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THE EFFICIENCY OF COUNTER-ATTACKS AND FASTBREAK SYSTEMS IN MODERN HANDBALL

Hungarian Men's Division 1 Championship Play-off, Top Tier, 2011-12
Men's Champions League Final Four, Cologne, 2012
London Olympic Games, Men's Tournament, 2012

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I. ABSTRACT

INTRODUCTION – In order to point out certain strategic and tactical principles in handball, it is important to have a thorough knowledge of international tournaments, and to analyse the characteristics of these events. Detailed and accurate professional analyses are needed if we want to become acquainted with the various strategies and to determine the main trends followed and applied by the majority of teams, not only in general but also with regards to counter-attacks and fastbreak systems. *Thus we can observe how many goals are scored from counter-attacks and fastbreaks, taking into consideration the total number of attacks. We can also find which forms of fastbreak prove to be the most efficient and how many passes are usually needed to complete successfully these offences.*

METHODS – To determine the strategies applied by various teams, I have set certain hypotheses. I have analysed the video recordings of several matches, making detailed statistics. Then I summarized and interpreted the data and finally found the answers to my hypotheses. The results of the statistical analyses confirm some clear and accurate principles.

RESULTS – Having analysed the matches I have found which fastbreak systems are mostly preferred, how many goals are resulted from counter-attacks and fastbreaks, and how many passes are needed to most efficiently complete a fastbreak.

KEYWORDS: statistical analysis, extended fastbreak by maintaining moving direction, by changing position, double pivot formation, by combined movements

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PART I: INTRODUCTION

Chapter 1: Introduction

Handball is a dynamic and exciting team game with a constant alternation of attack and defence, resulting in spectacular shots on goal and breathtaking saves.
But where does this beautiful game come from and how did its rules develop? Who and how many players played it before its present form and rules took shape?
These questions are the first to arise to which we must find an answer. After all, how can we evaluate anything if we only know its present? Everything that has a present can only be understood totally and evaluated through its past.

This is also the key to the emerging future. This provides us with the bases to come to conclusions about future tendencies. Certainly, these tendencies are impossible to be determined with total security, yet we must keep the ability to change and to be changed in ourselves in order to promote development. If our ancestors, after all, had not possessed these abilities, if they had only been playing handball in accordance with the already determined rules – without being open to take into consideration any new practical requirements –, well then the game would certainly have already vanished in the haze of the past.

It is possible that handball will once only be history for future generations who will be smiling at this „ancient" ball game. Let us learn from our past and be aware that we are part of a process with demands of change and we are the ones to carry out these changes.

Chapter 2: A brief history of handball

If we go through the origins and history of handball, we can see that the game has come a long way of development, resulting in the court of 20 by 40 metres and two teams of 7 players each who are involved in physical contact with the purpose of getting the ball into the opponent's goal. Handball has by now developed into a universal and entertaing game which satisfies the demands of modern man.

Handball is based on the same basic forms of movement – jumping, running and throwing –, which were indispensable for our ancient ancestors to sustain their lives. It happened in the era of antiquity that the first organized games emerged whose purpose was to pass and catch a ball precisely and to get it behind a line. We must mention Homer who, in his famous epic poem *Odyssey*, refers to a certain ball game called „urania".

In the Middle Ages, noblemen already built so-called ball houses which provided home to, among others, some primitive forms of handball. These were, however, just the first attempts to create a new game.

In the Modern Era, a spectacular development of the game began. The reason for this was that many considered football too rough and „shoe-consuming", but gymnastics still required some playful supplementary activity which contains loosening and skill-improving elements.

In most recent times, around the turn of the 19th and 20th centuries, three very similar hand-played ball games were created in three distinct regions. *Hazena* (Vaclav Karas, Kristof Antonin) made its debut in Prague, *haandbold* (Holger Nilson) is linked with the name of a Danish school master, and last but not least *torball* which was developed in Germany.

These three games can be considered as the real forerunners of present-day handball. Their rules, however, differed significantly from the ones known today. If we just have a quick look, for example, at the rules regarding the goalkeeper, we can see that the dimensions of the goal and the goal-area, as well as the goalkeeper's possibilities to move around the court were all different from the present ones.

It is interesting, though, that the Czech game *hazena* was so popular and wide-spread in Bohemia – and later in Czechoslovakia – that it had been played right until the end of the 20th century (until the time when Czechoslovakia ceased to exist) parallel with modern handball.

In Hungary the game was introduced in 1921, when Dückstein Zoltán translated the rules of handball played on a large field and the game became known in Hungary as „palmball". In those days the game was played outdoors, on a football field, with 11 players in each team. The rules concerning the goal and the goalkeeper have changed a great deal since those days. The first games of hazena in Hungary were organized by Szalay József, gymnastics trainer of VAC, in 1921.

The international spread and the growing popularity of handball were best proved by the fact that it appeared in the programme of the Berlin Olympic Games in 1936. As for us Hungarians, our national team – being favourite of the tournament – won the first Women's World Championship, held in Budapest in 1949. During those decades, however, both forms of handball still existed in great rivalry: the one played on a large (football) field and the other one played on a smaller court. In the 1940s, those in favour of the smaller court tried to find stronger and stronger arguments to tempt players and spectators to the game which was played on the small court, and was therefore faster and more enjoyable.

One of their arguments was the fact that the smaller court is easier to build and its possible usage does not depend on the footballers' to use it. It is also possible to create a new and more interesting repertoire of tactics, since the court is smaller and the game is faster and more dynamic. Things came to a head in 1953, after which year players were not allowed any more to play in both championships. They had to decide either to play the well-tried (football) field version or to transfer to the new trend.

The results were definitely in favour of the small court version, as there played only 24 adult teams on the field as opposed to 642 teams in the small court championship. As times passed, this difference became even more favourable for the latter version of the game. The days of field handball were therefore numbered.

To avoid the play being too scrutable and recognizable, and also to meet the requirements of modern times, rules are changing continuously. One can easily notice the technical and tactical development. Conditions are better and better and the game involves an ever-widening spectre of movements. All this results in a previously unexpected spread and popularity of handball.

Not wanting to express a subjective opinion on the matter, let us simply put down the fact: the goalkeeper has always been an integral part of the team. Standing in front of the goal, and being the last line of defence, has always been expected an outstanding performance.

To put it in a legal term, the goalkeeper is obliged to succeed. This obligation never changes, it cannot be worn out. The instructions given by present-day coaches are the same as in the old days: make as many saves as possible. Although the methods, forms and techniques of saving change, the main point still remains the same: DO NOT LET THE OPPONENT SCORE A GOAL!

Chapter 3: Curriculum Vitae

I have known and learned about handball for a very long time, practically since I was born, as the game has long traditions in my family. My grandfather used to play for the national team in field handball, while my father has played for several teams in Romanian first division and also for the national team.

I began to attend trainings during the first years of primary school in Székelyudvarhely, Romania, and with the team of the local sports school I had several good results during our primary and secondary school years. At the age of 15, I played in the senior team of Technoutilaj in the first division, then I continued my playing career in Cluj. I spent those years studying Physical Education and Sports at Babes Bólyai University, where I graduated in summer 2002. After university, I moved to Orosháza, Hungary where I started my coaching career with the youth teams of different age groups of Every Day KSE, and parallel I was teaching Physical Education for 4 years in Táncsics Mihály Secondary School. After a year off I returned to play for Every Day KSE. Coaching the youth team, we had several achievements: 3 gold medals in the tournaments called „students' olympics", a national championship title, 4th place in the youth championship, and 6th place in the World Handball Games for Students.

In 2004 I was invited to coach the men's team of Orosháza in Division 1B. Then in July 2006, I had the privilege to take the position of head coach for the Division 1 team of Erste Békési FKC. In the 2006-7 national championship we finished at 6th place, then in 2007-8 the team reached 5th place which enabled us to enter an international cup series.

The summer of 2008 brought along a great change. I accepted the invitation of the reputable DVSC women's team. In 2008-9 the team finished 3rd in the national championship and 2nd in the national cup series, thus winning medals for the club again after a 13-year pause.

In 2009-10 I left Debrecen and returned to a men's team: I became head coach with Csurgó KK in the first division in summer 2010. The team finished 6th in Division 1 in 2010-11 and 4th in 2011-12.

A significant and determining element of my coaching philosophy is playing fast, with all its beauty and secrets. That is why I have chosen the exciting topic of the efficiency of counter-attacks and fastbreaks.

Chapter 4: Hypothesis

1. In this thesis I am searching the answer to the following question: considering the number of attacks, how many percent of goals are the result of counter-attacks and fastbreaks?

2. In terms of efficiency, is there any difference between the various systems of fastbreak (extended fastbreak by maintaining moving direction, by changing position, with combined movements, or transferring to a double pivot formation)? How many passes are usually needed to successfully complete a counter-attack or a fastbreak?

PART II: ON COUNTER-ATTACKS

In the world of top sport, those sports will survive which are interesting, exciting and attract spectators' attention. We can say handball is one of these sports, since the game is spiced with numerous sudden changes, spectacular elements and excitement right until the very last moments of a match. The fight and the pace set by the teams and the individual players ensure that spectators are not bored. The rules of the game and the competition systems also support a faster game, thus the teams, players and coaches are better prepared than ever before. One must be able to bear the great pace and its risks, as spectacle and excitement are the elements that make both spectators and the media be interested in handball matches.

One of the most striking elements of playing fast is the attack against a disordered defence which is more advantageous for the attacking team, because it is easier to score against defences which fail to regain their positions properly and in time. This results in a growing number of attacks and goals, but faults and errors are also more common. Playing faster must not mean a decline of standards and effeciency.

A fast counter-attack is one of the most important and spectacular elements of attacking tactics and of the entire game. A prerequisite for this is an efficient and successful defence, the maint points of which are defending in an offensive way, narrowing the area and the chances of the attacking team, and trying to gain the ball. Following a turnover, the first task of the defending team is organizing and carrying out a counter-attack or a fastbreak.

This activity is divided into various phases:

- the opponent loses the ball
- technical fault
- the defending team gains the ball (by snatching, blocking, or rolling the ball out of the opponent's hand)
- the goalkeeper retains the ball after saving
- the ball gets back into the midfield from the goal posts or from the goalkeeper and the defending team gains it
- the opposing team is slow in retreating to defence
- the opposing team substitutes one or more players at an improper pace
- the player who falls to the ground after shooting or after getting injured fails to regain his position in defence.

A counter-attack or a fastbreak needs to be carried out quickly and accurately, as in the modern form of the game teams try their best to retreat to defence quickly and efficiently, this way trying to prevent getting „easy" goals. Therefore the main aim of the counter-attacking team is to get through the middle section of the court successfully and as fast as possible, thus to create a good chance to score and to complete the attack by scoring a goal.

The various forms of counter-attack are as follows:

- Individualfastbreak – to have a dynamic and position advantage
- Extended fastbreak, a counter-attack involving several players – to outnumber the opponent's defence
- Extended fastbreak involving the whole team – to attack on a disordered defence.

Chapter 1: Individual fastbreak

It is the fastest individual chance to score a goal. The player sets out more quickly and dynamically – using their shorter reaction time, more favourable position, better individual qualities and speed –, so after gaining the ball they can shoot on goal clearly from an advantageous position.

The timing and methods of an individual fastbreak are determined by the teams' and coaches' own philosophy. Some take the safer option, that is the player can only set out when their team is already in possession of the ball, turning special attention to gaining the rebounds from the goal posts or the goalkeeper, and involving in the action the wing players, too. For tactical reasons the wing players can set out earlier, that is at the moment of an offense player's shot, and thus have an advantage to score a goal in a counter-attack.

We can distinguish three different forms of individual fastbreak, depending on the player's position at the time of starting the attack:

- direct fastbreak
- indirect fastbreak
- self-fastbreak.

In the case of a direct fastbreak, the player gets the ball directly from the team-mate who had taken it from an opponent or had intercepted it, be it either a field player or the goalkeeper. In this case there are no preliminary passes.

The player who gains the ball should pass as fast as possible to the team-mate who is in the best position, since that player has an advantage not only over the opponents but also over their own team-mates.

In the case of an indirect fastbreak, the ball arrives from a different player than the one who had intercepted it. In such cases there emerges a pace difference because of more than one passes (the intercepting player is being obstructed, so he can only make a short pass).

The advantage of an indirect fastbreak is that passes are shorter and more accurate, and the turning player gets the ball from a better angle, so he can catch it more safely.

In the case of a self-fastbreak, the player who intercepted the ball gives himself a high release pass from which he shoots on goal directly. This can on the one hand be advantageous because a player can run faster without the ball, but also risky as the ball must be released really accurately and at the right curve to make the self-pass efficient.

A self-fastbreak is performed individually, but the player should always be prepared to pass if it is required by the playing situation.

Chapter 2: Extended fastbreak involving several players

Having gained the ball, several players start an offence move against the retreating defenders, with the aim of outnumbering the opponent and thus to complete the attack quickly and successfully from the most advantageous position.

It is essential to pull apart the opponent's defence towards the sidelines in order to force them to defend a larger area. It is also important for the attackers to be divided in depth and width, to change positions with and without the ball, to run in either from the ball's side or from the opposing side, and for the attackers to arrive in various waves and at the right time to the areas where they have a great chance to score a goal.

This form of fastbreak requires a good recognition and assessment of the situation, as well as a systematic and coordinated performance. Players must attentively watch their team-mates' and the opponents' positions and movements.
Considering all this, we can differenciate various fastbreak systems: **EXTENDED FASTBREAK BY MAINTAINING MOVING DIRECTION, BY CHANGING POSITION, RUNNING IN BY CHANGING POSITIONS, TRANSFERRING TO A DOUBLE PIVOT SYSTEM, EXTENDED FASTBREAK WITH COMBINED MOVEMENTS**.

Extended fastbreak by maintaining moving direction: all attacking players advance in accordance with their positions in defence, but at different time and pace.
Advantages: running forward in a straight line is the fastest, and there are no cross movements or position changes which could slow down the players and delay the ending of the attack.
Disadvantage: players can only move within a determined and relatively small area.

Extended fastbreak by changing position: players can leave their respective moving directions by making crosses and position changes, thus forcing the defenders to commit switching faults.

Advantage: applying a set and well-prepared system, the attackers can force the defenders to group in a certain, relatively small area, thus they are obliged to make quick changing movements, which will make the defence disorganized and vulnerable.

Disadvantages: applying a set system, there is less room for creativity and spontaneous decisions. Cross movements and position changes slow down the offence.

Running in by changing positions, transferring to a double pivot system: a system not treated in technical literature, yet according to my coaching experience and video analyses, this kind of fastbreak is utilized more and more frequently. The so-called defence specialist players have an important part in the development and application of this system, because in this way teams do not need to substitute too often: too many substitutions can slow down the offence. This form of fastbreak can be carried out either by maintaining moving directions or by changing position. The point is that it involves running in from either side (the ball's side or the opposing one), before or after passing, and so the attacking team transfers to a double pivot system.

Advantages: the attacking team makes good use of the empty areas behind the defence. The defenders' attention is divided as they are supposed to watch behind their backs, too. If the running-in happens with the right timing and from the right area, it can be very dangerous and efficient.

Disadvantages: defenders can block the passes to the pivots. Play can be squeezed into a too small area, therefore it is essential to maintain good contact with team-mates.

Extended fastbreak with combined movements: during the fastbreak there is a combination of movements of various fastbreak systems.

Advantage: it is hard for the defence to anticipate and to follow it, because actions happen in an unexpected way.

Disadvantage: it requires great tactical discipline, therefore can only be applied efficiently by teams with good harmony.

An extended fastbreak involving a group of players is a form of attack which only a few players take part in, but their number can be extended, therefore it is a kind of transitional system.

A counter-attack enables the attacking team to create a clear scoring chance, because it involves the opportunity of a numerous superior situation which is hard to anticipate for the defence. It also hides numerous potential faults, therefore requires a lot of preparation and extensive practice during trainings.

Chapter 3: Extended fastbreak involving the whole team

When a team cannot complete a counter-attack in an individual or in a group form, they can still put pressure on the defence by further offensive waves catching up, and exploiting the time while the defending team carries out its substitutions. In this case the attackers switch to a system which involves all players.

The defending players still have not regained their set defence positions, they have to carry out defending tasks which are not absolutely suitable for them, so the attack should possibly be completed relatively fast. If the offence should stop shortly or is indecisive, the defence will find time to organize themselves.

This form of attack puts an emphasis on players' ability to improvize, to anticipate the situation and to make decisions.

The defending team can be forced to commit faults and errors by passes, position changes, running-ins and direction changes. The second and the third waves can complete the attack with a breakthrough or a through shot, respectively.

All players take part in this form of attack, in a direct or an indirect way. It is usually carried out in an organized way, therefore it is a certain transition between counter-attacks and organized offence formations.

Chapter 4: Improvement of the rules of the game

Modifications of the rules of the game always intend to serve the interests of handball, since playing fast and applying exciting and spectacular actions are

attractive to spectators. That is why recent modifications aimed at speeding up the game. It is enough just to mention a few rules to see this statement proved.

Right from the moment of gaining the ball the team is entitled to commence an attack the in fastest possible way. When the ball gets out of the court across the base line, it is enough for the goalkeeper to step into the goal area with one foot only, and can immediately pass to a team-mate. It enables the team to create a really fast chance to score.

A slippery surface is always dangerous and can cause injuries, that is why there are frequent halts in a match for wiping the floor. According to new rules, however, when the game continues in the opposing direction, the referees are allowed to let it go on while wiping the floor can happen simultaneously, without having to halt the game unnecessarily.

Another significant modification is advantage rule in the case when a player remains on the ground after a fall so that the scoring chance can be completed, and just after that come in the medical team to tend to the injured player.

The rule modifications mentioned above are good examples of the tendencies which have already resulted in handball becoming one of the most spectacular and rapidly developing sports.

Chapter 5: The role of the fast throw-off

The introduction of the fast throw-off rule provides teams with a new great opportunity to score fast goals. As a result, coaches have created new tactical variations concerning the fast throw-off. Since then, matches have been characterized by more attacks and more goals, but at the same time players suffer greater burdens as they have no time for a slow retreat to defence, not even after scoring a goal.

Teams with smaller physical parameters (Korea, Iran etc.) have become more successful, as they can take more advantage of their speed even after the opponent has scored a goal.

Substitutions from attack to defence must be completed faster and more accurately, because teams have a double aim with the fast throw-off: their main aim is to score a fast goal. If they fail to make it, they try to prevent substitutions so the

opponent's weaker defence players are forced to stay in, therefore the attacking team has a chance for a more efficient position play.

Chapter 6: The improvement of retreating to defence

Playing faster results in a higher number of attacks and more chances to score easy goals, which greatly influence the outcome of matches. Teams which score more goals after fastbreaks, counter-attacks and fast throw-offs are in a better and easier position, since they achieve to play less time against a set and organized defence. That is why retreating to defence had to be modified and improved, as the prevention of fast attacks has gained major importance. A few years ago, 30-35% of attacks resulted from fastbreaks and counter-attacks, whereas the improvement of pulling back to defence has reduced this number to 20-25% by now.

All this proves that teams and coaches alike are well aware of the importance of fast and efficient retreat to defence, as preventing the opponent from playing fast is a really significant part of being successful. Thus practising to retreat to defence and to substitute in a more organized and accurate way have become a more important element of trainings, in order to give creative opponents less chance to exploit their opponent's failures.

PART III: THE EFFECTS OF FASTBREAKS AND COUNTER-ATTACKS ON OFFENSIVE PLAY

Counter-attacks and the various systems of fastbreak are a must in every team's repertoire. In order to put them into practice efficiently, it is indispensable to have good basic skills.

These forms of attack must be drilled and practised a lot if we want to carry them out well. In modern handball every team applies counter-attacks and fastbreaks which has an effect on offensive play:

- players can get accustomed to playing fast and dynamically
- a more offensive defence is required
- due to playing fast, players are in better physical condition

- players are better both technically and tactically, thus they can play on a higher level
- teams whose physical conditions and shooting power are weaker (e.g. South Korea), can still play more efficiently
- scoring easy goals after fastbreaks and counter-attacks can mentally inspire the players and demoralize the opponent
- they can weaken the opponent's offensive play
- they are spectacular and attractive elements of the game.

PART IV: THE GENERAL ASPECTS OF COUNTER-ATTACKS AND FASTBREAKS

There are some basic principles that must be considered in the case of counter-attacks and fastbreaks:

- one must always watch the path of the ball and the defenders' movements
- one must also watch the fastbreaking players' positions, movements and running directions
- to take advantage of the above, one needs speed, a quick recognition of the situation, individual tactics, the ability to make decisions and to deceive the defenders
- we must try to hold up the retreating defenders
- we should reduce the chances of errors and the defenders' opportunities to intercept, therefore we must be careful about unnecessary feints, dribbles, passes and jumps
- too frequent and too fast counter-attacks and fastbreaks should not turn into committing too many errors and faults
- as we learn to speed up the play, we should also learn and feel when to slow it down or even stop at the right moment, in order to avoid needless risks.

PART V: THE ROLE OF THE GOALKEEPER IN COUNTER-ATTACKS AND FASTBREAKS

The goalkeeper's task is not completed by simply saving, since the basis of counter-attacks and fastbreaks lies in taking possession of the ball. The goalkeeper – being the player with the last chance to gain the ball – has a significant role in it. When saving or after a rebound, they have to make an effort to retain the ball and then to pass it to a team-mate as quickly as possible. This will be, after all, the basis for a quick counter-attack or a fastbreak.

Once the ball is gained, it can get back into play either by a long-range pass (a direct fastbreak by the goalkeeper) or by a pass of varying range (a goal throw) the length and direction of which is determined by the current game situation.

In a direct fastbreak, the goalkeeper gives his team-mate either a long-range release pass or a shot pass. It is indispensable that the goalkeeper take good account of the situation and have good shooting power and technique. He should also watch the position of the retreating opponents, the substitutes coming from the bench, the opposing goalkeeper's movements, and he has to find the team-mate who is in the best possible position. Based on all this, there are several occasions when a goalkeeper scores a goal.

The direction, position and length of a goal throw all do depend on the game situation right after gaining the ball and also on the position of the retreating defenders.

Tactical instructions can also determine the conditions of a goal throw, because there are set positions in the case of pre-practised fastbreaks. There can also be certain players in a team whose set task is to bring up the ball, and if there is no direct fastbreak, these players should get the passes from the goalkeeper.

A good goalkeeper is the one who realises the significance of playing fast, always finds the team-mate in the best position, and this way can greatly contribute to the completion of quick and efficient counter-attacks and fastbreaks.

PART VI: THE SUBJECT OF THIS STUDY

Hungarian Men's Division 1 Championship Play-off, Top Tier, 2011-12
Men's Champions League Final Four, Cologne, 2012
London Olympic Games, Men's Tournament, 2012

Chapter 1: Means and methods of the study

I have analysed the video recordings of the matches, using statistical charts. The charts contain the types of counter-attacks and fastbreaks, the number of passes, the finishing positions (per half and per match), the number of attacks and goals, and also the number of faults and tackled fastbreaks.

Chapter 2: Study guidelines

I have analysed the video recordings of the matches (Hungarian Men's Division I Championship Play-off, Top Tier 2011-12, Men's Champions League Final Four 2011-12, London Olympic Games, Men's Tournament 2012) considering the following aspects:

I have created five groups:
1. Counter-attacks
2. Fastbreaks
3. Number of passes
4. Failed attacks (ended without scoring a goal)
5. Summary

I have studied and considered the following aspects:

1. - Direct fastbreaks
   - Indirect fastbreaks

2. Extended fastbreaks:

- by maintaining moving direction
- by changing position
- by position changes with running into second pivot; double pivot system
- with combined movements

3. Number of passes: goal was scored / there was a turnover / play was stopped after 1-2-3-4-5 or more passes

4. Attacks finished without scoring a goal:
    - technical fault
    - fault or stop
    - a 7-metre throw is awarded

5. Summaries:
    - per half
    - per match

PART VII: RESULTS AND DISCUSSION

The analysis of 17 matches has shown very clear and useful details about counter-attacks and fastbreaks, about the systems applied and about the playing philosophy of various teams.

Both in clubs and in national teams, coaches create a certain playing style for their teams, and fastbreak systems form part of these styles. It is influenced by the composition of the team, and by the number of substitutions when switching from defence to attack. Can players who are defence specialists also be applied in offence, and if so, in what positions? It has great importance to find the right game masters who are suitable for the certain tasks, and are creative, fast and decisive enough to make fast play efficient.

The majority of teams, after having gained the ball carry out only one or no substitution, since the success of fastbreaks is mainly decided during the first wave of the attack, when the offence must reach the other half of the court as quickly as possible. This is why coaches intend to bring defence specialist players also into the system of fastbreaks and only substitute for good cause, e.g. when the substitute player plays on the nearer side of the court.

Statistical data show that simple and fast systems are the most efficient which conceal very little or no slowing factor at all, like cross movements or changeovers.

- During the **17** matches studied, there were **1804** offense actions – **106** per match on average –, which is less than the usual **120-130** attacks per match in recent times. There are several reasons for this difference. Firstly, all teams are trying to play with the fewest errors possible, they pay special attention to the efficient completion of their attacks, and do not take unnecessary risks. This is especially true during the endgame, when each ball, each decision has increased significance. In that period of the match, most teams take the more secure options, or they slow down and apply their pre-practised position play in which they can play more organized attacks. Retreating to defence quickly and effectively has also become and important element of modern handball, so it also plays a significant part in reducing the number of attacks. The players' highly developed capacity of anticipation helps them to retreat to defence properly and to slow down the opponent's play.

  The time and place of the matches within the season is also a significant and influential factor, because the Champions League finals and the Olympic Games take place after the national championships have ended, and by that time players are already really tired and exploited. Certainly, the opportunity of success is a motivating factor, but it still cannot compensate for all the exhaustion.

  We must also differenciate between clubs and national teams. It is a well-known fact that club teams can train and practise together much more,

therefore harmony between their players during the game is bigger and better, and this is indispensable in the case of counter-attacks and fastbreaks.

- In the matches studied, out of **1804** attacks there were **404** counter-attacks or fastbreaks, which constitutes **22.4%** of all attacks. It is an important detail from the aspect of preparation and practice, as players must be able to bear this extra burden during a match. It is noticeable that nearly half of all attempts of counter-attacks and fastbreaks were finished without scoring a goal, due to the reasons mentioned above (faults, taking too much risk, etc.). The aim of every team is to finish these kinds of offence more efficiently, since scoring fast and easy goals can be decisive to the final result of a match.

- Considering the number of **1804** attacks, **203** goals were scored after counter-attacks or fastbreaks, which is **11.25%** of the total. In other words, 1 in 9 such attack is finished successfully. This can also be a motivation for teams to avoid taking unnecessary risk and rather to slow down their play in certain situations, because the 9 to 1 ratio is not really determinig. Nevertheless, this also seems to be deceptive, as we can still see the most successful teams apply fast play frequently and effectively.

- Teams started **404** counter-attacks or fastbreaks, which ended in **203** goals scored. It shows an efficiency of **50.2%**. This may be the area where the greatest improvement can be expected in the future, because now some **50%** (that is 1 in 2) of such attacks fail to result in scoring a goal. Teams must therefore make every effort to improve this ratio. If they are able to reduce it, the standards of handball will be raised, and that will further raise the number of offences and goals.

- Teams attempted **274** scores after counter-attacks or fastbreaks, ending in **203** goals, which means **74%**.

- There were **130** counter-attacks or fastbreaks which did not end in an attempt to score. These attacks were finished with a 7-metre throw awarded, a fault,

or the players simply halting the action because they did not take too much risk. This means that 1 in 3 such action remained unsuccessful for reasons mentioned above. The question that arises here is if coaches urge their players to endeavour more counter-attacks and/or fastbreaks, if there is point in taking more risk in the hope of scoring easier goals. If so, it will raise the probability of commiting errors and faults, thus giving the opposing team chances to get into more advantegous positions and situations.

Chapter 1: The analysis of direct and indirect fastbreaks

These are the fastest and easiest opportunities to score a goal. What is more, they consume relatively little energy and have a destructive and demoralising effect on the opponent. We have seen numerous cases when a team is attacking for minutes inefficiently, hardly finding the chance even to attempt a score on the goal, but then after a fault, the opposing team scores a fast goal within just a few moments and the first team has to start build up their offence again. We must see therefore that the various forms of fastbreak are a really important weapon, and if teams apply them successfully, they can determine the final result of a match.

In most cases, direct or indirect fastbreaks are made possible by a fault on the opponent's part. It can be a technical fault, a fault of handling the ball, an attacking foul, a step fault, or just a missed shot on goal after which the goalkeeper gains the ball. These instances can all present the opportunity for the wingmen to run a counter-attack.

In these cases the wingmen set out early which is based on a high level of anticipation: these players can really „read" the game, can see in advance what is going to happen next, and thus they can create such an advantegous situation in which it is impossible to catch up with them. The pivot is the other kind of player who often score goals after fastbreaks, since one of their tasks is – just as is that of the wingmen – to reach the opponent's goal area as fast as possible after a turnover. This is why in modern handball pivots are very fast and dynamic, because it is a demand for efficient fastbreaks and counter-attacks.

In the matches studied, there were **108** direct fastbreak attempts, out of which **66** resulted in scoring a goal, that is **61%**. There were altogether **91** shots on goal after direct fastbreaks and they scored **66** goals, which means **72.5%**.

17 attempts, however, ended without shooting on goal due to an efficient defence or a missed pass, and it means **15.7%** which is a remarkable number.

During the matches studied there were also numerous indirect fastbreaks. Their number was also decisive considering the end results of the matches. Backcourt players are at least as good as goalkeepers in starting a fastbreak or a counter-attack with an accurate pass, what is more, they often have to pass accurately while running fast or surrounded by opponent players.

1/a

1/b

1/c

Pictures 1/a – 1/c are from the match **Sweden vs. Iceland** at the London Olympics. During this fastbreak, Iceland player Olafur Steffanson gives a long pass from his own half of the court to the left wing.

Out of the **36** indirect fastbreaks **23** goals were scored (**63.8%**) and **6** times the attacking team did not manage to shoot on goal. **28** shots resulted in **23** goals scored (**82%**), which we can say is a good result.

During the **17** matches teams attempted **144** counter-attacks, which ended in **119** shots and finally **89** goals scored. These numbers indicate that on average every **1.6** attempts result in scoring a goal, that is **38.2%** of counter-attacks turn out to be unsuccessful. This is a proof of the phenomenon that teams take more and more care of efficient turnover play, that they make a special effort to prevent the opponent from creating fast and easy opportunities to score. If successful fastbreaks and counter-attacks are able to determine the final result of a match, we can say that retreating to defence efficiently is also an indispensable and decisive factor of winning really important matches.

2/a


M1
HD ÉLŐ
HUN 4
SWE 5
11:56 1ST
London 2012

2/b


M1
HD ÉLŐ
HUN 4
SWE 5
11:58 1ST
London 2012

2/c

2/d

Pictures 2/a – 2/d, from **Hungary vs. Sweden** at the London Olympic Games.

We can see in these pictures that an indirect fastbreak is successfully held up by the dive of a Swedish player while their defence is retreating. This also proves the significance of a quick and efficient turnover play.

Chapter 2: An analysis of fastbreak systems

Extended fastbreak with combined movements:

This is the least utilized, very rarely applied form of fastbreak, which is well shown by the fact that during the **17** matches studied, not more than **8** such attempts were made, resulting in **4** goals scored. In this case, the **50%** efficiency index is irrelevant, as the total number of attempts is very small. Following this type of fastbreak, there were 6 shots, and 4 goals, which means **66.6%**.

These numbers indicate that the numerous running-ins and position changes not only reduce the chances to score but also make it more likely to commit faults, therefore teams tend to leave out this form of fastbreak. Having analysed the video clips, we have the impression that these very few instances happen spontaneously rather than being well practised actions, because after changing positions there follows a running-in, or cross movement if it is a double pivot system.

3/a

3/b


KIE 10
ATM 9
VELUX

3/c


KIE 10
ATM 9
VELUX
Win an action holiday
adidas

3/d

3/e

In pictures 3/a – 3/e we can see moments from the Final Four final **Kiel vs. Atletico Madrid**. They show that the three inner attackers of Kiel, having gained the ball, run up wide, along the two sidelines, as well as in the middle, along the longitudinal axis of the court. After that, a changing of positions takes place, starting from the left hand side and focusing on the centre of defence.

With their cross movement they put pressure on the two inside defenders. Then the right back arriving across passes wide, thus opening space for the left back and the pivots. We can also notice that after preparing the action, the back does not

stay in the middle but runs into second pivot position.So the play is not sqeezed in a small area and the defnders are forced to switch.

4/a

4/b

4/c

4/d

4/e

4/f

4/g

In pictures 4/a – 4/g above you can see some moments from **Sweden vs. Iceland** at the London Olympic Games which illustrate a combined form of fastbreak on the part of Sweden.

The action is started by the right back, behind the Icelandic defender. The centre starts to the pass with a cross movement at the back, but the right second passes the ball back to the right back, thus forcing the defenders to do counter movements. The reaction of the attackers is a running-in with good timing and another change of sides. This way a large space opens on the opposing side where the attackers now have a 3 to 2 numerical advantage.

Another key element of the action is the right speed of the ball and the 6 passes completed by the attackers which was already too much for the defence to follow.

Extended fastbreak by changing position:

This is also a less utilized fastbreak system. In the matches concerned, there were **33** instances when the players in the second and third wave started with changing positions. **12** of them ended in scoring goals, which means an efficiency of **36.3%**.

Following these actions there happened **14** shots, resulting in the **12** goals mentioned (**85.7%**). The other **19** attempts ended in a fault or an error, which is a

remarkable number in this system, meaning that nearly 1 in 2 such actions was broken by a fault or a turnover. The position changes and the cross movements are rather risky, since the defenders with enough anticipation can hinder the attackers' movements, thus making the attackers commit mistakes. The cross movements and position changes are slower than running forward from the defence line, so the defenders will have more time to take their positions and to organize themselves. A great harmony is needed on the attackers' part because team-mates are moving from and to various directions which movements must be seen and perceived. In many cases there are movements parallel to the goal line, which means no threat and is favourable to the defence, since with good anticipation they can force the attackers to miss a pass.

This system is hardly ever applied by national teams, probably because of the lack of enough practice opportunities. If a team intends to utilize this system properly, they need to invest a lot of time in practising it. This is why it it usually applied by club teams – like THW Kiel –, but only in the last phase of the fastbreak when the attackerrs have already occupied the defence area between the 6-metre line and the 9-metre line. In this phase attackers can already change positions in different directions more safely, in order to make the defence more unstable and to force them to switch. Defenders are more likely to commit faults and errors because they should perform in a very much organized and harmonious way, while in this phase several defenders are still retreating and probably have not yet been able to take their set defence positions. Thus the attackers, using the right dynamics and making accurate position changes, are able to create situations of man superiority or opportunities of scoring a goal.

5/a

5/b

5/c


SZEGED, TISZA LAJOS KRT.
02:04
SZE 1
VES 0
PICK
MMBF
FERRO-EP
NOVOSEC
TOYOTA

5/d


02:05
SZE 1
VES 0
PICK
TISZA PALOTA
MMBF
FERRO-EP
NOVOSEC

5/e

5/f

Pictures 5/a – 5/f are from the Hungarian National Championship final **Pick Szeged vs. MKB Veszprém**. In these cuts one can very well see the situation of numerical superiority created by the dynamic and accurate position changes. After bringing up the ball, changing positions starts from the left back, thus moving the focus to the right hand side with a cross movement (hosszú feladásban), leaving out the arriving back and rather passing to the wing running inwards. The wing then attacks the area between the second and third defender, then passes across to the left where there is a man advantage and so the wing can complete the attack.

Extended fastbreak by changing positions, double pivot formation:

It is the second most frequently used fastbreak system. Out of **37** such attempts teams scored **17** goals (**45.9%**), and the **17** goals were the result of **21** shots on goal (**80.9%**).

In this system one can notice clear tactics and strategy, because it is usually the teams with defence specialist players which apply this form of fastbreak. It is an important tactical factor if substitutions take place on the further or the nearer side. The majority of teams substitute only one player on the nearer side, since that is what they have time for before getting the ball into play.

In most cases these defence specialists are pivots or can best be applied in the pivot's position, which is a good reason why coaches opt for switching to a double pivot system during a fastbreak (Berlin). Thus they can avoid losing time with substitutions.

Having analysed the matches we found that teams which generally apply more open defence formations are more likely to use the system of running into second pivot position, but in this case the forward defender remains in the pivot's position after fastbreak. This happens probably because the forward defender, due to his position, can set out from the best possible situation and therefore he is the fastest to reach the opponent's gol area (Sweden).

In these playing systems the various strategic options have special significance, which options are applied by different teams along different principles. The repertoire of these options include the following: positioning the pivots closer or further to each other; the wingmen's ability to co-operate with the pivot; and also, if a team plays fastbreaks without its wings, to ensure that the backs gain enough space and that they have the right contact with the pivots.

6/a

6/b

6/c

6/d

6/e

Pictures 6/a – 6/e show moments of a fastbreak during the Final Four match **Berlin vs. Kiel**. In these pictures one can clearly notice the double pivot fastbreak tactics of the Berlin team: in defensive play the left wing is substituted by a pivot, because the two inside defenders are the basic pillars of the fastbreak. We can also see that in this system they carry out only one substitution after a turnover, bringing in a back onto the nearer side, while one of the two pivots is positioned between the first and second defenders and the other in the centre of the defence line. The fastbreak is organized and completed without the left wing. The action is started from the left back's position, where the pivot and the back created the opportunity for scoring a goal, exploiting their dynamic and physical advantage against the defending wingman.

7/a

7/b

7/c

7/d

7/e

7/f

7/g

Pictures 7/a – 7/g illustrate the double pivot tactics applied by **Sweden** starting from an open defence during their match against **Iceland** at the London Olympic Games. The role of the forward defender is easily noticeable, as he is the fastest to reach the 6-metre line at the opponent's goal area and right after that arrives the pivot. This system is similar to the one played by the Berlin team, mentioned above: it is the backs who start to build up the offence and there is no player in the left wing's position. The Swedish pivots position themselves relatively far from each other, thus forcing the defenders to cover a larger area. This is a significant element of playing 2 against 2, since it is much more difficult – or even impossible – to successfully defend a larger area, as shown on the match clips.

Extended fastbreak by maintaining positions:

This is the most frequently applied fastbreak system, played significantly more often than other systems. The number of **182** attempts is much higher than any other mentioned so far, it is in fact nearly five times more than the second most frequent double pivot formation (**37** attempts). The **182** offences of this kind resulted in **114** shots and altogether **81** goals scored, which shows an efficiency of **71%**. Naturally, the number of failed attempts is also much higher: **68** attempts ended without a chance to score a goal, which means that fewer than 1 in 3 attacks in this system do

lead to a shot on goal, and that **44.5%** of this form of fastbreaks results in scoring a goal.

The main reason why most teams prefer the extended fastbreaks by maintaining positions is probably that this system contains no slowing factors like changing positions, cross movements or running-ins. What it involves is simply the fastest and most secure form of running: in a straight line. The players run up in determined positions, usually in a relatively wide formation. The first wave to reach the opponent's goal area is the wings and the pivots, followed by the second wave – further divided and bringing up the ball – of the three backs. In the case of well-organized teams one can notice the so-called „funnel-shaped" formation, which means that the wings are positioned in the two corners, the pivot on the 6-metre line, the two backs along the sidelines, while the centre is along the longitudinal axis of the court positioned a little further back than the right and left backs. The aim of this funnel shape is to ensure that each player has their ideal position and that the play can be intensified or slowed down if needed. Using the „funnel-shaped" formation teams manage to gain more space according to their own tactical repertoire.

8

9

Pictures 8 and 9 above well illustrate the „funnel-shaped" formation applied by the offending teams (Croatia and Iceland) which they use to ensure the players' appropriate and ideal positions in this system of extended fastbreak.

10/a

10/b


London 2012
M1
ÉLŐ
CRO 13
HUN 10
3:28 2ND
London 2012

10/c


London 2012
M1
ÉLŐ
CRO 13
HUN 10
3:29 2ND

10/d

10/e

10/f

11/a

11/b

11/c

11/d

Pictures 10/a – 10/f are from **Hungary vs. Croatia**, 11/a – 11/d are from **Iceland vs. Sweden**, both matches at the London Olympic Games.

Iceland and Croatia in most cases start building their offence from the left back's position and base their play on through shots and wavings. These players (Aron Palmarson, Blazenko Lackovic) possess excellent qualities and technical repertoire, a really great jumping and shooting power, an outstanding ability to feint and a perfect contact with the pivot.

It is noticeable in the picture series 10/a – 10/f that the Croatian team create a man advantage situation on the right hand side of the offence, starting with a waving from the left back's position, and thus they successfully complete their attack with a shot from the wing. It is important to stress the role of the centre-back who, with his jumping puts pressure on the defence and thus gains time to take the right decision. He can perceive the far left defender's movement towards the right back, intending to snatch the ball, and therefore the centre gives a long pass to the wing instead.

The pictures 11/a – 11/d show the build-up of a chance to score by Iceland, the key element of which is the offensive blocking of the pivot. The back who is arriving in the centre of the offence with an enormous dynamic advantage gets a pass from the left back and scores a goal from a jump shot.

In both cases, the significant role of the playmakers is evident, as they are the ones who organize and build up the successful offences, and also determine the character of the team's play and that of the fastbreaks. The question is if there is a suitable player for this task in the defence, and where and what role can such a player have in the defence who will then be the key of the fastbreaks. There are teams in which this task is carried out by a player in the wing's position. In the ideal case, a player who is also good at defence can perform this important task in the fastbreak.

In the cases mentioned above, the teams were playing with equal number of players, and in such circumstances managed to create situations of numerical superiority or a good chance to score, thanks to proper organization and preparations.

Nevertheless, it happens in countless occasions during a match that an attacking player fails to retreat to defence, or does it with great delay for various reasons, e.g. slips out of the court after shooting, suffers a minor injury, commits a tactical fault which leads to a disadvantageous position, argues with the referee, etc. Any of these instances can result in a situation in which the fastbreaking attackers can easily outnumber the defence. In such a case the central part of the offence is from where the action is being controlled and organized, the player who brings up the ball attacks the centre of the defence, keeps it under constant pressure and then passes to the side where they manage to create a situation of numerical superiority.

12/a

12/b

12/c

12/d

Pictures 12/a – 12/d – taken from **Iceland vs. Sweden** at the London Olympic Games – show a good example of the above mentioned situation of outnumbering the defence by a fastbreak. In this case the centre back attacks the centre of the defence with dribbling, then taking advantage of the lack of the defender who fails to regain his position in time, easily passes to the side where they manage to outnumber the defence, and thus the wingman has a chance to score a goal

Chapter 3: The efficiency of fastbreaks with regards to the number of passes

In this thesis, when I analyse the handball matches mentioned above, I put great emphasis on the number of passes during a fastbreak because in my opinion it is a key element of efficiency and success. For this reason, I have designed the statistical charts in a way that they indicate these important data. Thus one can also read out from the statistics if there is any difference in the number of successfully completed fastbreaks within the certain systems in terms of the number of passes.

