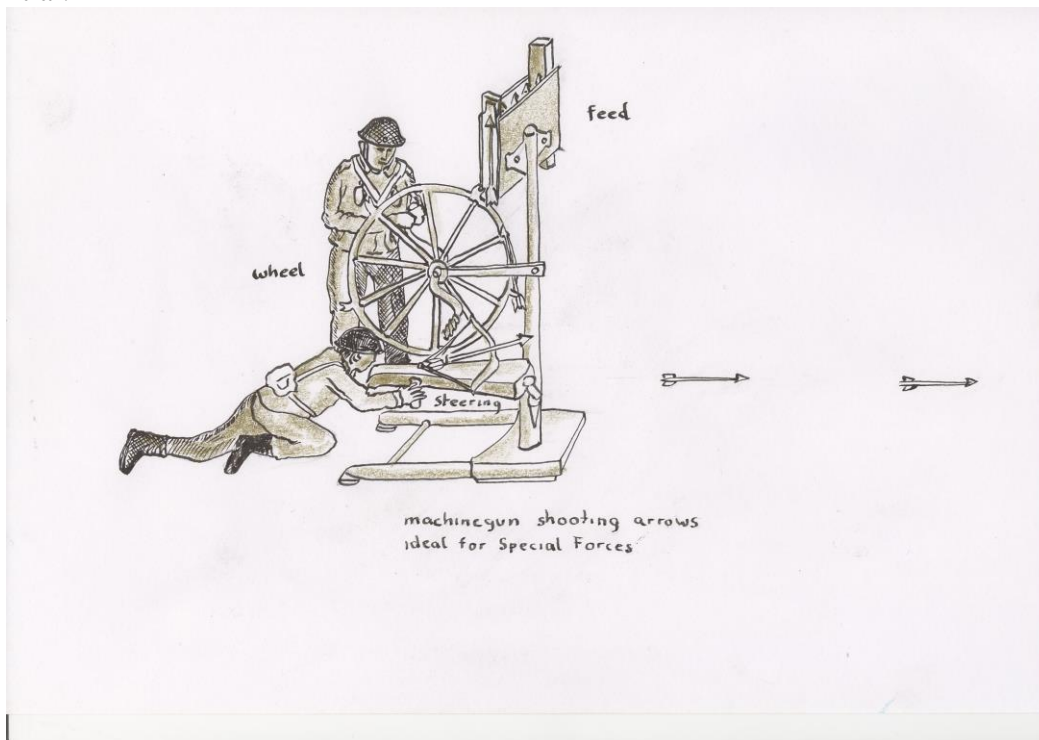

Figure 2. Machine gun shooting arrows. The wheel pulls an arrow from the feed and draws the bow. The model can be operated by just two strong men. Ideal for the Special Forces.

Today technical drawing is in decline. Most technical drawings are created with drawing programs which produce incredibly boring presentations of techniques. There seems to be no way around that. Even if we tried to decorate UML diagrams with some angels, flowers and animals, these decorations would look artificial and be dropped as silly

additions. There seems to be no other way than to wait that some day Microsoft employs somebody who understands drawing and can convince the firm that the Office software and applications to technical drawing as drawing tools represent a giant step backwards compared to the traditional pen.

