# Software Developed for Use in Family Mediation - AssetDivider

Emilia Bellucci[1]

[1]School of Management and Information Systems, Faculty of Business and Law
Victoria University
Emilia.Bellucci@vu.edu.au

**Abstract:** This article describes research into software that supports Family Law mediation. Most divorcing couples enter into mediation to resolve the decisions in who is allocated items from the common pool of assets. AssetDivider supports this task by asking parties to assign ratings to the items in question. The software takes this information and from it develops a list of allocations to each party. This list is developed with knowledge of an ideal "percentage split" that has been set by mediators. The system has been tested informally by our contacts at RAQ, and we now look forward to extensive testing and evaluation by mediators at RAQ in the near future.

**Keywords:** Negotiation Support Systems (NSS), Family Law Mediation

## 1. Introduction

The focus of this research is in extending our work in interest-based negotiation to developing research into systems for use in mediations. We have developed several Negotiation Support Systems (NSS) including DEUS, Split_Up and Family_Winner [1]. As a direct result of extensive media interest in Family_Winner [2], we were contacted and have been in negotiations with Relationships Australia Queensland (RAQ). Relationships Australia is a relationship support service, which conducts support services across numerous areas, including family mediation, parenting courses, pre-marriage counselling, and special support services such as counselling to families affected by drought and flooding. We have been in contact with RAQ to develop a new theory of decision support for family mediation.

Negotiation is a process by which two or more parties conduct communication or conferences with the view of resolving differences between them [1]. We believe cooperation between parties as paramount to ensuring both parties are satisfied with the outcome of the negotiation. Their involvement in the decision-making process encourages agreement with the settlement. Mutually satisfying resolutions [3] describe settlements arrived at by the interaction and input of disputants. Mediators agree with the need for mutually satisfying agreements and are willing to use a NSS if it can support the realities of the negotiation in the domain. We know this because RAQ are eager to use our software.

AssetDivider's predecessor is Family_Winner [2]. The underlying principle of each system is in their use of interests. The theory which best supports our definition of negotiation support is Principled Negotiation [4], developed under the Harvard Negotiation Project. It emphasizes parties look for mutual gains and focuses on the underlying values (or interests) that justify a disputant's position, as opposed to attempting negotiation solely from their positions.

Family_Winner takes a common pool of items and distributes them between two parties based on the value of associated ratings. Each item is listed with two ratings (a rating is posted by each party), which signify the item's importance to the party. A rating in Family_Winner is a number in value from 0- 100 (0 being of no importance; 100 to signify absolute importance). The algorithm to determine which items are allocated to whom works on the premise that each parties' ratings sum to 100; thereby forcing parties to set priorities. The program always checks this is the case, and if not, it realigns ratings to ensure all sum to 100. The basic premise of the system is that it allocates items based on whoever values them more. Once an item has been allocated to a party, the ratings of the remaining items are modified (according to the actions of trade-offs) to ensure the items (and their associated ratings) are ready for the next round of allocation [1].

Family_Winner was evaluated by a number of family solicitors at Victoria Legal Aid (VLA). Whilst the solicitors were very impressed with the way Family_Winner suggested trade-offs and compromises, they had one major concern – that in focusing upon negotiation, the system had ignored the issues of justice [2]. For example, Family_Winner simply allocates property to parties based on their interest in the item. It does not allow for monetary values to influence the allocation process. The dollar value of items is important to the dispute because each party wants to be allocated the right or 'just' amount of money. This concept contrasts with linking an interest value to an item, which is intrinsically different. An interest is an evaluation based on the significance of the item to a person. For example, party A may be very fond of a lamp that has been passed down throughout the generations, and consequently they give it a rating of 50. The remaining items are not as important to party A, and so are given much lower ratings. Whilst using interests to negotiate is a very interesting exercise, it does not in any way reflect the dollar value of the item. This is where Family_Winner fails to support the mediation process effectively. Whilst Mediators from RAQ consider the way Family_Winner supports interest-based negotiation by setting priorities as useful; they are also concerned with the missing influence of monetary values. Hence, our new theory of negotiation support (implemented in AssetDivider) incorporates the basis of Family_Winner's allocation and trade-off strategy by utilizing both interests and an item's monetary value.