According to the analysis of the matches, the majority of the successfully completed needed **2** to **4** passes. When more passes were made, much less goals were scored at the end of the offence.

In fastbreak situations there were **155** scoring attempts, out of which **125** attempts involved **2** to **4** passes, and in no more than **30** cases was the number of passes over 4 or less that 2.

The pictures taken from match videos clearly prove and support the hypothesis that teams tend not to take too much risk in tense or insecure situations, especially during the endgame or in case of a close score. If they seem to be unable to complete the fastbreak quickly and successfully, teams rarely opt for a longer and more complicated fastbreak system which would involve too many passes, but they rather switch to a more secure position play. The reason for this is that more passes mean more chances of errors and faults, since the defenders have more time to take their appropriate positions, or even to slow down the offence, to snatch the ball, or to commit a fault.

Answer to the hypothesis:

1. The analysis of the matches shows that in modern handball **11.25%** of goals are scored after a fastbreak or a counter-attack. During the **17** matches studied there were altogether **1804** attacks, out of which **203** counter-attack or fastbreak goals were scored, that is 1 in 9 goals are scored in these forms of offence play.
2. The numbers reflect and prove that the extended fastbreak by maintaining positions is the most efficient, therefore the most widely used fastbreak system. Out of the **260** fastbreaks **182** (**70%**) were carried out by

maintaining positions. This form of fastbreak was used five times more often than the second most frequent position changing, double pivot system. We also found out from the analyses that the majority of fastbreaks involve **2** to **4** passes: this was the case in **197** fastbreak attempts out of **260**, which means **75.7%**.

PART VIII: CONCLUSIONS

In this thesis I did examine the most beautiful and spectacular elements of modern handball: counter-attacks and fastbreaks. These elements determine all aspects of the game, both efficiency and spectacularity. What contributes to this is the numerous tactical and strategic possibilities and variations which are thoroughly prepared and practised by every team, since both carrying them out and blocking them successfully require great precision and accuracy. Today's modern handball is characterized by great speed and tough fighting, and in these circumstances there is little time to make the right decisions.

The results of the analysis confirm the above fact: in the matches studied, **22.4%** of attacks involved a fastbreak, but only **11.25%** resulted in actually scoring a goal. In this respect both efficiency and spectacularity can and should be improved, since over **10%** of all fastbreak attempts fail to score. That is why it is important to intensify speed and accuracy after a turnover, to aim at finding and making the right decisions. Better timing and concentration are also important because they can help to complete more offences efficiently and successfully.

All these would result in a greater number of offense actions and goals, which could make the game even more fascinating and exciting. The question that arises here is how far, how much more can players be burdened during the trainings and preparations. This is an indispensable element of speeding up the game, and the spectators and fans are ready to take in more spectacle and excitement, but on the other hand we must also care about the players' health. It is true that we must serve the spectators' demands, but we can´t have no team s without healthy and fit players.

Modifications in the rules of the game have always aimed at intensifying the speed, and so it might be in the future, too. New measures and changes can speed up

the game even more, and coaches will always develope strategies to adapt to the new circumstances. This can especially be exciting in the case of counter-attacks and fastbreaks, two aspects of modern handball studied in the present thesis.

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APPENDICES

1. A summarising statistical chart about the matches

	MATCHES																										
		FAST BREAKS SYSTEMS																								COUNT.ATTACK	
	POSITIONS	EXTENDID F.BR. BY MAINTAINING MOVING						CHANGING POSITION						CHANGING POSITIONS, TRANSF. TO A DOUBLE PIVOT SYSTEM						COMBINED MOVEMENTS						DIRECT	INDIRECT
		PASSING NUMBERS						PASSING NUMBERS						PASSING NUMBERS						PASSING NUMBERS							
		1	2	3	4	5	more	1	2	3	4	5	more	1	2	3	4	5	more	1	2	3	4	5	more		
A	WING SHOTS		1/2	10/12	1/2	1/1	1/3											1/1								36/51	11/13
			1/2	5/8	1/2	2/3						1/1															
	9M SHOTS	1/2	3/5	1/3	0/1	2/3			0/1	1/2					2/3		1/2				1/1		1/2				
		1/2	4/6	3/6	1/2	0/1					1/1							0/1							1/2		
	BREAK-THROUGHS	0/1	6/7	6/8	3/4		1/1		1/1						2/2	1/1		1/1				1/1				30/40	12/15
		1/1	1/1	2/2	4/4				4/4							1/1											
	PIVOT	1/1	2/2	4/4	2/2	1/1	1/1						1/1			1/1	3/4										
		1/1		4/5	2/2				1/1	1/1	1/1				1/1	1/1		1/1	1/1								
"A" SUMMARY		2/4	12/16	21/27	6/9	4/5	3/5		1/2	1/2			1/1		4/5	2/2	4/6	2/2			1/1	1/1	1/2			36/51	11/13
		3/4	6/9	14/21	8/10	2/4			5/5	1/1	2/2	1/1			1/1	2/2		1/2	1/1						1/2	30/40	12/15
"A" SUMMARY		5/8	18/25	35/48	14/19	6/9	3/5		6/7	2/3	2/2	1/1	1/1		5/6	4/4	4/6	3/4	1/1		1/1	1/1	1/2		1/2	66/91	23/28
"A" SUMMARY		81/114 = 71%						12/14 = 85,7%						17/21 = 80,9%						4/6 = 66,6%						89/119=75%	
"A" SUMMARY		203/274 = 74%												GOLS/ATTACK NUMBERS 203/1804 = 11,25%													
B	TECHNICAL FAULTS		4	4	1	2									1		1									7	4
			3	2	2	1	1			1						1										4	2
	7M		2	1	1														1							1	
				2	1																					1	1
	FAULT/STOP PLAY	2	6	3	6	2	4	1		4	3	2	1	1	2	2	3	1	2							2	1
		2	2	7	2	3	2			3	1	1	2		1								1		1	2	
"B"SUMMARY		2	12	8	8	4	4	1		4	3	2	1	1	2	2	4	1	3							10	5
		2	5	11	5	4	3			4	1	1	2		2	1							1		1	7	3
"B" SUMMARY		4	17	19	13	8	7	1		8	4	3	3	1	4	3	4	1	3				1		1	17	8
"B" SUMMARY		68						19						16						2						25	
"B" SUMMARY		130																									
"A-B" SUMMARY BY HALFTIME		2/6	12/28	21/35	6/17	4/9	3/9	0/1	1/2	1/6	0/3	0/2	1/2	0/1	4/7	2/4	4/10	2/3	0/3		1/1	1/1	1/2			36/61	11/18
		3/6	6/14	14/32	8/15	2/8	0/3		5/5	1/5	2/3	1/2	0/2		1/3	2/3		1/2	1/1				0/1		1/3	30/47	12/18
"A-B" SUMMARY BY THE MATCH		5/12	18/42	35/67	14/32	6/17	3/12	0/1	6/7	2/11	2/6	1/4	1/4	0/1	5/10	4/7	4/10	3/5	1/4		1/1	1/1	1/3		1/3	66/108	23/36
"A-B"SUMMARY		81/182 = 44,5%						12/33 = 36,3%						17/37 = 45,9%						4/8 = 50%						89/144=62%	
"A-B" SUMMARY		203/404 = 50,2%												FASTBREAK/ATTACK NUMBERS = 404/1804 = 22,4%													

ANALYSIS OF THE FINAL STAGES OF THE MATCHES OF THE 10TH MEN'S EUROPEAN HANDBALL CHAMPIONSHIP IN SERBIA IN 2012

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Contents

1. Abstract

Introduction: 33 of the 47 matches of the latest (2012) 10th Men's European Handball Championship in Serbia ended with a goal difference of 3 or less. In the last 10 minutes of these matches both teams had a chance to win. The present thesis is not looking for an unfailing trick how to win the final minutes of matches but examines the statistical indexes that characterise the final stage of close and not close matches and indicate significant differences concerning the final minutes and the preceding period of matches.

Methods: The following statistical figures have been selected: frequency of goals, goalkeepers' efficiency, number of punishments, number of technical faults and turnovers, efficiency of player majority and player minority situations, steals and types of finishing attacks. The data derive from the website activites.eurohandball.com/analyses and the visual material of the matches can be found on youtube.com.

Results: Our analysis revealed that in the case of certain components there is no (significant) difference between the periods compared (such as – among others – the frequency of goals and the rate of total punishments in the final minutes and in the preceding period), however, there are clear differences in the case of most of the selected indexes (e.g., goalkeepers' efficiency, number of punishments and steals, efficiency of player majority and player minority situations, number of technical faults and turnovers, etc.).

Keywords: comparing statistical indexes, final minutes of handball matches, close matches, mental energy.

2. Introduction

In the recent times the final ending of various level men's handball matches has often been unclear even in the final minutes of the matches.

Power relations have definitely become more balanced among the national representative teams, too. The world's – Europe's, as far as handball is concerned – top teams and stronger national (e.g., German, Spanish) championships attract the players of countries having lower economic potential or lower level championships. Since national teams are built around such players trained at outstandingly high level championships, a lot of representative teams having similar playing power can compete at various world championships. Even at the less balanced and high level championships, one can find a couple of teams of world standard or close to it (e.g., MKB Veszprém, PICK Szeged, Cimos Koper, Celje, Kielce, Croatia Zagreb, Czekhovskie Medvedi, etc.) whose players belong to the best ones, and as a result, they strengthen national teams significantly. In consequence of all these, the number of teams (including Hungary, and also – without aiming at completeness – Iceland, Sweden, Norway, Serbia, Slovenia, Macedonia, Russia, etc.) that follow directly the strongest national teams who have had the best results in the recent times (Denmark, Croatia, France and Spain) is constantly rising. The latter teams can compete with those said to be the strongest with good chances (see e.g., at the European Championship in Serbia: Spain – Hungary: 24:24, France – Hungary: 23:26), and sometimes they also influence who will get medals (e.g., in the 2010 European Championship in Austria, Iceland won a bronze medal and in the latest championship in Serbia the home team won a silver medal.)

Teams	Average of final results (half-time results) of matches					
	Preliminary Round		Main Round		Total matches	
DEN	26-25	(14-11)	31-27	(17-15)	28-26	(15-13)
SRB	22-20	(11-9)	21-21	(12-10)	22-21	(12-9)
CRO	29-26	(14-12)	25-23	(12-12)	27-25	(13-12)
ESP	28-26	(14-12)	30-27	(14-14)	29-26	(14-13)
MKD	25-24	(12-12.5)	27-26	(16-13)	26-25	(14-13)
SLO	30-30	(14-14)	30-31	(15-14)	30-31	(14.5-14)
GER	26-25	(14-14)	26-27	(13-16)	26-26	(13-15)
HUN	27-26	(14-15)	25-28	(12-13)	26-27	(13-14)
POL	29-23	(11-13)	29-29	(13-18)	29-27	(12-15.5)
ISL	32-32	(15-17)	27-27	(14-13)	29.5-29.5	(15-15)
FRA	26-26	(14-13)	26-28	(13-14)	26-27	(13.5-13)
SWE	28-28	(16-17)	25-28	(14-14)	26-28	(15-15)

Table No 1

Dr. Wolfgang Pollany: Qualitative trend analysis

The figures of the table show that the average of the final results of the matches of the first twelve teams of the European Championship is +3 in the case of Spain, and in the case of the other teams it is – in absolute value – two or less.

Considering the final results of the matches of the seven latest Men's European Handball Championship (2), we can see that among them it was the latest European Championship in Serbia that had the largest number of matches the final result of which had a goal difference of only three or less. (Activities.eurohandball.com/analyses)

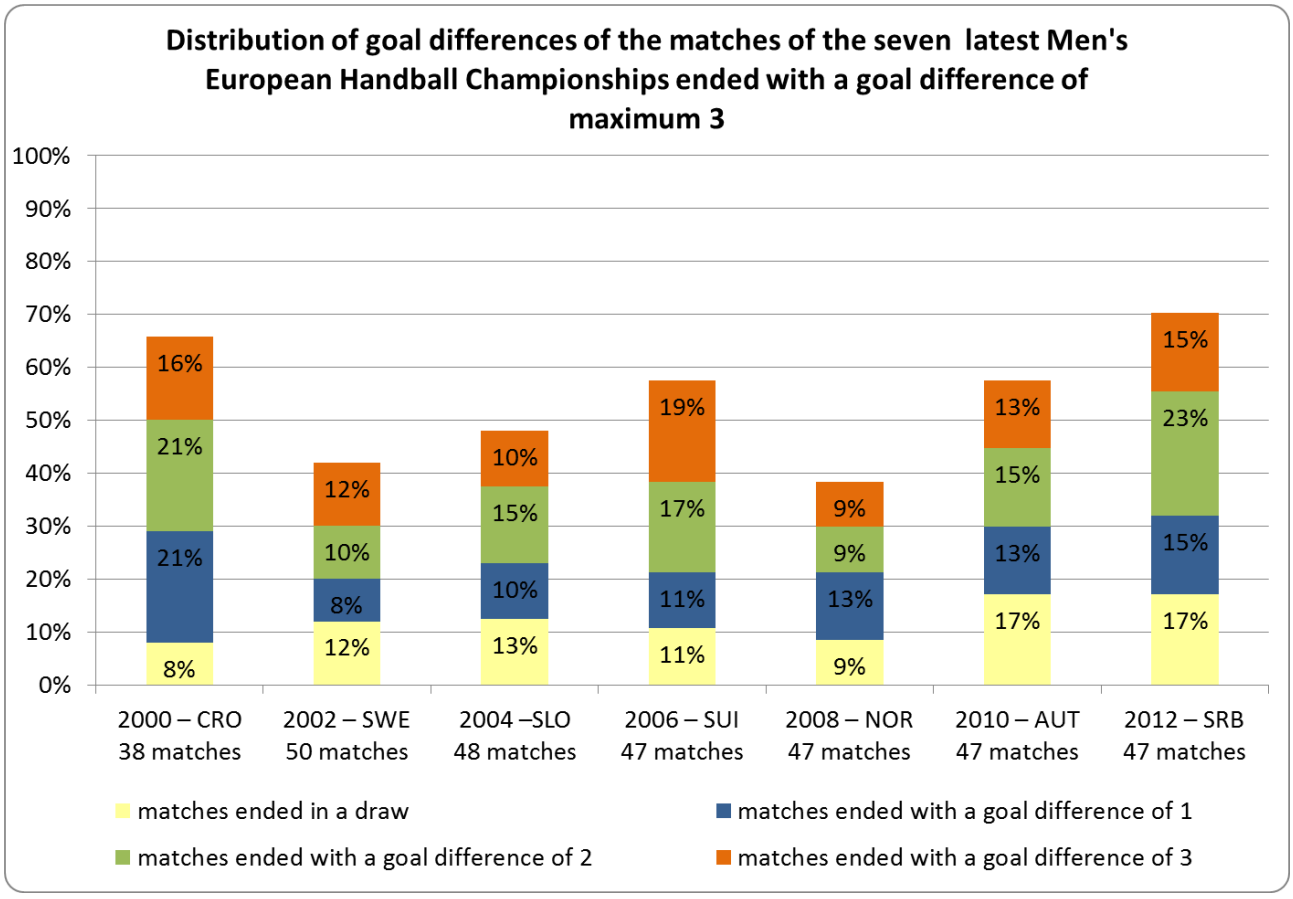


Table No 2

(see also: Appendix No. 1)

The bar diagram indicates that the number of matches with close fight at their final stage has constantly been growing for the past three years. If we disregard the results of the European Championship in Norway, the number of such matches has not been decreasing practically since the European Championship organised in Sweden in 2002. It is also shown by the table that a significant fall has been followed by several gradually increasing stages. In the case of both views of the processes, we can see that the rate of matches with close final stage tend to grow. A deeper look at the table reveals that the rate of matches ended in a draw or with one goal difference is about

30% in three championships (Croatia, Austria and Serbia), therefore, about a third of all the matches ended with such close results.

The criteria of analysis are not essentially different from the usual ones related to handball matches (e.g., the distribution of goals, goalkeepers' efficiency, efficiency of player majority situations, number of punishments), however, these are analysed in the final minutes of the matches. The criteria were selected from the material of the website "activities.eurohandball.com/analyses", on the basis of guidelines provided by the lectures of the EHF Open Master Coach & Licensing Course of the European Handball Federation.

Examining the above figures, one may ask whether we can find statistical components that significantly characterise matches where either of the teams can win in the final stage. Is there a numeric difference between the final and the preceding stages of close matches, or between the final stage of games ended with a goal difference of three and those ended with a goal difference of more than three?

There are various factors that influence performance in the final minutes of close and not close matches. In the case of taut matches, players' level of motivation is higher, at the same time, they are under more psychic pressure, which has an inhibiting effect in the case of certain players and a performance enhancing effect in the case of others. In my assumption, we can trace more significant difference between the two types of matches in the fields that are in connection with the maintenance of concentration and overcoming tiredness; e.g., factors related to the performance of defence play – such as fewer goals conceded – or, connected to it, the increasing performance of goalkeepers. In the case of attacks against organised defence, the strive for safer play must occur, while I expect lower risk taking in the field of ending attacks, i.e., the growing number of shots executed closer to the goal. I assume less number of goals in the case of attacks against disorganised defence (mainly because of fast and disciplined reorganisations). Teams that finished the championship in the top group are expected to have lower numbers of punishments and, therefore, fewer player minority situations. Those who have a lot of player minority situations in the final stages of matches cannot really be successful. The number of steals, the success of anticipation, technical faults and turnovers also depend on tiredness and concentration level – together with the tactics of the defending team, of course.

3. Methods

As the title of the present thesis indicates, the series of matches to be examined are the ones of the 10th Men's European Handball Championship in Serbia in 2012 and their final stages. Forty-seven (47) games were played in the above-mentioned European Championship, twenty-four (24) in the preliminary round and twenty-three in the main round, in the semi-finals and in placement matches. I consider the last ten minutes as the "final stage" or "final minutes" of matches, which I divided into two categories on the basis of their final results. Matches with close final stage are the ones that ended with a goal difference of three (3) or less. All of the latter ones had a goal difference of two (2) in the final ten minutes, which made it possible for either team – even the one with disadvantage – to win the match (considering the results only). The following matches are some of the examples of matches ended with a goal difference of three FRA – ESP: 26 : 29 (59th minute: 26 : 27), FRA – HUN: 23 : 26 (54th minute: 21 : 22), SRB – MKD: 19 : 22 (53rd minute: 19 : 19). In the European Championship there were altogether thirty-three (33) matches with close final minutes and fourteen (14) ones with not close final stage (ended with a goal difference of more than three).

The various statistics, tables and comparisons were made by collecting relevant data from specific parts of the website "activities.eurohandball.com/analyses" (Match Statistics, Overall Team Statistics), and by watching and taking notes of the final minutes of the matches in question (downloaded from YouTube). The average values (the mathematical averages of the listed components of the given sample), rates, percentages were calculated with the general mathematical rules of rounding.

The first stage of the analysis comprised the finding and recording of the material, as well as the determination of the segments to be examined. In the following stage, data were recorded, compiled into proper tables, averages, rates and percentages were determined, finally, the data were compared and analysed. Usually the figures of the two types of final stages of matches, their summary and the corresponding figures of the first fifty minutes of the matches were compared.

4. Development

4.1. Frequency of Goals, Development of the Results of Matches

One of the most typical and clearest data is the number of goals scored during a certain unit of time. In this respect there is no significant difference in the final 10 minutes' average of the two type of matches, moreover – owing to mathematical rounding – the figures appear identical. In the last minutes of both the close and not close matches and average of 8.8 goals per match were scored. However, there is a difference between the figures if we divide the last ten minutes into two 5-minute-long periods. In the case of close matches, the average numbers of goals are 4.5 and 4.3 in the two periods respectively, while in the case of matches of the other type this distribution is 4.0 and 4.8, respectively. The latter two figures indicate that in the final 5 minutes of not close matches the ending of which has already become clear by the final stage, the number of goals scored is rising as a result of the decreasing concentration and discipline of the teams, while it is more balanced in these two periods of close matches.

Comparing the number of goals scored in the last 10 minutes with the average number of goals scored in the first 50 minutes of the games, we find that in the case of close matches, 9 goals are scored every ten-minute-long period, which is more (although not significantly) than the goals scored during the final 10 minutes. In the case of not close matches, the same comparison shows that in the period preceding the final 10 minutes the same average number of goals (8.8) per 10 minutes is scored. In conclusion, in the case of close matches, more goals are scored until the 50^{th} minute of the game, while in the final 10 minutes there is no difference between the two types of matches. It is also supported by the figures we get if we examine the average number of goals scored in the three ten-minute-long sections of the second half of matches. In the case of close matches this data in due order is: 9.1, 8.8. and 8.8, respectively, while in the case of not close matches it is: 8.8, 8.2. and 8.8. The results indicate that in the case of close matches, more goals were scored in the first two ten-minute-long periods of the second half, while in the 3^{rd} (and final) ten-minute-long period the same number of goals were scored. In the above mentioned periods of close matches, the number of goals scored is more balanced, which indicates that the efficiency of attacks was steadier as a result of the taut situation.

Average of goal differences in the various periods of matches in both match types

Match	final result	half-time	2nd half,	2nd half,	2nd half,	50th min.	55th min.	final 5
Total:	887 : 883	434 : 455	147 : 152	154 : 135	152 : 140	735 : 743	817 : 812	70 : 71
Average of goals	26,9 : 26,8	13,2 : 13,8	4,5 : 4,6	4,7 : 4,1	4,6 : 4,2	22,3 : 22,5	24,8 : 24,6	2,1 : 2,2
Sum of goal dif.	50	91	69	65	48	62	53	45
Average of goal dif.	1,5	2,8	2,1	2	1,5	1,9	1,6	1,4

Development of results at close matches

Table No 3

Match	final result	half-time	2nd half,	2nd half,	2nd half,	50th min.	55th min.	final 5
Total:	363 : 375	191 : 185	57 : 66	57 : 58	58 : 66	305 : 309	328 : 343	35 : 32
Average of goals	25,9 : 26,8	13,6 : 13,2	4,1 : 4,7	4,1 : 4,1	4,1 : 4,7	21,8 : 22,1	23,4 : 24,5	2,5 : 2,3
Sum of goal dif.	84	46	23	23	26	78,0	77,0	15,0
Average of goal dif.	6,0	3,3	1,6	1,6	1,9	5,6	5,5	1,1

Development of results at not close matches

Table No 4

(see also: Appendix No. 2)

4.1.1. Comparison of Final and Half-Time Results

Comparing the half-time and final results, we can note that in the case of close matches, the half-time results were turned at eight out of twenty-five won matches (8 ended in a draw), and the team that was in disadvantage at half-time won the match, three matches ended in a draw and fourteen matches were won by the team leading at half-time.

At the 33 close matches the total of number of half-time results with a goal difference of at least 4 is 10. In today's fast handball, a goal difference of four within a game is not necessarily significant, but it is not negligible, either. Five (5) of those matches should be highlighted: in one case the team that was in disadvantage at half-time could turn the situation /POL – DEN: 27:26 (10:14)/, three cases ended in a draw after a relatively significant disadvantage /SRB – SVK: 21:21 (13:6)(!), POL – SWE: 29:29 (9:20)(!), SRB – GER: 21:21 (12:7)/, while in one case one goal advantage could be preserved from half-time to the end /MKD – SLO: 28:27 (16:12)/.

At not close matches, the teams that were in disadvantage at half-time managed to turn the situation in two cases /FRA – CRO: 22:29 (12:11), and SRB – CRO: 26:22 (13:14)/, in one case the result was draw at half-time /CZE – MKD: 21:27 (12:12)/, while in the eleven remaining games the team that led at half-time won the match at the end, too.

4.1.2. Comparison of the Final Results and the Final Minutes of Matches

Comparing the results of the final ten (10) minutes of the matches with their final results, the table shows that the final ten minutes of fourteen (14) out of twenty-five (25) close matches ending with victory were won by the team who won the game, too. There were not more than three of those matches /CRO – ISL: 31:29, end of 50th minute: (25:26); ISL – NOR: 34:32 (27:29); ESP – CRO: 24:22 (19:20)/ where either of the teams managed to turn the results in this period of the game. The result of the last section of the game was draw in four (4) cases, and in seven (7) cases the final 10 minutes was won by the would-be loser team (they managed to decrease their disadvantage but could not catch up with the leading team). We find that in the case of two (2) out of eight (8) matches that ended in a draw, teams that was in significant disadvantage managed to catch up with their opponents (FRA – ISL: 2:5; and POL – SWE: 7:3), in the remaining six (6) cases, the final 10 minutes ended mainly with one goal difference, and in 1 case in a draw and in another one with two goals difference. All these imply that no big changes took place in the results in the final 10 minutes. If we rank the matches where the team that was in disadvantage managed to turn the results in the final 10 minutes (there were 3 such cases) together with those where a team managed to equalize a relatively big (>3) goal difference (there were 2 such cases) in the same category, we see that there were five (5) matches among the ones having close fight in the final minutes of the European Championship where the team expected to win the game in the 50th minute changed in the final 10 minutes. The remaining twenty-eight matches either ended in a draw or won by the team that started the last minutes with advantage or the difference was so little at the beginning of the last 10 minutes that it could not determine the final result. It does not mean, of course, that there was not a gigantic fight in this period of the game, or it was not possible for any of the teams to win the game at the end, the data, however, indicate that in most cases the final result is mostly influenced by the period until the 50th minute, even if the final minutes see a close competition.

4.2 Saves, Goalkeepers' Performance

The performance of goalkeepers is a determining factor in the efficiency of teams, therefore, it is important to analyse it in the final minutes of the games. Table 2 shows the efficiency of the goalkeepers of the given teams in and before the final ten minutes of close and not close matches. The rates are given in percentage (saves/shots), rounded to the nearest integer according to the general rules of mathematics. (In certain cases the first decimal is also given in order to indicate the difference more precisely.) The performance of certain national representative teams (who could not get beyond the preliminary round: Norway, the Czech Republic, Russia, Slovakia) in the last

minutes cannot be evaluated in a well-grounded way because of their low number of games played, however, I considered that it can be included in the performance of all teams.

4.2.1. Goalkeepers' Performance in the Final Minutes of Matches

The summary of the final minutes of the two different types of games indicate that goalkeepers defend their goals more effectively in the case of close matches (35.2%, rounded as 35%) than at the other group of matches (30.9%, rounded as 31%). In my opinion, this figure does not indicate a negligible, accidental difference, but it is a general indicator of the period in question of the given type of game. The main reason for that must be – considering the taut character of the fight – goalkeepers' high level of concentration and tense mental state and the more intensive and concentrated defence play of teams.

Goalkeepers' performance in the final minutes of matches

Team	Match with close final stage last 10 minutes			%	Match with not close final stage last 10 minutes			%
	saves	shots	matches		saves	shots	matches	
DEN	14	41	6	34%	8	18	2	44%
SRB	14	38	6	37%	5	13	2	38%
CRO	8	25	4	32%	8	24	4	33%
ESP	9	39	6	23%	3	14	2	21%
MKD	19	44	6	43%	2	3	1	67%
SLO	20	58	7	34%	0	0	0	0%
GER	15	31	5	48%	5	6	1	83%
HUN	14	35	5	40%	1	5	1	20%
POL	11	27	4	41%	2	7	2	29%
ISL	8	23	4	35%	3	10	2	30%
FRA	9	26	4	35%	4	16	2	25%
SWE	8	24	3	33%	3	17	3	18%
NOR	5	17	2	29%	3	8	1	38%
CZE	1	6	1	17%	2	13	2	15%
RUS	2	11	2	18%	3	6	1	50%
SVK	1	4	1	25%	3	18	2	17%
Total:	158	449	66	35%	55	178	28	31%

Table No 5

4.2.2. Comparison of Goalkeepers' Performance in and before the Final Stage of Matches

The following table (No 6) shows goalkeepers' efficiency until the end of the 50th minute of the two different types of matches. Comparing the first fifty and the least 10 minutes with the corresponding figures of the previous table (No. 2), we find that in the case of close matches, goalkeepers' efficiency is 32% (31.9%) until the fifty-first minute, while it is 35% (35.2%) in the final minutes. The difference is not very big, but it clearly divides and characterises the examined periods, and indicates that goalkeepers' performance notably improves in the final section of these matches. The figures also show some improvement between the two stages of the other type of matches, however, it is not so significant and almost negligible. (30% until the 51st minute and 31% in the final minutes)

Goalkeepers' performance in the period proceeding the final minutes

Team	Goalkeepers' efficiency until the 51st min. at close matches			Goalkeepers' efficiency until the 51st min. at not close matches			Goalkeepers' efficiency during the complete time		
	saves	shots	%	saves	shots	%	saves	shots	%
DEN	66	191	35%	21	60	35%	109	310	35%
SRB	66	170	39%	21	53	40%	106	274	39%
CRO	40	131	31%	34	113	30%	90	293	31%
ESP	61	187	33%	16	62	26%	89	302	29%
MKD	65	194	34%	8	28	29%	94	269	35%
SLO	79	253	31%	0	0	0%	99	311	32%
GER	46	162	28%	8	31	26%	74	230	32%
HUN	50	163	31%	9	32	28%	74	235	31%
POL	36	134	27%	19	60	32%	68	228	30%
ISL	36	147	24%	19	64	30%	66	244	27%
FRA	38	131	29%	21	62	34%	72	235	31%
SWE	39	102	38%	34	109	31%	84	252	33%
NOR	25	74	34%	13	34	38%	46	133	35%
CZE	9	28	32%	16	65	25%	28	112	25%
RUS	20	72	28%	5	30	17%	30	119	25%
SVK	17	35	49%	20	76	26%	41	133	31%
Total:	693	2174	32%	264	879	30%	1170	3680	32%

Table No 6

It is noteworthy that some teams show outstanding goalkeeper's performance in the final minutes of close matches. The Hungarian national team is also among them, since our goalkeepers had 40% efficiency in the last 10 minutes of their five matches with close fight at the end. This category also includes the Macedonian, German and Polish teams, who can also boast with an efficiency of over 40%.

In the case of all teams listed, goalkeepers' efficiency improved significantly in the final 10 minutes of the games in comparison with the first fifty minutes. In the case of the Macedonians this change is 9% (from 34% to 43% in 6 matches), of the Germans it is 20% (!) (from 28% to 48% in 5 matches), of the Hungarians it is 9% (from 31% to 40 in 5 matches) and of the Polish it is 14% (from 27% to 41% in four matches). All the teams mentioned above ended up in the first half of the middle bunch (MKD 5., GER 7., HUN 8., POL 9.) right behind the leading group of teams. We can ascertain that the goalkeepers of these national teams play an especially significant role in the efficiency of their teams in the final minutes of close matches. The top teams (DEN, SRB, CRO) and the Slovenians are characterised by steady goalkeepers' performance, which changed by only a few percent in the final minutes of the games. The Spanish and Swedish teams belong to a separate category, in their case this index changed negatively by a significant rate: 10% (from 33% to 23% in 6 matches) and 5% (from 38% to 33%), respectively. The efficiency of the goalkeepers of the Icelandic and the French team shows an improving tendency in the final minutes, though it does not reach the high level of 40%. The former rose by 11% (from 24% to 35%), while the latter did so by 6% (from 29% to 35%).

4.3. Punishments

Another factor that influences the results of matches is the number of suspensions, since these periods create player majority and minority. 2 minutes suspensions have an effect on the game not only in the periods of player minority, but also afterwards when the number of players of the punished team has become complete, as defence and offence with player minority consumes a lot of energy in the field of motor performance and concentration. It is, however, beyond doubt that a period of player minority without a conceded goal or one that has been won – and it takes place more and more often – may significantly strengthen a team's mental state and cohesion.

There is a slight difference between the figure in the table "Punishments" in section "Overall Team Statistics" (altogether 353 pieces of 2 minutes suspensions at the complete European Championship) and the one used by me (357 punishments). The difference is due to the fact that the official table separated disqualifications immediately with a red card from 2 minutes suspensions,

because of the calculation of points, while the present thesis handles them together, since in the case of a single 2-minute-long player minority (majority) it does not matter whether the fault deserved a red card (disqualification) or just a "minor punishment". As the data show, there were four such cases at three matches: Spain – Italy (A. Chernoivanov), Norway – Slovenia (J. Jensen, L. Zvizej) in the preliminary round, and Poland – Germany (D. Klein) in the main round.

It is conspicuous in the table showing the development of the number of punishments that the teams' average punishments per match is clearly higher in the preliminaries (4.1) than in the main round or at placement matches (3.6). Among others, it is also because of the defence philosophy of the teams, which has evolved as the matches become more and more important in the direction that the opponents does not necessarily have to be "annihilated" by way of actions deserving punishment. As the tournament was advancing, the defence play of the teams was getting more harmonious and clearer, in consequence of which it was getting less necessary to prevent goals with faults deserving punishment. Another factor contributing to this tendency might have been that the participating teams accommodated themselves more and more to the style of referees. The latter change is especially conspicuous ion the case of the following national teams: Denmark (4.3 punishments in the preliminaries, while 2.4 in the main round and placement matches), Norway (5.7 then 3.5), Sweden (4.7 then 3.7) Slovenia (6.7 then 5.5). This tendency can also be traced – though the difference is not so significant – in the case of the national teams of Serbia (3.7 then 3.0), Croatia (3.7 then 3.4) Macedonia (4.3 then 3.8), Hungary (4.7 then 4.0) and Iceland (3.7 then 3.0). There was no change or the number of punishments per match even increased after the preliminaries in the case of the representatives of Spain (2.0 and 2,0), Germany (5.0 and 5.0) and France (from 1.7 to 2.3). In the case of the Spanish and French teams the average number of punishments per match is two, which is a very low value. The falling number of punishments in the second section of the European Championship implies a tendency which is characterised by few suspensions being one of the preconditions of successful defence.

The following part of this thesis examines whether there is a difference concerning the number of punishments between the final minutes of close and not close matches, between the final minutes and preceding period of the two types of matches, and examines the tendencies that characterise the given sections in the preliminaries and the later matches of the European Championship in this field.

Punishments

Team	Total suspensions of team	Preliminary Round								
		Close			Not close			suspensions in 2nd half	total suspensions	average of suspensions
		31st min. - 51st min.	final stage	No. of matches	31st min. - 51st min.	final stage	No. of matches			
DEN	25	4	2	2	2	1	1	9	13	4,3
SRB	26	2	1	2	0	1	1	4	11	3,7
CRO	28	3	3	2	0	2	1	8	11	3,7
ESP	16	3	2	3	0	0	0	5	6	2,0
MKD	28	3	0	2	1	0	1	4	13	4,3
SLO	42	8	5	3	0	0	0	13	20	6,7
GER	30	5	2	2	3	1	1	11	15	5,0
HUN	26	5	1	3	0	0	0	6	14	4,7
POL	24	1	2	1	3	0	2	6	11	3,7
ISL	20	6	0	3	0	0	0	6	11	3,7
FRA	12	2	1	2	0	0	1	3	5	1,7
SWE	25	2	0	1	3	3	2	8	14	4,7
NOR	17	3	2	2	2	3	1	10	17	5,7
CZE	13	1	0	1	4	2	2	7	13	4,3
RUS	15	4	4	2	2	0	1	10	15	5,0
SVK	10	1	1	1	4	1	2	7	10	3,3
Σ	357	53	26	**16** / 32	24	14	**8** / 16	117	199	66,3
Average	22,3	3,31	1,63		3	1,75		7,31	8,3	4,15

Table No 7

Team	Main Round & Placement Matches									
	close/not close 31-51 m./final stage	Close			Not close			suspensions in 2nd half	total suspensions	average of suspensions
		31st min. - 51st min.	final stage	No. of matches	31st min. - 51st min.	final stage	No. of matches			
DEN	11:3/2:1	7	1	4	0	0	1	8	12	2,4
SRB	6:3/1:1	4	2	4	1	0	1	7	15	3,0
CRO	9:4/3:4	6	1	2	3	2	3	12	17	3,4
ESP	5:4/0:1	2	2	3	0	1	2	5	10	2,0
MKD	9:4/1:0	6	4	4	0	0	0	10	15	3,8
SLO	12:9/0:0	9	4	4	0	0	0	13	22	5,5
GER	10:6/3:1	5	4	3	0	0	0	9	15	5,0
HUN	8:3/3:0	3	2	2	3	0	1	8	12	4,0
POL	6:4/3:0	5	2	3	0	0	0	7	13	4,3
ISL	7:0/2:2	1	0	1	2	2	2	5	9	3,0
FRA	4:3/2:0	2	2	2	2	0	1	6	7	2,3
SWE	2:2/5:4	0	2	2	2	1	1	5	11	3,7
Σ		50	26	**17** / 34	13	6	**6** / 12	95	158	42,4
Average		3	1,53		2,17	1		7,92	6,9	3,53

Table No 8

4.3.1. Punishments in the Final Minutes of Matches

At the thirty-three (33) close matches, the total number of punishments in the final minutes was fifty-two (52), which makes an average of 1.58 per match. When compared with the same figure (20 punishments) of not close matches (14), the average of which is 1.43, the difference is not so significant (about 10%). The reason for that difference must be the fact that in the case of close fights at the end of the game, the teams strive to make their defence as strict and hard as possible. If we examine these data in more details, seeing how they developed during the preliminary and the following round, the following can be revealed. During the preliminary round, the average number of punishments per match is 1.63 in the case of the final minutes of close matches and 1.75 in the case of the other type of matches. At the matches of the main round, the semi-final and at the placement matches, this value is 1.53 in the case of the final minutes of close matches and 1.0 in the other case. While the rate of punishments during the final minutes is higher in the case of not close preliminary matches, this ratio turns at later matches. In that section, the rate of punishments in the case of matches with close final minutes is much higher. A reason for that is that from the beginning of the main round, mostly those teams played not close games that had the fewest punishments in this section of the tournament. (DEN-SWE, HUN-ISL, FRA-CRO, ESP-ISL, SRB-CRO, CRO-ESP) Another reason to be mentioned may be that in the final stage of the championship, at matches the result of which has already been clear by the final minutes, the professional players did not endanger each other's physical safety through unnecessary faults deserving punishment.

4.3.2. Punishments in the Final Minutes and in the Preceding Period

It may be essential to compare the punishments in the final minutes and in the preceding period and to see if there is a difference between the two periods in this respect, because a punishment received in the final minutes may be a decisive factor in the outcome of the match. the first twenty (20) minutes of the second half of the match is considered to be the preceding period, as in the first half sendoffs usually take place less often due to the usage of yellow cards. Taking the whole European Championship into consideration, the ratio of punishments is essentially the same in the final minutes and in the preceding period of close matches (52 in the final 10 minutes and 103 between the 30^{th} and 51^{st} minute), and this ratio is similar in the case of not close matches (20 in the final 10 minutes and 37 in the preceding 20 minutes). On the basis of Table No 8 we can ascertain that the number of punishments taking place between the end of the thirtieth minute and the beginning of the fifty-first minute is close to two in the case of both types of matches in question. Since the first twenty minutes of the second half of the match is twice as long as the final period,

the rate of punishments in the periods examined can be considered (nearly) equal.

4.3.3. Punishments of the Various Teams

Examining the above issue, we can see typical differences when we examine preliminary, main and placement matches from the point of view of the teams. The comparison of the number of punishments concerning each team reveals that the distribution of the punishments among the final and the preceding period may be deemed balanced if there were twice as many punishments in the first twenty minutes of the second half as in the final ten minutes. Analysing the teams on that basis, we find that in the case of six teams that reached at least the main round, there were fewer punishments in the final minutes of close matches than in the preceding twenty minutes. (DEN: preceding period: 11, final minutes: 3; SRB: 6 and 3; CRO: 9 and 4; MKD: 9 and 4; HUN: 8 and 3; ISL: 7 and 0) These teams mostly ended the championship in the first half of the table or in the middle group at best. In my view it is not by chance, the teams deliberately strived to cut down the number of their punishments – especially in the final minutes of close matches – and it is also reflected by their efficiency. (Except for Spain and France, where the number of punishments is low in general.)

We can also examine this rate in the case of various teams during the preliminary and later matches. In comparison with the figures found during the preliminaries, the number of punishments during the final minutes is clearly fewer in main round and placement matches. (DEN, CRO, SLO, POL) In the case of Serbia and Iceland, this rate did not change, while in the second half of the European Championship, in the case of Macedonia, Germany, Hungary and Sweden, the rate of punishments was higher in the final minutes than in the preceding 20 minutes.

4.4. Efficiency of Player Majority Situations in the Final Minutes

The efficiency of player majority and minority situations has some interesting features (see: activities.eurohandball.com/Analyses/Overall Team Statistics/Teams), which reveal that not all teams can play in a player majority situation as efficiently as we may first think, and that teams with player minority can also be efficient. One can often see that a team in player majority stick too strictly to a movement and a set-up discussed beforehand in case of player majority. It cannot often be executed with the necessary precision, dynamics or authenticity, and sometimes they are compelled to finish the attack in a more unfavourable situation. It is occasionally the defending team that force the attackers to turnover or technical fault. When we summarise and compare the player majorities and minorities of the teams taking part, the first striking data is that the efficiency

index of all attacks (50%) is exactly the average of the efficiency rate of attacks with player majority (60%) and that with player minority (40%) (see: Appendix No. 3). In my opinion, these index numbers are not significantly far from each other, though this difference can be decisive at a taut match, especially in the final period. A closer look at the figures reveal that the top teams' attacking efficiency in player majority and minority situations also approximates to the average (except for the Spanish national representatives, whose player minority index of 21% diverges from the 40% average significantly). It is somewhat surprising that the teams that had the highest efficiency rate in player majority situations finished in the final order – except for the Slovenians – in the second half of the championship table (SLO 6th 68%; ISL 10th. 72%; SWE 12th. 67%; CZE 14th. 74%; RUS 15th. 76%).

In this segment of the game, the lowest index numbers belong to Germany (43%), Hungary (48%) and Norway (42%). The efficiency of attacks carried out during player minority towers over the average in the case of Iceland (56%) and Norway (57%), and it is rather low in the case of Spain, France, the Czech Republic, Russian and Slovakia. The latter teams (with the exception of Spain) all finished the championship in the second half of the table. Comparing the rate of player majority attacks with that of player minority ones, we can group the teams in three categories. In the first group there are teams whose index numbers approximate to the average (DEN, SRB, CRO, MKD, SLO, POL, SWE). These teams belong to the leaders. The next group consists of teams whose efficiency rates (in player majority and minority) are very close to each other (GER, HUN), or in an extreme case their player minority efficiency rate is even higher than their player majority one (!) (NOR). The third category includes teams whose index numbers are significantly different from each other (ESP, FRA, CZE, RUS, SVK), they usually finished at the second half of the championship table, both index numbers of the Icelandic team is extremely high.