4. Technical innovations

The usage of drawings for innovation and demonstration of innovations has declined ever since cigarette packets become impossible to draw on. Today smoking is so rare that we cannot hope for designs on a cigarette box. The special feature in this type of drawing is that the drawings can be allowed to be considerably more messy and sketchy than on other usages.
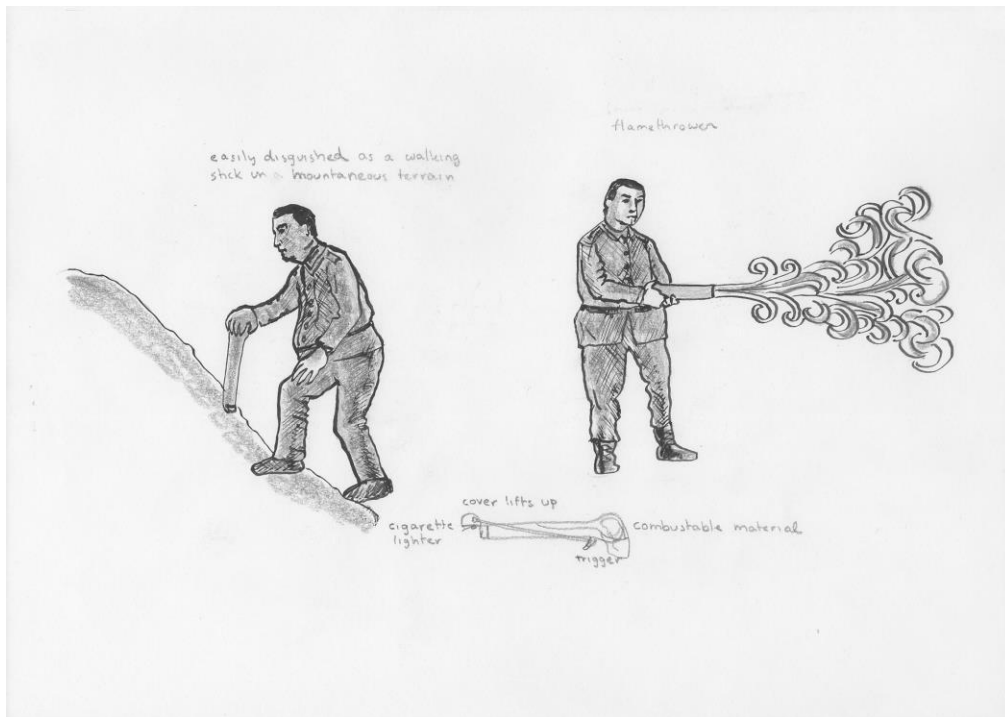
Figure 3. This bullpup type flame thrower is very convenient because of its small size. The gun is easily disguised as a walking stick in mountainous terrain. There actually is only one drawback: the container cannot be very large and consequently the flame is not of long duration.

The negative aspect of drawing as a research method for innovations is that it is easy to draw crank ideas and even to manage to present them in such a way that they seem to work. The drawings are thus not actually technical innovations, but they are ideas which help the reader to invent the idea himself. In this role drawings are probably better than text: if there is a drawing, it is more difficult to the reader to claim that he cannot even understand what is being written.

5. Illustration of future scenarios

In the military context the picture, or vision, of future war is of great importance and as a picture it naturally can be, and often is, represented with a drawing. This actually is a natural way of using drawings. Clip art and cutting and pasting photos from the Web or other sources produce photo montage which does not nicely represent scenarios.

Figure 4. Hacker attack. Artillery shoots an infrastructure ad hoc network to the terrain enabling the mobile COTS nodes with omnidirectional antennas to join the network.

Unfortunately these kinds of drawings are today produced by artists, not by researchers of techniques. An artist approaches drawings from the artistic point of view. It is more or less the same to ask an artist to describe a technical scenario that to ask a pure scientist to make the calculations for techniques. In the latter case you get a perfectly good scientific paper, which shows no understanding of the technical content. In the case of an artistic illustration there are typically similar drawbacks. Drawing as art is not the same as drawing as science. Leonardo's drawings are science or studies to his paintings, which are art. Dürer's drawings are art. The difference is whether the goal is presentation of new innovations or artistic perceptions. If researchers of technology would draw more scenarios, it might be much easier to explain e.g. to researchers in technical universities what applications and environment the researched piece of techniques has.

6.   Perception management

Drawings are quite powerful in perception management. While photographs are faster to take, one can never find as demonic a photo of the enemy as can be made with drawing. Drawings also make nice postcards for quite peaceful usage, as is seen in Figure 5.

When drawings are used for purposes where the intention is to create certain emotional responses, the use of colours is essential. As a rule, a black and white drawing has less effect in perception management than a coloured drawing. Strong colours are an option and they make drawings that look similar to those from Eastern art. The author has drawn Figure 5 with pastille colours. Let us consider this colouring option.

Figure 5. Notice, among other things, the stratospheric platform (the zeppelin) and the low-flying UAV. The strange arrangement on top of the UAV is the designed local communication solution.

In the author's opinion, use of naive colours suits well to happy illustrations provided that the drawing is made smaller. If the drawing is large, then such colours are too sweet.