Section 2 will detail this new theory of negotiation support, while Section 3 will discuss the presentation of a family law case to AssetDivider. We are in the process of organising the evaluation of AssetDivider at RAQ, and expect this to occur in the near future.

## 2. Negotiation Concepts

Early decision-support negotiation systems primarily used Artificial Intelligence techniques to model negotiation. LDS [5] used rule-based reasoning to assist legal

experts in settling product liability cases. SAL [6] also used rule-based reasoning to help insurance claim adjusters evaluate claims related to asbestos exposure.

NEGOPLAN [7] is a rule based system written in PROLOG which advised upon industrial disputes in the Canadian paper industry. Mediator [8] used case retrieval and adaptation to propose solutions to international disputes, while PERSUADER [9] integrated case based reasoning and decision-theoretic techniques to provide decision support to United States' industrial disputes.

Negotiation Support Systems (NSS) were primarily responsible for tracking past preferences and informing disputants about progress being made towards a solution to a conflict. We refer to these systems as template systems. Template systems assume disputants take on a passive role after the initial intake of preferences and issues, since they fail to implement any strategies that incorporate change. Modelling the dynamic properties of negotiation infers the incorporation of decision support into a traditional negotiation support system. DEUS [10], INTERNEG [11], CBSS [12], Negotiator Pro and The Art of Negotiating [13] are all template based systems.

We are mostly interested in extending the primary role of a template based NSS to a system capable of providing decision support. We have classified these as Negotiation Decision Support Systems (NDSS). A Negotiation Decision Support System (NDSS) supports negotiation by modelling the properties of a template NSS as well as applying functions to interpret the goals, wants and needs of the parties to provide advice on how disputes can be settled.

Our earliest NDSS was Family_Negotiator [14]. It utilises a hybrid rule-based and case-based system to provides disputants with advice on how to best resolve the issues in an Australian Family Law dispute. Whilst evaluating the Family_Negotiator system, we discovered that Family Law negotiation was not an appropriate domain in which to apply either Case-based or Rule-based Reasoning, due principally to the open textured nature[1], of the domain. Nor did the overall framework of Family_Negotiator provide in-depth solutions expected from real-life negotiations.

AdjustWinner [15], uses a utility function to achieve equal distribution of the common pool[2]. The algorithm used in the system was the Adjusted Winner procedure [16]. AdjustWinner resolves a dispute by dividing issues and items among disputants, through a mathematical manipulation of numeric preferences. Although not classed as a NSS, AdjustWinner provided the framework for decision-making support that was later incorporated into a NSS to form Family_Winner.

Family_Winner is a negotiation decision support system that allocates items to one of two parties in the dispute. Family_Winner's method of decision support involves a complex number of techniques, including the incorporation of an Issue Decomposition Hierarchy, a Compensation and Trade-off strategy, and an Allocation strategy. The trade-offs pertaining to a disputant are graphically displayed through a

[1] Open textured legal predicates contain questions that cannot be structured in the form of production rules or logical propositions and which require some legal knowledge on the part of the user in order to answer

series of trade-off maps, while an Issue Decomposition Hierarchy enables disputants to decompose issues to any required level of specification.

Mediator, Persuader, NEGOPLAN and Family_Negotiator are considered to be intelligent systems since they can generate solutions using the system's internal knowledge as well as users input. All incorporate some level of negotiation support, together with the ability to provide users with a resolution to the current problem.
Artificial Intelligence techniques such as case-based, rule-based and hybrid reasoning have had mixed degrees of success in providing negotiation support. The Mediator proved quite successful in its retrieval and adaptation of previous cases. NEGOPLAN used rule-based reasoning to successfully model Canadian industrial disputes, while PERSUADER successfully modeled US industrial disputes through the use of a hybrid case and rule-based methodology. Family_Negotiator however, did not perform to its initial expectations, primarily due to its relatively simple modeling of the domain.