4.4.1. Turnovers and Technical Faults

During the final minutes of the matches, the efficiency of player majority and minority situations (Table No 9, goal/shot/attack) may determine the final result, especially at the end of close matches. Besides them the number of turnovers and technical faults may also be essential, since in a taut situation, their quantity may also be decisive.

I examined the latter in the case of player majority, minority and equality (X) in the final 10 minutes of the playing time. (Since both actions involve losing the ball, they are indicated in one column (tt).) One might think the number of turnovers and technical faults is lower in the case of the team with player majority. However, if we examine the related index figures of the table, the

most striking thing is that in the case of matches with close final fight, the number of turnovers is higher in player majority (19) than in player minority (17) periods. The difference in the basic psychic stress related to the two situations (player majority and minority) undoubtedly contributes to this fact, too.

The team attacking with player majority feels being forced to score a goal (as they have more players on the court) and it often has a disadvantageous effect on their performance. Usually the level of motivation of the team playing with player minority rises to a higher level, and there is lower psychic stress on them if they happen to concede a goal, ("The opponent had player majority, they were in an easier situation.") therefore they take more risk, by which they can force the attackers to fault. The teams defending with player minority usually have various tactical solutions to survive the situation as favourably as possible, which are based on knowing the player majority movements of the attacking team, and to make their defenders having good anticipating skills efficient.

The typical aim of a team with player minority is to keep ball possession as long as possible, consequently, they choose safe solutions without risk in this period. The teams prepare for this situation with a serious range of tactics, too. All these greatly minimise the number of turnovers in such a situation.

In the 33 matches there were 77 technical faults and turnovers in the case of numerical equality, adding it to the corresponding number in player minority and player majority situations, it makes a total number of 113 in the case of matches having close final minutes.

The total number of technical faults and turnovers in the final minutes of not close games is 10 in the case of both player minority and player majority situations during the fourteen matches. Looking for the reasons, we may find the same as in the case of the final minutes of close matches, noting that in the latter case the psychic stress is even greater on the players in the hope of a possible victory than in the case of a match the final result of which has practically already become clear. The number of turnovers and technical faults in the case of this type of matches and that in the case of numerical equality makes up 78.

Comparing the total of the above figures in the final minutes of close and not close matches, we find that in the former case there were 3.4 such mistakes per match, while in the latter case this value is 5.6. The rather big difference is because in the case of the final minutes of not close matches, the teams already knew the final outcome of the match, so their level of concentration and discipline was lower.

Efficiency of player majority and minority situations in the final minutes

Team	Final stage of close matches											Final stage of not close matches											Total in the final stage										
	Player majority					Player minority					Equality	No. of matches	Player majority					Player minority					Equality	No. of matches	Player majority					Player minority					Equality	No. of matches
	efficiency					efficiency							efficiency					efficiency							efficiency					efficiency						
	goal	shot	att.	g/sh %	t t	goal	shot	att.	g/sh %	t t	t t		goal	shot	att.	g/sh %	t t	goal	shot	att.	g/sh %	t t	t t		goal	shot	att.	g/sh %	t t	goal	shot	att.	g/sh %	t t	t t	
Σ	43	74	89		19	36	65	70		17	77	66	17	29	38		10	11	24	30		10	58	28	60	103	127		29	47	89	100		27	135	94
% g/att.	48%					51%							45%					37%							47%					47%						
% g/shot	58%					55%							59%					46%							58%					53%						

Table No 9

(see also: Appendix No. 4.)

4.4.2. Player Majority and Player Minority Situations in the Final Stage

The efficiency of attacks carried out during player majority and player minority situations during the final minutes is interesting – on the basis of the table – in the two different types of matches. (The efficiency index is the ratio of goals and shots, similarly to the table of Eurohandball.com/Analyzes/Overall Team Statistics/Teams. I calculated player majority and minority situation from the end of the fiftieth minute only, therefore, it sometimes happened that the punishment was ordered in the forty-ninth or fiftieth minute, but it was still executed in the final section of the game.). In the case of the final minutes of close matches the efficiency of player majority attacks is not more than 48%, which significantly lags behind the rate of all player majority attacks, which is 60%. In this field the Serbians (27%) and the Macedonians (29%) have very low efficiency rate, which by far lags behind the efficiency rate of all of their attacks (57% and 61%, respectively). In such situations the most efficient teams were Croatia (57%), Germany (75%), Hungary (57%) and France (57%). (The index of national teams that finish in the ranks between the 13th and the 16th is usually high, but they played few matches of this kind.) The Croatian and the French national teams were nearly as efficient in the case of the final minutes of close matches as in all player majority situations throughout the whole European Championship (58% and 63%, respectively), while the German and Hungarian teams significantly surpassed it (in the Championship: 43% and 48%, respectively). The other teams (1st – 12th place) lagged behind the player majority efficiency rate produced throughout the complete Championship to some extent. In the case of the final minutes of close matches, an attack in a player majority situation creates a special situation, the effect being typical in such situations is more intense, because of the openness of the final result. Efficiency is strongly determined – besides the stake of the match, the team's tactical preparedness of the team, the players' skill level, the opponents' strength, tactics, training

level, etc. – by the mental state of the players – which also depends on their makings, socialisation, preparedness – the ability to endure and process the psychic stress put on them in such taut situations. One of the reasons of an accidental low efficiency level is that the team with player majority may be calmed down to a certain extent by the fact that they managed to get an opponent player suspended, which they may consider as "half success". They often stick to a previously discussed and well practised way of playing to solve such a situation too much, and its not too precise or authentic execution may lead to a mistake. Another reason might be that a given player does not undertake to finish the attack – also because of the previously agreed movement or in order to shift the responsibility – in a shooting situation that is usually efficient, and then his team is forced to shoot from a less favourable situation. In the case of teams defending in a player minority situation, goalkeepers are also in a tenser state of mind, which may increase their efficiency.

Analysing player minority attacks in the final minutes of the same type of matches, we find that the efficiency index is somewhat higher (51%) than in the case of player majority attacks. This surprising result may be because the level of fighting spirit, morale, motivation and assertiveness of the team with player minority increases to a great extent. Their players may take more risk when shooting and choosing the technique of shooting, especially in the case of a passive play (which is more often in such situations), sometimes when they feel "it is all the same". The teams prepare for such situations systematically and have a wider range of solutions to such situations. The tense of matches with taut final minutes and the player minority situation may have a psychic effect on the players which intensifies their determination and performance. Among the top twelve teams, the teams that had excellent attacking efficiency in such situations were Serbia (57%), Croatia (57%), Spain (67%), Slovenia (64%), Poland (63%) and Sweden (67%).

Comparing the efficiency of shots in the final minutes of this type of matches, in the case of player majority situations it was 58%, and in player minority ones it was 55% (that is the situation turned in comparison with the efficiency of attacks), which means that in player majority situations, in relation to the number of attacks, teams had fewer shots but they were more efficient.

In the case of the final minutes of not close matches – fourteen (14) in number – we can see that – unlike in the case of the other type of matches – the efficiency of attacks in player majority situations is higher (45%) than those carried out in player minority situations (37%). The rate of player majority situations is somewhat lower but it is still close to the corresponding figure in the case of matches with taut final minutes, the efficiency rate of player minority attacks is, however, much weaker than in the case of close matches. The difference in the field of player minority situations can mainly be explained by the fact that the balanced result and the possibility of winning generates more motivation in the case of close final minutes, there is, however, no such psychic drive in the case of matches the outcome of which has already become clear by this section of the

game. The reason for the relatively weaker efficiency of player minority attacks may be , on the one hand, the above mentioned situation and on the other hand, the lack of proper concentration and exhaustion caused by the serial load.

The efficiency of shots is 59% in the case of player majority attacks, while it is 46% in the case of player minority attacks; this difference is a logical consequence of the possibilities created by numerical majority or minority situations, respectively.

Summing up the indexes concerning player majority and player minority attacks in the final minutes of matches, we can see that in both cases the efficiency rate concerning goals and attacks was 47%. These values were primarily determined by the indexes of close final minutes. Player majority attacks – in comparison with the overall index of the whole European Championship of (60%) – had weaker efficiency, while player minority attacks had higher one (40% at the whole Championship). Primarily, all these are consequences of the special nature of the final minutes of matches, which is characterised by the high efficiency of player minority attacks – mainly due to psychic and motivational reasons – and low efficiency of player majority attacks – due to the already mentioned reasons – in the case of close matches, and lower efficiency of player minority attacks of not close matches, too – due to the lack of proper concentration and motivation.

4.5 Steals in the Final Minutes of Matches

The analysis of steals is included in the present thesis because in my opinion, a significant number teams include this tactical element in their defence strategy deliberately, and one or more steals in the final minutes of close matches might be decisive as far as the final result is concerned. In the case of a successfully executed steal, there is chance to score a goal easily, which does not only change the result but it also influences the team's morale and mental state. Its success may depend on several factors, which we see applied together and individually, too. Among them I would highlight collective team or team-part tactical solutions (e.g., ball traps), which enforce to opponents to carry out a certain pre-calculated action. The other important thing is the good anticipating ability of players, which enables them to forecast the course of the game and to execute a steal on that basis. The related figures of the European Championship in Serbia are shown by the following table:

Steals in the final minutes of matches

Team	Steals in final stage				Total in final stage		Steals in Championship	Average steals per 1 match	10 min. average of steals in 1st-51st min.	average steals per 1 match in final stage	10 min. ave. of steals in 1st-51st min. per 1 match
	Close final stage		Not close final stage								
	steals	No. of matches	steals	No. of matches	steals	No. of matches					
DEN	4	6	0	2	4	8	21	2,625	3,4	0,500	0,425
SRB	3	6	0	2	3	8	17	2,125	2,8	0,375	0,350
CRO	1	4	4	4	5	8	19	2,375	2,8	0,625	0,350
ESP	0	6	1	2	1	8	24	3,000	4,6	0,125	0,575
MKD	3	6	2	1	5	7	23	3,286	3,6	0,714	0,514
SLO	3	7	0	0	3	7	18	2,571	3	0,429	0,429
GER	2	5	0	1	2	6	19	3,167	3,4	0,333	0,567
HUN	3	5	1	1	4	6	11	1,833	1,4	0,667	0,233
POL	7	4	2	2	9	6	32	5,333	4,6	1,500	0,767
ISL	0	4	2	2	2	6	16	2,667	2,8	0,333	0,467
FRA	1	4	0	2	1	6	19	3,167	3,6	0,167	0,600
SWE	0	3	1	3	1	6	13	2,167	2,4	0,167	0,400
NOR	0	2	2	1	2	3	4	1,333	0,4	0,667	0,133
CZE	2	1	2	2	4	3	12	4,000	1,6	1,333	0,533
RUS	0	2	0	1	0	3	9	3,000	1,8	0,000	0,600
SVK	0	1	0	2	0	3	1	0,333	1	0,000	0,333
Total	29	33	17	14	46	47	258		43,2		
Average	0,88		1,21		0,98				0,91		

Table No 10

4.5.1. Steals in the Final Minutes

The first and the third columns of the table show the number and the average of steals in the final minutes of the two types of matches. We can primarily see that there are significantly more steals in the final minutes of not close matches (1.21 per match) than in the same period of close ones (0.88). The difference is almost forty percent (37.5%), which is quite significant. It probably results from the fact that in the case of close matches, especially in the final minutes, the attacking team concentrates more on precision, takes fewer risks and the defending team also undertakes to execute risky steals to a lesser extent and concentrates more on avoiding goals than scoring an easy goal with more risk. In the case of matches the final result of which has already become clear, a player is usually more willing to carry out tactical elements with uncertain result. However, the related figures of certain teams are distinct. There are teams where it is a typical part of the tactics of the final minutes of close matches to try to steal the ball (such a team is, among others, Poland with 7 steals and Denmark with 4 ones). On the other hand, there are teams where deliberate and successful steals are not typical elements in the final minutes of such matches due to various reasons (the team's strategy, playing style, players' abilities), like in the case of Croatia, Spain, Iceland.

4.5.2. Steals in the Final Minutes of Matches and in the Preceding Period

The next data to compare is whether teams carried out more steals in the final minutes of matches (considering all matches) or in the preceding period. (The two values can be compared in the way of reducing the total number of steals by that carried out during the final minutes of matches and dividing the result by five – as the subtraction has given the number of steals in fifty minutes, therefore the division will give the average number of steals in 10 minutes. This value derives from a single team's total number steals at all the matches.) The teams can be grouped in three categories – because of the number of matches, here I calculated only with the twelve teams getting beyond the preliminary round– depending on whether the number of steals was higher in the final minutes of matches or in the preceding period or there was no significant difference between the two periods. The last group includes the selected team of Denmark (4 steals in the final minutes and 3.4 ones in the preceding period), Serbia (3 and 2.8) Slovenia (both values are 3) and Iceland (2 and 2.8). (Note: their average place was 4.75). The next group consists of teams where there were significantly more steals during the final minutes than in the preceding period. These include the national representative teams of Croatia (5 and 2.8), Macedonia (5 and 3.6), Hungary (4 and 1.4) and Poland (9 and 4.6). (Note: their average place was 6.75). Here I would like to focus on the team of Poland, who produced extreme results concerning both the absolute number of steals (32) and especially the number of steals in the final minutes of matches (9). (A team playing against them must prepare for a high number of stealing attempts.) The indexes of the Hungarian national team are also interesting. A significant proportion (4) of the low number of steals (11) took place in the final minutes, which suggests a deliberate tactical application in their case. The third group comprises those teams where the number of steals is lower in the final minutes of matches in the preceding period. These teams are the representatives of Spain (1 and 4.6), Germany (2 and 3.4), France (1 and 3.6), and Sweden (1 and 2.4). (Note: their average place was 8.5.) This time the figures of the Spanish team are noteworthy, as only on (1) of their twenty-four (24) steals took place during the final minutes of a match. This fact indicates that they put a special emphasis on stealing during the matches, however, in the final minutes of a match they focus on safe defence without taking risks. (The four teams that could not get beyond the preliminary round and, therefore, had few matches, were Norway, the Czech Republic, Russia and Slovakia. Among them, the teams of Norway and Slovakia had an insignificant number of steals, while the other two had several ones.)

4.5.3. Comparing Steals of Various Teams

In order to be able to compare the teams' steals, the figures should refer to one match. That is what the last two columns of the table indicate. (The values were divided by the number of matches, so the last but one column shows the average number of steals in the final minutes of one match, while the last column shows the number of steals in 10 minutes of the preceding period on average.) These indicate that as far as the number of steals in the final minutes of matches is concerned, the top teams are the representatives of Poland, Macedonia, Hungary and Croatia, while the teams of Poland, France, Spain, Germany and Macedonia have the highest rate of steals in the first fifty minutes of matches.

4.6. Distribution of Goals

One of the most general segments of the statistical analysis of handball matches is the distribution of goals according to the quantity and efficiency of the various forms of finishing attacks at a given match. Therefore, on that basis we are going to examine the related characteristics of the final 10 minutes of the matches of the 10th Men's European Handball Championship in Serbia. The figures of Table No 11 show the data concerning the final stage and the preceding 50 minutes of the various types of matches as rounded percentages. (These data derive from the Table "Overall Team Statistics" and section "Match Statistics play by play" of the website http://activities.eurohandball.com/analyses by counting, organising them into tables and summing them up.)

Distribution of Goals

	7m	6m	W	BT	FB individual	FB team	9m	Total
Total in final stage	48/67	89/130	79/150	47/64	19/26	45/61	89/265	416/763
%	72%	68%	53%	73%	73%	74%	34%	55%
					74%			
Total until 51st minute	210/282	382/571	384/631	220/273	330/442		566/1423	2092/3622
%	74%	67%	61%	81%	75%		40%	58%
Average of total goals in final stage	11,50%	21,40%	19,00%	11,30%	15,40%		21,40%	
Average of total goals until 51st min.	10,00%	18,30%	18,40%	10,50%	16,00%		26,60%	

Table No 11

(see also: Annex No. 5)

4.6.1. Distribution of Goals in the Final Minutes of Matches

Firstly, we are going to compare the indexes of the final minutes of close and not close matches.

a., We cannot see any significant differences in the column of 7-metre shots (72% and 71%) and 6-metre shots (69% and 67%), consequently, the teams used these opportunities in this field in the case of both types of matches to a similar extent.

b., There is more significant deviation – by about ten percent – as far as the efficiency of wing (W) shots (51% and 56%) and breakthrough (BT) shots (75% and 69%) is concerned. While the former type of shot was more efficiently executed in the final minutes of not close matches, the latter was more efficient at close matches. In the former case (W) goalkeepers' will, in the latter case (BT) players' concentration was stronger.

c., We can see a significant difference and an interesting distribution in the case of attacks against disorganised defence (individual fastbreaks (FB) and team (part) fastbreaks) in the table. (It is worth mentioning that after synthesizing the figures – individual and team fastbreaks in the final minutes of close and not close matches – I obtained rates that were very similar to the ones in the table "Overall Team Statistics".) In the case of the 33 matches with close final minutes, the efficiency rate of individual fastbreaks was 7/15 (50%!!), while that of team fastbreaks was 37/45 (82%); while in the case of not close matches the same values were 12/12 (100%) and 8/16 (50%!), respectively. It reveals that in the case of close matches, individual fastbreaks against disorganised defence lagged far behind the indexes of team fastbreaks, concerning both their absolute quantity and their efficiency rate. The number of individual fastbreaks at close matches was low because in the final minutes the teams reorganised in an extremely fast and disciplined way after turnovers, and the main reason for their efficiency was the goalkeepers' performance. In consequence of the disciplined reorganisation of the defending teams and the attackers' strive to attack fast, the number of team (part) fastbreaks is much higher than that of individual ones. The efficiency of the latter is also significantly higher. In the final minutes of the 14 not close matches, the number of individual and team fastbreaks is much closer to each other (12 and 16), and their efficiency rate (100% and 50%) is just the opposite of the corresponding values of close matches. In my opinion, in the case of a match the final result of which is already clear, goalkeepers do not try to fight a 1-1 situation against a player performing an individual fastbreak with high concentration, while in the case of team fastbreaks, the attackers carry out the attack with low concentration level.

d., As far as distant field throws (9-metre shots) are concerned, their efficiency is striking, as it is 30% (59/194) in the case of close matches and 42% (30/71) in the case of not close matches, so the efficiency rate is clearly higher in the latter type of matches. It corresponds to the fact that the

goalkeepers' performance is more efficient in the case of matches with close final stage. Good goalkeeper's efficiency usually assumes good defence, too; consequently, we can also ascertain that defence play was efficient in these cases. Another data supporting it is that the efficiency of all shots in the two types of final minutes is four percent higher in the case of not close matches than in the case of close ones.

4.6.2. Distribution of Goals in the Final Minutes of Matches and in the Preceding Period

In the final minutes of matches and in the preceding 50 minutes, there is no remarkable difference as far as the efficiency of penalty and 6-mertre shots are concerned, however, there is a significant difference in the field of wing shots (W) and breakthroughs (BT) (53% and 61%, and 73% and 81%, respectively). There is a relatively bigger difference concerning the efficiency of 9-metre shots (34% and 40%), consequently, the efficiency of all shots is higher in the first fifty minutes of the matches than in the final stage.

4.6.3. Rate of Attack Finishing Types

It is worth comparing the data according to what type of shots (e.g., 6-metre shots, field throws, etc.) are typical of a given stage of matches to what extent.

a. Comparing the final minutes of close and not matches, we find no significant difference as far as 6-metre shots, wing shots and fastbreaks are concerned (21.5% and 21%, 18.5% and 20%, 15% and 16%). In the field of penalty shots, breakthroughs and 9-metre shots, we can see three or four percent differences. In the case of 7-metre shots, 3% more goals were scored from penalty during close matches, while this difference was 3.5% in the case of breakthroughs (12.5% at close matches, 9% at not close matches). The two figures are in connection with each other, if a team tries to carry out more breakthroughs during attacks, they will probably be awarded more penalties. Another implication might be that in comparison with not close matches, teams score more goals from breakthroughs and fewer ones from field throws in the final minutes of close matches. (The rate of 9-metre goals compared to all goals: 20% and 24%, respectively.) They try to finish attacks closer to the goal of the opponent team in order to make them more efficient in this way.

b. When summing up the figures of the final minutes of matches and comparing them with those in the first fifty minutes, it becomes clear that the difference may be deemed typical in the case of two types of attack finishing: 6-metre shots and 9-metre shots. In both kinds of final stage, the rate of all types of attacks ending in 6-metre shots is higher (>21%) than in the preceding period

(just a little higher than 18%). In the case of field throws, the difference is over 5%. In the first fifty minutes of matches, about every fourth goal was scored from a field throw, while in the final minutes of matches every fifth goal was scored in that way (26.6% and 21,4%, respectively).

5. Results and Discussion

The present thesis analyses the final stages of the matches of the 10th Men's European Handball Championship organised between 15th and 29th January, 2012 in Serbia. The main question it attempts to answer is that whether we can find distinctive data typically characterising the final stage of the matches played (especially those that ended with a goal difference of not more than three) on the basis of the selected statistical aspects. I consider the final ten minutes of a match as its final stage. I compared, on the one hand, the final stage of the (afore-mentioned) close matches and those ended with a greater (over three) goal difference, and on the other hand, the final stage and the preceding period of matches. I tried to select the statistical components on the basis of how typically they can indicate the development of the final result of handball matches, mainly concentrating on the possible reasons that characterise the final minutes of close matches.

The first aspect to examine was the number of goals and the development of the results. These data revealed that the same number of goals was scored in both types of matches. There is not a typical section of matches which we can deem the one deciding the final result of close matches. In connection with the latter statement, it has been found that in the case of five out of the 33 close matches, a team with a significant disadvantage managed to turn the results or equalise, while in the rest of the cases, the team that was leading in the 51st minute won the match. It is worth comparing the number of goals in the final minutes with the goalkeepers' performance. In the final stage of close matches the goalkeepers' overall performance was 35%, in the case of the controlling type of matches it was 31%, the average number of goals scored in the last 10 minutes was 8.8 in both cases; consequently, there were more shots with lower efficiency in the case of close matches. All these are in line with the fact that the shooting efficiency of close final minutes was 53%, while it was 47% in the case of not close ones.

It is the goalkeepers' performance that depends mostly on their mental state – which is influenced by a lot of factors – and that resulted in a remarkably high performance in the case of some teams (e.g., MKD 43%, GER 48%, HUN 40%, POL 41%) in comparison with the indexes of the first fifty minutes.

Goalkeepers' performance is strongly influenced by the quality of defence. I examined defence play by analysing punishments and steals. One can notice a characteristic decreasing tendency of the number of punishments at the five latest Men's European Handball Championships. In 2004 in Slovenia there were 502 calls of 2-minute suspensions and 12 red cards; in Switzerland, 2006: 455 2-m suspensions (15 RCs); in Norway, 2008: 403 2-m suspensions, (18 RCs); in Austria, 2010: 418 2-m suspensions, (10 RCs); in Serbia: 353 2-m suspensions, (12 RCs). We can also see a

decreasing tendency of the number of punishments in the case of the preliminary, main round and placement matches of the European Championship. In the preliminary round there were fewer punishments in the final minutes of close matches than in the case of not close matches. After the first round – in the case of most teams that finished in the leading group – there were fewer punishments in the final stage of matches than in the preceding fifty minutes; consequently, in the most important period of the matches, the teams deliberately wanted to avoid faults creating player minority situations. It is a general trend that teams deliberately try to minimise the number of punishments, creating authority by intimidating the opponent is an aim to a lesser and lesser extent. On the other hand, the new trend is rather being formed by defence plays that are offensive, try to make the opponents insecure, often change their system and set-up, and use creativity methodically. This tendency can be traced in the endeavour to steal the ball and enforce technical faults and turnovers, too.

Steals and attempts to force the opponents into technical faults and turnovers are important segments of defence. They are not the results of the technical shortcomings of attacking teams, but those of the changing defence philosophy, which strives to prevent the organisation and evolution of attacks at an as early stage as possible by flexible defence system shifts, making the opponents insecure. The present thesis examines steals from the point of view of their total number, and their distribution in the final stage and in the preceding period of matches. In the former field, the teams that had the highest indexes were mainly Poland (5.3 steals per match), Macedonia (3.3), Germany (3.2), France (3.2) and Spain (3.0), while in the latter case the best teams were again Poland and Macedonia, but also Hungary, Croatia and Denmark. As far as technical faults and turnovers are concerned, their average number per match in the final stage was 3.4 in the case of close matches and 5.6 in the case of not close matches. It is a surprising statistical figure that the number of technical faults and turnovers was at least as many in player majority situations as in player minority ones.

The efficiency of player majority and player minority situations also shows an unexpected picture. In the final minutes of close matches, player minority situations were utilised more efficiently than player majority ones, while it was the other way in the case of not close matches, and all in one, they were equal. In a player minority situation, more risk can be taken, players' creativity can prevail more, less often used technical and individual tactical elements can be carried out and become more effective.

In the field of the types of shots, we have seen that in the final minutes of matches, attacks were less often finished with distant field throws and fastbreaks against disorganised defence, while the rate of all the other types of shots was somewhat higher than in the first fifty minutes of matches. As far as their efficiency is concerned, we could see almost identical rates in the case of penalty

shots, 6-metre shots and fastbreaks, while the efficiency rates of the other types of attack finishing were significantly lower in the case of the final stage of matches. In the final minutes of close matches the efficiency of breakthroughs and fastbreaks was higher than in the case of not close final minutes, while the efficiency rate of field throws and wing shots was lower.

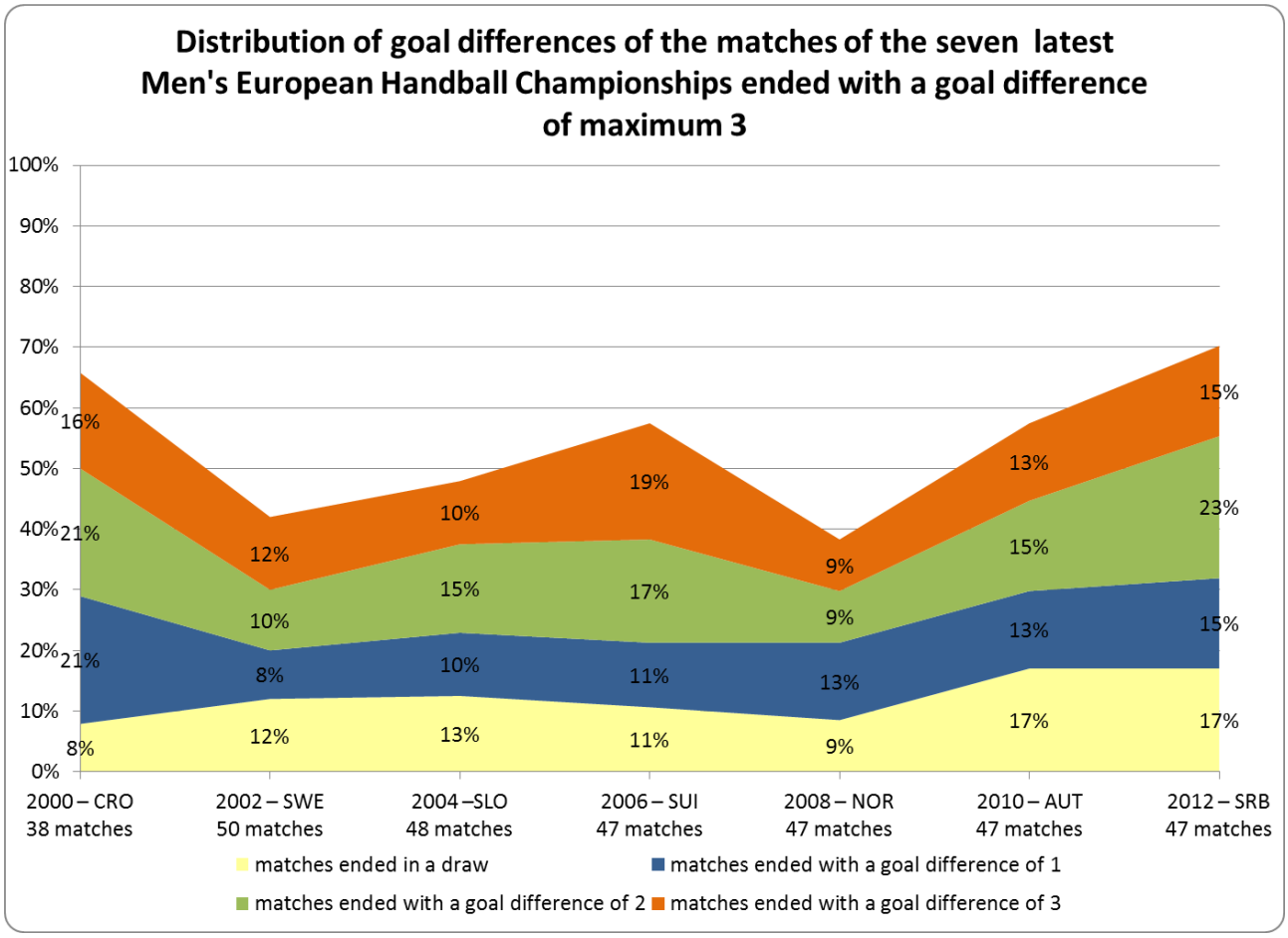
6. Conclusions

The summary of the results shows that the statistical analysis of the final stages of the matches of the 10th Men's European Handball Championship in Serbia reveals indexes that typically characterise and significantly describe the final minutes of matches. In some cases (e.g. the number of goals scored in the final ten minutes of matches) there was no difference between close and not close matches, but in the case of most statistical components selected, typical differences could be detected. The same could be ascertained in the relation between the final stage of matches and their first fifty minutes. The present thesis is not looking for an unfailing trick how to win the final minutes but for characteristics that help describe the final minutes of matches as precisely as possible. To reach that goal, I have chosen the criteria found in the present thesis. There are several other factors that, when analysed, might contribute to throw a wider light upon the issue (e.g., without aiming at completeness: various defence systems and their shifting; offence systems and their shifting; the number of attacks, the number of preparatory passes during attacks; typical dual and trial connections in and before the final minutes; the number of substitutions, the change of substitution tactics in the final stage, etc.).

The success of the final minutes of close matches largely depends on the momentary mental state and morale level of the players. Five of the six matches played by the national men's handball team of Hungary showed close final minutes, of which they won one, lost one and the remaining three ended in a draw. On the basis of several aspects examined in the present thesis, we can ascertain that our national players' mental energy and moral power significantly contributed to the fact that they managed to hold their ground in taut situations under enormous psychic pressure. Our goalkeepers' efficiency rate was 40% in the final minutes of close matches, a significant proportion of our steals took place in these periods, which was also the stage characterised by the highest efficiency rate of our player majority play and the lowest rate of punishments. All these indicate that our national representative players were very strong in this field and they are able to complete serious tasks in the most difficult situations.

Appendices

Appendix No. 1



Appendix No. 2

Average of goal differences at various stages of matches

2.1. Development of the results in close matches

Match	final result	half-time result	2nd half, 1st 10 min.	2nd half, 2nd 10 min.	2nd half, 3rd 10 min.	50th min. result	55th min. result	final 5 min. result
SRB-DEN	24 : 22	10 : 12	7 : 4	4 : 3	3 : 3	21 : 19	22 : 22	2 : 0
SRB-SVK	21 : 21	13 : 6	2 : 5	3 : 5	3 : 5	18 : 16	20 : 18	1 : 3
POL-DEN	27 : 26	10 : 14	6 : 6	6 : 2	5 : 4	22 : 22	24 : 24	3 : 2
GER-CZE	24 : 27	9 : 14	7 : 3	3 : 6	5 : 4	19 : 23	22 : 25	2 : 2
SWE-MKD	26 : 26	14 : 13	1 : 6	8 : 3	3 : 4	23 : 22	25 : 24	1 : 2
MKD-GER	23 : 24	12 : 12	5 : 3	3 : 5	3 : 4	20 : 20	22 : 21	1 : 3
FRA-ESP	26 : 29	13 : 15	4 : 6	4 : 4	5 : 4	21 : 25	25 : 27	1 : 2
HUN-RUS	31 : 31	19 : 19	3 : 5	6 : 3	3 : 4	28 : 27	30 : 28	1 : 3
ESP-HUN	24 : 24	11 : 12	3 : 3	5 : 4	5 : 5	19 : 19	23 : 21	1 : 3
ESP-RUS	30 : 27	17 : 11	4 : 5	3 : 6	6 : 5	24 : 22	28 : 24	2 : 3
FRA-HUN	23 : 26	14 : 12	2 : 4	4 : 5	3 : 5	20 : 21	21 : 22	2 : 4
CRO-ISL	31 : 29	14 : 15	7 : 6	4 : 5	6 : 3	25 : 26	27 : 28	4 : 1
NOR-SLO	28 : 27	14 : 14	4 : 7	4 : 1	6 : 5	22 : 22	25 : 24	3 : 3
SLO-CRO	29 : 31	12 : 16	5 : 3	6 : 7	6 : 5	23 : 26	26 : 29	3 : 2
ISL-NOR	34 : 32	18 : 20	3 : 5	6 : 3	7 : 3	27 : 29	31 : 31	3 : 1
ISL-SLO	32 : 34	13 : 17	7 : 8	6 : 5	6 : 4	26 : 30	28 : 32	4 : 2
DEN-MKD	33 : 32	16 : 19	5 : 3	6 : 4	6 : 6	27 : 26	30 : 28	3 : 4
POL-SWE	29 : 29	9 : 20	8 : 3	5 : 3	7 : 3	22 : 26	26 : 28	3 : 1
SRB-GER	21 : 21	12 : 7	4 : 7	3 : 4	2 : 3	19 : 18	21 : 20	0 : 1
DEN-GER	28 : 26	17 : 14	5 : 5	3 : 4	3 : 3	25 : 23	27 : 24	1 : 2
SRB-SWE	24 : 21	14 : 11	3 : 2	2 : 4	5 : 4	19 : 17	22 : 19	2 : 2
POL-MKD	25 : 27	12 : 18	4 : 2	3 : 4	6 : 3	19 : 24	22 : 25	3 : 2
SRB-MKD	19 : 22	10 : 11	3 : 3	4 : 4	2 : 4	17 : 18	19 : 19	0 : 3
POL-GER	33 : 32	18 : 17	7 : 5	4 : 4	4 : 6	29 : 26	29 : 30	4 : 2
FRA-SLO	28 : 26	14 : 15	3 : 4	6 : 3	5 : 4	23 : 22	25 : 25	3 : 1
ESP-CRO	24 : 22	11 : 14	6 : 3	2 : 3	5 : 2	19 : 20	21 : 21	3 : 1
HUN-SLO	30 : 32	13 : 14	3 : 7	8 : 6	6 : 5	24 : 27	27 : 30	3 : 2
ESP-SLO	35 : 32	15 : 15	5 : 8	7 : 2	8 : 7	27 : 25	30 : 28	5 : 4
HUN-CRO	24 : 24	13 : 12	4 : 6	4 : 2	3 : 4	21 : 20	23 : 23	1 : 1
FRA-ISL	29 : 29	12 : 15	7 : 4	8 : 5	2 : 5	27 : 24	28 : 27	1 : 2
MKD-SLO	28 : 27	16 : 12	2 : 5	8 : 6	2 : 4	26 : 23	27 : 25	1 : 2
DEN-ESP	25 : 24	12 : 10	5 : 3	2 : 6	6 : 5	19 : 19	23 : 21	2 : 3
SRB-DEN	19 : 21	7 : 9	3 : 3	4 : 4	5 : 5	14 : 16	18 : 19	1 : 2
Total:	887 : 883	434 : 455	147 : 152	154 : 135	152 : 140	735 : 743	817 : 812	70 : 71
Average of goals:	26,9 : 26,8	13,2 : 13,8	4,5 : 4,6	4,7 : 4,1	4,6 : 4,2	22,3 : 22,5	24,8 : 24,6	2,1 : 2,2
Sum of goal dif.:	50	91	69	65	48	62	53	45
Average of goal dif.:	1,5	2,8	2,1	2	1,5	1,9	1,6	1,4

2.2. Development of the results in not close matches

Match	final result	half-time result	2nd half, 1st 10 min.	2nd half, 2nd 10 min.	2nd half, 3rd 10 min.	50th min. result	55th min. result	final 5 min. result
POL-SRB	18 : 22	7 : 11	2 : 5	4 : 4	5 : 2	13 : 20	14 : 21	4 : 1
DEN-SVK	30 : 25	15 : 12	5 : 4	4 : 4	6 : 5	24 : 20	26 : 23	4 : 2
SVK-POL	24 : 41	13 : 17	5 : 8	3 : 7	3 : 9	21 : 32	21 : 36	3 : 5
CZE-SWE	29 : 33	17 : 19	4 : 4	1 : 4	7 : 6	22 : 27	25 : 29	4 : 4
CZE-MKD	21 : 27	12 : 12	2 : 4	5 : 6	2 : 5	19 : 22	20 : 24	1 : 3
GER-SWE	29 : 24	20 : 15	2 : 4	4 : 4	3 : 1	26 : 23	28 : 23	1 : 1
RUS-FRA	24 : 28	11 : 16	4 : 5	4 : 4	5 : 3	19 : 25	21 : 26	3 : 2
CRO-NOR	26 : 20	13 : 8	4 : 4	4 : 3	5 : 5	21 : 15	23 : 18	3 : 2
DEN-SWE	31 : 24	18 : 11	4 : 6	5 : 2	4 : 5	27 : 19	28 : 22	3 : 2
HUN-ISL	21 : 27	10 : 14	3 : 6	4 : 3	4 : 4	17 : 23	19 : 25	2 : 2
FRA-CRO	22 : 29	12 : 11	5 : 5	2 : 6	3 : 7	19 : 22	21 : 26	1 : 3
ESP-ISL	31 : 26	17 : 13	5 : 5	6 : 2	3 : 6	28 : 20	29 : 24	2 : 2
SRB-CRO	26 : 22	13 : 14	5 : 2	5 : 3	3 : 3	23 : 19	25 : 21	1 : 1
CRO-ESP	31 : 27	13 : 12	7 : 4	6 : 6	5 : 5	26 : 22	28 : 25	3 : 2
Total:	363 : 375	191 : 185	57 : 66	57 : 58	58 : 66	305 : 309	328 : 343	35 : 32
Average of goals:	25,9 : 26,8	13,6 : 13,2	4,1 : 4,7	4,1 : 4,1	4,1 : 4,7	21,8 : 22,1	23,4 : 24,5	2,5 : 2,3
Sum of goal dif.:	84	46	23	23	26	78,0	77,0	15,0
Average of goal dif.:	6,0	3,3	1,6	1,6	1,9	5,6	5,5	1,1

Appendix No. 3

Efficiency of player majority and minority situations in the Championship

Efficiency of player majority and minority situations						
Team	Attack		Player majority		Player minority	
	goal/attack	%	goal/attack	%	goal/attack	%
DEN	216/422	51	32/51	63	14/35	40
SRB	176/388	45	27/47	57	12/33	36
CRO	216/422	51	30/52	58	14/35	40
ESP	224/435	51	33/55	60	4/19	21
MKD	185/356	52	43/70	61	14/33	42
SLO	207/398	52	28/41	68	28/67	42
GER	156/323	48	13/30	43	19/46	41
HUN	156/319	49	23/48	48	15/35	43
POL	173/336	51	28/49	57	16/36	44
ISL	177/328	54	28/39	72	17/27	56
FRA	177/328	47	29/46	63	6/19	32
SWE	157/339	46	28/42	67	17/42	40
NOR	80/170	47	11/26	42	12/21	57
CZE	77/160	48	16/23	74	4/14	29
RUS	82/165	50	13/17	76	6/20	30
SVK	70/163	43	14/23	61	5/17	29
Average	2508/5054	50	397/659	60	201/499	40

Appendix No. 4

Efficiency of player majority and minority situations in the final stages

Team	Final stage of close matches											Final stage of not close matches											Total in the final stage										
	Player majority					Player minority					Equality	No. of matches	Player majority					Player minority					Equality	No. of matches	Player majority					Player minority					Equality	No. of matches
	efficiency					efficiency							efficiency					efficiency							efficiency					efficiency						
	goal	shot	att.	g/sh %	t t	goal	shot	att.	g/sh %	t t	t t		goal	shot	att.	g/sh %	t t	goal	shot	att.	g/sh %	t t	t t		goal	shot	att.	g/sh %	t t	goal	shot	att.	g/sh %	t t	t t	
DEN	3	6	7	43	0	2	2	4	50	4	5	6	2	2	2	100	0	1	2	1	100	0	5	2	5	8	9	56	0	3	4	5	60	4	10	8
SRB	3	6	11	27	5	2	3	3	67	0	7	6	0	0	0	0	0	0	0	2	0	2	5	2	3	6	11	27	5	2	3	5	40	2	12	8
CRO	4	7	7	57	1	4	7	7	57	0	2	4	1	1	3	33	2	4	6	6	67	1	9	4	5	8	10	50	3	8	13	13	62	1	11	8
ESP	1	2	2	50	0	4	6	7	57	1	5	6	1	2	2	50	0	0	2	1	0	0	6	2	2	4	4	50	0	4	8	8	50	1	11	8
MKD	2	6	7	29	3	0	3	4	0	1	5	6	0	2	2	0	0	0	0	0	0	1	4	1	2	8	9	22	3	0	3	4	0	2	9	7
SLO	3	7	7	43	1	9	13	14	64	2	13	7	0	0	0	0	0	0	0	0	0	0	0	0	3	7	7	43	1	9	13	14	64	2	13	7
GER	3	4	4	75	0	5	9	10	50	3	8	5	0	2	2	0	1	2	4	4	50	0	2	1	3	6	6	50	1	7	13	14	50	3	10	6
HUN	4	5	7	57	4	1	2	4	25	2	5	5	0	2	3	0	1	0	0	0	0	0	0	1	4	7	10	40	5	1	2	4	25	2	5	6
POL	5	8	10	50	1	5	8	8	63	1	3	4	2	3	5	40	2	0	0	0	0	0	1	2	7	11	15	47	3	5	8	8	63	1	4	6
ISL	5	9	10	50	1	0	0	0	0	0	3	4	1	1	1	100	0	0	1	1	0	0	1	2	6	10	11	55	1	0	1	1	0	0	4	6
FRA	4	7	7	57	1	0	4	2	0	2	2	4	1	2	4	25	2	0	0	0	0	0	7	2	5	9	11	45	3	0	4	2	0	2	9	6
SWE	1	1	2	50	1	2	3	3	67	0	10	3	3	6	7	43	0	1	4	6	17	2	4	3	4	7	9	44	1	3	7	9	33	2	14	6
NOR	2	2	3	67	0	1	2	1	100	0	3	2	1	1	2	50	1	3	3	4	75	1	2	1	3	3	5	60	1	4	5	5	80	1	5	3
CZE	0	1	2	0	1	0	0	0	0	0	1	1	4	4	4	100	0	0	1	3	0	2	5	2	4	5	6	67	1	0	1	3	0	2	6	3
RUS	1	1	1	100	0	1	2	2	50	1	3	2	0	0	0	0	0	0	0	0	0	0	2	1	1	1	1	100	0	1	2	2	50	1	5	3
SVK	2	2	2	100	0	0	1	1	0	0	2	1	1	1	1	100	1	0	1	2	0	1	5	2	3	3	3	100	1	0	2	3	0	1	7	3
Σ	43	74	89		19	36	65	70		17	77	66	17	29	38		10	11	24	30		10	58	28	60	103	127		29	47	89	100		27	135	94
% g/att.	48%					51%							45%					37%							47%					47%						
% g/shot	58%					55%							59%					46%							58%					53%						

Appendix No. 5

Distribution of goals

Team	Goals scored in final stage of close matches									
	7m	6m	W	BT	FB individual	FB team	9m	Toal	%	No. of matches
DEN	3/3	4/7	5/14	4/7	1/1	5/6	6/18	28/56	50	6
SRB	2/2	6/13	2/5	3/6	0/1	1/1	5/17	19/45	42,2	6
CRO	3/5	1/1	3/9	4/4	½	2/2	3/8	17/31	54,8	4
ESP	5/6	7/10	10/13	6/6	0	3/3	3/11	34/49	69,4	6
MKD	5/6	9/12	0/4	2/2	2/3	¾	1/19	22/50	44	6
SLO	6/12	13/16	3/7	6/9	0/2	4/6	2/9	34/61	55,7	7
GER	0/1	7/8	3/7	½	2/3	0	8/19	21/40	52,5	6
HUN	5/5	3/3	5/6	¾	1/1	½	4/17	22/38	57,9	5
POL	0/1	¾	3/7	2/2	0	9/10	5/11	22/35	62,9	4
ISL	3/5	3/6	3/6	½	0	6/6	5/13	21/38	55,3	4
FRA	2/2	2/2	4/9	0	0	1/3	6/21	15/37	40,5	4
SWE	0	2/2	3/5	1/1	0	0	4/13	10/21	47,6	3
NOR	1/1	1/3	5/6	0	0	0	2/9	9/19	47,4	2
CZE	0	½	½	0	0/1	0	2/4	4/9	44,4	1
RUS	0	½	2/2	2/2	0	1/1	3/5	9/12	75	2
SVK	1/1	0	2/3	1/1	0	1/1	0	5/6	83,3	1
Σ (goal/shot)	**36/50**	**63/91**	**54/105**	**36/48**	**7/14**	**37/45**	**59/194**	**292/547**	**53,4**	**33**
%	**72%**	**69%**	**51%**	**75%**	**50%**	**82%**	**30%**	**53%**		
Rate of total goals	**12,50%**	**21,50%**	**18,50%**	**12,50%**	**15,00%**		**20,00%**			

Team	Goals scored in final stage of not close matches									
	7m	6m	W	BT	FB individual	FB team	9m	Toal	%	No. of matches
DEN	0	3 / 4	1/1	4/4	0	¼	1/3	10/16	62,5	2
SRB	0	1 / 2	0/2	1/1	0	0	3/9	5/14	35,7	2
CRO	3 / 3	3 / 4	6/8	2/3	0	0	7/12	21/30	70	4
ESP	4 / 7	1/ 2	2/2	0/1	0	0	½	8/14	57,1	2
MKD	0	0/2	2/5	1/ 2	1/1	0	1/1	5/11	45,4	1
SLO	0	0	0	0	0	0	0	0/0	0	0
GER	0	1/1	0/2	0	0	0	2/5	3/8	37,5	1
HUN	1 / 2	1/1	0	0	1/1	0/1	1/3	4/8	50	1
POL	1 / 1	¾	2/2	0	2/2	3/3	3/5	14/17	82,4	2
ISL	0	4/4	0/2	1/ 2	2/2	1/3	2/6	10/19	52,6	2
FRA	2 / 2	2/2	1/ 2	0	0	0	1/5	6/11	54,5	2
SWE	0 / 1	3/7	2/5	2/3	1/1	0/1	3/7	11/25	44	3
NOR	0	0	1/1	0	1/1	1/1	2/2	5/5	100	1
CZE	0	0	¾	0	4/4	0	2/7	9/15	60	2
RUS	0	0	3/5	0	0	2/3	0	5/8	62,5	1
SVK	1/1	4/6	2/4	0	0	0	¼	8/15	53,3	2
Σ (goal/shot)	**12/17**	**26/39**	**25/45**	**11/16**	**12/12**	**8/16**	**30/71**	**124/216**	**57,40%**	**14**
%	**71%**	**67%**	**56%**	**69%**	**100%**	**50%**	**42%**	**57%**		
Rate of total goals	**9,50%**	**21,00%**	**20,00%**	**9,00%**	**16,00%**		**24,00%**			

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The Analysis of the Technical Activity of the Centre Back against Set- Defence

Research on the Performance of the Centre Back based on the London Olympics 2012 Women's Handball Tournament

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ABSTRACT

Introduction- In this paper my aim is to study the role of centre back players in handball, which even if not representing the sport as a whole, may still, as an important part of it, reflect the social changes since the birth of handball, the evolution of the ideal. In today's competitive sports only those can be successful and effective who, in addition to their personal abilities, take part in high level training and education.