The dogs in Figure 5 are rather realistic because in the author's opinion naive drawing style is risky to use. In general, it tends to make drawings look like cheap imitations of the style of naivists. If naive drawing style is used, the author suggests magic colouring, that is, very strong dream-like colours, not pastille colours. It is rather hard to get magic colours fit into a drawing as they are too strong, so naive drawing style is really more suitable to painting than drawing.

7. Encryption method to an anonymous receiver

If both parties of communication know each other and have had the possibility of earlier exchange of keys we can use symmetric encryption as a method of confidential communication. In the 60ies there was a new discovery: there are so called asymmetric encryption algorithms that enable confidential communication between parties who know each other but have not had a chance of previous exchange of keys. It is also possible to establish communication between anonymous parties provided that there is a chance of previous exchange of keys. This can be made by publishing encrypted material on some public source, for instance on a WWW-site. It is possible that both sides of communication are anonymous, e.g., if the public site is maintained by an unrelated party. Let us consider the case that the receiver is anonymous, the sender prefers to stay anonymous and there is no way to exchange keys. Such a case can appear for instance if we want to send confidential information to parties who are not yet privy to the confidential material. Let us assume we do not know who will be the parties who will be granted the right to read the material. Clearly, this is easily solved. We put the material in a safe and the key to the safe will be given to the candidate by a trusted party after the candidate has reached the level that he can be granted the right. In this case the trusted party has the access to the material. Let us assume we do not accept this kind of a third party. The communication problem seems difficult but actually it has long ago been solved by drawings, paragraphs of text or sayings. Esoteric knowledge is passed in this way. The information is presented in symbolic form to the third party. The third party is only a delivery channel to the information and needs not be able to understand it. The receiver must decrypt the information using a long process of maturing to the level where he can understand the information. It is possible to publish the symbolic information in public sources, but typically the third party keeps the information secret from the public eye. This makes it less probable that somebody accidentally discovers the key to the symbols, or what is worst, delivers the information to parties who should not have access to it. Various hermetic sects, such as Gnostics, Cabbalists, Alchemists, have used drawings in this way.

Let us look at an example of a hermetic drawing. In Figure 6 the famous alchemist Cagliostro is discussing with the legendary rabbi Abraham Eleazar. We know that the discussion is about Opus Magnum, the making of gold, because of the symbolism. In the middle down the bathing king suggest that we dilute some gold. The fire tells us to apply heat to the bottle. The two dragons are naturally mercury and sulphur. Up left is flying the philosopher's mercury acting as an escalator to the process. The moon and sun to the right usually mean mercury and sulphur. The mountain with a walled city is naturally the new Jerusalem. The girl can only be Sofia with two books: the exoteric knowledge and the esoteric knowledge. Naturally, deciphering this picture was unusually easy as it was created by the author. For instance, we know that the character to the left is Cagliostro because the drawing is modelled after Loutherbourg's caricature of the alchemic (see [4], p. 176), Rabbi Eleazar and most of the symbolism are from [3].

Usually we unfortunately must admit that the symbolism is so difficult to decipher that the method has no practical military value as a cryptographic technique, but if cryptography in the future ends up into difficulties with quantum computers, we may have to revisit these old ideas.

Figure 6. Alchemist Count Cagliostro discusses the details of Opus Magnum with Rabbi Abraham Eleazar. Notice the use of symbolic drawing for hiding the exact meaning from outsiders. The key must be recovered by the receiver.

8. For some other technical purposes

We promised a complete classification of the usages of drawing in technical research. The Chinese way of complete classification suggests adding a placeholder for all other purposes. There naturally are many technical applications of drawing which have not been touched. One of them is drawing techniques: it is techniques, isn't it.

Figure 7. The author discusses Leonardo's drawing techniques with the infant St. John the Baptist and the angel. No military applications to this picture are known.

9. References:

[1] Carlo Pedretti, Leonardo Art and Science, Giunti Gruppo Editoriale, Florence, 2000. TAJ Books, 2005.
[2] Michael White, Leonardo the first scientist, Abacus, 2000.
[3] Alexander Roob, The Hermetic Museum, Alchemy and Mystism, Taschen, 1996.
[4] Iain McCalman, Alchemik, Cagliostro – ostatni mag Europy, HarperCollins, 2003, Polish edition, Bellona, Warszawa, 2005.