Apart from AdjustWinner, most of the systems surveyed above do not make allowances for measuring the fairness or justness of the settlement. Further, most of the systems discussed are rarely based on theories derived from practice or empirical studies. For example, INSPIRE [11] and SmartSettle [17] use Pareto Optimisation techniques to suggest optimal solutions. Our goal is to provide feasible suggested solutions to the conflict that are acceptable to the user, rather than searching for optimal solutions.

AssetDivider is our latest development in negotiation support systems. It extends on Family_Winner by modifying its' decision making theory to provide advice based on interests and the monetary value of items. Family_Winner provides advice based only on interests (known in the system as ratings). The rest of the paper will discuss the architecture and theory behind Asset Divider and in Section 3 we will illustrate how AssetDivider operates though an example.

## 3.Theory implemented into AssetDivider

This section will discuss the theory used to develop AssetDivider. The main principles behind AssetDivider were derived from theories developed and implemented in Family_Winner. [18] gives a thorough comparison of the similarities and differences between AssetDivider and Family_Winner.

### 3.1AssetDivider's input and output

Family_Winner takes a list of issues (items for distribution between two parties) and allocates them based on ratings given by the parties in dispute. Two sets of ratings are provide, one for each party in dispute. This rating (a numerical value between 0 and 100) does not represent the monetary value of the item, instead it symbolises how important the item is to the party. We assume a party wants to keep an item they feel is important to them.

AssetDivider accepts a list of items together with ratings (two per item) to indicate the item's importance to a party. In addition it also accepts the current monetary

value of each item in dispute. We assume this dollar value has been negotiated (if necessary) before AssetDivider is used[3]. Hence, only one dollar value is entered per item. The proposed percentage split is also entered; this reflects what percentage of the common pool each party is likely to receive in the settlement. The system is not capable of determining the percentage split; this figure has to be derived from the mediator's knowledge in past cases or from computer systems such as SplitUp [19], which can provide a percentage split given certain characteristics and features of divorce cases.

AssetDivider's output consists of a list of items allocated to each party. All of the items (except one) on the allocation lists were provided in the intake screen by the disputants. The additional item is a "payout" item, which reflects the amount of money a disputant would need to pay the other party for the items they have been allocated and collectively are valued greater than the percentage split offers them. For example, party A have been allocated a total value of $100,000 in assets, and party B $115, 000. Under a 50/50 % split, party B will need to pay $15,000 to party A to satisfy the percentage split.

### 3.2 AssetDivider's Allocation Strategy

The order by which issues are allocated is of paramount importance in a negotiation. Professional mediators have indicated issues attracting little disputation should be presented foremost for allocation, so as to help foster a positive environment in which to negotiate. By summing the ratings of issues to 100, the level of discourse surrounding an issue can be measured by calculating the numerical difference between the ratings of an issue assigned by each of the parties. For example, if two parties assign the same high rating to an item, then it is expected the level of disputation surrounding the issue to be substantial (because both parties want the item), whereas large differences between the ratings of parties indicate the issue will be resolved much more quickly. AssetDivider uses this strategy in deciding the order by which items are presented for allocation.