In the modern game of handball what tasks are to be fulfilled by the centre back in order to show a good performance?

Methods- I have chosen video analysis of games as my method of research. The aspect of survey is attack against well organized set defence. I am interested in the technical elements they apply and the moves they carry out with or without the ball.

Results- Based on the presented data, we may see that centre backs are technically highly skilled players.

Following this analysis of modern handball, it is clear that centre backs not only have to engage in organizing the game and finishing the attacks but they also deal with defensive duties. This means they spend a lot of time on the court which requires endurance, speed and stamina.

Introduction

In this paper my aim is to study the role of centre back players in handball, which even if not representing the sport as a whole, may still, as an important part of it, reflect the social changes since the birth of handball, the evolution of the ideal. In today's competitive sports only those can be successful and effective who, in addition to their personal abilities, take part in high level training and education. Today's handball is a fantastic game! Why? Maybe it is because there has been a great development in technical and tactical knowledge, playing abilities and the speed of the players. They used to have good physical qualities, but today – so it seems – they play more vividly with what they have got. The coach covers an important part in discovering and teaching more efficient technical and tactical elements to his team. Luckily, this sport has become very popular all around the world. For this reason I think every player should endeavour to make it better, and more popular and spectacular. In a team the most determining player is the centre back, the topic of my paper is related to those in this position. In my opinion, every player has to obtain a unique technical repertoire. Because of the nature of the game there is always one team that is attacking and another that is defending. The purpose of the attackers is to score points, which they have to carry out within the framework of the rules. Faking techniques, such as starting fakes, changeovers, passing fakes and shooting fakes are not prohibited. They are also adopted by the players in case of preparatory actions or when trying to break through the defence wall in order to score a goal. Positioning, offensive blocking and passing are specific forms of preparing for the scoring or helping a teammate to score from another position.

Handball is built up of short, temporary movements; it requires overall strength and the versatile training of the body, a high level of coordination and combinatory skills. In addition to these, tolerance of pain, self-discipline and sense of collectiveness is also necessary. Even with extensive technical and tactical knowledge this puts great and regular stress on the human body. The position of the centre back requires maybe the widest repertoire. The present-day game of handball has become faster, and more accurate and variable. The centre back may be the most decisive player regarding the results. This player has an important role from the aspects of preparatory actions, getting other teammates into the position of scoring and the completion of attacks and other actions (the precision of ending an action is of key importance). We are particularly talking about centre back players because in the three inner positions, in terms of scoring they present the same danger.

It is the duty of the centre back player to unite and coordinate the actions of the attack, and to respond to the technical and tactical shifts with constructive ideas. The centre back must be able to visualize the full court and the position of the members of both teams, and has to adapt to the tactical changes of the opponent in a fast and creative way.

The competition among the most highly skilled teams is greatly influenced by the activity of the centre back. The game has speeded up and has also become more aggressive, this may be connected with the development of precision and efficiency. This is the pace which the centre back has to keep up with and still present outstanding performances. My being a centre back for more than twenty years and the above mentioned purposes have convinced me to choose *The Analysis of the Technical Activity of the Centre Back against Organized Set-Defence. Research on the Performance of the Centre Back* as the title of my thesis. My research is based on the best four women's teams at the 2012 Olympics and the observation of the preparatory actions of the centre backs – which teammate they changed positions with and how this influenced the performance of the team.

Accordingly, the questions that form the basis of my research are: In the modern game of handball what tasks are to be fulfilled by the centre back in order to show a good performance? At the end of the attack, prior to the position of scoring, in what way do the actions of the centre back influence the efficiency of the attack?

The positioning of the centre back

The centre back's scope of movement accords with that of the left and right backs, with the only difference that while the left and right backs carry out their activities in the side zone extended in width and depth, the centre back's movement is more concentrated, during a static attack it is the size of a circle with a diameter of six metres. The reason for this is that it is easier to control the team from the centre, and when necessary support may also be given either to the left or right side. Centre backs may leave their scope for a shorter or longer period but their main activities are carried out within this area. The direction of their movement is largely determined by whether they primarily focus on organizing or also put effort into frequent attempts to score as well. They execute their organizational duties mainly in width, with cross-directional running, the thwarting of changeovers and inception of fakes, while their movement in depth, aiming at the goal, is carried out – just as in the case of the back court player – with fractional running and different step combinations to build up the impetus.

The movement opportunities of centre backs are diverse not only because they have an extended range of movement but also because of their duties. However such a player always has to be positioned in a way not leaving the original post abandoned for too long a time, must be capable of supporting teammates in both directions, and, in situations of urgency, can be easily found with the ball.

Preparation

During the preparatory activity of the centre back, numerous tactical tasks are to be dealt with: to control the tasks of the attack, to coordinate the activity of the individual players and the different parts of the team, and to participate personally in providing opportunities for a team member to score a goal. This is a considerably complex task that also demands creative and improvisational tactical activity: the centre back has to identify the events on the court with a good sense of getting an overall picture, recognize the main opportunities for the attack, notice the random chances of scoring, solve unexpected situations and modify the original tactics underway or support other teammates in scoring a goal if necessary. All these tasks are executed rapidly, with continuous movement, even the organizing tasks to seem offensive and to help the attacks to end in scoring.

This results in that centre backs always have to be on the move and show activity in their position with continuous, energy-saving footwork which allows them to act promptly to all directions at any time.

Since it is centre backs who most frequently has contact with the ball, they have to be extremely confident in catching and passing it in many different ways. In addition, their organizing and preparatory activity is more efficient if it is carried out with determined goalscoring attempts. This may at the same time distract the defenders' attention from the actual action, and at best they may directly get the chance to score a goal. Because of changing positions, offensive blockings and passing to the pivot, the centre back primarily contacts the pivot and the other back court players often occupying their positions for a shorter or longer period.

The centre back's quick identification and estimation of the situation, confident decision-making and adequate actions are the most important in special game situations. In the case of numerical advantage with offensive blocking, the centre back sets up a position for a teammate. The game of figures also requires a quick-thinking, experienced centre back, since

numerous manoeuvres are built upon his/her play, mostly started and occasionally ended by him/her too.

Conclusion of the attack

Besides organization, positioning and preparation, another important part of centre backs' attacking activity is the conclusion of the attack with an attempt at scoring. Their opportunities for goalscoring are excellent, since their attacks are concentrated at the centre of the court, the most favourable position for scoring. This is why today's centre backs have to be outstanding back court players as well and similarly seize the opportunity to score, both from the ground and the air, by noticing the gaps over, or between the defenders.

Zone of the long range shots

Shots from the air

- jump shot pushed off from the opposite leg of the throwing arm
- lay away jump shot
- jump shot from both legs
- jump shot pushed off from the corresponding leg of the throwing arm
- delayed jump shot

Shots from the ground

- underarm shot
- ground shot
- lay away shot
- bracing

Shots from the close shooting zone

- long jump shot
- fall shot
- dive shot in the opposite direction of the throwing arm
- dive shot in the corresponding direction of the throwing arm
- delayed shot
- lob shot

Faking techniques of the centre back

- **starting fake**: from the centre back's basic position the attacker, with one leg, or while in motion with both legs, steps out into a feigned position. Depending on the execution of this movement once or more times in alternate directions, it can be identified as a simple or combined starting fake.

- **arm swinging fake**: the movement in the second part of the fake when the attacker swings his/her arm above the defender. It can be used effectively primarily in the vicinity of the goal area as a prelude to breaking through or goal scoring.

- **rotation fake**: the attacker spins around his/her vertical axis thus breaking away from the defender moving in the opposite direction.

- **passing fake**: by executing a part of the throwing process the player feigns passing the ball. It can be carried out with any one-handed or two-handed pass, in basic position or while moving.

- **shooting fake**: by executing a part of the throwing process the attacker tries to make the defender and the goalkeeper believe that he/she intends to take a shot at the goal. With this the defenders' attention can be distracted, and they can be forced into movement in width or depth, blocking or checking. The fake can be carried out by preparing the ball into the throwing position, keeping the ball in the throwing position, moving the ball forwards and stopping it and carrying out the throwing motion.

Faking techniques are especially important parts of both the preparing and concluding actions of the centre back.

Methods and aspects of survey

Hypothesis

In my thesis I am searching for the role of the centre back in today's speeded-up game of handball. I have divided these players into two types: one an old time classic, so-called preparing centre back and the other, recently more popular, shooting centre back. In modern handball it is more common to play a set up of three backs when the player in the centre back's role or position, based on external, anthropometric properties corresponds with that of the left/right back. With my observations, I intend find out whether it can be clearly stated

that one of the two styles is represented by the ‘modern centre back’ or perhaps both types of players have their place in today’s handball.

Methods of survey

I have chosen video analysis of games as my method of research. I am going to examine some national team matches. The mentioned teams play current leader board handball. The aspect of survey is attack against organized set defence. I am going to observe the players positioned as centre backs at the beginning of the attack. I am interested in the technical elements they apply and the moves they carry out with or without the ball. After the research I will highlight the centre backs who contributed most to the game, point out their best qualities and construct the ideal centre back that may help in the coaching of young handball players.

Aspects of survey

Changing position of the centre back

The conclusion of the attack often builds upon internal position switch, blocking and forming the focus which allows the centre back to show up at practically any part of the court, although due to perceptibility, at the time of the inception of the movement, play is usually organized from that particular area. The direction of movement is largely determined by whether the focus is primarily on organizing or whether some effort is put into frequent attempts of scoring as well. The most important thing in positioning is to be able to back up teammates on both sides of the court.

Shooting methods of the centre back

Shooting habits – how wide is the range of the centre back’s shooting techniques? Are there any dominant types of shots in the centre back’s? Is the player more active on the ground or in the air?

Faking techniques of the centre back

Faking is an important element of attack. It is the intentional deceiving of the opponent, forcing him/her into a disadvantageous position, for the sake of preparation and a more efficient way of carrying out further technical elements. A common feature of faking techniques is that they all require the changing of direction in some way, which involves the torso and limbs with or without the ball to various extents.

Ways of passing to the pivot and applied types of offensive blocking

There are special and ingenious ways of passing the ball with the purpose of setting up a position for the pivot or the player running in. They help the pivot or the player sweeping in to fulfil their functions, encourages participation in group manoeuvres and thus directly and indirectly increases the efficiency of the attack.

Offensive blocking is physically obstructing the opponent's freedom of movement. This is the teamwork of two or more attackers, one of whom in order to set a clear lane for the teammate, holds up either his/her own defender or that of the teammate.

Efficiency of the centre back

With the implementation of the suitable goalscoring technique determined by the occupied position, successful conclusions of the attack are scoring, through-shot, breaking through and providing an assist.

South Korean national team: 2012 London Olympics, 4th place

Overview of 8 games (295 attacks)

London Olympics 2012:

Korea 29 – Spain 31 (13-13, 24-24, 28-28)

Norway 31 – Korea 25 (18-15)

Russia 23 – Korea 24 (11-14)

Sweden 28 – Korea 32 (13-16)

Korea 21 – France 24 (12-10)

Norway 27 – Korea 27 (13-15)

Korea 25 – Denmark 24 (11-10)

Spain 27 – Korea 31 (12-16)

Centre backs: Kim On-A

Jung Ji-hae

Lee Eun-Bi

Summary:

The South Korean team won Olympic fourth-place.

I have examined all the matches they played in the Olympics. Three centre backs were employed, I have analysed 295 attacks.

Because of an injury, the first centre back, Kim On-A, could only participate in the first game but her play was significant in defeating the Spanish team. Under her direction, I have examined 41 attacks; she has a colourful character and is a highly skilled player; during the attacks she turned up in numerous positions. She often changed position mostly with the left and right backs. She presented a threat to the goal in any position. She used every fake against her opponent, with or without the ball. She also adopted all kinds of shooting styles and ways of passing to the pivot. Based on the results of her scoring it can be stated that she is a preparing and concluding centre back. What underlines her efficiency is that during the attack, before or after catching the ball, she executed some kind of starting fake, keeping the defence wall under constant pressure. She utilised the possibilities presented by the opponents' errors, her favourite was the jump shot from the zone of the long range shots, and she used all types of it: jump shot, delayed jump shot, and lay away jump shot. During this one match, she employed all kinds of starting fakes, and was the only one who typically tried a combined arm swinging and rotation fake.

The second centre back is Jung Ji-hae, who participated in the most attacks, took a great part in organizing, turned up on all three internal positions, after changing position with or without the ball she helped to set up a position for her teammates; she is also a highly skilled technical player. She was less efficient than On-A Kim because of fewer goal scoring attempts from the zone of the long range shots, she more often broke through or gained advantage, her game style was rather organizing and preparing.

The third centre back, Lee Eun-Bi received fewer opportunities. She got the chance to act as centre back after playing as left winger in the attack. In my opinion, she got to play when Jung Ji-hae needed a rest. Her play was mainly to get advantage over the opponent and to set up positions for her teammates. She did not play a significant role as centre back in the team.

South Korean national team: 2012 London Olympics, 4th place

Table 1: Changing position of the centre back without the ball

changing position/ name	Kim	Jung	Lee
Changing position with the left back	7	52	10
Changing position with the right back	10	78	18
Changing position with the left winger			
Changing position with the right winger			
running in to the pivot position	1		2
sweeping in/out		8	2
positional play	14	30	2

Table 2: Changing position of the centre back with the ball

changing position/ name	Kim	Jung	Lee
Crossing with the left back		14	2
Crossing with the right back	4	10	2
Crossing with the left winger	2		
Crossing with the right winger	3	4	2
Preparation for the pivot	1	18	12

Table 3: Goalshooting of the centre back

Goalshooting/name	Kim	Jung	Lee
Overarm shot		6	2
Underarm shot	1	4	4
Jump shot	2	16	4
Delayed jump shot	1		
Lay away jump shot			
Arhythmic			
Lay away shot			

Table 4: Fakes and cuts of the centre back

Fakes and cuts/name	Kim	Jung	Lee
Changing direction	3	32	6
Arm swinging fake	5	4	
Double starting fake	2	6	2
Shooting fake (on ground)	1		2
Shooting fake (in the air)	5	28	2
Passing fake	1	16	6
Rotation fake	2		
Bouncing fake	1	10	8
Breaking in	2	11	5

Table 5: Passing to the pivot and blocking of the centre back

Passing to the pivot and blocking	Kim	Jung	Lee
Bounced passing to the pivot		8	2
Overarm passing to the pivot		6	
Jump passing to the pivot		4	
Side by side blocking			2
Supplementary blocking	1	2	

Table 6: Efficiency

Efficiency /name	Kim	Jung	Lee
Number of attacks	41	214	52
Goals	4	25	8
Assists	7	8	11
Break through	0/1	8/11	3/5
Through-shot	4/4	6/26	3/10

Spanish national team: 2012 London Olympics, bronze medal

Overview of 8 games (344 attacks)

2012 London Olympics:

Korea 29 – Spain 31 (13-13, 24-24, 28-28)

Spain 26 – Montenegro 27 (13-13)

Spain 25 – Croatia 22 (13-12)

Norway 20 – Spain 25 (11-11)

Spain 25 – Sweden 24 (11-10)

Spain 24 – Denmark 21 (14-9)

France 18 – Spain 18 (7-10)

Spain 27 – Korea 31 (12-16)

Centre backs: Macarena Aguilard

Andrea Barno San Martin

Summary:

I have examined 344 attacks of the Spanish team. Of the two centre backs Macarena Aguilard played more – and she participated in 272 attacks. Based on the data presented in the table, she represented the preparing centre back, but when she got the opportunity she also presented great danger to the goal. She was more active in the zone of the close range shots; throughout the eight games she only scored one goal in five attempts. She carries out a wide range of position changes either with or without the ball. She often applied dribbling and passing fakes. Because of this, she was able to complete breakthroughs. Among her techniques for passing to the pivot, she most commonly used overarm throws, but also employed bounces and balls delivered following a jump into the air. Her statistics were 22 goals and 33 assists.

The second centre back, Andrea Barno San Martin acted in a preparing way. She was continuously changing her position and tried to set up positions for her teammates with her fakes.

Spanish national team: London Olympics 2012, bronze medal

Table 7: Changing position of the centre back without the ball

Changing position / name	Barno	Aguilard
Changing position with the left back	26	70
Changing position with the right back	32	75
Changing position with the left winger		
Changing position with the right winger		
running in to the pivot position	2	6
Sweeping in/out		
positional play	9	60

Table 8: Changing position of the centre back with the ball

Changing position / name	Barno	Aguilard
Crossing with the left back	13	20
Crossing with the right back		9
Crossing with the left winger	8	4
Crossing with the right winger	7	5
Preparing to the pivot	16	16

Table 9: Goalshooting of the centre back

Shots/name	Barno	Aguilard
Overarm shot		4
Underarm shot		
Jump shot	1	
Delayed jump shot		
Lay away jump shot		
Arhythmic		1
Lay away shot		

Table 10: Fakes and cuts of the centre back

Fakes and cuts/name	Barno	Aguilard
Changing position	5	25
Arm swinging fake		8
Double starting fake	3	2
Shooting fake (on ground)		2
Shooting fake (in the air)		
Passing fake		16
Rotation fake		
Bouncing fake		22
Break through	4	13

Table 11: Passing to the pivot and blocking of the centre back

Passing to the pivot and blocking	Barno	Aguilard
Bounced passing to the pivot		3
Overarm passing to the pivot	4	19
Jump passing to the pivot		2
Side by side blocking	2	
Supplementary blocking		

Table 12: Efficiency

Efficiency /name	Barno	Aguilard
Number of attacks	73	272
Goals	3	22
Assists	5	33
Break through	3 /4	11/13
Through-shot	0/1	1/5

Montenegro national team: 2012 London Olympics, silver medal

Overview of 8 games (279 attacks)

2012 London Olympics:

Norway 26 – Montenegro 23 (13-10)

Spain 26 – Montenegro 27 (13-13)

France 22 – Montenegro 23 (13-13)

Montenegro 25 – Russia 25 (15-16)

Croatia 27 – Montenegro 26 (12-12)

Montenegro 30 – Angola 25 (13-14)

Brazil 27 – Montenegro 25 (15-16)

Montenegro 31 – Great Britain 19 (18-12)

Centre backs: Marija Jovanović

Milena Knežević

Anđela Bulatović

Summary:

I have examined 279 attacks of the team of Montenegro. Of the three players, Marija Jovanović played most as centre back with 104 attacks. Her play is characterized by preparing activities and she participated in the attacks from all three internal positions. She was efficient from the zone of the long range shots, performing mostly jump shots. Her 15 assists also underpin the fact that she was effective in setting up a position for one of her teammates. She often employed shooting fakes.

The second centre back is Milena Knežević who may also be titled as a preparing centre back. She most often changed positions with the left back but also with the right back. She made fewer attempts to score from the zone of the long range shots than Jovanović did, but her favourite jump shot got her three goals from four shots.

Centre back number three, Anđela Bulatović directed 89 attacks. Similar to the other centre backs of the Montenegrin team, preparing actions were also typical of her, she changed position many times and rather attempted to set up positions for the back court players. She scored one goal and provided 6 assists.

Montenegro national team: 2012 London Olympics, silver medal

Table 13: Changing position of the centre back without the ball

Changing position / name	Jovanovic	BulatovicA	Knezevic
Changing position with the left back	29	37	48
Changing position with the right back	27	10	4
Changing position with the left winger			
Changing position with the right winger			
running in to the pivot position	9	8	2
Sweeping in/out	8	2	
positional play	2	17	28

Table 14: Changing position of the centre back with the ball

Changing position / name	Jovanovic	BulatovicA	Knezevic
Crossing with the left back	17	3	2
Crossing with the right back	10	8	3
Crossing with the left winger		4	
Crossing with the right winger	2		
Preparing to the pivot			

Table 15: Goalshooting of the centre back

Shots/name	Jovanovic	BulatovicA	Knezevic
Overarm shot	3	1	3
Underarm shot			1
Jump shot	9	1	5
Delayed jump shot			
Lay away jump shot	2		
Arrhythmic	1		
Curved shot			

Table 16: Fakes and cuts of the centre back

Fakes and cuts/name	Jovanovic	BulatovicA	Knezevic
Changing position	5	18	9
Arm swinging fake	3	3	6
Double starting fake		7	
Shooting fake (on ground)	5		
Shooting fake (in the air)	10		
Passing fake	22	5	6
Rotation fake			2
Bouncing fake	6	9	11
Break through fake	5		4

Table 17: Passing to the pivot and blocking of the centre back

Passing to the pivot and blocking	Jovanovic	BulatovicA	Knezevic
Bounced passing to the pivot	1	1	1
Overarm passing to the pivot	2		
Jump passing to the pivot	2		
Side by side blocking		2	
Supplementary blocking	4	3	

Table 18: Efficiency

Efficiency /name	Jovanovic	BulatovicA	Knezevic
Number of attacks	104	89	86
Goals	9	1	7
Assists	14	6	10
Break through	3/5	0/2	3 /4
Through-shot	3/15	0/2	2/9

Norwegian national team: 2012 London Olympics, gold medal

Overview of 8 games (276 attacks)

2012 London Olympics:

Norway 26 – Montenegro 23 (13-10)

Norway 31 – Korea 25 (18-25)

Brazil 19 – Norway 21 (13-9)

Norway 20 – Spain 25 (11-11)

Denmark 23 – Norway 24 (11-12)

Norway 27 – Korea 27 (13-15)

Sweden 21 – Norway 24 (9-14)

Norway 23 – France 24 (12-17)

Centre backs: Karoline Dyhre Breivang

Ida Alstad

Gøril Snorroeggen

Summary:

I have examined 276 attacks of the Norwegian team. Karoline Dyhre Breivang, who played in 104 attacks, is a preparing-concluding centre back. She mostly executed position changes and cross movements with the back court players without the ball. She often occupied the position of the pivot where she used blocking from the side and also by standing in front of her opponent, supporting her teammates in their scoring attempts. Her most frequently used faking technique was a passing fake but she also attempted double starting fakes, shooting fakes from the ground and position switches. She showed great interplay with the pivots, setting up positions for them mainly with high balls. Her favourite shooting technique was the high ground shot with which she was efficient as well. Over the 8 games she scored 14 goals and provided 28 assists which truly presents her role as a preparing-concluding centre back.

Of the other two centre backs, Ida Alstad directed 76 and Gøril Snorroeggen 96 attacks. Both of them mostly carried out position switches with both back court players. The game style of both of them was more concluding than preparing. They mainly carried out jump shots and overarm shots. They mainly applied shooting and passing fakes and, more rarely, double starting fakes. Their statistics were very similar; the team play did not change when they

substituted each other. They both scored 20 goals; Alstad provided 7 assists and Snorroeggen provided 14.

Norwegian national team: 2012 London Olympics, gold medal

Table 19: Changing position of the centre back without the ball

Changing position / name	Alstad	Breivang	Snorrdeggen
Changing position with the left back	22	16	26
Changing position with the right back	18	14	4
Changing position with the left winger			
Changing position with the right winger			
running in to the pivot position	4	14	6
Sweeping in/out		4	
positional play	6	4	46

Table 20: Changing position of the centre back with the ball

Changing position / name	Alstad	Breivang	Snorrdeggen
Crossing with the left back	13	14	8
Crossing with the right back	8	27	6
Crossing with the left winger		8	
Crossing with the right winger		3	
Preparing to the pivot			

Table 21: Goalshooting of the centre back

Shots/name	Alstad	Breivang	Snorrdeggen
Overarm shot	9	11	9
Underarm shot	4	8	8
Jump shot	18	1	10
Delayed jump shot			
Lay away jump shot			
Arrhythmic	1		
Lay away ground shot			

Table 22: Fakes and cuts of the centre back

Fakes and cuts/name	Alstad	Breivang	Snorrdeggen
Changing direction	7		4
Arm swinging fake			4
Double starting fake	3	8	6
Shooting fake (on ground)	2	3	
Shooting fake (in the air)	4		6
Passing fake		16	6
Rotation fake			
Bouncing fake	5	24	16
Break through	4	9	4

Table 23: Passing to the pivot and blocking of the centre back

Passing to the pivot and blocking	Alstad	Breivang	Snorrdeggen
Bounced passing to the pivot		8	6
Overarm passing to the pivot	3	5	4
Jump passing to the pivot	1	1	1
Side by side blocking		16	
Supplementary blocking		8	4

Table 24: Efficiency

Efficiency /name	Alstad	Breivang	Snorrdeggen
Number of attacks	76	104	96
Goals	20	14	20
Assists	7	28	14
Break through	0/4	4/9	4/4
Through-shot	14/32	5/20	9/27

Summary description of the players

I have analysed four national teams throughout my research: the South Korean, the Spanish, the Montenegrin and the Norwegian. Altogether I have studied 22 matches, 1194 attacks against organized defence and 11 centre backs.

The tables indicate the main features of the centre backs' technical skills and efficiency.

We can see that the Norwegians had the fewest attacks against organized set defence, which may be due to their game strategy. In the first half and at the beginning of the second half of the games they tried to score easy goals against the unorganized defence. When employing

a rapid overruns they usually tried to finish the attack after 7 or 8 passes, in which they were very successful.

The Spanish team executed the most attacks. Their strategy was to finish the quick attack after 2 to 3 passes; when there was no scoring opportunity, they rather tried to succeed against unorganized defence.

The teams of Montenegro and South Korea followed a combined strategy. They either finished the attacks against unorganized defence after 7 or 8 passes, though on occasion after 2 or 3 passes, or, if there was no scoring opportunity, they slowed down to advance against organized set defence.

It may be said of all four cases that the positioning of the centre back was not connected to the centre position. They frequently changed their positions, mostly with the left and right backs. After that they aimed to finish the attacks according to their style or set up a position for their teammate who was in the centre position then.

The most popular way of crossing was with the left back without the ball. This phenomenon occurred a total of 343 times. A reason for this is that all of the centre backs surveyed are right-handed and this may be a comfortable position for them to execute a successful goalscoring attempt. The second most popular way of changing position was with the right back. Overall, the centre backs appeared in every position, but those of left back, right back, centre back and pivot were the most common. The centre backs changed their positions with the left and right wingers the fewest times. The statistics show that the positions of the left and right backs had a decisive role in shaping the activity of the centre back. During the attacks they spent more time in the position of either the left or right back than in their own.

Altogether the centre backs attempted a shot on goal 193 times. The most popular type of attempt was the jump shot but all the other types listed were present in different proportions. The lay away jump shot was the least popular which, in my opinion, is a difficult technical element and requires a high degree of flexibility.

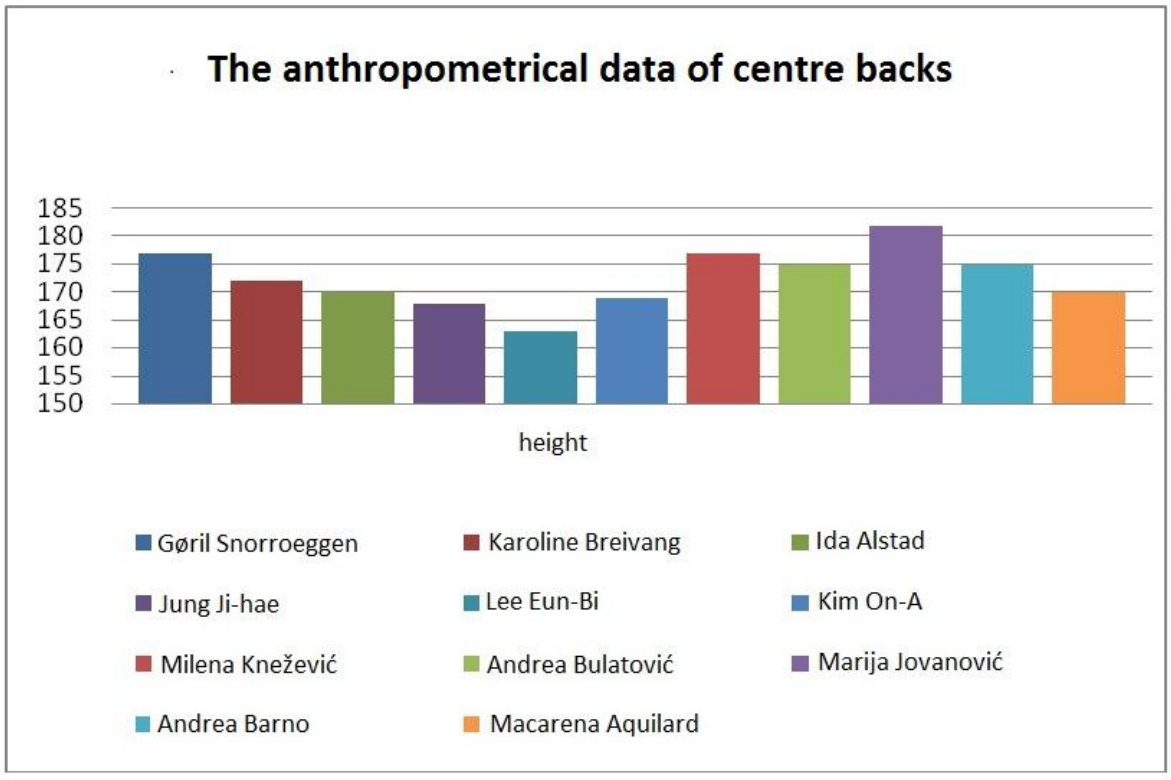
The numbers clearly show that the fake that involves changing direction is the most favourable among the faking techniques. Centre backs know how to execute fakes in the direction of both their left and right hands. Rotation fakes were applied least frequently.

During the 1194 attacks, the centre backs scored 86 goals (with breaking in or through shots) and provided 135 assists.

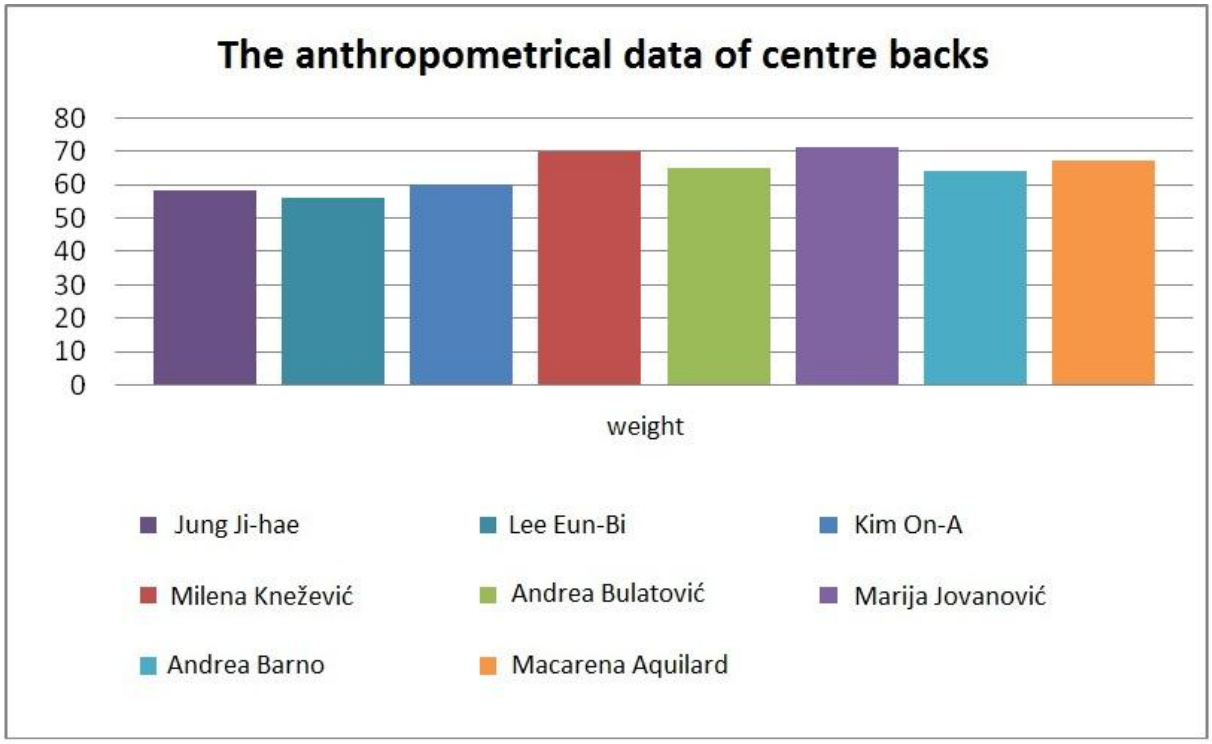
The anthropometrical data of the centre backs

The diagram showing the anthropometrical data of the centre backs faithfully reflects (apart from one or two exceptions) what slight differences there are regarding height and weight in the international leader board. Of the 11 centre backs Lee Eun-Bi is the shortest, at 163 cm, and Marija Jovanović is the tallest, at 182 cm. These two players both represent the organizing-preparing type of centre back which supports my point that height and weight are not of fundamental significance in the game style of the centre back.

The average height of the centre backs is 172.5 cm and the average weight is 63.8 kg.



Pict.1: Height of Centre backs



Pict.2: Weight of Centre backs

The prototypic centre back

The data listed in these tables are the result of calculating an average. With the help of this I will try to describe the "perfect" centre back.

Changing position and crossing are the most common actions of the centre back. However, positioning as a player running in following cross-court runs can also be found in the player's repertoire. The centre back requires a varied scope of movement which means having to be able to execute the necessary actions from the inception until the conclusion of the attack, in any position from right to left winger.

The "perfect" centre back should also acquire and carry out a wide range of faking techniques. The most commonly used should be the dribbling fake both to the right and left side. A complete repertoire should contain various forms of passing and shooting fakes on the ground and from the air as well. Centre backs should use all possible faking techniques against the opponent, with or without the ball, in order to set up a scoring position for themselves or a teammate.

Attempts on goal should be threatening both from the ground and from the air but jump shots should be used most often. Through shots from the zone of both the long and short range shots should be attempted. It is important to be efficient in overarm shots and underarm shots

as well. Based on the table below, in each match the centre back should execute 8 jump shots, 6 overarm shots and 5 underarm and arrhythmic shots, but lay away ground shots, lay away jump shots and delayed jump shots should also appear in the player's technical repertoire.

The prototype centre back should have a close and efficient rapport with the pivot. On average 3-4 bouncing passes, 5 overarm passes, and 1-2 jump passes to the pivot should be performed during a game.

According to the statistics, a minimum of 5 blocks per game are to be executed by the centre back, either side-by-side or supplementary blocking. After sweeping in, the centre back must stay in the defence wall to block the defenders.

I have constructed the prototype centre back to support the work of my colleagues who are engaged in training youngsters to play handball. The data and statistics are only relevant in case of organized set defence.

Table 25: Changing position of the centre back without the ball

Changing position with the left back	343
Changing position with the right back	292
Changing position with the left winger	
Changing position with the right winger	
running in to the pivot position	54
sweeping in/out	24
positional play	184

Table 26: Changing position of the centre back with the ball

Crossing with the left back	106
Crossing with the right back	85
Crossing with the left winger	26
Crossing with the right winger	23
Preparing to the pivot	63

Table 27: Goalshooting of the centre back

Overarm shot	45
Underarm shot	31
Jump shot	69
Delayed jump shot	1
Lay-away jump shot	2
Arrhythmic	2
Lay-away ground shot	

Table 28: Fakes and cuts of the centre back

Changing direction	111
Arm swinging fake	27
Double starting fake	44
Shooting fake (on ground)	15
Shooting fake (in the air)	55
Passing fake	94
Rotation fake	4
Bouncing fake	123
Break through	110

Table 29: Passing to the pivot and blocking of the centre back

Bounced passing to the pivot	29
Overarm passing to the pivot	42
Jump passing to the pivot	11
Side by side blocking	22
Supplementary blocking	18

Table 30: Efficiency

Number of attacks	1194
Goals	133
Assists	135
Break through	39/62
Through-shot	47/131

Practical Application

Based on the data presented above, we may see that centre backs are technically highly skilled players. The majority of them can easily execute 3 or 4 starting fakes and can also determine which one to use depending on the position and movement of the defender. They are also able to apply 3 or 4 types of through shots, blocking after cutting and setting up a position for their teammates. Following this analysis of modern handball, it is clear that centre backs not only have to engage themselves in organizing the game and finishing the attacks but also deal with defensive duties. This means they spend a lot of time on the court which requires endurance, speed and stamina. These qualities have to be developed in accordance with the age of the player.

The methods acquired in leader board sports and the basic features that characterize players mainly determine the coaching of junior teams. We have to develop training sessions and the preparation of youngsters on the grounds of current methods and tendencies of development.

The targets set and the extent of the demands placed upon players must be ascertained. In order to determine necessary levels and be reactively consistent, the environmental factors that affect an individual's development must be taken into consideration and institutional possibilities must be exploited to their full extent.

Peculiarities congruent to a player's age are very important when planning training sessions and choosing coaching methods. The results of scientific research and conclusions drawn from experience typify the development of sporting performance. Naturally, the biological development of the human body plays the most significant part in this. The biologically-determined system of preparation, the training routines and health regulations all affect the adaptability, the capacity for physical demands, the ability to learn techniques of movement and the psychological development of players in junior age categories. In addition, the unique characteristics of this sport also play an important role.

The fundamental effects of training and the extent of physical demands which determine performance, which differ between various sports, are dependent on the construction of programmes of training and preparation, on the choice of methods, and on the selection of athletes. Knowledge of this is an essential condition of being trained to the highest standard.

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The changes in and the importance of the pivot-play in the past 10 years.

Hungarian Handball Federation Hungary

István Gulyas

1. Abstract

Purpose: This study was conducted to compare the line player's positioning, catching, his shooting techniques and how he gains momentum before shooting on target.

Methods: 20 video analysis were attached to the study. The examined matches were from EHF Men's Champions League, and National competitions.

Results: One handed catch: The difference is huge between today's data and the 10 year old ones. One handed ball catches occur 6 times more. We can observe, that there has also been a big change in the line player's positioning. They try to use up as much space of the court(in width) as possible. This way , using up the defending areas on the wings has also doubled itself.

Conclusion: The results support, that the line player's role has gone through a big development, and has become much more important.

2. Introduction

How things have changed in the past decade, how things have changed in handball, especially in the action of line players. The gameplay is constantly accelerating, it is more attractive, and for laymen it is slowly becoming untraceable. However, the dynamics and the number of frequent goals make this sport so interesting, enjoyable and spectacular more than other ball games.

Men handball is forcefully shifting in the direction of power. Nowadays, two metre tall players(100-120kg) play in the international elite. Effective and fast runs, throws and jumps leave athletes ashamed. There are huge fights among attackers and defenders for taking up better positions. Movement without the ball and positioning is becoming more and more important in today's game. Teams' defense work has sped up. Thanks to the physical attributions of the defending players, the left/right backs need more and more support by the line player for the sake of a successful and good finish.

Important jobs of the line player:

- breaking up the closed, jointed defence lines in depth, and interrupting the lateral and in-depth defensive movements.
- stepping out of the defence line, assissting with the ball and distracting the opponents.
- the line player and those players who are moving or running towards the pivot position play a huge role in a successful finish. Of course, this does not refer to the line player only, but to any other player who will occupy the pivot position, because in case of position-switch and multitactical attacks, not one, but two attacking players could get into the pivot position.

2.1 Rise of the pivot position

The pivot play dates back to the 1950's when the 'big-court-handball' was sidelined, and the 'small-court-handball' came into view. The change in size of a handball court created a new attacking strategy along with a new position, the pivot position. Initially they were given static tasks such as creating blocks and free spaces by working themselves into the defence line.
Later on, as we have looked over the development of Handball sport, they became more mobile and more skillfull, more acrobatic.
In the past 10 years, the pivot position have gone through a huge alteration, which I present in my work.

2.2 Attributions of the line player

- Tall, powerful body. Handball is the only sport where the bigger weight is an advantage among the players, positions. Especially when a player already owns the ball and turns towards the goal.
- mobile, dynamic stature
- brave, firm
- has a fierce game concept/interpretation of rules
- steady balance
- outstanding skill for ball catch and ball possession
- tactical discipline

3. Choice of topic

Two reasons played a very important role in choosing my topic

- In my opinion, the line players played an important and determining role in the past ten years. As men, so do women important tactical jobs in attacks. Their roles have become crucial in creating goal shot situations as well as in finishing.
- I have not found professional articles analysing the development of handball from this point of view. It examines them creating goal situations, catching the ball, and furthermore, the most recent shooting styles.

4.Hypothesis

I would like to call your attention to some things, that are very important to me. During the examined ten year time interval, in my opinion, four factors went through the biggest change listed below. I hope that the result of the examined and analised matches at the end of my paper, will support my hypothesis and show a way to the actual trend in the development of the line player.

4.1. The biggest and also the most obvious change can be seen in how line players catch the ball. In most cases, they catch the ball with one hand compared to previous years (2000 and before). All of their assisting movements help them to create a suitable situation for catching the ball properly. This way they can get more chances of faster finishing.

4.2. We can also see changes in building up the impetus before shooting. The regular 1 or 2 steps momentum-gainer is continually taken over by jumping from both legs or diving in.

4.3. Another obvious change is how the players position themselves. We got used to it, that in most cases they try to maneuver in the middle of the defence (the width of the two posts) or 1-1 metre right,left from that position in order to provide free space for other players or finish an action. Compared to this, in today's handball, it is a completely accepted strategy that the line players tend to move between those **1-2 defender** who face the dominant right/left back of the offense.

4.4. In my opinion, another alteration is how players move in depth. It is not odd that players run out up to 10-12metres, who continually take part in building up attacks, or distract the opponent players. It is easier for them to get from one side to the other, where the planned tactical task is to be achieved.

5. Processing of the literature

The background material of my work was assured by a book.

Béla Fekete:

- His book „A kézilabdázás technikája" lists all the technical elements of a line player with outstanding thoroughness. Here I should note, that in the book-list only the title of the books are tagged, as the definitions, which I took over from the descriptive part of the book, cannot be written in any other way.

6. Demonstration of the survey sheet

The range-card I created in an Excel table, clearly depicts the number of shots, ball-catches and positionings during the actual game. The efficiency of the shots taken by the listed technical elements. I observed situatuions, in which the line player played an important role. I recorded only those actions, from which goals or 7 metre shots resulted. The chance of scoring, hundred percent safe to say, was built up by the effective contribution of the line player by assisting, blocking for the right/leftbacks.

I used an ordinary way to analyse the matches. I tried to pick national teams and club teams, which have different handball culture. This way we get a more comprehensive and more real data.

Survey sheet 1. shows during the actual game in the year of 2000 and nowadays

- Where and how many times did the line player position himself at the given place
- The way he caught the ball (with one or both hands)
- How he gained momentum (1 step, 2 steps or jump)
- The number of movements in depth (blocking, moving out to the 9 metre line)
- Passes (from ground, from jumping, or bounced)

Survey sheet 2. also shows during the actual game in the same time interval

- What shooting technique he used

2012.Survey sheet 1.																	
	Place and time of match	*Number of pivot goals*	*Positioning of the line player*					*Catching the ball*		*Building up impetus before the shot*			*In-depth movement of line players*		*Way of passing*		
			Between 1-2	Inside area	Sideway	With his back to the goal	Facing the goal	One hand	Both hands	1 step	2 steps	From stance	With ball	Without ball	Bounced	From stance	From jump
1.	**Atletico M.-THW Kiel 30.09.2012**																
2.	**Flensburg-Hanburg 11.2012**																
3.	**Kielce-Skoje 22.10.2012**																
4.	**Zagrab-Berlin 24.11.2012**																
5.	**Montpellier-Belgrad 25.11.2012**																
6.	**Hamburg-Ch.Medvedi 04.10.2012**																
7.	**Atletico M - MKB Veszprém 14.10.2012**																
8.	**MKB Veszprém-THW Kiel 18.10.2012**																
9.	**Celje- Savehof 13.10.2012**																
10.	**Gorenje – Chambery 24.11.2012**																
	Total																

2012.Survey sheet 2.

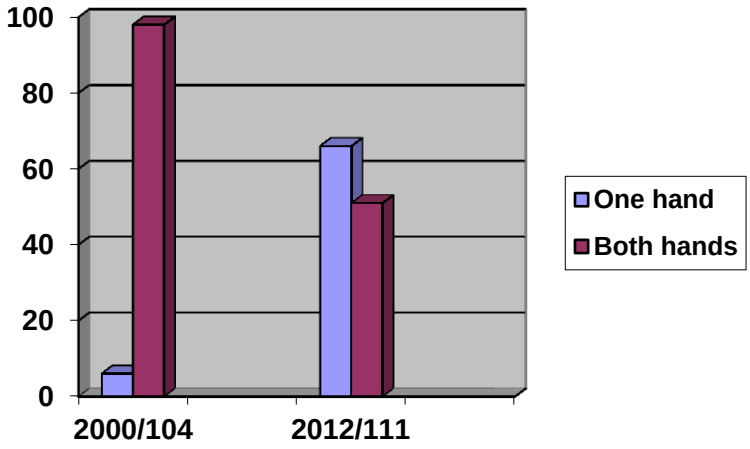
Place and time of match	Number of pivot goals	Shooting techniques of the line player																				Special shooting techniques			
		Opposite direction of the throwing hand												Same direction as the throwing hand											
		Long jump shots		Falling shots		Dive shots		Kempa		Lob shots		Curved shots		„Curved-lob" shots		Long jump shots		Falling shots		Dive shots		Kempa		Lob shots		Curved shots		„Curved-lob" shots		Back pass	Punching the ball	Dive backwards	Diving after a turn
		D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.				
Hungary-Slovenia 2001.Veszprém																																	
Veszprém-Barcelona 2001																																	
Hungary-Slovakia 2001.12.22.																																	
Hungary.Norway																																	
Norway-Hungary																																	
Hungary-Croatia 1999. Egypt																																	
Hungary-Russia 2003 Portugal																																	
Hungary-France 2003 Portugal																																	
Sweden-Russia Sydney final 2000																																	
Hungary-Ukraine																																	
Total																																	

Hint: D.A. Same arm same leg/ D.E. Different arm different leg

7. Conclusion

I wanted to focus „only" on 4 parts out of the plenty of technical and tactical repertoire a line player has. In my opinion, these are the 4 fields where the most changes happened.

7.1. Catching the ball



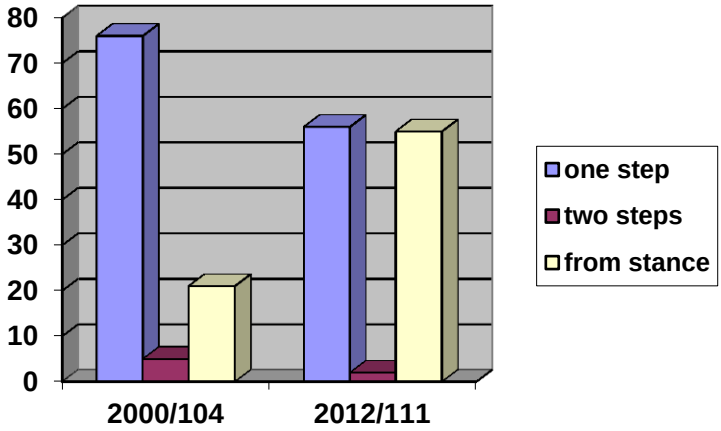
In the period ten years ago we could barely see one-handed catches. Sometimes the defending player grabbed one arm of the line player, therefore the latter had to squeez the ball to his body with his other hand. One-handed catches did not happen on purpose back then.

The facts I have just mentioned are supported by coloumn c, technique of ball catch, Survey sheet 1. On the 10 games analysed, line players or the ones who moved to the pivot position, caught the ball with one hand 6 times out of 104. On 104 occasions the line players received the ball. This means that we can anticipate an average of 1,6 one-handed catches per game (which could also happen by accident).

Two-handed catches were noticed 98 times on the analysed games. The average data is 9.8 per match. Players caught 6% of the balls with one hand and 94% of them with two hands.

In today's handball, the measured data show increadibly different values. 111 times were the ball played to the line player. Out of that, on 66 occasions(59%) was the ball caught with one hand, whilst on 51 occasions(45%) with both hands. The difference between the data today and ten years ago is huge. **We can see a six-fold increase in one-handed catch!**

7.2. Building up the impetus before the shot



In 2000, out of 104 balls:

After one step: 76 shots were taken(73% of all)

After two steps: 5 times, which is 0,5%

Jumps or shots from stance: 21 times, which is 20%.

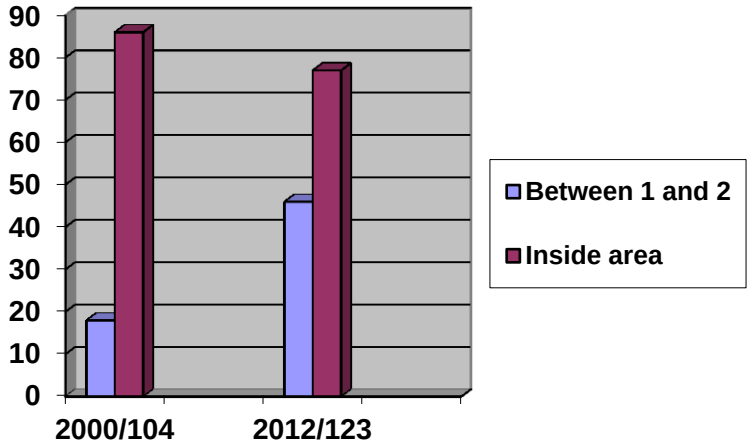
This changed in 2012 as well. Out of 111 balls:

After one step: 56 shots were taken,which is 50%.

After two steps: Ten years ago we could rarely see this way of gaining momentum. Nowadays, this number has further decreased. Out of 111 shots, only twice did the player take two steps before shooting, which is 1.8% of the events.

Jumps or shots from stance: We can see a change in trends here too. Out of 111 situations 55 times did the player jump from stance(49%). This number has doubled.

7.3. Positioning of the line player



The measured areas are the ones between the 1-2 defenders, and the height of the two posts+1metre. The inside defender area is about 5m.

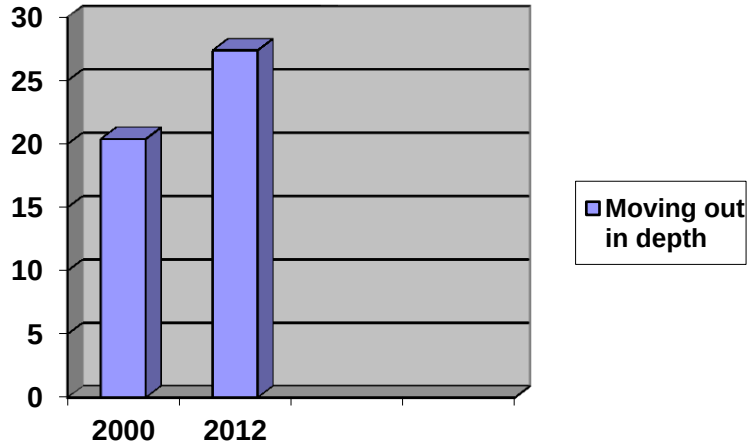
The starting value is again 104, occupied position, out of which 86 times(82%) did the line players position themselves inside the defender area.

The area between defenders 1 and 2 was taken only 18 times(17%) by the line players, so that they finished the attack successfully.

Nowadays the line player takes up a position 123 times, from which a successful attack can be finished. They were 46 times(37%) between defender 1 and 2.

We can conclude that there has been a big change in how line players position themselves. They try to use as much part of the court(in widht) as possible. That's why the number of use of the area between defender 1-2 has doubled.

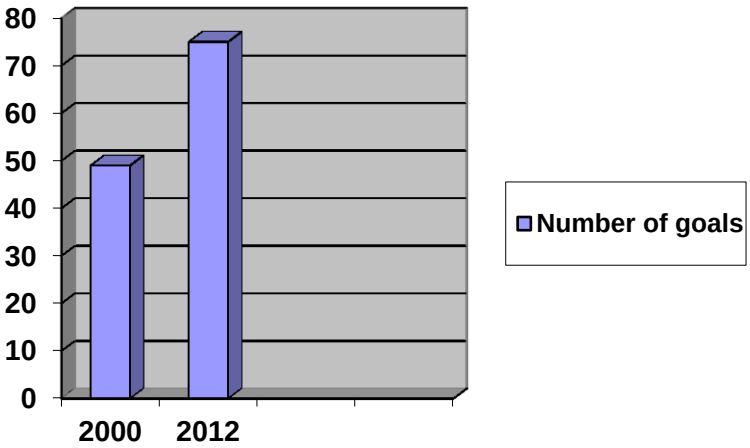
7.4. In-depth movement of line players



Beyond the free-throw area, the line players took up positions 30 times in 10 games where they distracted their opponents.(2000) The average per game is 3. Today's measurements don't show significant changes. In 10 games, 38 times did the line player move out in depth and assisted beyond the 9m line.

I must ascertain, that the measured data at this area did not support the alteration awaited by me. I must note, that in some games, the chosen tactic caused the line players to move out in depth more often than the average shows.

7.5. Number of goals scored by line players



We can see another big change.

49 goals in ten games in the year of 2000. This is 4.9 goals on average.

Concerning 104 actions, this is 47%.

75 goals in ten games (nowadays). This is 7.5 goals on average.
Concerning 123 actions, this is 60%.

If we took into account the number of goals only, we can still say it's a big change.
The changes sketched in the Hypothesis part get relevance in terms of

- the change in type of ball-catch
- gaining momentum before the shot
- concerning the positioning of the line player

However, the alterations aiming at the in-depth motion of the line player did not meet the expectations. There has been an increase in line players moving out in-depth to assisst, but not a significant increase.
The pivot position has become a more important position than ever before. A team who has a skillful line player, has many opportunities strategically.

7.6. Other data

I never thought I would come across outstanding changes in the measured 10 games. The data in the 'special shots' coloumn are worth mentioning. These numbers support the huge development in acrobatical moves. I was not able to record one single special shot taken in a game in 2000. Players have to perform well in champions league games under vast pressure. They scored only 5 times in ten games though. Not a big number, but it is 5 times more than it was ten years ago.

8. Recommendations

Having concluded everything, there is nothing left but to provide professional recommendation with some thoughts and ideas for the next line player generation. The measurements support by 100% that in order to follow the international trend, there have to be alterations in exercises during the training sessions. However, we do not have think on big things.
We can simply change the rules of the support games we have played so far (scorer, ball tag, post handball etc.) so that players are allowed to catch the ball with one hand only.

- In fast break exercises, the player has to catch the ball in the designated area with only one hand and score without bouncing the ball. Using sponge balls could be advantageous in the beginning.
- We can also build in the one-handed catch rule in relay races, fast break relays, pace games.
- Catching different balls after it has bounced(tennis ball, american football ball etc.)

The development of the shooting repertoire has to be started during a player's childhood by ensuring trainings and matches with a bigger degree of freedom. Do not forbid the children practising curved and drawn shots.

Holding individual trainings where the acrobatical exercises can be practised should provide many-sided opportunities.

- performing a somersault, one-handed ball catch then shooting
- Sitting at the crossing of the baseline and 6m line. Shooting from this position from both sides
- Catching the ball in hardened situations(lying, standing on one foot, checking etc.)
- Volley shots from stance, with different landing techniques.

I think the positioning is the easiest of all, because a few changes in attacking tactics could provide a lot more opportunities for our skillful and agile line players.

- The line player checks all time with defenders using his lef/right shoulder. Opposite to them, a player is dribbling. On a given sign one of the defenders steps out. To take an advantage of this, the attacker bounces the ball to the line player.
- The line player blocks the side from which the defender tries to snatch the ball away, and tries to catch the ball above the penalty area.
-

9. Cue

In my work, I tried to give a clear picture of the increadible progress of this sport. Even a small part of this single pivot position shows, how diversified and complex properties the rising handball society has.

Coaches always have to examine and monitor, or in some cases come up with new techniques, opportunities of progression.

10. Appendix

- Bibliography
  Béla Fekete, László Kovács: 'Handball'
  Béla Fekete: 'The technique of Handball'
- Presentation of the filled survey sheets.

2000.FELMÉRŐ LAP 1.																	
	Mérkőzés Helye, ideje	*Beállós gólok száma*	*Beálló helyezkedése*					*Labdaátvétel módja*		*Lendületszerzés*			*Mélységi kilépés*		*Bejátszás módja*		
			1-2 közé	közép (2 kapufa magassága)	oldalt	háttal a kapunak	szembe a kapuval	egy kéz	két kéz	1 lépés	2 lépés	helyből	labdás	labda nélküli	Pattintott	Talajról	Felugrásból
1.	Magyar O.-Slovenia E.B. Selejtező 2001. Veszprém	6	0	11	8	6	1	0	11	10	0	1	1	6	1	8	1
2.	Veszprém-Barcelona 2001. Veszprém	5	3	10	8	6	0	1	13	10	0	4	1	1	0	10	3
3.	Magyar O.-Szlovákia 2001.12.22.	5	1	7	6	6	0	0	11	8	1	3	0	3	1	8	2
4.	Magyar O.-Norvégia	5	0	10	5	4	1	0	10	6	1	3	0	4	4	2	3
5.	Norvégia- Magyar O.	3	0	7	1	3	1	0	5	3	0	2	0	4	0	3	1
6.	Magyar O.- Horvát O. 1999. Egyiptom V.B.	4	3	8	5	5	0	0	8	8	0	2	0	4	4	6	0
7.	Magyar O.- Orosz O. 2003. Portugália VB.	7	1	11	8	4	0	1	11	8	0	3	0	2	3	5	4
8.	Magyar O.- Francia O. 2003. Portugália VB.	3	3	4	4	1	1	0	6	4	0	2	0	2	1	4	1
9.	Svéd O.- Orosz O. Sydni Döntő 2000.	8	4	11	5	9	2	2	14	12	0	0	0	0	2	9	3
10.	Magyar O.-Ukrajna Budapest 2002.	3	4	7	4	5	1	2	9	5	3	1	0	2	4	5	1
	Összesítés	49	18	86	56	49	7	6	98	74	5	21	2	28	20	60	19

2012.FELMÉRŐ LAP 1.																	
	Mérkőzés Helye, ideje	*Beállós gólok száma*	*Beálló helyezkedése*					*Labdaátvétel módja*		*Lendületszerzés*			*Mélységi kilépés*		*Bejátszás módja*		
			1-2 közé	közép (2 kapufa magassága)	oldalt	háttal a kapunak	szembe a kapuval	egy kéz	két kéz	1 lépés	2 lépés	helyből	labdás	labda nélküli	Pattintott	Talajról	Felugrásból
1.	Atletico M.-THW Kiel 2012.09.30.	10	7	12	9	4	2	11	4	5	0	6	0	0	5	3	4
2.	Flensburg-Hanburg 2012.11.	6	1	7	6	1	0	2	5	3	0	4	0	9	1	4	2
3.	Kielce-Skoje 2012.10.22.	11	5	9	10	4	0	8	5	7	1	6	0	6	5	9	1
4.	Zagrab-Berlin	5	7	2	4	4	1	5	4	5	1	4	0	7	2	7	1
5.	Montpelie-Belgrad	8	4	9	10	2	1	8	4	7	0	4	0	6	6	5	1
6.	Hamburg-Cs.Medvegyi	4	5	7	11	0	0	7	4	6	0	4	0	6	6	2	3
7.	Atletico M - MKB Veszprém	9	3	6	8	3	0	7	4	3	0	9	0	2	6	3	2
8.	MKB Veszprém-THW Kiel	6	6	8	11	2	1	6	8	5	0	8	0	0	2	8	4
9.	Celje- Savehof	8	2	9	8	2	1	5	6	7	0	5	0	1	4	5	2
10.	Gorenje - Chambery	8	6	8	13	0	1	7	7	7	0	5	0	1	7	8	0
	Összesítés	75	46	77	90	22	7	66	51	56	2	55	0	38	43	54	20

2000/FELMÉRŐ LAP 2.																															
Mérkőzés helye, ideje	Beállós gólok száma	Beálló játékos lövésmódjai																													
		Dobókézzel ellentétes irányba														Dobókézzel azonos irányba													Különleges lövési módok			
		Beugrásos lövés		Bedőléses lövés		Bevetődéses lövés		Légi dobás		Ejtés, ívelés		Pörgetés		Húzott lövés		Beugrásos lövés		Bedőléses lövés		Bevetődéses lövés		Légi dobás		Ejtés, ívelés		Pörgetés		Húzott lövés		Hátra húzás	Labda ütése	bevetődés hátrafelé	Visszafordulás utáni bevetődés
		D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.				
Magyar.O.-Slovenia 2001.Veszprém	6	3	1	1	0	1	1	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Veszprém-Barcelona 2001	5	0	3	0	0	0	1	0	0	0	0	0	0	0	0	1	2	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MAGYAR O.- Szlovákia 2001.12.22.	4	0	2	0	1	0	3	0	0	0	0	0	0	0	0	1	1	0	0	2	1	0	0	1	0	0	0	0	0	0	0	0	0
Magyar O.- Norvégia	5	0	3	0	0	0	2	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
NORVÉGIA - MAGYAR O.	3	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magyar O. Horvát O. 1999. Egyiptom	4	0	2	0	4	0	2	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magyar O.- Orosz O. 2003 Portugália	7	0	1	1	2	0	3	0	0	0	0	0	0	0	0	0	2	0	2	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Magyar O.- Francia O. 2003 Portugália	3	1	2	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Svéd O.- Orosz O. Sydni Döntő 2000	8	0	3	0	2	0	4	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	1	1	2	0	0	0	0	0	0
Magyar O.- Ukrajna	3	2	3	0	1	0	1	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
Összegzés	49	7	21	2	10	2	19	0	0	0	1	0	0	0	1	8	10	3	5	4	3	1	1	2	1	1	2	0	0	0	0	0	0

2012/FELMÉRŐ LAP 2.

Mérkőzés helye,idelye	Beállós gólok száma	Beálló játékos lövésmódjai																															
		Dobókézzel ellentétes irányba														Döbókézzel azonos irányba														Különleges lövési módok			
		Beugrásos lövés		Bedőléses lövés		Bevetődéses lövés		Légi dobás		Ejtés, ivelés		Pörgetés		Húzott lövés		Beugrásos lövés		Bedőléses lövés		Bevetődéses lövés		Légi dobás		Ejtés, ivelés		Pörgetés		Húzott lövés		Hátra húzás	Labda ütése	hátrafelé bevetődés	Visszafordulás utáni bevetődés
		D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.	D.A.	D.E.				
BM Atletico Madrid - THW Kiel 30.09.2012	**10**	**0**	**1**	**1**	**1**	0	**2**	0	0	0	0	0	0	0	0	**0**	**3**	**1**	**2**	**2**	**2**	0	0	**1**	0	0	0	0	**1**	0	0	1	0
Flensburg - Hamburg 25.11.2012	**6**	0	**1**	0	2	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kielce - Hc Metalurg 2012.11.24.	**11**	0	**2**	0	**1**	0	**5**	0	0	0	0	0	0	0	0	0	**2**	0	0	**1**	**2**	0	0	0	0	0	**1**	0	0	**1**	0	0	0
Croatia-Zagreb- Fuechse Berlin2012.11.24.	**5**	**1**	**5**	0	0	0	**1**	0	0	0	0	0	0	0	0	0	**2**	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Montpellier - Belgrad	**8**	0	**5**	0	**1**	0	**1**	0	0	0	0	0	0	0	0	0	**3**	0	**2**	0	**1**	0	0	0	0	0	0	0	0	**1**	0	0	0
Hamburg - Cs.Medvegyi	**4**	0	**2**	0	**1**	0	**3**	0	0	0	0	0	0	0	0	0	**1**	0	**3**	0	**1**	0	**1**	0	0	0	0	0	0	0	0	0	0
Atletico - Veszprém	**9**	0	**2**	0	**2**	0	**3**	0	0	0	0	0	0	0	0	**1**	0	0	**2**	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0
Veszprém-Kiel	**6**	0	**3**	0	**3**	0	**3**	0	0	0	0	0	0	0	0	0	**1**	**1**	**1**	0	0	0	0	0	0	0	0	0	**1**	0	0	**1**	0
Celje-Savehof	**8**	0	**1**	0	**1**	0	**2**	0	0	0	0	0	0	0	0	0	**4**	0	0	0	**3**	0	0	0	0	0	0	0	0	0	0	0	0
Gorenje-Chambery	**8**	0	**4**	0	**1**	0	**3**	0	**1**	0	**1**	0	0	0	**2**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Összegzés	**75**	**1**	**26**	**1**	**13**	**0**	**23**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**3**	**1**	**16**	**3**	**10**	**3**	**9**	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**2**	**3**	**0**	**2**	**0**

István Gulyás

EHF Master Coach Course undergraduate

The Handball Knowledge Transfer through the Meme theory

The "new" approach of the further education of handball coaches and preparation of players in the 21st century

János Györfi

Hungarian Handball Federation, Hungary

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Introduction

After acquiring my Sport Coach degree specialized in handball (2006) I was motivated to achieve the European Master Coach level **to be able to bring knowledge into coach and further education of handball from interdisciplinary areas** that can help in deeper understanding and more efficient practical working in the sport.

I was thinking about the **further education opportunities** of those coach colleagues who have already had hundreds of outstanding matches on the sideline and already have a reasonable knowledge on handball so that it is enough to talk only about the strategic and tactical essences of the sport – as they are all clear with the basics – and know the possible moves in typical situations but who also able to recognize the passed away chances.

As the president of the Hungarian Handball Federation's Coach Committee I had the chance to work on the further education of handball experts – where we might have some achievements – however, we must think about the possible improvements all the time.

To the education of the leading handball experts we could plug in new methods and new knowledge from the new areas of sciences but first of all, we should encourage the developments of new and innovative approaches. I believe that the area of **the Meme theory** and the achievements of the network theory can be plugged in, just as some elements of the chaos theory, the decision sciences or the system theory.

The fundamental target is to make it more understandable, get quicker decisions and achieve a quicker and more intuitive understanding on the essences. The new type of analyzing the situations can provide impulses for the transfer of the knowledge and the **"traditions"** of other team sports.

I believe that **the applicability if the Meme theory** is not only important in he case of interactions between players (for example: cooperation of two or three players, tactical bases, defenders possible reactions) but during the **whole process of the knowledge transfer** as well. The new approach can influence our educational and pedagogical works but we still have to know that this is rather a **return** to our most precious national and international **traditions**.

According to László Mérő's (2004, p.98) definition **"Memes are the smallest units of thoughts that have, even individually, a reasonable meaning, which cannot be detected genetically and which can be copied confidently and productively enough from one men's mind to the other."**

We could make the process of the knowledge transfer quicker for the young coaches or even for the players by **making them see the correlations and structures of "material – energy – information"** and we could synchronize the modules and elements approaching from the **style of play** – from the whole – from the targeted national style of play and we could strengthen the educational – pedagogical – ethical bases with renewed didactical methods.

Of course, **innovative IT software and programs will support** the analysis of the tactical situations in the future because sport experts can understand the essence by analyzing and modeling the situation and based on the **visuals (rhythms, spaces, dynamics)** and they can see it as a complex phenomena. In the later stages of the work it is necessary to set up and record national **handball meme collections** (basic situations, basic correlations, structures, connections) with the help of **3D technological solutions and methods** combining them with the existing techniques like video and modeling programs.

As for the visual presentation and knowledge transfer, I suggest the creation of a video or an on-line digital conference system that I have managed to try in the recent years and I introduced it to the Hungarian sports practice by organizing 75 conferences like this. This method is tested and it saves costs because no travel is needed.

The other factor of motivation in my job was to find how to make more efficient and understandable and how to show differently the needed **material for the young coaches or players (like Centre backs) and how to quicken the pickup of the game situations by new audiovisual and IT methods in order to help them choose the best solution form the possible decision alternatives.**

For my job I took some ideas from the religious and philosophical background of the eastern **budo martial arts**, which mental base – according to my estimation – would significantly help the modern, 21st century renewing of sports. Sports have preserved

their artistic nature in the traditions of budo. During its transfer they are setting out from **simulated basic structures**. We try to quicken the decision-making process by creating starter basic situations and practicing alternatives of solution situations in order to let the most productive decision be chosen.

The **technical repertoire** in the modern team sports is not that clearly analyzed than in the eastern martial arts and the **structures of the basic situations** are not determined and modeled enough but the world of IT and the modern technical inventions would provide the opportunity for that.

In the eastern martial arts the understanding of the **style** helps the acquisition in the early stages of the learning. This is an extremely complex material and a concept only identified by descriptions; and this way **only appears in the very late stages of the European knowledge transfer**. In the transfer there should be an attempt for the understanding from this way.

The style of the Hungarian handball is well known and practiced by all of our experienced coaches. We should attempt to correct our defects and foster the quicker understanding by plugging in new visual tools and the informatics, matching them to the Japanese **satori** practice and striving to analogical understanding.

It takes long years to become a **structure-sighted** coach – of course, there can be genius trainers or players but that is exceptional. For the training of the new coach generation we should try new ways.

Beside the specialized literature of the martial arts, my sports science connections to the **Japanese budo universities** also supported my work.

Dr. Toshinobu Sakai *(Tennodai, Tsukuba-shi, Ibaraki-ken, JAPAN)* ***leader of the BAMIS – integrated body and mind science centre*** (*Graduate School of Comprehensive Human Sciences Doctoral Program of Health and Sport Sciences Tsukuba University, University of Tsukuba) honored us at one of our conference, called Differently about Sports (*Budapest, Hotel Aréna 2010-10-20.), *and explained his results to the Sports Innovations Committee of the Hungarian Sports Science Association.*

My work is an experiment to set the foundations of a new theoretical method and to set up a to do list, hoping that I may add a few new aspects to the values of the Hungarian Handball and to the educations and further educations of the handball coaches.

It is important to transfer the oral traditions and instructions of the Hungarian handball more efficiently because the **"memes, as the essences of the thoughts can remain for a long time, even for generations."** (László Mérő, 2004, p. 99)

Basically my work would like to support the set up of the "Master – Follower" relationship by facilitating the transfer of the behavior and the decision-making patterns between interpersonal relationships.

However, I know that this kind of analyzing, model-setting and implementing activity can only be started via these very lines that I am writing.

The review of the analyzing process

Antecedents and preparation: Sport expert further education videoconference (25 occasions at 7 places); **testing the technical arrangements of an on-line conference** (Cooperation and synergies in the changing Hungarian sports and Knowledge development in the 21st century – I. digital sport conference Budapest, House of Hungarian Sports, 2011. December 1. 10:00 – 13:00.); in 2012, 2011 and 2010 cooperating with the National Sports Association and with the higher educational institutions dealing with sports expert programs, by organizing regular further educational programs for handball experts. For instance:

- Best exercises of handball: International trends and national development ways – László Skaliczki, head coach of PICK Szeged, ex national head coach, Master Coach May 25th 2011. 10:00 – 14:00 National video conference
- Modern further education possibilities in referee training Béla Cserpes, president of the Referee Committee of HHF, May 25th 2011. 10:00 – 14:00 National video conference

- Trends of modern Handball, possibilities of education – Csaba Konkoly, head coach of the Győri Audi – ETO April 28th 2010. *10:00 – 14:00 National videoconference*

- Query of sport coach colleagues (in writing) – **verbal memes**
- **Interview with Sakai Tosinobu** (Cukuba University, Japan)
- **Recording during moving** from the view of a right, left and center backcourts **with a head camera**
- Recording the basic situations of handball by **using 3D technology**
- Recording with traditional video techniques (VHS) **from a fix point but not** from a bird's perspective (no higher than the height of the court). The fixed point should be at the **longitudinal axis of the court, behind the center back, 17 meters from the posts.**
- Setting up an educational **matrix** and suggestions for recording a meme collection (connections between 2-3-4-5 player)
- Overviewing **the specialized literature**
- The next step that still should be worked out: Creating and programming a **3D handball software** so you could have an educational software helping you looking around the basic situations but it would still require further capital.

Applied technical background and method

- **Normal video record (not just a head camera but a studio quality equipment)**
- **Head camera**
- **3D stereoscopic recorder and display system**

3D stereoscopic display system

The stereoscopy is a kind of imaging method that can help you enhance the illusion of space in a picture. The stereoscopic vision is realized in our everyday life that the two slightly shifted pictures, seen by our two eyes, is processed in our brain in real time and it is merged together. So we show two pictures shot from the two slightly shifted point to each eyes and then the feeling of the virtual deepness is formed.

Description of methods and tools:

Passive circular 3D display system:

Depolarization free projection screen (Silver screen)

2 projectors

Circularly polarized filter pair

A high-performance PC that is capable of projecting 3D and displaying special graphical features

Circularly polarized 3D glasses

Active 3D displaying system

Any kind of projecting surface (possibly a light surface in a darkened room)

1 DLP projector

A high-performance PC that is capable of projecting 3D and displaying special graphical features

Active locking 3D glasses

For shooting stereoscopic videos

A 3D camera matching to the record's needs

Table 1: 3D system

Sports Art – Martial Art – Spirit of budo

The competitions of the modern Olympic games still preserve some ancient marks (the Olympic Flame, points for the execution, the aesthetical joy) but the sport of our days has completely changed so its methods of analyzing have changed as well.

J. Huzinga already defined the separation of the sport from the cult and the celebration: ”In the life of the modern society the sport is actually running beside the flow of culture, **it takes place out of it. In the archaic cultures, the competitions were the part of the holy ceremony** and the sacred and salutary actions were indispensable. In the modern sport, this interior correlation among the sports and the cult disappears there is a total lack of devotion. It does not have the organic connection with the community itself anymore.” (Huizinga 1990. 207. p.). It actually lost its aesthetical concept at the beginning of the modern Olympic Games. The idea of considering the sports and the arts as both of them are the essential part of the culture and they are not far from each other is originally Greek in addition, the father of the modern Olympic Games, Baron Pierre de Coubertin also shared this idea.

The spirit and the conception of the ancient cultures possibly survived for the longest time in the spirit of the budo. After ending the wars they lived on and they live for the longest within the pacifying martial arts. In some cases it may happen that some of them stand still until today so we started a research with the Hungarian Budo Culture Forums and with the help of their leader, Abe Tetsushi about the measurements of the positive effects of sports (like change in behavior, stress resistance, mental characteristics and decision-making skills). We cooperated with the excellent researchers (**Prof. Sakai Toshinobu**, Mori Shintaro, Kiryu Shusaku, Arita Yuri) of the prominent Japanese university, called **Tsukuba University**. We had several research topics (for example: The body shape, the physical condition and the personality of a kendo athlete – Comparison of kendo athletes with ordinary students – The kihon and the dosas and the amount of exchanging energies during practice – Ki energy physiological impacts in the aikido, uniting the body and soul) in order to adopt the educative and ethical effects of sports into the Hungarian conditions. During my work, I managed to get familiar with the **traditional concept** of sports, which is significantly different from the European ones. It showed me excellent examples for

refract lines of motions to the smallest reasonable elements, while it still considered sports, as an art.

The Bujutsu marks fighting techniques that durably merged with some ethical contents thanks to the tenets of the Zen. The focus was on the concept of letting go your fear from death by martial arts but during the centuries (After 18th century, AC) it has changed. The goal was not to beat your enemy anymore but to beat your own self. That has become the new goal. So the goal is to make people get familiar with their own inner correlations and via practice improve their personality to perfection. Hard practice makes you free from the slavery of yourself. The Budo helps you create the balance between yourself and your environment. The Route (do) teaches you to know and control yourself. The meditation is the school of attention and its consequence is being an observer. The opportunity of the martial art is to achieve the meditative status and to exist in that. While you acquired the techniques, the respect of your opponent, the respect of place of practice and the respect of your Master also got acquired. The assertivity and the impulsivity describe the training not the rough spirit (psychoticism). The features of the fight (bujutsu – sei), the martial art (bujutsu) and the religious features (shukyo – sei) complete each other.

The **aesthetical features** (shukyo – sei) were extremely important. The fighting arts (bugei) raised the fighter to "moral leaders", which was mainly because of the educational features (shukyo – sei). The bujutsu has changed related to the early wartime period. You acquire a technique to learn how to reify the higher elements in yourself and to improve the morality (justice, heroism, sympathy politeness honesty). The key is the way you form your character, which is marked by the expression rei that also means politeness, decency, respect and the observation of the etiquette as well. Rei means respect and peace in one time.

In other words, **you have to unite the technique and the theory (*jiri- itchi*)** during the practice.

The bugei is the art of fight and the geido is the way of fight. This aspect has remained among the traditional keeper schools and trends. The consubstantial idea of body and soul was forced back and also disappeared in many a place, while the martial arts have become sports.

During the years many different types of schools were formed. For instance, Uesiba Morihei (1883 – 1969) founded the **aikido**. Within the expression of aikido, the **"ai"** means meeting, harmony, contact and union; the **"ki"** means energy, power, vibration, and life essence that is the power influences everything; while the **"do"** is the spirit route. The main principle of the aikido is the **miszogi**, which is the purgation, which provides both physical and energetic clearance as well, which is the result of the kokyu practice that flows the **ki**. The clarity of the emotions and thoughts is considered to be one of the basic conditions, which comes from the honest and completely participated trainings and it makes your mind light and calm. Not only the motion lines but also the virtues of honor, ethic and justice have to be practiced by the "athletes". The hard practice of the motion lines never divides from the virtues and from the aesthetical and heroic aspect of the motions.

The founder of the Kódókan Judo (the place teaching the Route) was Kano Dzsigoró who was also in connection with Baron Pierre de Coubertin because he was the first Asian member of the IOC. Kano worked out the "route of mildness" – and introduced budzsucu into the education – because he knew perfectly the essence of the philosophy of the martial arts: There is no technique and no practice without moral and mental development. There is no execution without the consideration of the proper decision making points.

What is called budo?

"First and foremost, we have to start with the exact meaning of budo. There are several types of the martial arts in Japan, however the Japanese Budo Association (*Nihon Budó Kjógikai*), uniting different groups of martial arts, has only nine branches. Some examples for the nine branches are the **judo, kendo, sumo, karate or aikido.** The budo expression today is used, as the summarizing name of these similar, martial like branches in Japan. After all, I would like to analyze the budo expression itself from closer.

The mark of "bu" of "fight" has several definitions and now I would like to deal with two of them. One of the definitions is to push forward to beat the opponent with a weapon in the hand. According to a different explanation it has the meaning of take control of the opponent' power. According to the second definition the true nature of the "bu" or the "fight" is about helping other people by overcoming the martial

activities of those who have harmful intentions. This is not about one of the definitions being true or false. The different definitions do represent the aspects of different periods. In order to express the cultural aspects of the martial arts that developed through times. After the beginning of the modern era in Japan (1868) they connected the "bu" prefix with the "do", meaning "route". This is why they call this kind of branches budo. Before that they used the expression of "budzsucu" or "martial techniques" for this reason." Sakai Tosinobu (Cubuka University, Japan)

Adaptation opportunities of budo – Written summary of the interview with Prof. Sakai Tosinobu

"Bringing up solid souls is in the focus."

Sakai Tosinobu (Cukuba University, Japan)

Our fundamental goal is to find a solution against the demolition of the consciousness. The body is under the control of the mind so the body and the spirit are inseparable from each other. You cannot form your mind artificially by yourself; anyhow you try to control it directly.

The modern martial artists tried to approach the spirit through the body. They deepened the spirit in themselves by strict practice and through physical exercises. As the mind can affect the body, basically they tried to control the spirit but they tried to achieve it through the body.

The theory of the union of body and spirit is applied to the consciousness maintained against the enemy in the real, life-and-death battlefield situation. So the focus should not be on the connection with the enemy but **on your own self.** We can say that **the goal is to set up a firm consciousness** that can stand still even in a lethally sharpened situation.

The modern budzsucu's practical efforts have two completely different aspects: one of them is the consciousness maintained against the enemy that was in connection with the Zen Buddhism, while the other is the **moral character**, which was based on the Confucianism.

It was **Kanó Dzsigoró's** method to find a way out from the critical Japanese period, so he **focused onto the moral spirituality** and he also created a role for the budo in

the education, as the tool of forming personality. At the beginning of the modern era Kanó Dzsigoró's renewed budo took a solid root into the society, as a device for personality development.

In the new Japanese high school curriculum, introduced in 2012, budo has become a core course; however, it was an elective before. The goal of the modification was to make the Japanese people, living in the globalizing world, realize their cultural values through the practice of budo.

In the scientific world a large-scale program has been commenced as well. This sees the tool in the budo that shows the way to the solution of the problem of the falling rate of physical and mental performance of the youngsters and of the problem of our stressful world's depression.

In the Cukuba University, a four year planned project, called **Body and Mind Integrated Science,** has been started under the topic of "sports innovations for developing a solid consciousness". The goal is to approach the question from four different directions – from **sports medicine, from budo and research of other motions, from cognitive neuroscience and from the view of applied sports science** – in order to contribute to the solution of the problems coming up in the modern society.