Asset_Divider allocates items to parties according to whoever values them the most. Once an item has been allocated to a party, the remaining ratings (of items still in dispute) are modified by trade-off equations. These modifications attempt to mimic the effect losing or gaining an item on the rest of the items still in dispute. The equations directly modify ratings by comparing each against that of the item recently lost or won (each party's set of ratings are modified as a result of an allocation). The equations update ratings based on a number of variables - whether the item allocated was lost or gained, the value of the allocated item in relation to items still in dispute and the value of the item whose rating will change as a result. The allocation strategy described above is similar to that implemented in Family_Winner. It describes the extent to which ratings were modified as

[3] Sometimes the parties cannot agree on the monetary value of the item. In this case, mediators would reference standard objective tables and the like to reach a consensus. For example, if parties are arguing over the value of a car, then mediators may access websites that gave independent valuations, such as redbook.com.au.

determined through an analysis of data we collected from mediation cases provided by the Australian Institute of Family Studies. These are detailed in [1].

AssetDivider's allocation strategy works by provisionally allocating an item to the party whose rating is the highest. It then checks the dollar value of items it has allocated previously (that is, their current list of items), the dollar value of the item presently allocated and the dollar amount permitted under the percentage split given by mediators. If by allocating the item in question the party exceeds its permitted amount, the item is removed from its allocation list and placed back into negotiation. In this case, the item has not been allocated to a party. If the dollar value of the item was within the limits of the amount permitted under the percentage split rule, then the allocation proceeds. Once an allocation has occurred the 'losing party' is compensated by the trade-off equations modifying ratings.

The equations used to modify ratings depend on a number of variables. One of these is the rating of the issue allocated. The following table (Table 1) lists the ratings and corresponding the equations that apply.

**Table 1:** Rating ranges and corresponding equations.

| **Rating range of issue allocated** | **If this issue is lost** |
|---|---|
| <= 10 | GraphLose0 |
| 11 to 20 | GraphLose1 |
| 21 to 35 | Graphlose 2 |
| 36 to 55 | Graphlose3 |
| > 55 | Graphlose4 |

The following pseudo code gives the reader an understanding of the equations fired and under what conditions. Where RR = Rating(issue in dispute) – Rating(issue lost).

```
if party has lost the issue
  If issue's rating was <= 10 then  /* graphlose0 */
            If RR between -10 and 0 then %change is 0.5* RR + 5
            if RR is between 0 and 10, then %change = 5
            If RR is between 11 and 25 then %change = -2/15*RR + 6
            If RR is between 26 and 100 then   %change = -5/75*RR + 7
  Endif

  if issue's rating was between 11 to 20 then  /* graphlose1 */
             If RR is –20 to 0 then %change = 5
             If RR is between 0 and 89, then   %change = -5/89RR + 5
                  Endif

  if issue's rating was between 21 and 35 then  /* graphlose2*/
             if RR is between –40 and –10, then %change is -5/30 *RR + 3
             if RR is between –10 and 0 then %change is 5/10RR + 10
             If RR is between 0 and 15 then % change = -5/15RR + 10
```

```
        If RR is between 15 and 44 then %change = -5/29RR + 8
        Endif

        if issue's rating was between 36 and 55 then  /*graphlose3*/
        If RR is –55 and –25, then %change = 15%
        If RR is between –25 and –20 then %change = -RR -8
        If RR is between –20 and 0 then %change = 5/20RR + 15
              If RR is between 0 and 70, then %change = -15/70 + 15
    Endif

        if issue's rating was above 55, then /*graphlose4 */
              If RR is between –100 and 0 then %change is 15%.
              Endif
    endif /*if item was lost*/

    elseif /*item was won*/
No change
EndIf
```

### 3.3 User Interface Issues

We have tried to focus on good usability when designing the user interface of the software. Since the software will be used by non-technical and persons not directly involved in the project, it is important the screens are self explanatory, model actual decision making and are helpful. For instance, there is space on screen for users (we presume will be mediators) to enter additional information about the case. We have also added reporting services, which in one case, will print case details such as case identifiers (case number), initial ratings given by users, ratings upon allocation and a final summary of the solutions arrived at by the system. This summary will include, for each solution, the allocation list for each party and the monetary value of each 'allocation list'.

The system has been designed so users can print a number of percentage split scenarios very easily. Once the information pertaining to a case has been entered, the user can press the back button on the screen to arrive at the screen where the user can change the percentage split, and then press the 'allocate' button on the next screen to see the results. A mediator from RAQ commented they would this a useful feature as it would allow clients to view allocation lists based on different percentage split scenarios.

## 4. An example using AssetDivider

This section will review the process and outcome of a Family Law case on AssetDivider. The aim of this exercise is to demonstrate AssetDivider's operation in practice.

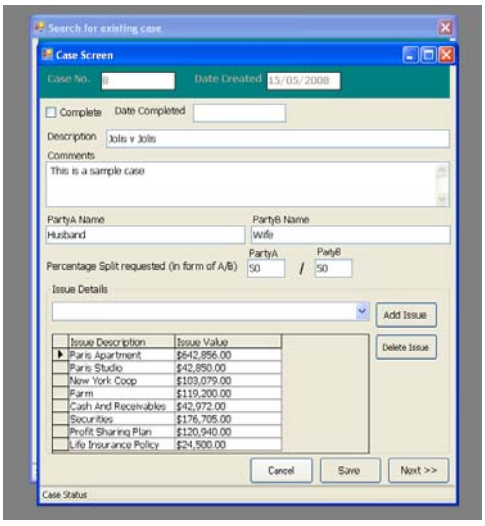
The case description of this real-life divorce scenario and the relative point allocations have been extracted from [16] page 105. The case Jolis v Jolis, began on

December 5th, 1980, and concluded on October 30th, 1981. The case was heard in New York City, at a time when a new law subjecting all martial property to a 50 –50 split was being introduced. The couple had been married for 41 years, of which 33 they spent together. The Wife had given up her early and successful career to care for the couple's four sons. The couple had lived together in substantial wealth, primarily due to the expansion of the Husband's diamond business.
There are both real estate and liquid assets to be divided. The Husband's diamond business is not treated as marital property as its growth was primarily due to market forces, especially the diamond boom of the 1970's. The children's welfare is not included as an issue as they are no longer considered minors at the time of separation.

**Table 6.1.** Point allocations and dollar valuations [16], page 105.

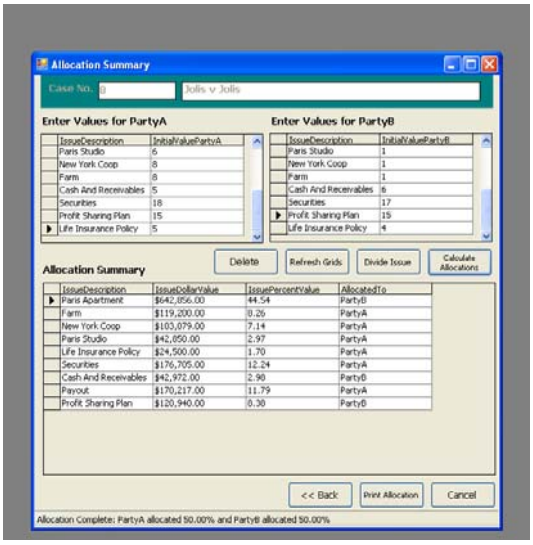
| **Issues** | **H's ratings** | **W's ratings** | **Dollar value of asset** |
|---|---|---|---|
| Paris Apartment | 35 | 55 | $642,856 |
| Paris Studio | 6 | 1 | $42,850 |
| New York Coop | 8 | 1 | $103,079 |
| Farm | 8 | 1 | $119,200 |
| Cash And Receivables | 5 | 6 | $42,972 |
| Securities | 18 | 17 | $176,705 |
| Profit Sharing Plan | 15 | 15 | $120,940 |
| Life Insurance Policy | 5 | 4 | $24,500 |
| Total | 100 | 100 | $1,273,102 |

The relevant case information is entered in screen 1.