The fundamental target is to set up the same traditional method in the modern society as well that tries to provide the unwavering consciousness through budo. Its modernity is based on the fact that as the part of the interdisciplinary approach also the budo received a role and that the first state of spirit the development of the firm consciousness, being ignored by Kanó Dzsigoró at beginning of the modern era, is now in the focus."

The summary of the interview with the project leader of the BAMIS (Body and Mind Integrated Science) Sakai Tosinobu (Cukuba University, Japan)

The **kata**, practiced in several branches **– k – possible situation practice against imagined opponents** – beside the technical practice it deepens the practice rooting on old ethical basis. Nowadays we usually only practice the techniques and the tactics. I suggest it for reconsideration to reach the minimum level of the adaptation that can be fit to the European principles. We should not only give the information but also the

structured knowledge and the real decision-making help even if we are also on the way of looking for the wisdom of our sport...

So my work has three targets:

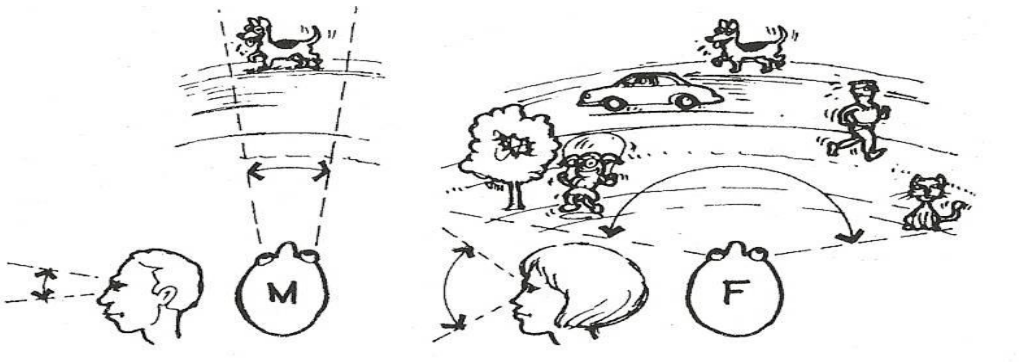
- Introduce **new recording techniques** that can help to **quicker and more intuitive pickup!**
- Beside the technical and strategic practice, always present the **educational aspect** in the trainings and **let us always continuously improve our player's decision-making mechanism by our wisdom, our structured knowledge and our heuristic vision of the world!**
- **Improve our players by establishing match like modules and decision games in every workout – in a way that they can understand as well – and execute them with the maximum speed!**

Interdisciplinary areas concerning different analytical methods

Seeing and stereoscopic vision

The human eyes' angel of view is around 170-180°. Seeing supplies two different tasks: beside detecting and recognizing objects they enable to carry out actions on them, however, already in the detecting part significant differences can be determined for instance, the differences between the male and the female players.

Zoltán Marczinka writes this in his presentation about the males and females field of perception: **"The difference in seeing between males and females has developed according to the division of labor.** Thanks to the collecting, child protecting, family home carrying and establishing role more taps and rods were developed in the **women's** eyes so **they have a better peripheral sight and they can detect the happenings beside them better.** While **the men's** hunting, predatory and life sustaining role provided a **tunnel vision** for them. **Their field of view is rather narrow and they mostly can notice that they exactly looking at but they can see in the deepness better.**

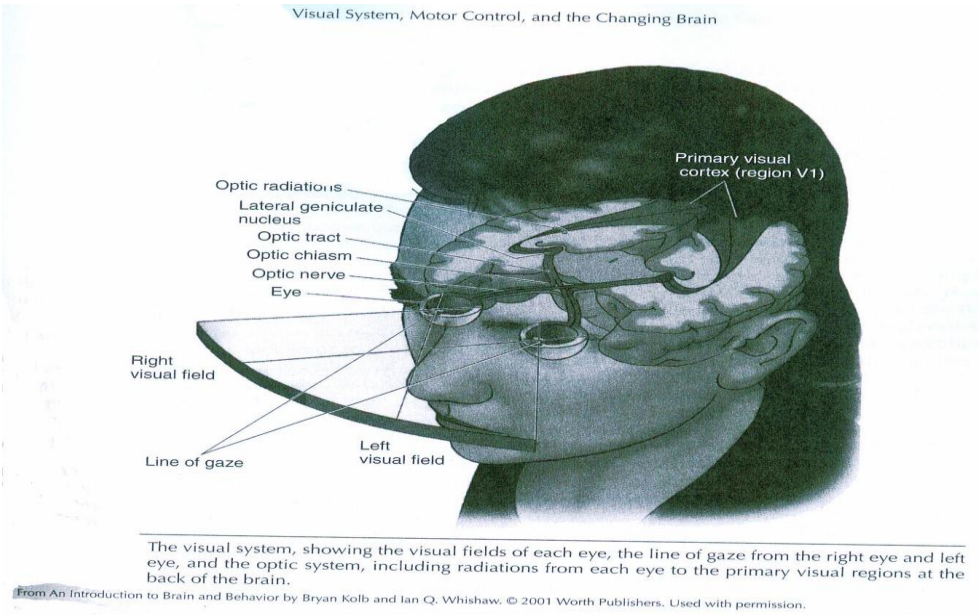


Field of vision of male and female

So female handball players can look through the whole court better on its whole width and they react more sharply to the actions at the edge of the field of view. A technically well-skilled female playmaker can confidently shoot the ball with her shooting hand to the same side winger, while she is looking to the goal. **Men are usually better in targeting they make fewer mistakes in attempts requires series of shots** or in keeper warm up exercises. **Thanks to their stereoscopic vision they estimate the power of shooting and the passing distance and they also feel playing with the pivot better."**

Sports expert further education series III. (2011) National Sports Association, Budapest

Zoltán Marczinka: A női és férfi kézilabda játékosok közötti különbségek a sportági felkészítésben 133 – 142 p.



Joan N. Vickers, PhD (2007, p.19): Perception, Cognition, and Decision Training - The Quiet Eye in Action.University of Calgary

Help of patterns – help of cognitive phycology

Cognitive phycology is a tendency of the phycology, which has been developed from the experimental phycology and today it is considered to be an individual science. As for its essence, its objective is the human cognition and it deals with the question that how the knowledge is formed inside of us and how is it related to the real world.

The cognitive neurosciences have developed different object recognizing tests, which have the result that 50 milliseconds are enough for our brain to be able to categorize correctly the showed up object, despite the fact that during this time it is still not truly realized what we have exactly seen. Quick categorizing of different objects is carried out without even having a feedback from that certain area of our brain, which is responsible for the cognitive processes.

The pattern concerns cognitive structures, stored in the memories, which are the abstract representation of the relations of the real world and the objects and actions. So processing based on the patterns is like looking for the most suitable pattern for the information incoming to the memory.

Markovics Klára: Az információkeresés és -feldolgozás szubjektív tényezői a döntéshozatal folyamatában - különös tekintettel a vállalatfejlesztési döntésekre e - tudomány 2006 / 3. szám II – 7 p.

Mihály Gáspár depicts the role of patterns like this:

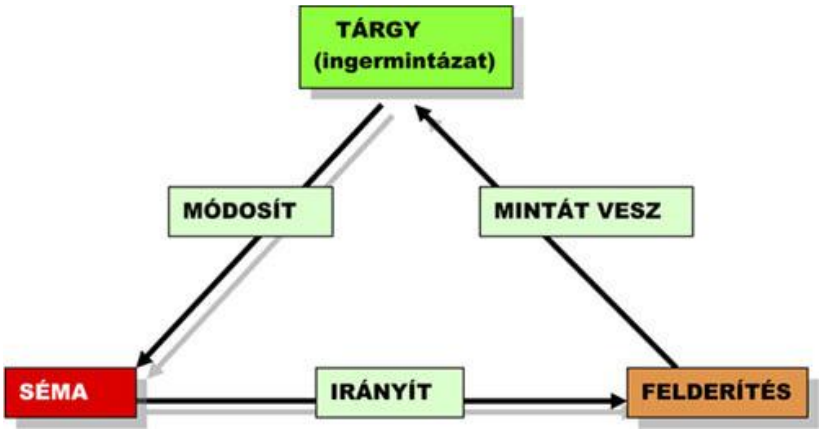


Fig. 1: Gáspár Mihály: Sport és pszichológia, test és lélek *A séma működési vázlata*

Source: http://sek.nyme.hu/_layouts/1038/Sport/Nadori-Dancs-Retsagi-Ekler-Gaspar%20-%20Sportelmeleti%20ismeretek/sportelmelet.html#d5e2688

Incorrect solutions applied in crises – The characteristics of mistakes

Dealing with problems incorrectly has basic types (Watzlawick – Weakland – Fisch, 1990)

- They try to achieve the solution by pretending that there is no problem at all: ***act would be needed but no one acts.***
- They try to change a problem, which is actually impossible to change or does not even exist: ***so they act when it would not be necessary.***
- **They act on the first level when the case would require a higher level action or they are trying a higher level action but it would be enough to act on the first level: so they are on the *wrong level.***

The mistakes of players and coaches can be categorized according to these three groups. It can be undoubtedly determined for example in chess, in a certain situation grandmasters see only 1.8 alternatives generally, while those who are behind them hierarchically see more, 4 or 5 alternatives (László Mérő, 2001). This is why it is worthy to implement new technological opportunities (like head cameras) into the microanalysis of handball decision analysis in order to reach a higher level of reporting through common analysis.

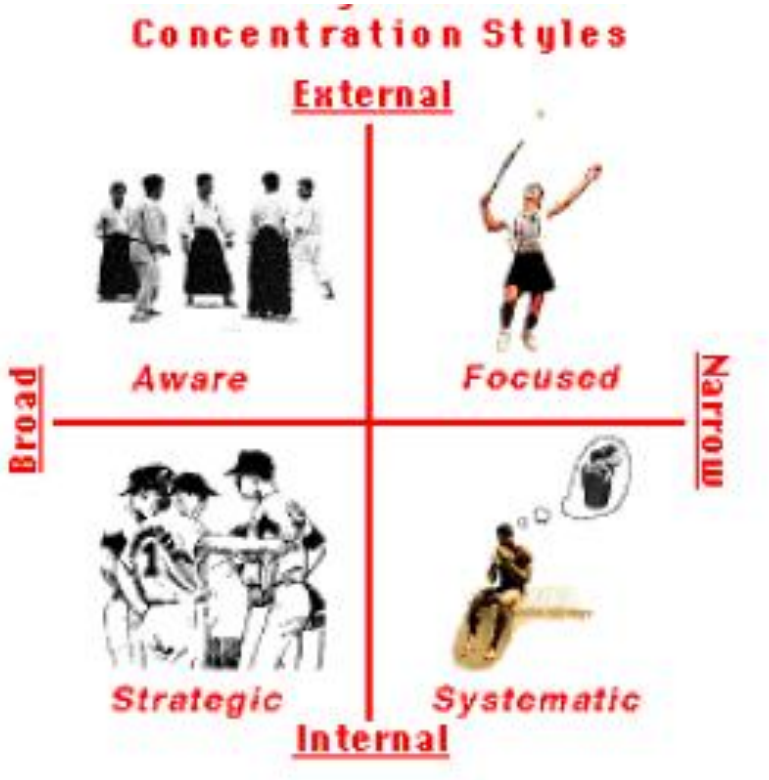
About 80% of the latency period of reactions is about recording and processing the signs and only 1/5 of that is about the kinetic answer and after reaching a certain

technical knowledge the attitude of the cortex dynamism, considered as decision time, comes into the fore. In the decision process the time ratio – due to the shared attention – takes a rather large part so the speed, the accuracy and the propriety of the decision significantly influence the quality and the result of the activity.

When you analyze decisions – due to the complexity of the behavior – it is necessary to analyze the various multilateral factors contained in the decision. In the analysis, **the available time, the level and quality of mistakes and the level of attention represent an outstanding role.**

Attention and Interdisciplinary style collection (Advantage Certification Program)

Bob Nideffer observed that the **quality of attention** is what matters the most.



Source: http://www.qualifying.org/redesign/about/tais.php

The fundamental goal is to improve the predictability. Bob Nideffer examined external and internal characteristics through a 144-question test (TAIS test). Nideffer describes 4 styles. The attention and concentration focus is divided to dimensions by its extent (wide – narrow) and by its way (internal – external).

The **wide – external concentration focus** is used when we continuously have to keep eye on our environment and we always have to be ready for the automatic and intuitional reaction if something happens around us.

The **wide – internal concentration focus** is used for analyzing and strategic planning tasks. We acquire information from the external world and we compare them with the information stored in our long-term memory, then we make our future strategy.

The **limited – internal concentration focus** is used for acquiring regular, repeated information or if we would like to repeatedly check and influence our internal status (for example, attention to our breading).

The **limited – external concentration focus** is used for personal relations and delivering practical exercises.

According to Nideffer (Nideffer, 1976) **every single individual being has personally preferred attention style** but a person certainly can change between his/her attention types. Of course, at the important decision-making points, requiring attention, these changes stop and the attention is focused only to the exercise. The attention is concentrated.

With the increase of the importance the emotional factors increase as well and the changes lead to physiological changes (cardiac rhythm quicken), the cognition changes and the individual prepare for the reaction. Successful solutions need confidence but the lack of confidence provides dangers and fears that can decrease attention and the concentration can decrease as well. Beyond the abilities in sports the level of proficiency (number of repeats) is extremely important as well because of the automatisms turning on in the case of stressful situations. It is also very important to know some techniques that can keep the attention high. The cognition of time depends on the number of changes between the external and internal focuses. This is why it is extremely important to analyze the decisions from various kinds of aspects (with different tools) and to practice the situations in models with unexpected variances but with previously reviewed, recognizable and typical situations.

The development and essence of the Meme theory

In 1976, **Richard Dawkins** (Dawkins, 1986) developed his theory, which created the definition of meme. The expression of meme has been created and become popular by merging the Greek word, **mimesis (journey)** and the expression from the genetics, **gen**. So he named the gens of culture (Dawkins, 1986) to meme, "which is the self repeating element of the culture that spreads by imitation" (Dawkins, 2005). According to Dawkins' theory these memes contain information packages and structures that inherit and reproduce themselves. **The copies are not perfectly correct but the basic structures can remain for a long time.** The memes are passed during the human knowledge transfer and some of the memes are able to survive for thousands of years, which proves a massive viability. Dawkins was examining the spread and the survival of these memes in the culture. Meanwhile, a serious debate has emerged around the theory. The numerous works dealing with the memetics represent the fact that the Meme theory has moved some significant amount of researching energies by its thought-provoking attitude (no matter, which side do you choose in the debate) and it helped the improvement of the scientific researches.

The basis of the Dawkins-explanation is that different **replicators** are fighting for survival. A replicator can be understood, as a line of command, dedicated to copy itself. So replicators have the task to copy themselves with the smallest possible difference. Replicators that do fit better to the given environment are able to work more efficiently, so they can be copied more successfully, rather than those who do not fit to the environment very well. We can consider something to be a meme that spreads by imitation.

The **replication, however, is not perfect** and not mechanic either - just like the genetic inheritance, the mutations do play a major role in the successful accommodation to the changing environment but the efficiency is detected by the statement that **"the essence of the thoughts can remain for a very long time, even for generations"** (Mérő 2004 99.p.). The content (essence) is slightly the same, the formation is infinitely rich and individual, in addition, the memes can form a **meme complex** together. Moreover, "we can combine and twist the ideas in our thinking and we can create new combinations from them. The human skills of creativity are the procedure of the variation and recombination" (Blackmore, 2001 42 p.), so the

analysis of the combinations and successful solutions is a heroic but reasonable exercise.

Factors of success in the spread and the speed of spread of memes:

- Memorability, remarkability
- Simple to copy
- Not too difficult structure
- Advantageous utility

"Memes are forming a co-adapted meme complex and these constant groups of memes are called **memplex**. Memplexes are copied together and memes belonging to the same groups help each other's survival, support the better copying and during the natural selection they lead to a greater chance of excretion" (Blackmore, 2001).

According to my conviction, it is rather similar within the traditions of handball. While the handball has changed so much, the number of players, the time of the game and the space of the game (in the small court period) have not changed at all. So the basic structures are being repeated and the coaching instructions concerning their solutions may change but they are accommodating to the accelerating and forming game and their essences and the information applied in the knowledge transfer remain similar. From the player's view the quick understanding and the efficient applicability have an outstanding importance, as the players, having higher level of playing intelligence, and talents are quicker in understanding the basic situations – the coaching empiric experience knows that – and this can be an extremely important aspect when we are choosing our playmakers.

The new examination and usage of the concepts help us to understand processes, which were difficult to understand before. For example, one of them is the spread of the **"conception virus"** (Gladwell, 2007), which depicts well the spread of fashions when small changes had a large influence on processes and can lead to crucial changes. For experts, dealing with epidemics, it is well-known fact that the basic condition of spreading epidemics is the speed of copying need to be greater than 1. In their case, their task is to hinder and slow down the flow. In the area of culture, the modification and the speed of spread of an artistic tendency is a briefly examined area like the similarities and the differences of the Italian, German or English Gothic.

In handball, you can observe the intellectual reflection and the influence of the working achievements and the instructions of a charismatic and outstanding colleague like Lajos Mocsai, however the delicate features of their instructions have been hidden before. The foundations of handball are the same but in the knowledge transfer our specific features and tones are recognizable but for that new types of technical tools are needed and the new type of analyses can give a great hand in that.

Applicability of the meme theory in handball

I invited László Mérő, the biggest national classic of the Meme theory, to our conference („Differently about sports" conference Budapest, Aréna Hotel 2010. X. 20.) where he enforced his statements that he previously explained in his books, as the meme theory can be applied to the area of sports and to some traditions of different sports.

According to László Mérő's definition **"Memes are the smallest units of thoughts that have, even individually, a reasonable meaning, which cannot be detected genetically and which can be copied confidently and productively enough from one men's mind to the other."** (Mérő, 2004, p. 98).

According to my conviction, it is possible to use the meme theory and examine the memes in two areas of the traditions of handball

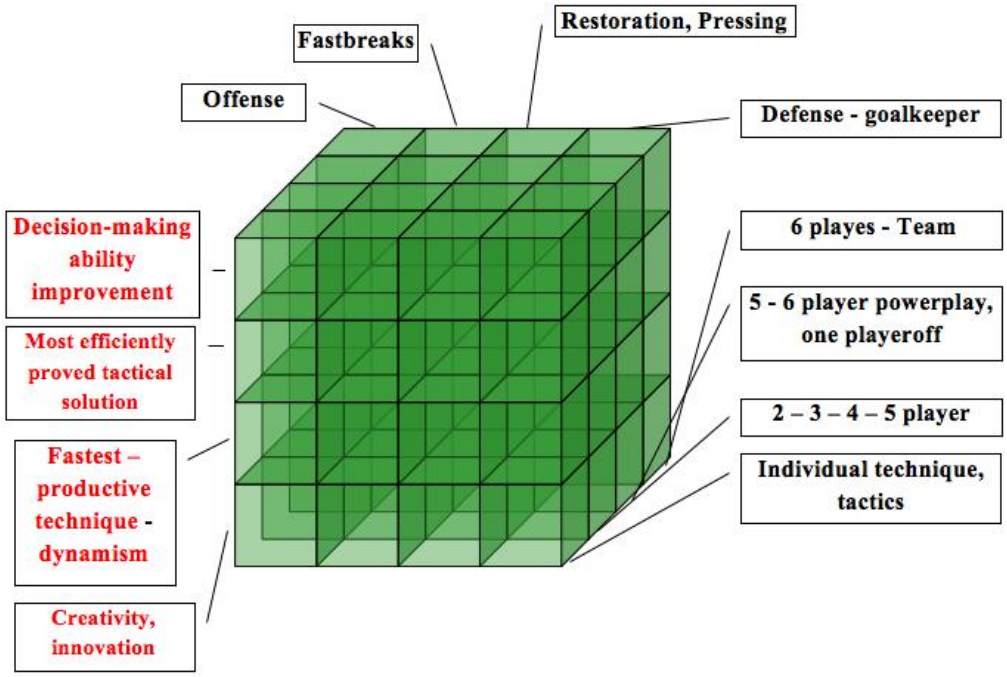
- Examining the **verbal knowledge transfer** when **we have limited time** to carry out the practical coaching duties (in workouts, in matches or during time outs) so we have to speak out the tasks straight forward. The patterns and the schemes of the basic structures and the possible answers that can be given to them are important, especially when it is extremely important that **the coach and the players understand the given structure of the situation rather similarly** in order to **choose and execute the most productive alternative of actions,** concerning the skills and the abilities of the players. Naturally, the coach does not take part in the execution so this is why it is very important to have the **mental and strategic harmony and the previously created structural vision**. It should not be developed only during the practice but also during the mental preparation because the common analyzing and evaluating work can have a crucial role here. The

teaching of the individual technique does not belong to this currant analysis because in that case we try to fit an ideal process of motion to the individual skills and abilities of a player, while this currant meme analysis trial deals with structures of space, time, dynamism and speed. Of course, if the practice contains a defender then the individual technical elements and the individual strategic decisions belongs to this circle also.

- At the other area, **by the application of new technologies** (3D solutions, cameraman records from new points of view, apply of new IT programs) **new demonstration materials can be implemented** into the coach training and the preparation of players (especially, center backcourts). **The analysis of space structures** and the illustration of changes in time can make the game situations more understandable and can help both the coaches and the players to accept and to find good solutions. Finding and using the shooting corridors, creating space for cuts, improving situation evaluation skills, consciously creating places for players cutting and feeding them with (assists). Of course, the application of new technologies can bring revolutionary changes for example in the **referee trainings** because the positioning of the referees and their angle of vision seriously determines their decisions, which are sometimes difficult to accurately follow and understand with the analysis of traditional, upper camera position video recordings. The fundamental goal of my thesis is to suggest new informatics and media solutions to the further education of coaches that are not so widespread in Hungary but the technical conditions available in a cost-efficient way.

Of course, I do not believe that the simple usage of the meme theory would be convenient but the record of a basic meme collection (situations and productive solution alternatives) would inspire further our works as well as our thinking. Thus a system theoretical approach could lead to the stage when a **model based on a dynamic meme network** can be outlined. In order to achieve that, the professional workshop activity of Hungarian coaches would be certainly necessary. In my opinion, the only one opportunity for stepping on would be the cooperative and professional activity in the group.

Fig.2: **The collection of handball memes (basic structures) and the help for their didactical understanding**



I have made **education matrixes** where I have created **3 main logical groups and from their correlations I have created 64 practice projects according to the main goals of each practices. The contents of these trainings are also compatible to the goals** so it goes from the simpler ones to the more difficult and more complicated ones. I am leading my players to understand the correlations not just the figural solutions.

We did not reach the goal all the time. With my teams, playing in the amateur national second league I could make great successes (for example: NB. I. Men 1st place; Hargita, NB.I, B. Men 1st place; Pestszenlőrinc, NB. I. B. women Kispest 4th place). Among the first class teams the method was successful if the conditions around the team were not too professional (players still were not working for serious amount of money or benefits). These teams had a strong social identity and the cohesion (for example: NB. I. 5th place Százhalombatta VSE). The intentions of adopt something new, the openness and the quality of attention had high quality.

The **mental training** was a necessary element of my practice, teaching strategic correlations. We numbered the motion situations that give the not compulsory motion paths and we regularly practiced the different variations of them with defenders.

I. Offense
    a. Individual technique, tactic
        i. Improvement of decision-making skills
        ii. Most productive proven tactical solution
        iii. The most quickly carried out successful technique
        iv. Creativity, innovation
    b. Team part 2-3-4-5 players
        i. Improvement of decision-making skills
        ii. Most productive proven tactical solution
        iii. The most quickly carried out successful technique
        iv. Creativity, innovation
    c. Power play – One player off 5-6 players
        i. Improvement of decision-making skills
        ii. Most productive proven tactical solution
        iii. The most quickly carried out successful technique
        iv. Creativity, innovation
    d. 6 players – Team
        i. Improvement of decision-making skills
        ii. Most productive proven tactical solution
        iii. The most quickly carried out successful technique
        iv. Creativity, innovation

II. Fastbreaks
    a. Individual technique, tactic
        i. Improvement of decision-making skills
        ii. Most productive proven tactical solution
        iii. The most quickly carried out successful technique
        iv. Creativity, innovation
    b. Team part 2-3-4-5 players
        i. Improvement of decision-making skills
        ii. Most productive proven tactical solution
        iii. The most quickly carried out successful technique
        iv. Creativity, innovation
    c. Power play – One player off 5-6 players
        i. Improvement of decision-making skills

ii. Most productive proven tactical solution
iii. The most quickly carried out successful technique
iv. Creativity, innovation

d. 6 players – Team
i. Improvement of decision-making skills
ii. Most productive proven tactical solution
iii. The most quickly carried out successful technique
iv. Creativity, innovation

III. Defense – Goalkeeper

a. Individual technique, tactic
i. Improvement of decision-making skills
ii. Most productive proven tactical solution
iii. The most quickly carried out successful technique
iv. Creativity, innovation

b. Team part 2-3-4-5 players
i. Improvement of decision-making skills
ii. Most productive proven tactical solution
iii. The most quickly carried out successful technique
iv. Creativity, innovation

c. Power play – One player off 5-6 players
i. Improvement of decision-making skills
ii. Most productive proven tactical solution
iii. The most quickly carried out successful technique
iv. Creativity, innovation

d. 6 players – Team
i. Improvement of decision-making skills
ii. Most productive proven tactical solution
iii. The most quickly carried out successful technique
iv. Creativity, innovation

IV. Restoration, Pressing

a. Individual technique, tactic
i. Improvement of decision-making skills
ii. Most productive proven tactical solution
iii. The most quickly carried out successful technique

iv. Creativity, innovation

b. Team part 2-3-4-5 players
   i. Improvement of decision-making skills
   ii. Most productive proven tactical solution
   iii. The most quickly carried out successful technique
   iv. Creativity, innovation

c. Power play – One player off 5-6 players
   i. Improvement of decision-making skills
   ii. Most productive proven tactical solution
   iii. The most quickly carried out successful technique
   iv. Creativity, innovation

d. 6 players – Team
   i. Improvement of decision-making skills
   ii. Most productive proven tactical solution
   iii. The most quickly carried out successful technique
   iv. Creativity, innovation

We reviewed and numbered the possible logical variations of the possible connections and we marked the starter motion ways.

Even relations *and for example: names applied by us*	**LW**	**LB**	**CB**	**P**	**RB**	**RW**
LW		**12**	**13**	**14**	**12e**	**11**
LB	**21**		**23**	**24**	**22**	**21e**
CB	**31**	**32**		**34**	**32e**	**31e**
P	**41**	**42**	**43**		**42e**	**41e**
RB	**21e**	**22**	**23**	**24**		**21**
RW	**11**	**12e**	**13**	**14**	**12**	

Table 2: Example of variations

Triple relations for example: LW – LB – **CB,** LW - LB - **P**, LW - LB - **RB,** LW – LB **– RB,** LW – LB **– RW, etc. and we also regularly reviewed the quadruple and the five player connections as well.**

The possible variations **(57)** should be catalogued, just like the Japanese katas, and we should process them didactically with different kinds of technical tools (4D tools, IT programs) in favor of the more efficient transfer and involve them into the trainings of the coaches and the players. If we would complete the process with the technical and tactical analysis of the individual player positions and we would examine the team setups then we get a complex analysis matrix, containing 64 "basic projects" that can help us create a more conscious work. In case of the positive welcome of my work I would like to deal with this in the future. Recording the collection of handball's basic patterns and memes, following its elements and variations in a 21st century way and dealing with the possible system of the coach instructions will be a very exciting duty for me.

Of course the 64 basic elements should be recorded also in power play and in shorthanded situations as well and analyzed from the view of the possible tasks.

Naturally, from the possible 64 variations not all of them are regular solutions but theoretically it is possible. The situations coming up more frequently, of course, will have a larger attention but imagining and modeling of a situation leaded us to creative solutions.

Of course, during my career we have reviewed the variations for 4:2 setups and for running in situations with duplicate pivots. In the training of the center backs the logical order was a great help.

Summary and conclusion

As an antecedent I participated the s**port expert further education videoconference** (25 occasions at 7 places) series, organized by the National Sports Association, in order to try whether what kind of new technological solutions can be applied in the handball education and further education. The method of videoconference and on-line conference was successful so it is prove that it can be applied in a wider scale in handball. I have involved sport experts (like László Skaliczki, Csaba Konkoly and Béla Cserpes) into my work in order to make the sport more popular and improve it professionally. I have introduced the didactical opportunities of the 4D solutions in front of a 300 member plenum. The success of the projects was officially admitted by

the leaders of the national Secretaries of the State (ÖTM, NEFMI, EMMI) and the feedbacks of the experts were positive (I have documents and letters to prove it).

In order to approach the sport heuristically, from the "Whole", I have built international (Japan) inter sports (kendo, aikido) connections. For the aesthetical approach of the sports I have found examples in the budo sports and I managed to involve into the research international sport experts (like Professor Sakai) as well. It has been enforced by Japanese experts that there is no renewal without the rephrasing and strengthening the ethical and educational materials and it can be based on the returning to the traditions. Hungarian traditions are rather strong so it is worth rethinking it. **The start of the national program of the conscious and planned mental development (involving young sport psychologist to the field work) is urgent.**

In my opinion, I managed to achieve the goal of my thesis, as I could review the available techniques and IT opportunities that can create development, new aspects and new types of approach and presentation opportunities for the further education of coaches, for the player trainings and for the match preparations than it was before. The technical solutions were tried, the technical difficulties were revealed and the applicable solutions were developed. The more dimensions records can color up the videos but the technical background previously need to be formed for the further education. The video records about the game events and the training events can provide a more accurate analysis and discussion. **While the head camera records can make the players decision options visible by an entirely new point of view**. In this case it is possible to analyze the number of decision options and the order of priority between each decisions so much more clearly (for example in a presentation form). By this kind of analysis you are not only able to see the options of the head camera player but you also can see the whole picture where you can observe all the opportunities around. At greater teams, having reasonable sources, it worth acquiring a head camera like this and use it this way. The feedback of the players was really positive. According to their explanation, they have been missing this for so long because those who are watching the actions from outside will see a situation in a very different way. Presenting the different roles was extremely interesting in the case of the goalkeepers and the defenders because they could see their roles from different aspects and they could see the missed interaction points in their movements. I could

not assign the coaching communication memes and patterns to the visual material because of the poor feedback of the coaches responding to the questionnaire so this research still must be continued in the future with further interviews and questionnaires.

The overview of the interdisciplinary areas of the sports sciences needs to be a fairly deliberated theoretical and didactical stair of the professional renewal both in the practical and in the theoretical side. It is also important to implement new knowledge and if we do that it is essential to transcript the high elite knowledge to a different practical language and to try to understand it practically. Let us try to define practical and training exercises from the latest research results (chaos theory, network theory). It is a reasonable task to try to match some practical experience with high flying theoretical researches.

So the trial of the videoconferences and on-line conferences is tested and it is cost effective and feasible (cooperating with the national higher educational institutions of sports related courses). So it is worth making coaches and referees of the large national training centers ((Budapest (Collage of PE, ELTE), Szeged, Pécs, Nyíregyháza, Eger, Szombathely, Győr, Veszprém)) sit down in front of the displays and analyze handball situations and solutions. It is also worth for the sport related courses to try something new as well.

In the future, in case of the available resources, also new types of analysis, teaching materials and IT software may be created besides applying the technical opportunities mentioned in this paper.

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The methods of power-training and its possible application for younger age categories

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Summary

Introduction: One of the basic conditions of the success of a handball player is an appropriate level of conditional abilities. Power plays a prominent role within conditional abilities. All forms of the appearance of these abilities (maximal power, speed power and stamina power) get a role in the various conditional ability trainings in the various age groups. These development trainings will give a stable basis for the future, for a successful performance among the adults. In order to be successful in the development trainings, we need exact calculations of the results. These will secure a continuous feedback about the professional work done.

Methods:

In case of handball players -especially in the younger age categories -speed power development trainings play a main role. It is recommended that this type of power be trained by throws where the speeds of the various body segments are added together at the time of the throw and this secures the dynamic background of the speed power development. Furthermore we can get the answer to which segment of the body takes part with the greatest efficiency in the throws. I analyzed the data of the measurements, both before and after the development trainings with the methods of statistics and mathematics (“T” probe and correlation coefficients) These results proved the efficiency of the trainings.

Results:

We successfully proved what role the various body segments played in the throw. We also got our answers to the exact time necessary for the throw, before and after the development trainings.

Keywords:

Conditional abilities, Speed power development, Characteristics of various age groups, Education of throws in a step by step system, Mathematical statistics.

I.

Introduction

A considerable part of sports – science deals with the possibilities of developing motor abilities.

In the approach of training theory, the systematic development of these abilities has to be taken into account among the main tasks and goals of training methods. The physical ability of the individual, who is developed in every respect is one of the essential components of the inner qualities of the person and at the same time one of the basic segments of the person's complex physical ability.

The physical ability is greatly influenced by motoric abilities: conditioning, coordination and agility.

These are the three factors which build and influence the level of motoric abilities. That group of motor-abilities which is defined by mainly energy factors is called: "conditional abilities" (The Development of Sport Abilities by Nádori 1973.)

Power, speed, endurance and flexibility are in this group with a functional connection between them.

Recently handball has gone through revolutionary changes. The speed of the game both in attack and in defence had unbelievably speeded up. (number of attacks and the number of tackles has increased)

Those handball players have appeared who are of the so called athlete type. These players are tall, strong, quick and clever.

In the up to date training and teaching of handball players, the teachers and coaches have to take the utmost care – more than before – of the high standard while forming their conditional abilities.

Review of literature

Starting from the 1950-ies a lot of articles, studies and books have been published in Hungarian about the methods to be used in power training for adults. We may gain information in detail, mostly from the works of László Nádori about power training. (Nádori 1958, 1962, 1965, 1968, 1972, 1975, 1977, 1981, 1986, 1995, 2001)

In these works the author tries to draw a map about the possibilities of power training in various forms of power, based on his theoretical and practical experience. We may get valuable information referring to which characteristics of development and maturing should be taken into consideration at the younger age category during power development.

Similar a way of progress may be seen in the works of László Harsányi (1975, 1995, 200, 2003.) were we can find a lot of practical examples and recommendation that give us a lot of help in our every day work.

In the 2003/2. issue of the „Magyar Edző"(Hungarian Coach) journal he gives us a comprehensive picture in an article about the power training possibilities of younger age category sportsmen, together with widespread recommendation.

In the focus of the studies of Stemmler (1964), Farmosi (1990), and Bakonyi (1981) we may also see the power training suitable for younger age category power development at given ages. From the analysis of the development of movement sketched by the authors we may know that at a very young age (4–11. yrs.) there is a varying but effective development of the maximal and speed power as well as of power stamina.

The authors Fejes (1968) and Nagykáldi(1968) got to the conclusion by way of experiments that taking into consideration the rate of maturity it is possible to develop power at a very young age.

The complex conditional exercise to develop abilities in adult handball players may be seen in a study from László Kovács (1973). The head coach publishes a complete, comprehensive practical material which resulted in considerable conditional changes at the teams prepared by him and these changes had a positive effect on the achievements of the players too.

dr .B. Fekete (1995) examined the result of power trainings made by medicine balls of various weights in his thesis where in the focus of research were the examination of the power characteristics of the arm, its changes and the changes in the kinematic chain of the basic throws.

His examinations prove that throws taken with heavier balls can really help in a better technical execution, thus in the better coordinated function of the muscles. This is expressed mainly by the top speed of the various body segments nearing to the top speed of the ball.

II.

Material and Development

‘Power training is also based on the principle of biological adaptation, according to which the inner systems (heart, blood–circulation, breathing, motor-function, digestive extension, central and vegetative nervous system) will be reinstated at a higher level, due to the external work load and training stimulus. (S. Eckschmiedt 1996. Auxiliary material to the education of power training T.F. Budapest)

As a consequence of the power training the energy reserves in the muscles decrease and during the relaxation time increase to an extent surpassing the starting level. This process is called “super compensation” in the training theory.

Starting level, internal work load, external work load (training), Restoring the original state, Increased restoration, super-compensation,

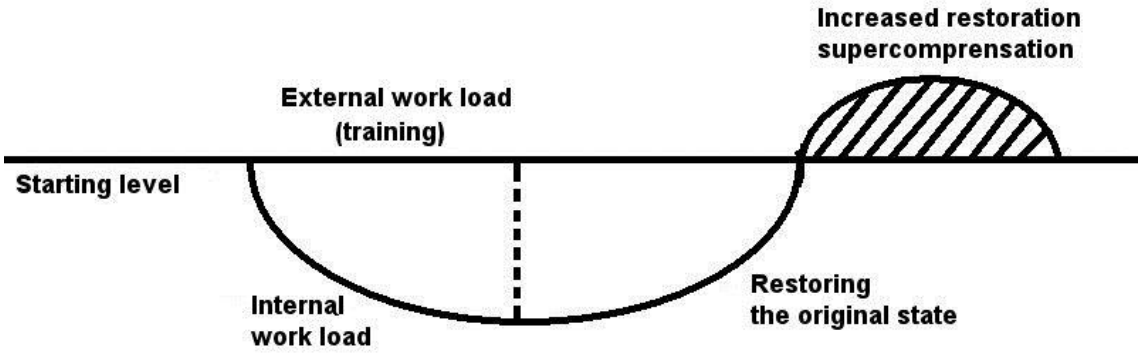


Figure 1.

The effect of the repeated external work load and super-compensation is the increase of muscle performance. Anatomy makes a clear difference between smooth muscle, heart muscle and skeletal muscle.

In connection with power training we have to take into consideration the function of skeletal muscles.

The muscles can be of three different types: longitudinal muscle, unipennate muscle, and bipennate muscle.

We can measure the cross section of the muscles perpendicularly to the surface that is perpendicular to all muscles tissues.

We get the anatomical cross section, when the measurement is perpendicular to the surface, and the physiological cross section is essential and of utmost importance from the aspect of muscle development.

The connection between power and muscle, depends not only on the arrangement of tissues, but also on the type of muscle tissues.

Principally there are two types of tissues, red and white, but we also distinguish a mixed type of tissues.. In humans we never find only slow (red) or only quick (white) , but these two may be found mixed together. Rate of the slow and quick tissues can be 40-60%, 30-70%, 20-80%. The slowly contracting muscles create favourable preconditions to gain aerob energy, so they are capable of long lasting work. The quick tissues ensure the same favourable conditions to gain anaerob energy, so they offer an optimal possibility for work that needs less time and bigger power.

From the aspect of power training the quick tissues are far more considerable.

The next table shows us the peculiarities of the muscle types.

Table No. 1.

Tissues	***Function***	***Meta-bolism***	***Stretching***	***Vein***	***Fatigue***	***Nutritive material***	
						Carbo-hydrate	***Fat***
Red	*slow*	*aerob*	*slow, low*	*high*	*little*	*average*	*average*
Mixed	*quick*	*aerob/ anaerob*	*average*	*average*	*average*	*average*	*little*
White	*quick*	*anaerob*	*high*	*little*	*high*	*high*	*none*

While examining biological basis, it is of utmost importance to register the fact, that the pre-stretched is capable of more power the non pre-stretched. The reason for this is that pre-stretching causes the myotatic reflex of the muscle itself.

Pre-stretching should last for a short time, and it has to be sufficient.

1. Basic principles for a power training of younger age category sportsmen

A lot of people say that the physiological basis of power training, among the youth, is missing, since the male hormones which are necessary to make muscle tissues thicker, will be sufficient in quantity only after the age of 10 or 11.

In spite of this (Farmosi 1990: The Development of Movement; The body development, the physiological endurance and motoric level of 3 to 6 year old infants TSTT. Bp.) we know from these studies, that both maximal power, and the speed power as well as power endurance, is developing in a fluctuating way, but effectively from the age of 4 to 11 and after.

In speed power, those children who have regular trainings between the age of 8 to 17, surpass by approximately 20 – 40 % those who are not trained.

In childhood the development of all types of power, depend on not only the increase in the cross section of the muscles, but it is also due to:

1. Inter-muscular coordination
2. Intramuscular coordination
3. The level of adaptation of the nervous system to the trainings

Due to this – in the early stages of power training – a considerable increase in power is developed with intramuscular coordination.

Underneath, I would like to introduce those principles, that we have to keep in sight during the power training of sportsmen in their youth

Basic principles in the power training of younger age sportsmen

1. During the development and improvement of the inter and intramuscular coordination, the power training of children in their childhood (4 to 7 yrs.) can be solved by games with a lot of movement.
2. Following early childhood we may consider the age group of 11 to 13 yrs. among girls and from 11 to 16 yrs. among boys, to be a very complex and sensitive stretch. At this age – when most muscles and most types of power develop very fast – the androgenic hormonal conditions arise at this stage of life.
3. The visible forms of power (maximal power, speed power, stamina power, and reaction power are bonded together tightly on the one hand and on the other hand there is great transfer affect at the age of 4 to 12.
4. During childhood the stamina power plays the main role since in this case the external load is the lowest (own body weight, 0.50 – 2.0 kg. heavy balls, dumb bells and discs). These exercises may be done with a relatively low

intensity so the load on the joints is not too heavy. Furthermore these exercises prepare the body to tolerate bigger loads, later in life.

5. We don't thrive to increase maximal power in childhood. We can be satisfied with the increase caused by the development of stamina power and speed power.
6. In the power training of younger age groups, the body muscles get the main role because the spine gets a separate muscle support to tolerate power impulse created by the limbs.
7. During childhood and at the beginning of adolescence (from 10 to 14 yrs.) we primarily use such equipment and exercises which we may do easily. These can be the following: raising the legs and the body, springing, jumping, and throwing balls of various weights with one and both hands. I would like to emphasize the multifunctional movements which are team games. The statement of Nagykáldi (in 1968) refers to this : 'Among the youth playing various games in sports, the power of those developed the most, in whose trainings team games were dominant.'
8. The principle of keeping order of effectiveness in power training must be kept during the power training of youth.

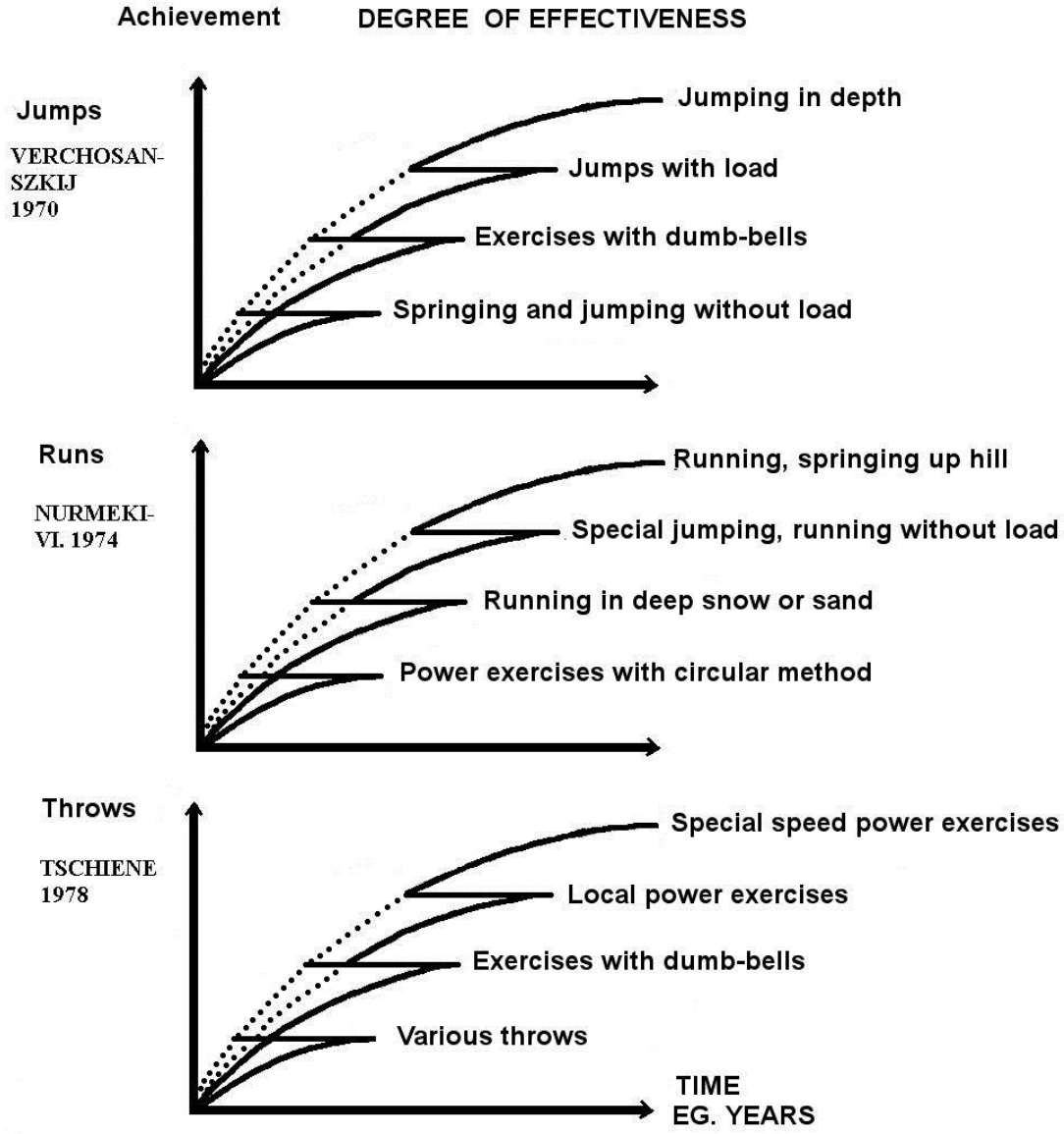


Figure 2: Order of application of power trainings according to effectiveness (Verchosanszkij, 1978.)

As seen in figure 2, we can see that the effectiveness of power exercises is optimal if we take into consideration the fact, that the application of higher effectiveness exercises may be used only if the previous ones don't improve the achievement.

9. The possibility to train the muscles depends on the gender and the structure of the body. This possibility begins in childhood, the most sensitive age is between 20 and 30 yrs. Men are stronger than women.

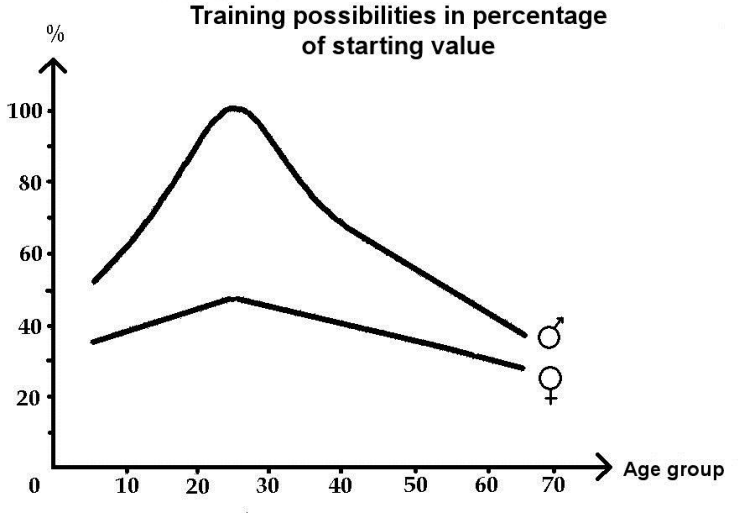


Figure 3: The training of muscles (Hettinger, 1970, p. 94)

10. The training of muscles in case of children may be effective if it affects as many muscle groups as possible. In case of adolescents with average activity, dynamic power training is advised in 10- 25 minutes daily. Of course in case of sportsmen we need a bigger load corresponding to the biological maturity.
11. The power training and the increase of power depends on:
    a. The standard of proficiency of movement
    b. Growth – development – maturation
    c. The effect of trainings
    d. Nutrition

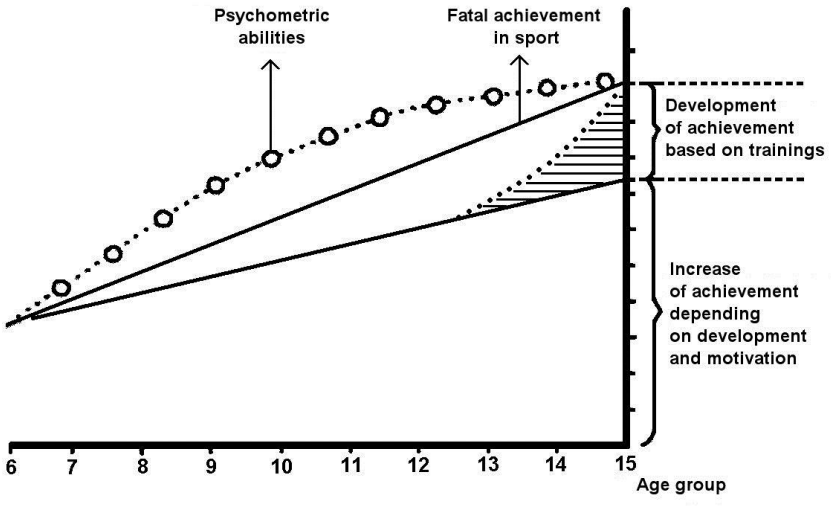


Figure 4: Basic elements in the improvement of movement performance, in the growth and maturity period (Martin, 1982. 283. p.)

As seen in Figure 4. this means that the main role is that of the training used in movement techniques, the various complex, easy and average loading. The development trainings of abilities in the age group of 12–13 yrs.

From the age of 14 – 15 yrs. we may hope for a larger scale development of power only if a maximal external load replaces the average power trainings.

12. Through the increase of the total loading we have to secure a transition, step by step. These are the following:
    a. We have to keep the order of effectiveness throughout the training.
    b. It is necessary to apply the methods of beginners for at least a year, when we begin power training with dumb – bells. This method may be used to increase the inter and intra muscular performance as well as the cross section of the muscles. Keeping these rules we can prepare the development of maximal and speed power abilities and the stamina, at the same time spare the body from overloading.
    c. The maximum of external loading may be increased to the level of adults only step by step, according to the age group of the child. We take into consideration the suggestion of Harre and his work group. (table No. 2.)

Table No. 2. : The values suggested for the external loading of younger age group categories.

Age (yrs.)	***Duration of training (yrs)***	***Upper limit of external loading (percent)***
15	1	50%
16	2	60%
17	3	70%
18	4	80%
19	5	90%
20	6	100%

Note: If the duration of training is more by one year than in the table above, a 10 % higher external loading can be applied.

According to practicing professionals, there are beginners for whom the above indicated 50% means extremely low load (e.g.: 30 kg. maximal bench-press performance it would be only 15 kg.) so we suggest that the sportsman should do 6 – 8 series with the dumb – bell which he can repeat only 10 – 12 times until the next appraisal of maximal power. After that we may increase the load, thus we can reach the necessary power stamina level, which secures the corresponding base to the increased standards.

We have to get prepared for such exercises where the definitions in Table No.2. are not valid (e.g.: rotation of the torso with weight) in this case the careful planning of the coach is necessary.

In the above, I tried to overlook the principles and information concerning the power training of younger age categories. If we take these principles and information seriously we can plan and carry out the power trainings of younger age sportsmen safely.

2. Basic principles in power training

Muscle strength is the power effect derived from the active function of the muscles which shows its effect in overcoming, limiting and counter balancing the forces affecting the human body.

2.1. Forms of muscle function

a) Concentric muscle function: The muscle is strained, contracted, and shortened. The origin of the muscle and the place of its adherence get nearer to each other. With this function of the muscle we can overcome the forces having an effect on the body. (concerning the quadriceps extensor, while standing up from crouching with the weight of dumb – bells on the shoulders)
b) Excentric muscle function: The muscle is strained, then stretched. The place of origin and that of the adherence get farther from each other. With this muscle function we can limit the power affecting the human body. Muscle function is

slowed down (concerning the quadriceps extensor with dumb – bells on the shoulders)

c) Eccentric – concentric muscle function: The method put in effect is a limiting – overcoming one, e.g.: springing up after jumping down from a higher place, or in case of leaping off. Concerning quadriceps extensor – at the end of the leap off, the muscle functions for a little while, in an eccentric way, then in a concentric way. The muscle functions in two ways while executing of the exercises.

d) Static muscle function: The muscle is strained but there is no change in the distance between the place of origin and the place of adherence. We may call this a counter balancing method. E.g.: concerning a triceps extensor when pressing the wall.

2.2. Forms of power

a) Maximal power: The biggest exertion is achieved with intentional contraction of the muscles.

b) Speed power: Overcoming the forces affecting the body by high speed muscle contraction. Combination of power and speed.

c) Explosive power: The power-effect that appears when overcoming the static forces affecting the body.

d) Reaction power: A short period of pre- stretching. Power displayed for a short period by the contractions of activated muscles following a pre stretching activity.

e) Stamina power: It means the long term overcoming, limiting or counter balancing the forces affecting the body by muscle function. Combination of power and stamina.

2.3. Concepts to state the exact load

a) Intensity, external load: An external load (above the body weight) which has to be overcome limited or counter balanced by muscle function during exercises.

b) Serial number: The number of exercise series

c) Number of repetitions: It means the number of repetitions in a series, following each other without a break or a longer pause.

d) Relaxing time: Duration of time spent by rest between exercises.

2.4. Factors influencing the effectiveness of power training

a) Ability standard: We can control the actual standard of ability by assessments, and the performance in the assessment exercises. These assessments are the basics to the control of the actual power training performance effectiveness. It is expedient to do these appraisals every 6 – 8 weeks.

b) Aspects of didactics: In the course of power training a gradual increase, a consecutive build-up of exercises is important. Progress has to be made from simple to more complex and from easier to more difficult, as well as from general into a special direction. It is expedient to keep the gradual increase:

- Preparatory stage : average intensity – big extent
- Development stage: keeping the conditions for the development of the forms of power like: intensity, extension, relaxation time, method of execution.
- Maintained grade: high intensity – average extent

c) Age: The development of muscle power is influenced by the function of hormones. Before hormonal conditions we may achieve development of power coordinative improvement. It is especially important to put in effect regular power training according to the age and the standard of development.

d) Gender: Theoretically power training has the same effect on women as on men but, because of the lack of testosterones – which has a protein integrating effect – the increase of power lags behind that of the males. There is no difference in the coordinative improvement-based performance but the development of muscles depending on hypertrophy is less in case of women than of men.

2.5. Conditions necessary for adaptation

a) **Sufficient intensity of stimulation:** In order to achieve the necessary form of power by power development training, the intensity of power development training (external load) has to be adjusted to the actual level of power. When planning the highest individual performance of the sportsman, it has to be taken

into consideration to prepare the optimal power development training for him (her).

b) **Sufficient scope of training:** To reach the level of sufficient adaptation, a regular work – out is necessary which results in the fatigue of specific groups of muscle. (Super-compensation is derived from fatigue and from rebuilding a state which exceeds the original). The fatigue caused by the training load has to reach an extent from which the sportsman can sufficiently recover. It is the basic principle of training theory, that we can develop power and speed only if we are sufficiently rested. Otherwise the organism doesn't react appropriately to training stimulation, so there is no development of power and the training may have effect only on stamina.

c) **Appropriate frequency of trainings:** Power trainings create a development of power only if the number and frequency of trainings is sufficient. During the competition season to 2 – 3 power trainings are advised for handball players per week, while during the preparation period daily power trainings are suggested, in order to achieve appropriate adaptation. The duration of power training should be minimum 1 hour, maximum 2 hours, if we deal with several clusters of muscles.

d) **Appropriate changing of the load:** In order to increase the adaptation level, a continuous increase of load is necessary. This means that in the long run, power training load has to increase gradually. The scheme of this increase in loading is the same as the one adapted during the development of other abilities in the principles of training theory.

According to this: *First we increase the extent, leaving the intensity (external load) untouched. In the second step we increase the intensity, (external load) with a parallel decrease of extent. In the third step we increase the extent, leaving the intensity (the acquired higher level) untouched.*

e) **Nutrition:** One of the basic conditions of human life is nutrition. If we speak about sportsmen, the regular and appropriate nutrition is even more essential. From this nutrition our body derives all the essential materials (carbohydrates, fats, proteins, vitamins and minerals), and that is how we develop and build our body. Food, rich in proteins, creates excellent conditions for the concentrated physical and mental achievements.

Proteins usually increase the activity and the performance of people. These proteins are not stored in the organism, so we have to acquire them day by day. The most important sources of protein are milk, eggs and meat.

The necessary total calories for an adult sportsman are 5000-6000 Kcal, which is made up of: approximately 18-22 % proteins, 30-36 % fat and 52-42% carbohydrates.

3. Suggestions for methods of education

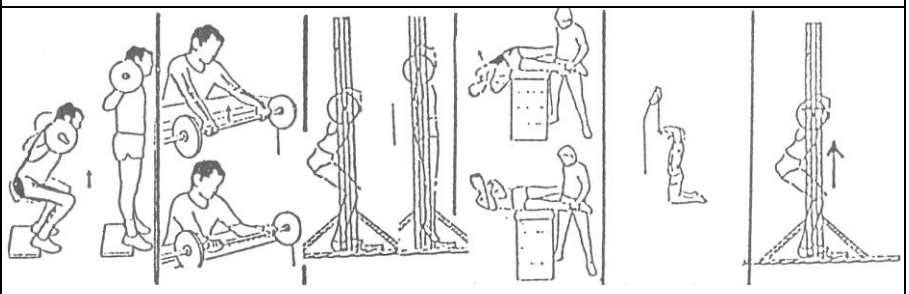
3.1. The characteristics of general methods for power training

	Method	Effect	Result of application
1.	Hypertrophy Training	Increase in cross section of muscle tissues	Development of maximal power
2.	Synchronization Training	Contraction of several muscle tissues Simultaneously	Speed power improves with the maximal power development
3.	Mixed or combined Training	Hypertrophy and simultaneous contraction of several muscle tissues	Development of maximal and explosive power
4.	Reactive methods	Improvement of nerve and muscle coordination	Development of speed and maximal power
5.	Methods of stamina power	Improvement of local muscle power stamina	Formation of long term training
6.	Method of beginners	Complex effect	Preparation of muscles and joints and the metabolism for the application of other methods

Table 3

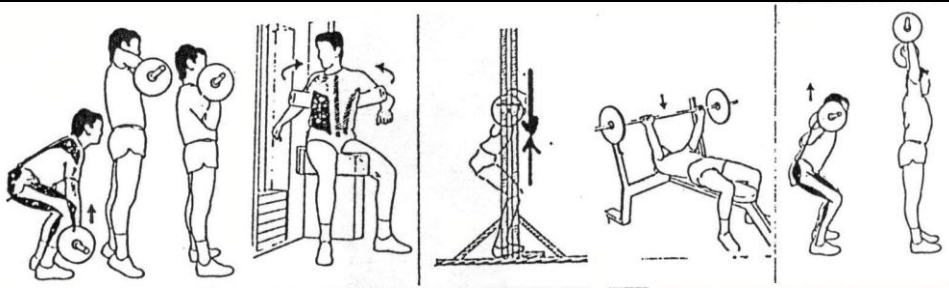
3.2. Methods of general power training

Table No.4. Methods of increase in cross section of muscle tissues

Aim		Increase of maximal power					
Method		Method of constant load	Method of increasing load	Method of extensive body-building	Method of intensive body-building	Isokinetic method	Isometrical method
Effect		Development of maximal power by the increase of the number and thickness of muscle tissues					
Exercises							
Dosage		After 6-12 weeks it is expedient to find the new maximal load and/or change of methods or exercises					
Type of muscle contraction		concentric	concentric	concentric	concentric	concentric excentric	isometric
Periodicity		This method is applied during the yearly preparation after the stamina power training section					
Extent	Frequency of trainings	4	4	4	4	4	4
	No. of series	3-5	4	3-5	3-5	3-5	3-5
	Repetition	8-10	12-10-7-5	15-20	8-5	15-	10
	Time	-	-	-	-	-	10-12s
Load		80%	70-80-85-90%	60-70%	85-95%	70%	100%
Intensity	Speed	average slow	average slow	average slow	average slow	average slow	average slow
	Form of movement	continuous	continuous	continuous	continuous	continuous	continuous

Frequency	Pause between repetitions	-	-	-	-	-	-
	Serial pause	3-5	5	2-3	3-5	3	3
Content of serial pause		Light stretching of muscle					

Table No. 5. Methods of improve the synchronization

Aim		Increase of maximal power				
Method		Near to maximum	Maximum concentric	Maximum isometric	Maximum eccentric	Maximum eccentric - concentric
Effect		Within a muscle the maximal power increases at same rate as the number of simultaneously contracting fibers				
Exercises						
Dosage		After 6-12 weeks it is expedient to reinstate the 100% load and/or to change the method and/or the exercises				
Type of muscle contraction		concentric	concentric	isometric	excentric	concentric - excentric
Periodicity		Within the yearly preparation they follow the power training to increase cross section				
Extent	Frequency of trainings	4	4	4	4	4
	No. of series	4+1	5	5	3	3-5
	Repetition	3 1 1 1 +1	1	2	5	6-8
	Time	-	-	5-6s	-	-
Load		90-95-97-100%	100%	100%	approx. 150%	70-90%
Intensity	Speed	explosive	explosive	explosive	explosive	explosive
	Form of movement	continuously	continuously	continuously	continuously	continuously
Frequency	Pause between repetitions	-	-	-	-	-

	Serial pause	3-5	3-5	3	3	5
Content of serial pause		Light stretching of muscle				

Table No. 6. Mixed methods

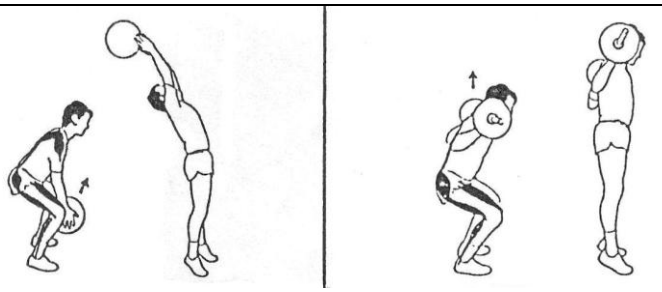
Aim		Increase of standard of explosive power	
Method		Method of explosive power	Pyramid method
Effect		The increase of maximal power by the simultaneous contraction of several fibers and expansion of the muscle fibers within a muscle	
Exercises			
Dosage		After 6-12 weeks it is expedient to reinstate the 100% load and/or to change the method and/or the exercises	
Type of muscle contraction		concentric	concentric
Periodicity		We can form a transition between the trainings to increase power and the speed power trainings during the yearly preparation work	
Extent	Frequency of trainings	3-4	3-4
	No. of series	5	7
	Repetition	7	7-5-3-2-1-3-7
	Time	-	-
Load		35-50%	80-85-90-95-100-95-85%
Intensity	Speed	explosive or quickening	
	Form of movement	It happens with high initial speed or continuously increasing speed	
Frequency	Pause between repetitions	10s	10s
	Serial pause	3-5	3-5
Content of serial pause		Light stretching of muscle	

Table No. 7. Reaction or plyometric methods

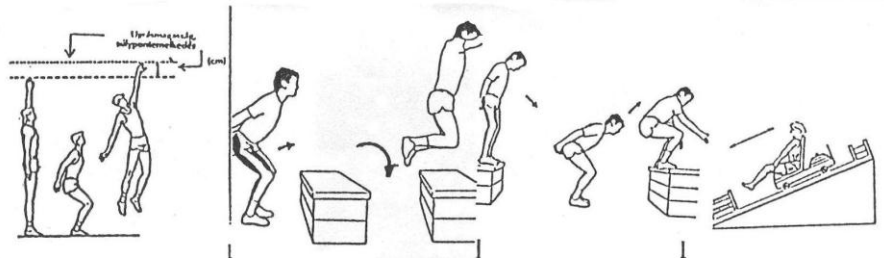
Aim		Improvement of cooperation between the muscle and the new system			
Method		Method of springing	Method of leaping	Method of jumping down	Methods of special facilities
Effect		Increase of explosive and speed power			
Exercises					
Dosage					
Type of muscle contraction		eccentric - concentric	eccentric - concentric	eccentric - concentric	eccentric - concentric
Periodicity		Increase of sport specific power, after the cross section and synchronization training methods			
Extent	Frequency of trainings	2-3	2-3	2-3	2-3
	No. of series	3	3	3-5	3
	Repetition	30	10	10	15
	Time	-	-	-	-
Load		Only after a duration of training throughout several years should we apply the method(e.g. sand vest) in not more the 5% of the body weight			
Intensity	Speed	high	high	high	high
	Form of movement	explosive	explosive	explosive	explosive
Frequency	Pause between repetitions	1-2s	1-2s	1-2s	1-2s
	Serial pause	5	5	10	5

Table No. 8. Methods of power endurance - Adults

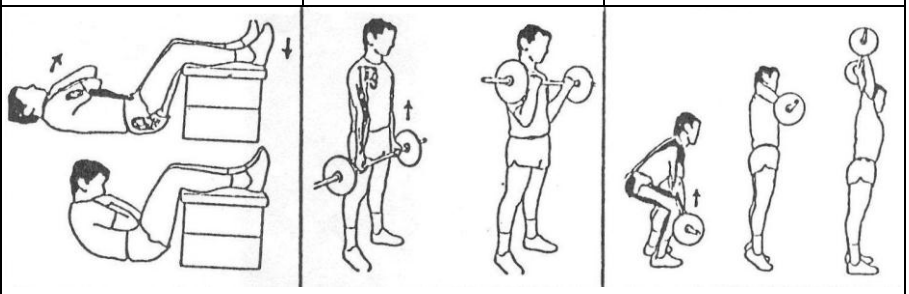
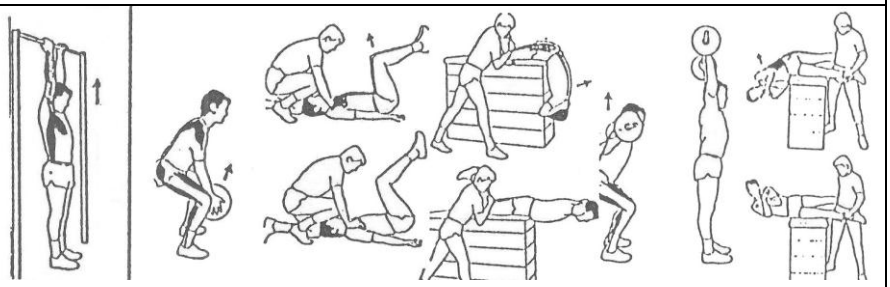
Aim		Increasing the long term or repeated resistance to big loads		
Method		Method of intensive power endurance	Method of average power endurance	Method of extensive power endurance
Effect		Increasing power with power endurance	Power and endurance increasing at the same rate	Increasing endurance with power
Exercises				
Dosage		After 6-9 weeks it is expedient to find the new load for change of methods		
Type of muscle contraction		concentric	concentric	concentric
Periodicity		During the season with specific exercises and before the season with average exercises		
Extent	Frequency of trainings	3-4	3-4	3-4
	No. of series	3-4	4-6	
	Repetition		15-20	approx. 30
	Time	-	-	-
Load		50-60%	40-60%	25-40%
Intensity	Speed	high	high	average
	Form of movement	continuous	continuous	continuous
Frequency	Pause between repetitions	-	-	-
	Serial pause	1-3	0,5-1,5	0,5-1

Table No. 9. Methods for beginners

Aim		Preparation of power training
Method		Method of power training for beginners
Effect		Complete
Exercises		
Dosage		After 12 weeks it is expedient to find the new load and/or changing exercises
Type of muscle contraction		Eccentric – concentric
Periodicity		None
Extent	Frequency of trainings	3 then 4
	No. of series	6-8
	Repetition	Approx. 8-15
	Time	Main muscles: 1
Load		45-65%
Intensity	Speed	Average
	Form of movement	Continuous
Frequency	Pause between repetitions	-
	Serial pause	1-3
Content of serial pause		Light stretching of muscle

3.3. Throwing from long distance

„It is characteristic of the technically well done (ideal) throws, that after a certain preparation, energy is suddenly mobilized and the various parts of the body **gradually** gather speed, and afterwards in the same sequence gradually slow down and fade away" (Eckschmiedt 1999: The technique, teaching and adaptation of athletic throwing exercises TF. Bp.)

The throws have special dynamics (at the starting part), which is expressed mostly during the effort done in a **given period**, and in the unrestrained acceleration**, explosive execution** of the movement.

During these throws what we are actually teaching is the effort done during the given period, the extensive and **quick mobilization** of power, the quick change in the muscle lengths, the good intra and inter muscular coordination, the corresponding pre - stretching and the quick reaction within the various movement structures.

The exertion of speed power has a coordinative pattern which is manifested in the special dynamics of the throws.

The special dynamics of the exertion of speed power is achieved both by full body throws and throws done by the so called „various parts" of the body.

At the beginning of the throws or during them, the pre-stretching of the muscles means the somewhat activated, toned muscles and not the ones passive or slackened.

As I have already mentioned in „in the Basics of Biological Power training" paragraph the pre-stretching of the muscles is effective if the stretching is powerful is enough, sufficient and last only for a short time. The effect influencing the shooting performance positively becomes possible only in this case, through the myotatic reflex which is reflex of the muscles.

The so called „rocket principle" is valid at the long distance shots.

It means with the exception of the first step (which means the start of the throw) that the speed of the new muscle contractions is added to the already existing speed of movement.

The assertion of this principle ensures the formation of the dynamics of speed power, the continuous speed up.

We can teach this kind of muscle function exclusively by throws from a standing position, since the kinetic chain mentioned before is able to function only here completely, the coordination level becomes evident.

It is expedient – as you can see above – the speed power should be taught by throws, because the characteristics of these throws make it possible for the sportsmen to learn the movement with the appropriate resistance, gradually, step by step from the simple movements to the complicated ones.

III.

The hypothesis and the structure of the examination

In the previous paragraphs of my thesis I tried to give you an insight into the basics of power training and the place, the role and the possibilities of power training, in the preparation of young sportsmen.

My aim was to highlight the basic principles which helped me immensely in my work

These are the following:

- Introduction of the biological basics
- Importance of nervous systems
- The characteristics of the various age groups
- Basic principles connected to different throws

The second part of the thesis is about direct research which I performed according to the description in the first part.

My aim was to keep the rules of younger age power training, to build up a gradually, step by step achieved throw from a diagonal standing straddle position.

Teaching of a throw in a gradual system

While teaching a throw in a gradual system we progress from the simple ones to the more complicated ones.

The most important characteristic of this step by step system is that we start from throwing by one arm, by throwing out. Gradually we integrate more and more muscles and parts of the body into the throwing motion, and with these grades we always teach more and more parts of the complete movement until we complete the series.

The advantages of throwing in a gradual system:

- With the exception of the first move we teach all the new parts of movement in a way that connects it to the previous move, thus teaching not only the movements themselves, but also the way they are connected.
- The previously learnt movements are automatically followed by the new ones with a gradually increasing speed

- The sportsman can achieve a complicated throwing technique through a series of easier throws.
- The new motion by which we begin the throwing technique of the given grade is at the beginning of the movement. Here the speed of movement is less, thus there is more possibility for self- examination and correction of movement.
- With these grades of teaching we can show each important and consequent move, so later these part – motions will not have to be taught which is impossible anyhow, in most cases.
- In each grade, the newly learnt movements may be completed as a throw out by the sportsman, in this way the sportsman has a good sport feeling and more motivation for further practice.

My hypothesis is the following:

The speed power of handball players increases in this step by step system which is expedient in the teaching of these throws and their intramuscular coordination improves as well. We may also get an answer to the question: which part of the body influences the change in shooting performance the most within the elements of the kinetic chain.

1. **The structure of the examination is the following:**
   a. **Appraisal:**

      The appraisal of the throw which is done by one hand in forward direction by in a diagonal, standing straddle position, as well as in the following positions:

      - back lying position
      - sitting position
      - kneeling side straddle position
      - diagonal kneeling straddle position
      - diagonal straddle position on one knee
      - standing side straddle position
      - diagonal standing straddle position

The throws are performed with 0.80 kg balls. Executed, with 100 % power.

Video recording is made of the throws from the side

b. Development:

After the appraisal, the teaching of the throws from the positions listed in point „a" with the correct technique by both hands and with each hand separately. (The rules of the execution of these shots are to be found in: The Technique, Teaching and Application of Athletic Throwing Exercises by S. Eckschmiedt TF. 1999.)

In these types of throws the speed power development is performed by various, different weight medicine balls, keeping to the conditions of the speed power development (weight of the ball, number of throws, rest time, performance and fatigue).

Time of this development is 12 weeks.

c. Repeated appraisal:

Following this period of development a new appraisal is due, according to the criteria of point „a", but only concerning the throws performed from the diagonal standing straddle position.

2. Evaluation:

The comparison of the appraisal results, of the video recordings and of the throwing performance by methods of mathematical statistics.

The comparison was made between the throws performed in diagonal standing straddle position since the elements of the kinetic chain – which I was teaching throughout the complete the development course – can be observed as a whole in this form of throw.

At the first appraisal I gave the sportsmen only the most essential information needed for the throws done from the various positions. For example I called their attention to the stable starting position and to the handling of the ball. Each throw was repeated three times by the pupils. The three throws were not done in sequence one after the other but, with changes after each throw, so theoretically each throw was done after a rest

The video recording of these throws was made according to the following:

Analysis of the move:

The analysis of the move is made up of four steps: The collection of data (video recording), the digitization, the informatics performance and the presentation of the results. Only the collection of data is not computerized that is the cameras have to be used independent of the APAS hardware.

Collecting of data:

In this phase one, two, three or four cameras may be used for the recording of the motions. The rules governing the collection of data have to be adjusted to the aims of the examination. I have pre – set the position of the cameras, the orientation and the distance between the object and the recorder taking into consideration the optimal visibility of the motion. For the optimal positioning of the camera, the visual angle has to be almost orthographic, but at least min. 30 degrees in angle.

Digitizing:

The APAS system has a manual and an automatic digitizing function. During the automatic digitizing, the computer is in control. We have possibility to recognize the mistakes and we get a feedback about correct performance too. Since all information depends on the quality of the data process, it is essential to make precise recordings of the desired points. For the digital recording we need clearly visible markers which can be followed precisely by the system during the automatic digitization after the first two pixels have been digitized manually. In my thesis I applied the manual digitization.

Calculation:

The calculating phase becomes possible only after digitizing all the video recordings made from all the different visual angles. The aim is to create a three dimensional data base for the calculation of which we use the two dimenzion digitalized coordinates we got from the pictures made by the cameras.

Presentation:

The modules included here are to represent the picture calculated during the analysis. This phase allows us, to present the calculated results in different forms. The position of the body can be represented in dots or in three dimensions as a moving figure, but flow – diagrams may also be described. The speed and acceleration vectors may be added to the picture which can show us the character of the movement. In no way do these methods influence or change the presented data.

IV.

Examination of the hypothesis and evaluation of the results

1. The time of the preparatory phase has not changed considerably before and after the development of the throws. In both cases the time during which the thrower reaches from the starting position to the so called back side position – from where he/she can start the active phase of the throw - is nearly the same. (1.st. attachment)
2. To contradict this we can observe in the throws after the development that during the implementation of the throw the speed of the hip, shoulder and the wrist has changed considerably compared to the throws before the development. At the hip and the shoulder only to a small extent but showing an increasing tendency while at the wrist the increase may be experienced in an accumulated way, which proves the good technical implementation of the throw, in other words it proves the „ rocket principle" mentioned in the thesis.(1.st. attachment)
3. There isn't a considerable difference between the elapsed time of the active part of the throws before or after the development. (t = constant). We can draw two conclusions from this:
    - Based on the relationship between speed, time and acceleration which we can demonstrate with:

      $$S = V_0 * t + \frac{a}{2} * t^2$$

      we can say that if „ t „ is constant then the speed of the movements in throws after the development has increased considerably. The conclusion is that the acceleration of the ball was made on a longer course, the result of which was the longer throw.

      (The changes in distance may be seen in the attached tables 2 – 3.)
    - Our second conclusion is that we could experience intramuscular coordination development in considerable extent by the end of the training period. We can prove this because the time structure of the throws did not change, but the speed dimension of the throw has considerably changed after the development. From this we can draw the conclusion that during the same time – in throws after the development – the players can switch on simultaneously a larger number of muscle fibers, within the muscle when

implementing the motion, thus the active phase of the throwing movement gathers more speed.

4. From the examination of the correlation coefficient of the statistics – were we compared the distance of the throws to the changes in the speed of the hip, the shoulder and the wrist on the throwing side – we may conclude that in the increase of the performance of the throw the biggest role is that of the shoulder with its change of speed, with a 0. 7253 correlation coefficient. (hip: 0.6022, wrist: 0.6724). (4^{th} attachment)

   We analyzed with a „ T „ probe the speed of changes in various parts of the body before and after the development. The results of the "T" probe indicate that the change of speed shows significant difference in every joint. These are 0.028 in the case of the hip, 0.02 in the case of the shoulder and 0.03 in the case of the wrist (This difference is considered significant under the value of 0.05). The results of the „T" probe are in attachment 4.)

V.
Discussion

The aim of the implemented development is to evaluate, summarize the results of the development, to make sure whether the speed power of the handball players has developed or not due to the power training. Furthermore we have to examine if this development was successful or not with reference to the handball as a sport and whether it confirms the legitimacy of the sport as it was known so far.

1. We can see the result of the successful development when analyzing the results of the survey and statistical data. This is proven by the tables of the throwing performance in attachment 2 – 3, and by the" Evaluation of the results, the Examination of the Thesis" in paragraph „c", as well as the data in attachment No.1., concerning the data showing the changes in the speed of the movement of the joints.

   When talking about handball we have to highlight the changes in the speed of wrist movements among the changes in the other parts of the body. The considerable change in the speed of this part of the body while implementing the throw justifies the function of the „rocket principle."

   In the success of the handball players' throws, this part of the body plays the main role. The wrist is the last loop of the kinetic chain where the functional speed is the greatest, due to the acceleration of the body parts and the pre-stretched muscles. From the aspect of the execution of the throws the last possibility of modification is at the wrist. (This typical for all throws used in handball.) Consequently we have to handle the development of this part of the body with utmost care that is to give it high priority when developing its function.

   The development program applied by me can influence successfully the development of the handball player's, speed power and can enhance an increase in the speed of the wrist's function.
2. In paragraph II.1 of the thesis I have remarked that the development of the intramuscular coordination plays main role in the power training of the younger age category sportsmen.

3. From the results gained by the evaluation of points 2 and 4 of the measurement results we can prove that, even though the biggest change of speed was measured in the wrist, it is still the shoulder which part of the body influences most in a positive way the speed of the throws and the changes of the performance. Consequently when training our handball players the shoulder joint and the muscles of the shoulder have to be developed in an outstanding manner.

VI.
Conclusions

I tried to give a brief assessment and review in my thesis about the power training of handball players. I did this in particular because even nowadays we may hear opinions based on misunderstanding in many cases concerning power trainings for younger age players. Unfortunately these opinions dispute the justification of power trainings. These opinions – I am convinced – are mostly expressed without sufficient knowledge of the methods of power training. A number of trainers and parents consider power trainings dangerous for children. One of these negative opinions is that dumbbell lifting at an early age hinders the growth of bones. Modern medical examinations and studies contradict this misunderstanding, saying that as a consequence of power trainings the bones become thicker because the trainings stimulate the density of mineral content of the bones and does not hinder the lengthwise growth at all. Naturally in order to have our pupils perform power training in a safe manner, both the teacher and the pupils have to be in command of appropriate proficiency in their own field. I, myself have been dealing with younger age handball players for nearly 20 years, and the methods and principles used by me during the power trainings, are the same as those mentioned in this thesis, and which methods have proven successful during these years.

The development of a handball player's training program needs attention and professionalism on behalf of the trainer. To achieve an unbroken development with each player one must make them do the appropriate training that is suitable for their age and their mental and somatic development. Those abilities that we neglect to develop in the so called „ sensitive" periodes, can be supplemented later on only in a difficult way, or not at all.

During the development of adult players regular power training needs a redoubled effort, since the players have to meet the requirements of the actual game during the match. For a well prepared and structured handball player regular power training is in dispensable. Of course the player can meet these requirements only if he/she had been prepared in a painstaking way, suitable for his/her age group. Actually this has to become an inner need of the player after a time. In order to make the inner need form in the players, we – trainers, teachers – have a huge responsibility since we

have to give the exact direction and professional aim to them, so as to achieve our common success.

Last but not the least I would like to say thanks and express my gratitude to my Masters Mr. László Kovács and Mr. Lajos Mocsai for the great support they had given to me in writing this thesis.