**Screen 1**: Intake screen for negotiation

The next screen (screen 2) that appears lists the issues in dispute, their ratings and the allocation summary, which is filled in appropriately when the user clicks button "Calculate allocations". In the Allocation Summary table, we can see that the ratings for Husband (party A) and Wife (party B) are scaled to add to 100 in columns ComputedValuePartyA and ComputedValuePartyB respectively. It is then these ratings that are used to drive the allocation.




**Screen 2:** Final screen of AssetDivider. It gives the user the allocation list for each party; which includes a payout figure allocated accordingly.

According to AssetDivider, the preferred outcome, taking into account each party's' priorities (ratings) and percentage split indicates as follows:

**Table 3:** Allocation list for Husband (party A) and Wife (party B) using AssetDivider.

| **Husband (Party A)** | **Value of** | **Wife (Party B)** | **Value of** |
|---|---|---|---|
| *Farm* | $119,200 | *Paris Apartment* | $642,856 |
| *New York Coop* | $103,079 | *Cash and receivables* | $42,972 |
| *Paris Studio* | $42,850 | *Profit Sharing Plan* | $120,940 |
| *Life Insurance Policy* | $24,500 | | |
| *Securities* | $176,705 | | |
| *Payout* | $170,217 | | -$170,217 |
| *Total:* | $636,551 | *Total:* | $636551 |

In analysing the case, we can see that both parties wanted the Paris Apartment above all else; though Wife (party B) valued it more than the husband (Party A). As a consequence, both parties gave the rest of the items relatively low values. On the whole, both parties received the items they valued considerably (except for Party A's loss of Paris Apartment to Party B – since she valued it much greater). The only item valued equally by the parties was profit-sharing plan (15). It was given to Party B. Party B also need to pay out Party A the amount of 170,217 to ensure the split is exactly 50%.

## 5. Conclusion and future work

This article describes AssetDivider as a new Negotiation Decision Support System (NDSS) in family law mediation. The software is one of many developed by our lab at Victoria University, including Family_Winner. Family_Winner was developed from the theories in the author's PhD, and AssetDivider represents an improved version, following advice from our industry partners, Relationships Australia (Queensland).

AssetDivider uses the interest (rating given to symbolise the importance of the item to the party) to temporarily assign the asset to a party. AssetDivider tests whether the asset's dollar value exceeds their allowable amount (given by the percentage split set by the mediator).

We are currently assessing AssetDivider via the CCCF System Operational Context Checklist [20]. As a result of this evaluation, we expect to compose questionnaires that ask uses to comment on the operation and use of the system. In order to evaluate successfully, we need to understand how the program is likely to be used. During recent discussions, we believe RAQ would use the software to move clients away from trying to attain a particular percentage of the value of the common pool. Often lawyers or family friends may have provided this advice. There may also be issues with a 'loss of face' if they do not fight for a percentage they consider fair. The program used in this way will help clients see what items make up the given percentage split. They may move their position if they see what items (including the associated payout) they are likely to receive.

The software can also be used to provide mediators with confidence to effectively mediate property-related issues. Most family law mediators have degrees in social work or law. Their expertise lies in mediating child-related issues such as visitation schedules, primary care and other child related issues. If AssetDivider were to be used in child related mediations, it is expected both child-related and property issues could be resolved in one set of session (with mediators); thereby reducing their reliance on lawyers and of course often exuberant associated costs.

AssetDivider has not been extensively evaluated at this point in time. It is expected mediators at RAQ will test and evaluate the system in the near future. We are expecting results from testing to indicate further improvements to the decision making module and in particularly to the user interface. Our research has revealed a lack of negotiation support systems used in family law. We hope our collaboration with RAQ will enable AssetDivider to be used in their organisation, being the first negotiation support systems to do so.

## 6. References


1. Bellucci, E. (2004), "Developing Compensation Strategies for the construction of Negotiation Decision Support Systems". PhD thesis, La Trobe University, Bundoora 3086, Victoria, Australia
2. Bellucci, E and Zeleznikow, J., 2006. "Developing Negotiation Decision Support Systems that support mediators: a case study of the Family_Winner system", Journal of Artificial Intelligence and Law, 13(2), 233-271
3. Bui, T. and Shakun, M. F. 1997. Introduction to the Negotiation Support Systems Minitrack, In Thirtieth Annual Hawaii International Conference on Systems Science - Mini track on Negotiation Support Systems IEEE, Hawaii.
4. Fisher, R. and Ury, W., 1991. Getting to Yes: Negotiating Agreement without Giving In., Boston: Haughton Mifflin.
5. Peterson, M. and Waterman, D. 1985. Evaluating Civil Claims: An Expert Systems Approach to Evaluating Product Liability Cases. In Computer Power and Legal Reasoning (Ed, Walter, C.) West Publishing Company, pp. 627 - 659.
6. Waterman et al 1986
7. Matwin, S., Szpakowicz, S., Koperczak, Z., Kersten, G. E. and Michalowski, G. 1989. NEGOPLAN: An Expert System Shell for Negotiation Support, IEEE Expert 4:50-62
8. Kolodner, J.L. and Simpson, R. L., 1989. The Mediator: Analysis of an Early Case-Based Problem Solver, Cognitive Science, 13:507-549.
9. Sycara, K. 1993. Machine Learning for Intelligent Support of Conflict Resolution, Decision Support Systems, 10:121-136
10. Zeleznikow, J., Meersman, R., Hunter, D. and van Helvoort, E. 1995. Computer tools for aiding legal negotiation. ACIS95 — Sixth Australasian Conference on Information Systems, Curtin University of Technology, Perth, Western Australia: 231-251.
11. Kersten 1997
12. Yuan, Y., Rose, B. J., Archer, N. and Suarga, H., 1998. A Web-Based Negotiation Support System, EM - Electronic Markets, 8.
13. Eidelman, J.A., 1993. Software for Negotiations, Law Practice Management, 19(7): 50-55.
14. Bellucci, E. and Zeleznikow, J. 1997. Family-Negotiator: an intelligent decision support system for negotiation in Australian Family Law. Proceedings of the Fourth Conference of the International Society for Decision Support Systems, Lausanne, International Society for Decision Support Systems: 359-373.
15. Bellucci, E. and Zeleznikow, J., 1998. A comparative study of negotiation decision support systems, In Thirty-First Hawaii International Conference on System Sciences IEEE Computer Society. Los Alamitos, California, pp. 254 - 262.
16. Brams, S. J. and Taylor, A. D., 1996. Fair Division, from cake cutting to dispute resolution. Cambridge University Press, Cambridge, UK
17. Thiessen, E. M. and McMahon, J. P., 2000. Beyond Win-Win in Cyberspace. Ohio State Journal on Dispute Resolution, 15: 643
18. Bellucci, E. (2008b), "AssetDivider: a new mediation tool in Australian Family Law", to appear in the proceedings of HuCom 2009.
19. Stranieri, A., Zeleznikow, J., Gawler, M. and Lewis, B., 1999. "A hybrid—neural approach to the automation of legal reasoning in the discretionary domain of family law in Australia. Artificial Intelligence and Law 7(2-3), 153-183.
20. Hall, M. J. J. and Zeleznikow, J., 2003. A method for evaluating legal knowledge-based systems based upon the Context Criteria Contingency guidelines framework, In Proceedings of the Ninth International Conference on Artificial Intelligence and Law ACM Press, Edinburgh, Scotland, pp. 274-283.

21. Bellucci, E. and Zeleznikow, J. 2001. "Representations for decision making support in negotiation". Journal of Decision Support, 10(3-4), 449-479
22. Mnookin, R., Peppet, S. R. and Tulumello, A. S., 2000. Beyond Winning: Negotiating to Create Value in Deals and Disputes, The Belnap Press of Harvard University Press.