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VIII. Attachments

Attachment No. 1

Name	Throw 1	Throw 1/1	Throw 1/2	Throw 2	Throw 2/1	Throw 2/2
Nyitrai Szabolcs	21,90 m	1,179 s	0,41 s	24,6 m	1 s	0,42 s
Speed of the hip cm/s		24,398	19,06		32,8	59,5
Speed of the shoulder cm/s		21,376	91,07		51,3	119,09
Speed of the wrist cm/s		31,924	344,28		46,2	464,07
Guba Tamás	22,70 m	1,12 s	0,42 s	27,20 m	0,9 s	0,39 s
Speed of the hip cm/s		25,28	19,75		36,26	65,29
Speed of the shoulder cm/s		22,15	94,324		56,72	131,67
Speed of the wrist cm/s		33,09	356,56		51,08	513,11
Molnár Viktor	27,10 m	0,9 s	0,49 s	30,30 m	1,2 s	0,45s
Speed of the hip cm/s		36,20	65,01		40,39	72,73
Speed of the shoulder cm/s		56,60	128,9		63,18	146,67
Speed of the wrist cm/s		49,55	510,2		56,90	571,58
Lázár Soma	19,80 m	1,12 s	0,42 s	22,40 m	1 s	0,42 s
Speed of the hip cm/s		22,05	17,22		24,9	18,5
Speed of the shoulder cm/s		19,32	82,27		21,45	90,24

Name	Throw 1	Throw 1/1	Throw 1/2	Throw 2	Throw 2/1	Throw 2/2
Speed of the wrist cm/s		28,86	311,08		30,12	350,79
Zubai Gábor	27,00 m	0,9 s	0,49 s	30,80 m	1,2 s	0,45 s
Speed of the hip cm/s		36,20	65,01		41,39	73,73
Speed of the shoulder cm/s		56,60	128,9		64,18	147,67
Speed of the wrist cm/s		49,55	510,2		57,90	572,58
Nyeste Balázs	17,30 m			21,20 m	1,14 s	0,46 s
Speed of the hip cm/s		19,23	14,98		224,398	18,90
Speed of the shoulder cm/s		16,35	79,54		1921,37	90,1
Speed of the wrist cm/s		25,54	305,21		29,924	342,28
Mezei Bence	17,20 m	0,9 s	0,49 s	20,00 m	1,14 s	0,46 s
Speed of the hip cm/s		19,14	14,98		23,05	18,72
Speed of the shoulder cm/s		16,10	79,54		20,32	83,27
Speed of the wrist cm/s		25,48	305,21		298,86	312,008
Király Gergő	19,40 m	1,12 s	0,42 s	24,10 m	1 s	0,42 s
Speed of the hip cm/s		21,05	16,22		31,8	58,5
Speed of the shoulder cm/s		18,32	81,27		50,3	118,09
Speed of the wrist cm/s		27,86	310,008		45,2	463,07

Name	Throw 1	Throw 1/1	Throw 1/2	Throw 2	Throw 2/1	Throw 2/2
Jacsó Attila	20,40 m	0,98 s	1,45 s	22,60 m	1 s	0,42 s
Speed of the hip cm/s		23,98	16,85		24,9	18,5
Speed of the shoulder cm/s		21,32	84,27		21,45	90,24
Speed of the wrist cm/s		299,86	313,008		30,12	350,79

Throw 1: The first – before the development – distance of throw

Throw 1/1: The first – before the development – throw, the time of preparation movement. The acceleration

Throw 1/2: The first – before the development – time of the active section of the throw. The throw

Throw 2: The second – after the development – distance of the throw

Throw 2/1: The second – after the development – throw, time of preparation movement. The acceleration

Throw 2/2: The second – after the development – throw time of the active section. The throw

Attachment No. 2

The results of the first achievement assessment (2003-12-22)

Throws

Name	Back lying position	Siting position	Kneeling side straddle position	Diagonal kneeling straddle position	Diagonal straddle position on the knee	Standing side straddle position	Diagonal standing straddle position	Diagonal standing straddle position **Average**
Nyitrai	9,90	**12,00**	16,30	**18,30**	19,20	**21,60**	21,70	
Szabolcs	8,70	11,50	16,50	17,50	18,90	20,70	**21.90**	**21,7**
	10,10	11,50	**16,80**	17,60	**19,30**	18,50	21,70	
Guba Tamás	9,30	11,50	17,40	19,20	**19,00**	**22,20**	**22,70**	
	9,30	**11,60**	17,10	**19,20**	17,90	21,90	21,60	**22,1**
	10,10	11,50	**18,60**	18,90	18,90	22,10	22,20	
Molnár Viktor	11,70	16,00	18,80	21,00	21,00	22,60	26,10	
	12,70	15,00	18,00	**21,10**	19,50	**23,90**	**27,10**	**26,7**
	13,20	**16,30**	**20,00**	22,00	**22,10**	22,90	27,00	
Lázár Soma	9,70	10,30	**14,90**	16,50	**17,70**	17,00	**19,80**	
	9,75	**10,30**	13,40	**16,60**	17,00	17,60	19,20	**18,8**
	9,00	9,70	13,40	16,40	17,20	**17,80**	17,50	
Zubai Gábor	12,20	15,40	17,50	21,20	19,30	**23,70**	23,80	
	12,80	**15,50**	**21,00**	**21,30**	18,90	21,90	25,00	**25,2**
	13,50	14,90	20,00	21,00	**20,10**	22,30	**27,00**	
Nyeste Balázs	7,40	8,70	**12,30**	**14,00**	13,10	**16,90**	16,20	
	7,80	**9,70**	10,90	12,50	**13,60**	15,70	**17,30**	**16,4**
	6,80	9,40	11,60	13,20	11,40	15,70	15,80	
Mezei Bence	**9,70**	9,50	11,90	17,10	**14,00**	**15,70**	**17,20**	
	8,60	9,60	**12,80**	16,90	13,60	15,50	16,90	**16,70**
	8,50	**9,70**	12,70	**17,20**	13,80	15,10	16,20	
Király Gergő	7,70	10,10	13,00	**15,90**	**15,90**	17,20	19,10	
	7,80	11,10	13,60	14,90	14,80	16,90	**19,40**	**19,1**
	7,80	**11,20**	**14,90**	15,00	15,70	**18,00**	19,00	
Jacsó Attila	7,90	**12,40**	15,50	17,00	15,90	18,40	19,80	

	9,80	11,50	15,60	**17,60**	15,90	19,30	**20,40**	**18,0**
	9,30	11,40	**15,90**	16,80	**16,30**	**19,40**	14,00	
Galkó Ádám	9,30	11,60	15,50	17,00	16,20	18,40	**20,80**	
	9,50	**11,80**	**15,50**	16,30	**16,90**	18,10	20,40	
	9,50	11,50	14,80	**17,10**	16,10	**19,50**	18,60	
Average of the team								**20,52**
Average of the best throws							**23.73**	

Attachment No. 3

The results of the second achievement assessment (2004-04-01)

Throwing from a diagonal standing straddle position

Name	1.	2.	3.	4.	5.	6.	Average of the best three throws
Nyitrai Szabolcs	23,20	23,30	24,30	24,10	**24,60**	24,40	**24,40**
Guba Tamás	26,05	26,60	**27,20**	26,30	25,10	25,00	**26,70**
Molnár Viktor	28,80	30,20	29,70	29,40	**30,30**	invalid	**30,00**
Lázár Soma	22,10	20,80	21,30	21,90	21,80	**22,40**	**22,20**
Zubai Gábor	**30,80**	30,00	30,80	29,80	29,90	29,40	**30,50**
Nyeste Balázs	19,90	20,80	18,50	**21,20**	19,20	19,10	**20,60**
Mezei Bence	**20,00**	19,30	18,60	18,80	19,10	19,90	**19,70**
Király Gergő	22,70	22,70	23,30	22,90	**24,10**	23,40	**23,60**
Jacsó Attila	21,10	21,80	22,10	**22,60**	22,20	20,60	**22,30**
Galkó Ádám	INJURED						
Average of the team							**24,44**
Average of the best throws							**24,80**

Attachment No. 4

Examination of the correlation coefficients related to the changes of achievement

	Hip		Shoulder		Wrist		Throw	
	Former	**New**	**Former**	**New**	**Former**	**New**	**Former**	**New**
Nyitrai Szabolcs	19,06	59,5	90,07	119,09	344,28	464,07	21,9	24,6
Guba Tamás	19,75	65,29	94,32	131,67	356,56	513,11	22,7	27,2
Molnár Viktor	65,01	72,73	128,9	146,67	510,2	571,58	27,1	30,3
Lázár Soma	17,22	18,5	82,27	90,24	311,08	350,79	19,8	22,4
Zubai Gábor	65,01	73,73	128,9	147,67	510,2	572,58	27	30,5
Nyeste Balázs	14,98	18,9	79,54	90,1	305,21	342,28	17,3	21,2
Mezei Bence	14,38	18,72	79,14	83,27	304,11	312,08	17,2	20
Király Gergő	16,22	58,5	81,27	118,09	310,08	463,07	19,4	24,1
Jacsó Attila	16,85	18,5	84,27	90,24	313,08	350,79	20,4	22,6

	Hip change	**Shoulder change**	**Wrist change**	**Throw change**
Nyitrai Szabolcs	40,44	29,02	119,79	2,7
Guba Tamás	45,54	37,35	156,55	4,5
Molnár Viktor	7,72	17,77	61,38	3,2
Lázár Soma	1,28	7,97	39,71	2,6
Zubai Gábor	8,72	18,77	62,38	3,5
Nyeste Balázs	3,92	10,56	37,07	3,9
Mezei Bence	4,34	4,13	7,97	2,8

Király Gergő	42,28	36,82	152,99	4,7
Jacsó Attila	1,65	5,97	37,71	2,2
	0,602258	0,725377	0,672447	

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Hip former	27,6422	9	21,33933	7,11311
	Hip new	44,8300	9	25,46037	8,48679
Pair 2	Hip former	94,2978	9	20,23301	6,74434
	Hip new	113,0044	9	25,47440	8,49147
Pair 3	Hip former	362,7556	9	85,52996	28,50999
	Hip new	437,8167	9	101,93999	33,98000
Pair 4	Hip former	21,4222	9	3,67076	1,22359
	Hip new	24,7667	9	3,80164	1,26721

Paired Samples Correlations

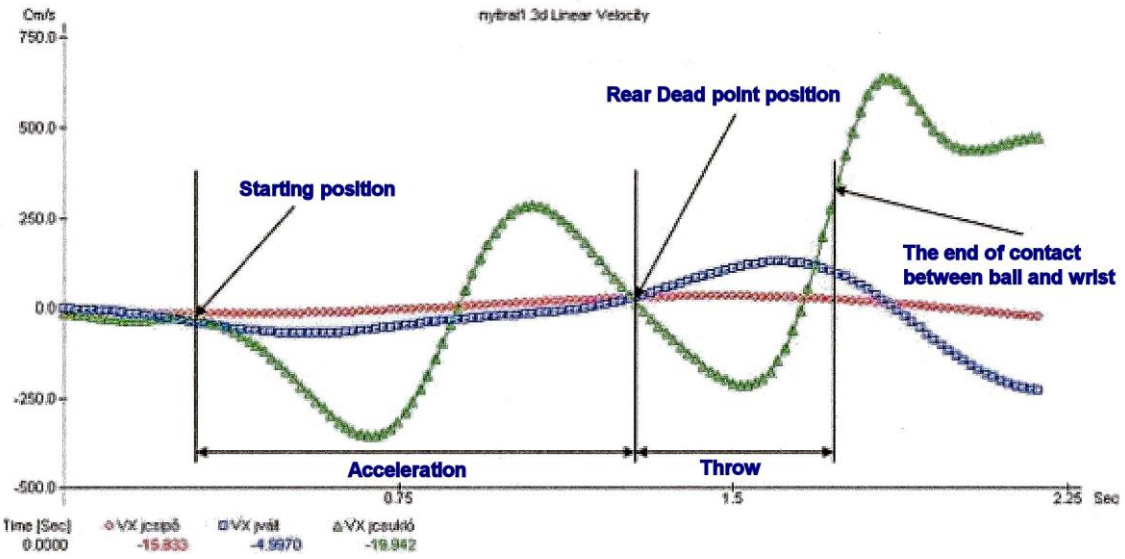
	N	Correlation	Sig.
Pair 1 Hip former & Hip new	9	,674	,047
Pair 2 Shoulder former & Shoulder new	9	,864	,003
Pair 3 Wrist former & Wrist new	9	,846	,004
Pair 4 Throw former & Throw new	9	,973	,000

Paired Samples Test

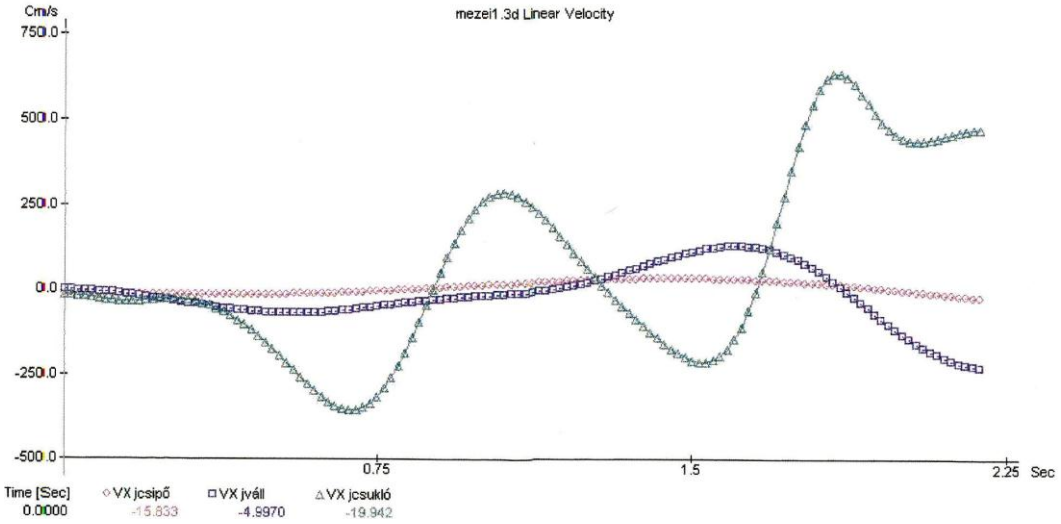
	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviaton	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 Hip former - Hip new	17,18778	19,26968	6,42329	31,99991	-2,37565	-2,676	8	,028
Pair 2 Shoulder former - Shoulder new	18,70667	12,93860	4,31287	28,65216	-8,76118	-4,337	8	,002
Pair 3 Wrist former - Wrist new	75,06111	54,37297	18,12432	-116,858	33,26635	-4,141	8	,003
Pair 4 Throw former - Throw new	-3,34444	,87337	,29112	-4,01578	-2,67311	-11,488	8	,000

Attachment No. 5

The speed of the horizontal and the vertical movement of the ball and of the various parts of the body in time; before and after the development training.



Mezei Bence


Cm/s
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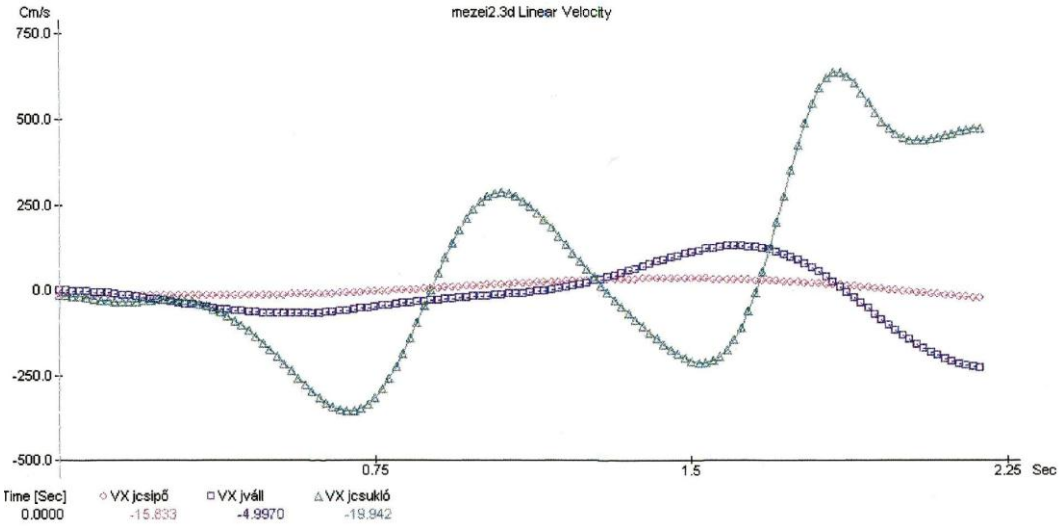
750.0
500.0
250.0
0.0
-250.0
-500.0
0.75
1.5
2.25
Sec
Time [Sec]
VX jcsipő
VX jváll
VX jcsukló
0.0000
-15.833
-4.9970
-19.942


Cm/s
mezei2.3d Linear Velocity
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500.0
250.0
0.0
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-500.0
0.75
1.5
2.25
Sec
Time [Sec]
VX jcsipő
VX jváll
VX jcsukló
0.0000
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-4.9970
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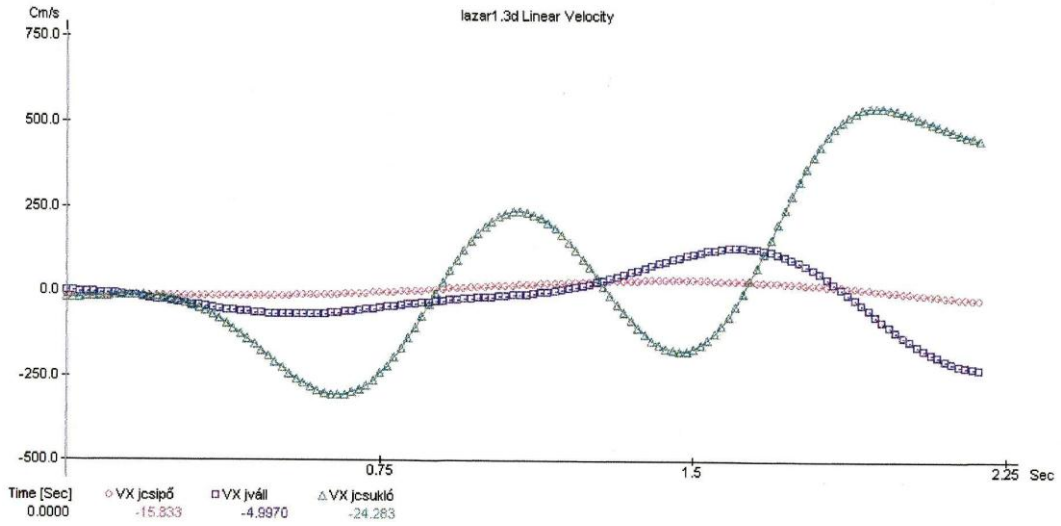
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Cm/s
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500.0
250.0
0.0
-250.0
-500.0
0.75
1.5
2.25
Sec
Time [Sec]
VX jcsipő
VX jváll
VX jcsukló
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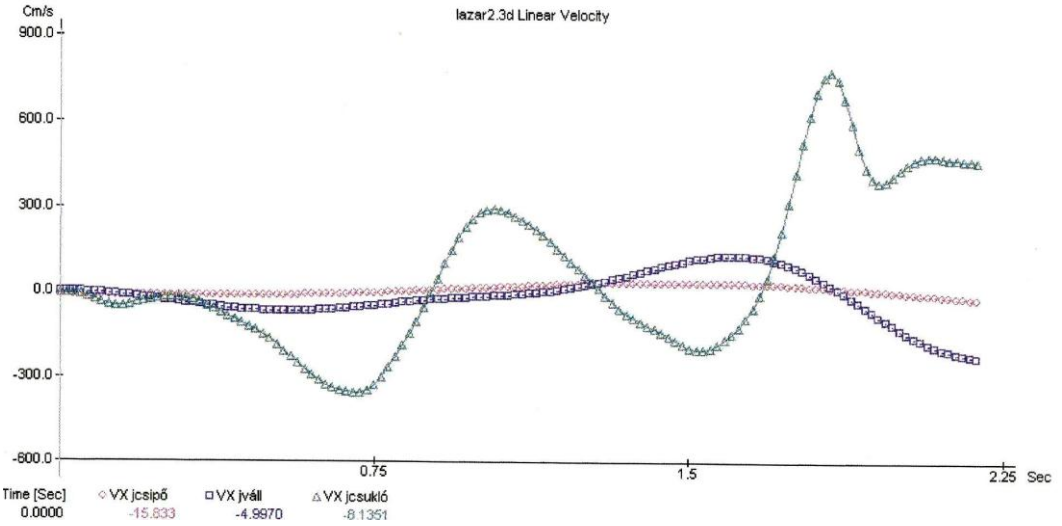
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Cm/s
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300.0
0.0
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-600.0
0.75
1.5
2.25
Sec
Time [Sec]
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VX jváll
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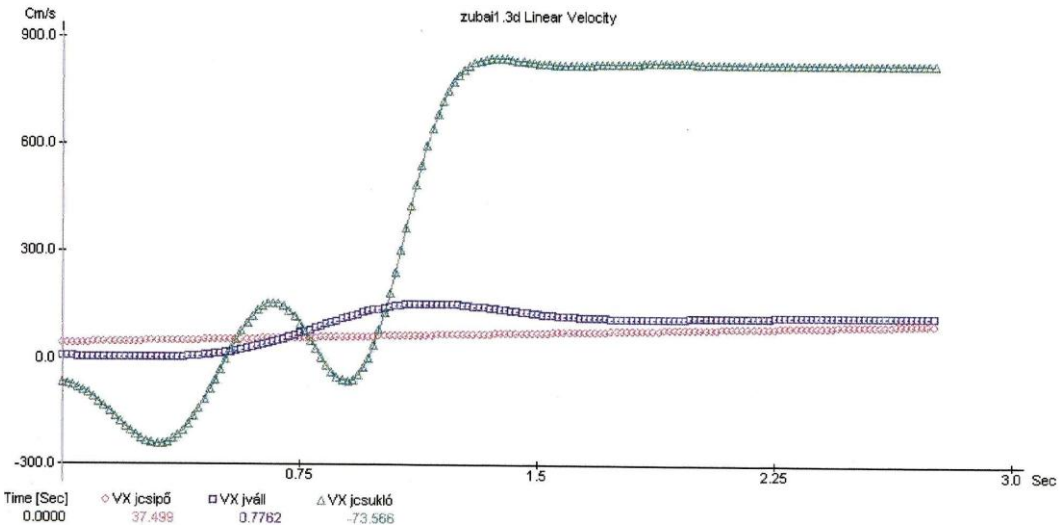
Cm/s
zubai1.3d Linear Velocity
900.0
600.0
300.0
0.0
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0.75
1.5
2.25
3.0 Sec
Time [Sec]
VX jcsipő
VX jváll
VX jcsukló
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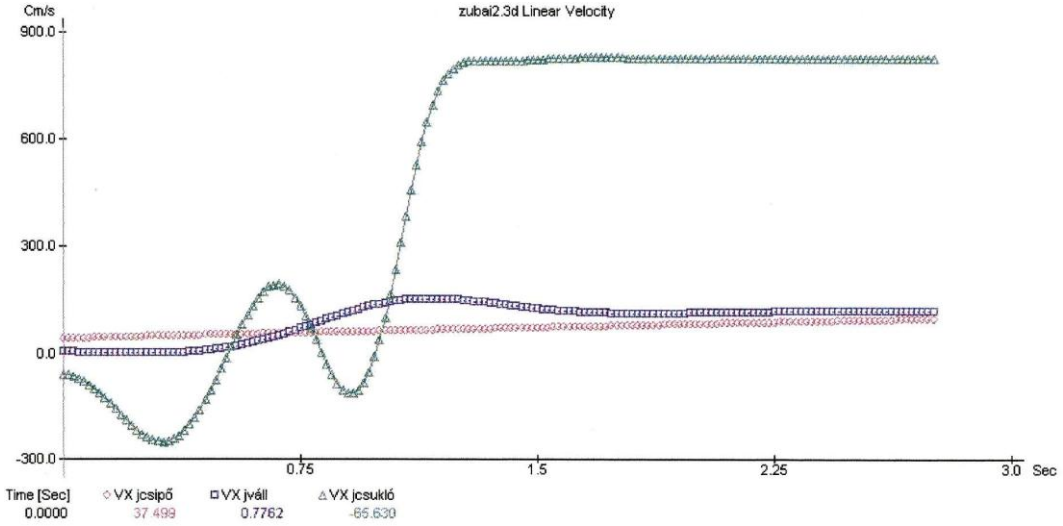
Cm/s
zubai2.3d Linear Velocity
900.0
600.0
300.0
0.0
-300.0
0.75
1.5
2.25
3.0 Sec
Time [Sec]
VX jcsipő
VX jváll
VX jcsukló
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37.499
0.7762
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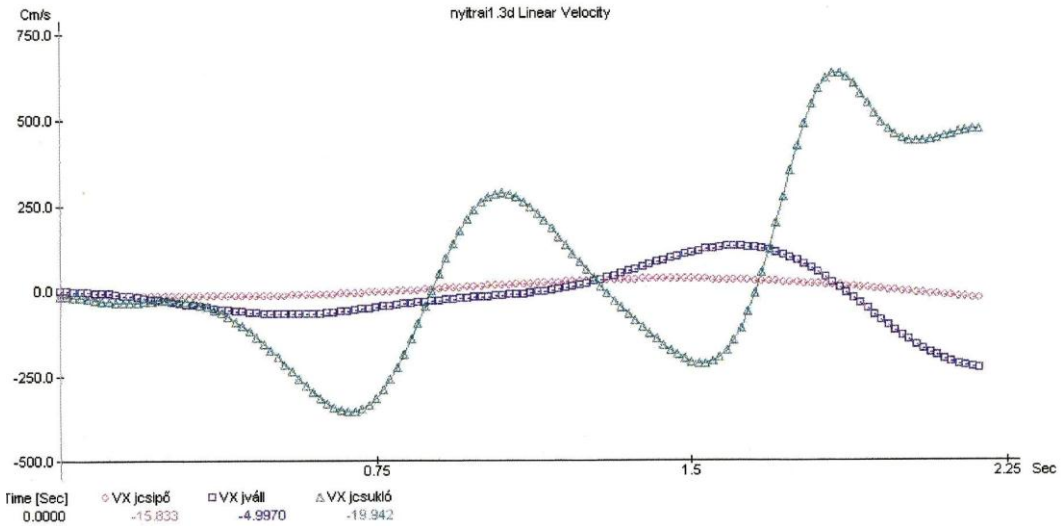
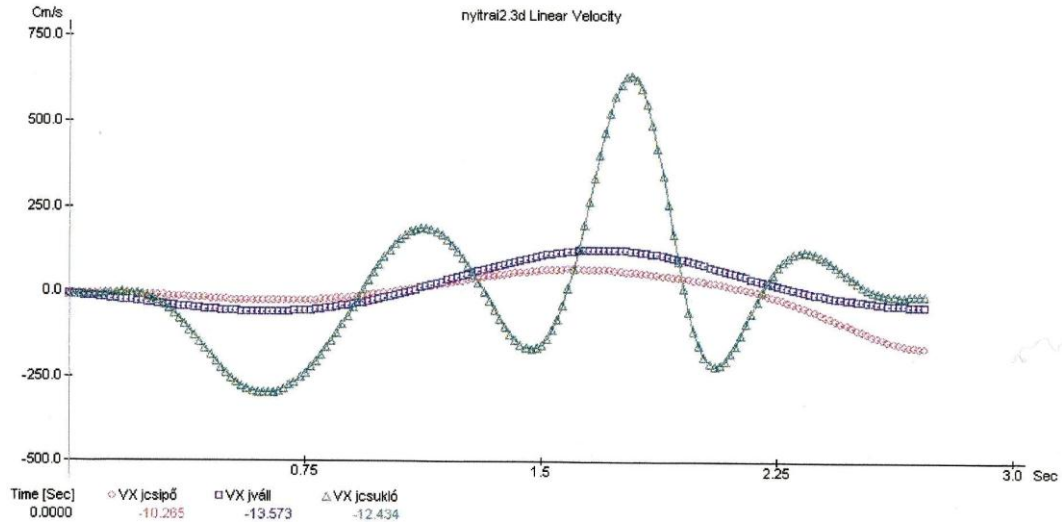
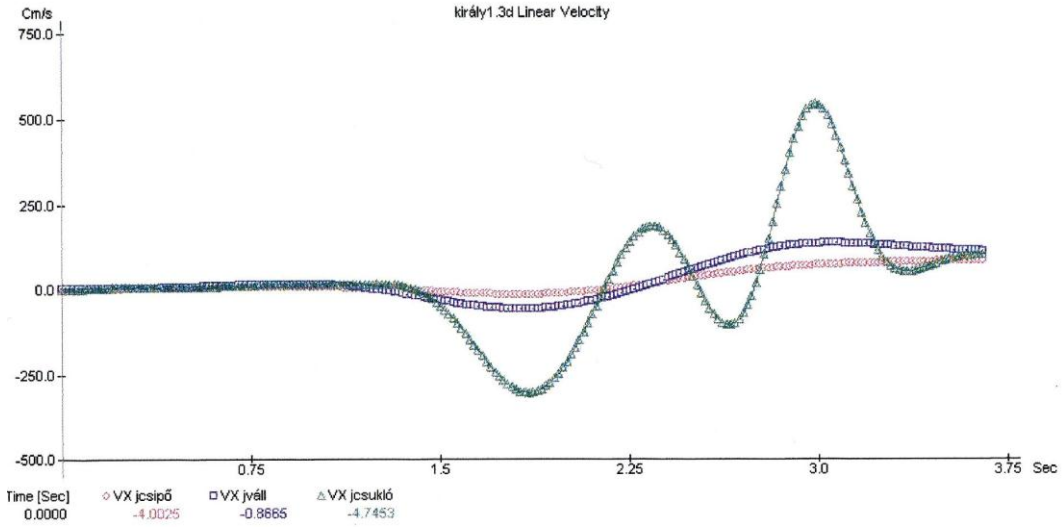
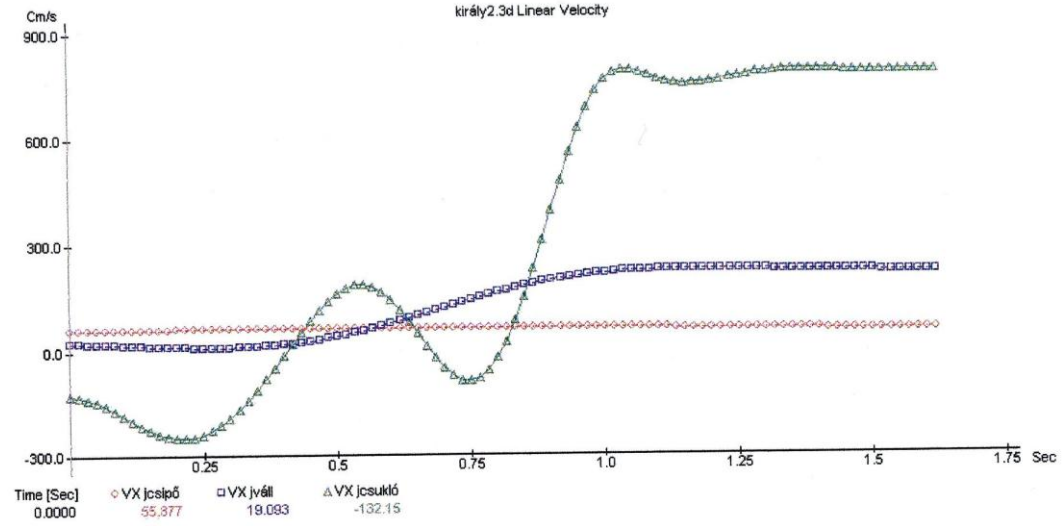

nyitrai1.3d Linear Velocity
Cm/s
750.0
500.0
250.0
0.0
-250.0
-500.0
0.75
1.5
2.25
Sec
Time [Sec]
VX jcsipő
VX jváll
VX jcsukló
0.0000
-15.833
-4.9970
-19.942

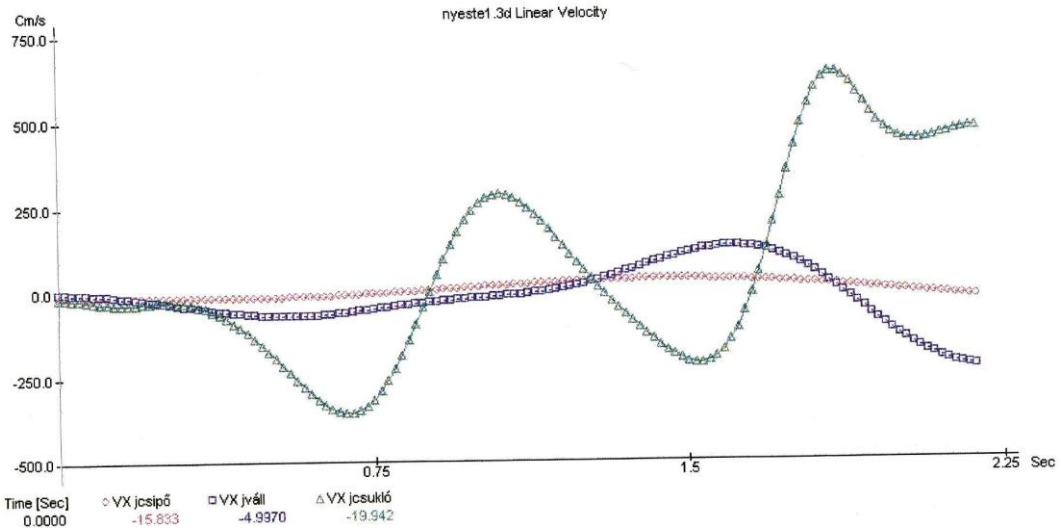

nyitrai2.3d Linear Velocity
Cm/s
750.0
500.0
250.0
0.0
-250.0
-500.0
0.75
1.5
2.25
3.0
Sec
Time [Sec]
VX jcsipő
VX jváll
VX jcsukló
0.0000
-10.265
-13.573
-12.434

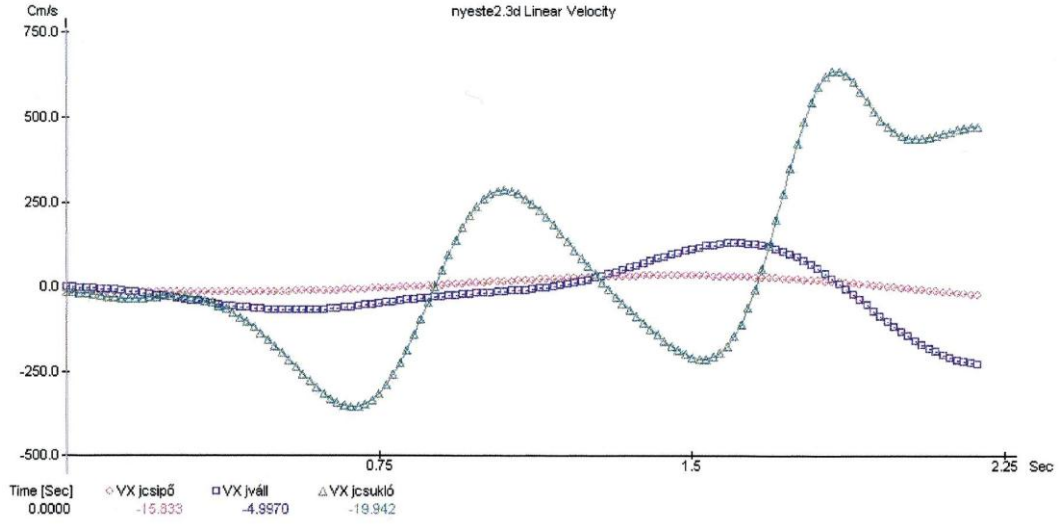
Király Gergő

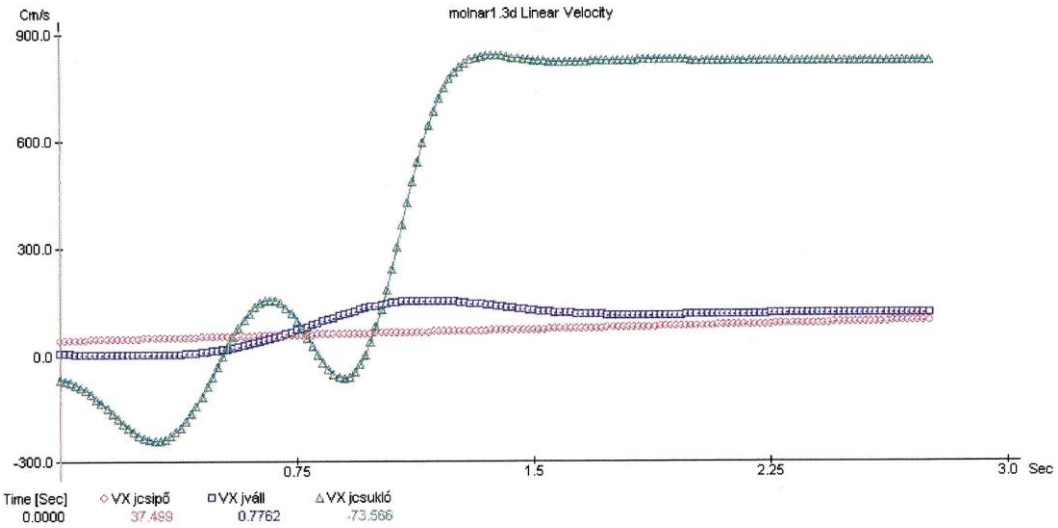


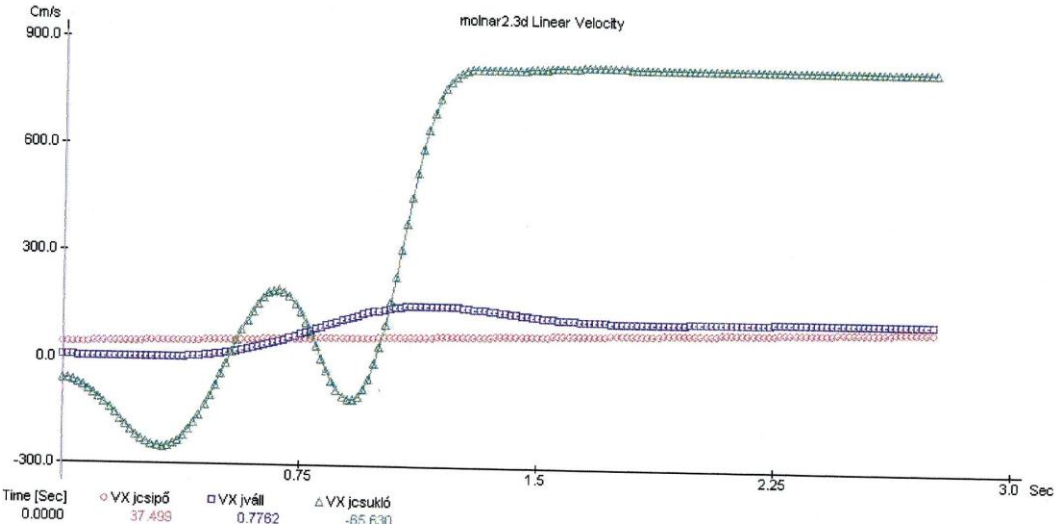


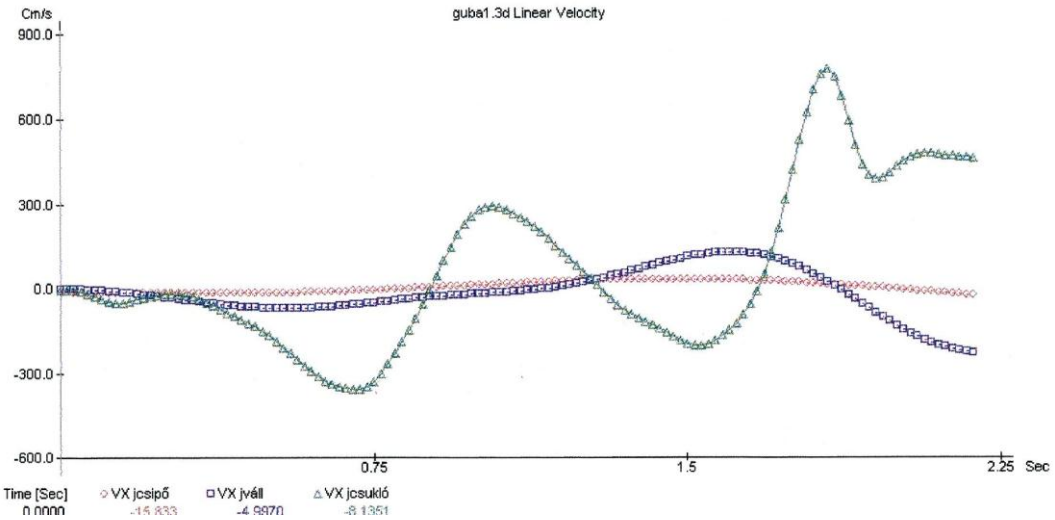
Nyeste Balázs

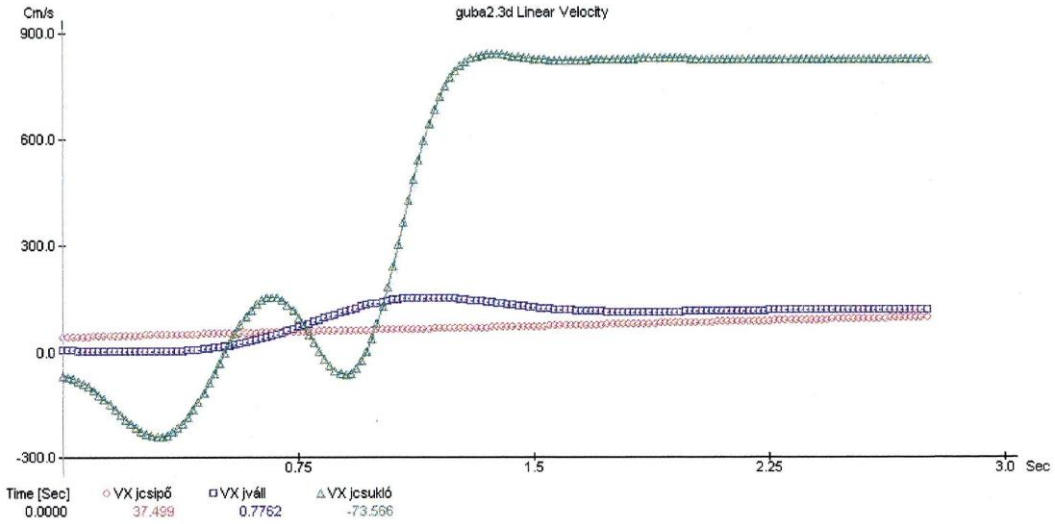


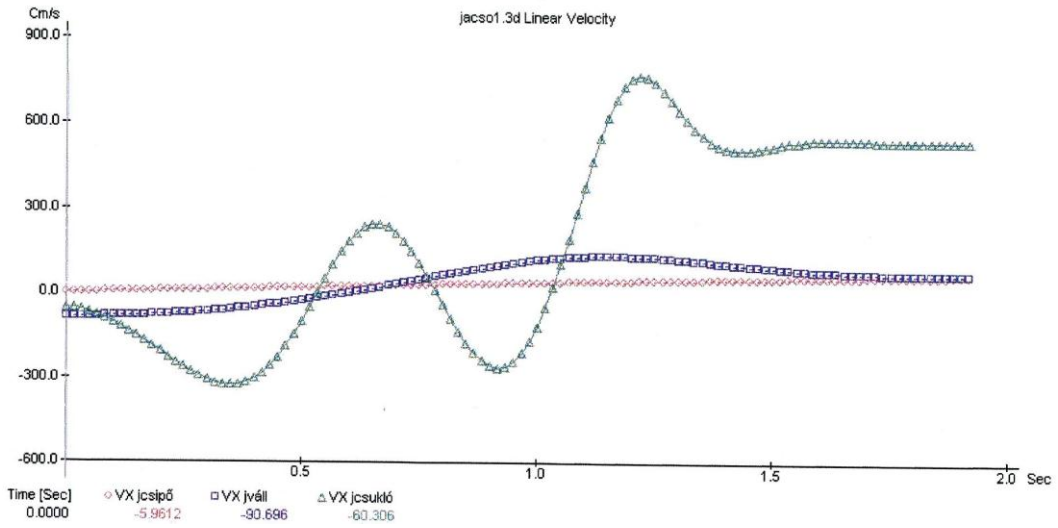


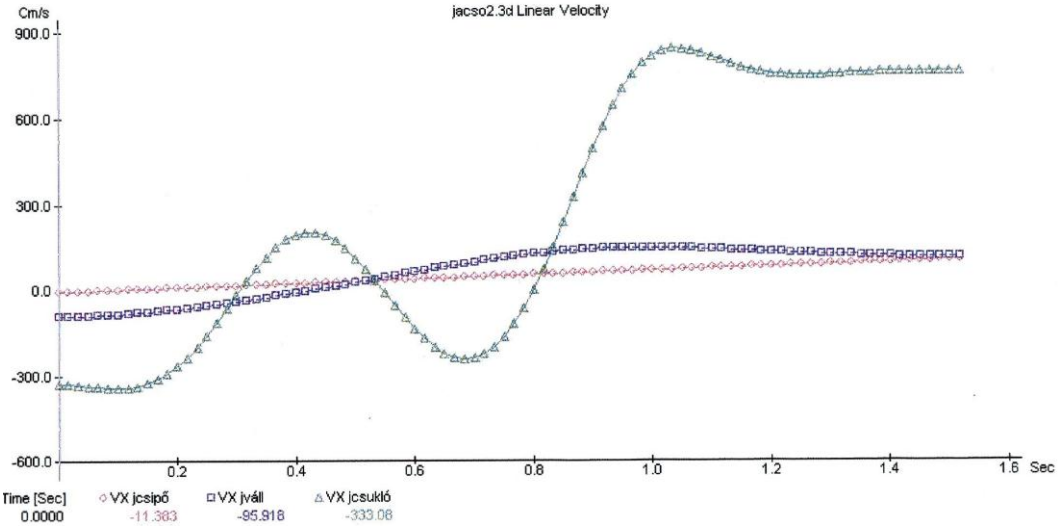

Cm/s
molnar1.3d Linear Velocity
900.0
600.0
300.0
0.0
-300.0
0.75
1.5
2.25
3.0 Sec
Time [Sec]
VX jcsipő
VX jváll
VX jcsukló
0.0000
37.499
0.7762
-73.566


Cm/s
molnar2.3d Linear Velocity
900.0
600.0
300.0
0.0
-300.0
0.75
1.5
2.25
3.0 Sec
Time [Sec]
VX jcsipő
VX jváll
VX jcsukló
0.0000
37.499
0.7762


guba1.3d Linear Velocity
Cm/s
900.0
600.0
300.0
0.0
-300.0
-600.0
0.75
1.5
2.25
Sec
Time [Sec]
VX jcsipő
VX jváll
VX jcsukló
0.0000
-15.833
-4.9970
-8.1351


guba2.3d Linear Velocity
Cm/s
900.0
600.0
300.0
0.0
-300.0
0.75
1.5
2.25
3.0
Sec
Time [Sec]
VX jcsipő
VX jváll
VX jcsukló
0.0000
37.499
0.7762
-73.566


Cm/s
jacso1.3d Linear Velocity
900.0
600.0
300.0
0.0
-300.0
-600.0
0.5
1.0
1.5
2.0
Sec
Time [Sec]
VX jcsipő
VX jváll
VX jcsuklő
0.0000
-5.9612
-90.686
-60.306


Cm/s
jacso2.3d Linear Velocity
900.0
600.0
300.0
0.0
-300.0
-600.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
Sec
Time [Sec]
VX jcsipő
VX jváll
VX jcsukló
0.0000
-11.383
-95.918
-333.08

Attachment No. 6

Representation of the throwing movement sequences